The Spatial Organization of Physical Distribution in the Food Industry

by

Alan Campbell McKinnon

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Abstract

Efforts to improve methods of freight traffic forecasting, to regulate lorry movements in sensitive environments and to rationalise deliveries to shops have been inhibited by limited knowledge of the way products are distributed. This thesis examines the shortcomings of previous methods of freight flow analysis, then proposes an alternative approach which takes much more account of the frameworks of marketing and physical distribution within which freight transport is organised. This approach is then adopted in an investigation of the factors that influence the routing of food products from factories to shops. This investigation is based on data collected in surveys of manufacturers, multiple retailers, wholesalers and distribution contractors, and drawn from various published sources.

Consideration is given first to the allocation of food manufacturers' output between different marketing channels. This determines the number and nature of agencies handling this output. Of these agencies, the manufacturer and multiple retailer generally have a choice of logistical channel, i.e. they can either transport goods directly or channel them through an intermediate stockholding/transhipment point. The research examines the factors influencing the choice of logistical channel and the nature of the link between channels controlled by food manufacturers and retailers. The spatial structure of these logistical channels is also explored, particularly in terms of the number and locations of intervening nodes between factory and shop. Later sections of the thesis investigate the routing of flows through this framework of distributive nodes. A distinction is made between the "strategic" routing of bulk movements between factories and depots, and the more localised "tactical" routing of deliveries to shops.

At each stage, attempts are made to explain variations in the spatial organization of firms' distribution operations and to establish general relationships between distribution variables. Data on the present state and recent development of the food distribution system are used to help to explain trends in general freight statistics. The thesis concludes with an assessment of the advantages and limitations of this approach and consideration of the implications of the research findings for the way in which freight traffic is forecast and regulated.
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Chapter 1

Introduction

Over the past decade there has been an increased demand from various public and private agencies for more detailed analysis of the spatial pattern of freight movement. Much of this demand has come from organizations interested in forecasting the growth of freight traffic. Such forecasts are required by central government departments principally to plan the provision of new transport infrastructure and to estimate future energy needs. Following numerous criticisms of its traditional method of freight traffic forecasting, the Department of Transport (DTP) devised a new forecasting model in 1978 which required more data on the logistics of freight movement (DTP, 1980). To firms engaged in transporting goods and supplying transport equipment, national freight traffic forecasts represent an important source of market intelligence. At the local scale, planning authorities have been required since 1973 by the Heavy Commercial Vehicles (Control and Regulation) Act to monitor lorry movements in their areas and, if possible, reduce their impact on the environment by means of access restrictions and the designation of lorry routes. Concern about the environmental effects of freight transport has given rise to a series of studies by Government committees (Pettit, 1973; Armitage, 1980) and pressure groups representing industrial and environmental interests (Sharp, 1973; Civic Trust, 1970 and 1979; Hamer, 1978). These studies have been hampered, however, by a dearth of available information on the way in which goods are distributed.

Research conducted over the past 30 years has, nevertheless, provided valuable insights into many aspects of the freight transport system. Major studies have been undertaken on three of the four stages into which flow analysis is conventionally divided:

1. Traffic Generation: Mention has already been made of official efforts to devise models that accurately forecast
the aggregate volume of freight movement for the country as a whole. These have been complemented by attempts to correlate the amounts of freight traffic generated by smaller areas (Chisholm and O'Sullivan, 1973) or even individual premises (Starkie, 1967; Bartlett and Newton, 1982) with such variables as employment, industrial output and retail sales.

2. Traffic Distribution: Much of the early research in this field sought to generalise patterns of commodity flow and use them to explore the spatial structure of national and regional economies (Hay, 1979). Later work has tried, with limited success, to simulate the pattern of freight movement between traffic zones by means of gravity modelling and linear programming techniques (Chisholm and O'Sullivan, 1973; Heyman, 1971; Pitfield, 1978a). It is important to note that the "pattern" which these studies have analysed is the spatial distribution of individual inter- and intra-zonal freight journeys. This is not the pattern produced by the through-movement of particular freight consignments.

3. Modal Split: The allocation of freight traffic between transport modes, particularly between road and rail, has been a very contentious issue and given rise to extensive research on the cost structure of the various modes and the factors influencing industrialists' choice of mode (e.g. Bayliss and Edwards, 1970).

4. Flow Routeing: By comparison with the previous three stages of flow analysis, the routeing of freight consignments from point of production to point of sale has received little attention. Numerous algorithms have been developed to optimise the distribution of bulk (or "primary") flows among factories and warehouses, and the routeing of delivery vehicles to customers, but there have been very few studies of the actual patterns of product flow. Unlike the traffic distribution models which employ the freight journey as the unit of analysis, the study of product routeing attempts to trace the through-movement of
consignments from "first origins" to "final destinations".

In the absence of detailed studies of freight routeing, it has been very difficult to establish a relationship between general freight transport statistics (compiled almost entirely on the basis of individual vehicle journeys) and the way in which firms organise the movement of their products on the ground. Insufficient attention has been given to the frameworks of production, storage and distribution within which firms plan their freight operations. As a result, traffic generation and distribution models have been based upon only a superficial understanding of the forces that shape the pattern of freight flow. By examining the routeing of these flows one is able to explore more directly the causal links between transport and the economic activities with which it is associated.

Research on the routeing of freight flows has been inhibited by the lack of available data. Official statistics on freight flows, collected on the basis of individual vehicle journeys, are of little use in this context. Analysis of freight routeing must, therefore, rely upon original surveys of firms' production and distribution systems. Major studies of this type were commissioned by the DTp in 1975 and carried out by three research teams at UWIST and the Universities of Newcastle upon Tyne and Leeds. The purpose of these studies was to:

"i) establish a data-base relating to the flows of a limited number of important commodities in terms of their origins, destinations, modes, packaging and handling characteristics.

ii) consider changes affecting the provision of transport within the commodities (sic); and

iii) consider changes affecting the generation and demand for the chosen commodities."

(Pike and Gandham, 1981, p4)

Data collection was facilitated by the fact that most of the commodities studied were the products of monopolistic or oligopolistic industries. The teams also confined their attention to primary flows (i.e. "flows from the point of
production to redistribution depots, ports or manufacturing plants") and largely ignored the delivery of goods outwards from depots to customers. They did not, therefore, examine the complete through-movement of commodities from "first origins" to "final destinations".

Nevertheless, even within this limited field of enquiry, they found that "there is a wide range of explanatory variables which shape freight flow patterns" and concluded that "the number and complexity of these variables preclude the modelling of freight flows on anything other than a highly aggregate basis or on an individual commodity basis" (Pike and Gandham, 1981). Where an "individual commodity" is produced by a large number of firms, however, rather than by a monopoly or oligopoly, these firms can vary enormously in the way in which they organise their distribution (Thorpe et al., 1973; Hemingway, 1979). Under these circumstances, attempts to model the routeing of flows, even of a single commodity, would prove formidable, especially if one tried to incorporate into the analysis the delivery of products to customers. Such an exercise would also be seriously constrained by firms' natural reluctance to divulge information about the movement of their stocks. Much of the data received by the teams studying commodity flows, for instance, were given a "commercial-in-confidence" rating and the results of the subsequent analysis made available only to the DTp (Pike and Gandham, 1981). It would be extremely difficult, therefore, to construct operational models to simulate and forecast the complete through-routeing of freight flows, even on the basis of "individual commodities".

The formulation of operational models need not, however, be the sole objective of routeing studies. Another important purpose of these studies is to explain the routeing of freight flows and to account for changes in the pattern of movement. A detailed explanation of product routeing can provide an insight into the workings of the freight transport system lacking in the more general modelling exercises. It may also identify the processes that have contributed to the growth in the total volume of freight movement and, thereby, place forecasting on a firmer
explanatory basis. An investigation of this type may also enable planners to assess more fully the scope for rationalizing the pattern of freight movement and the likely effects of restrictions on lorry traffic.

This thesis examines the factors influencing the routeing of one class of commodities - dry groceries, from the factory at which their processing is completed to their point of sale. These factors are analysed within the framework set out in figure 1.1. At the most general level, consideration is given to the trading links between the various types of organization involved in the production and distribution of groceries. Firms belonging to the same marketing channel can organise the delivery of goods to their customers in different ways. Most firms have available at least two "logistical channels" through which they can route their products. These logistical channels differ in the number and location of intervening storage and transhipment points and in the distribution of bulk flows among these nodes. The spatial structure of the logistical channel is analysed in depth as this determines the strategic routeing of products to the depot from which delivery to shops takes place. Attention is finally directed to the routeing of local deliveries from depots to retail customers.

The aim of this study is not only to furnish forecasters and planners with a description and explanation of the spatial structure of the grocery distribution system. It is also intended that this work be of interest to firms engaged in the production and distribution of grocery products. Much of the previous research in this field, particularly that undertaken by operations researchers, has tended to be either normative and highly theoretical or to be in the form of detailed case studies of individual companies. As firms have begun to attach greater importance to physical distribution, a demand has risen for more general surveys of distribution operations that permit inter-company comparisons and promote the dissemination of new ideas. Many firms, for example, have recently begun to
Figure 1.1: Analytical Framework.
participate in an ongoing survey of distribution costs (McKibbin, 1982a). The few general, positive studies of distribution systems so far conducted have tended to neglect the spatial dimension. The spatial structure of a distribution system is, nevertheless, a major determinant of its efficiency and effectiveness in meeting marketing requirements. For example, a survey of firms that have recently raised the efficiency of their distribution systems, revealed that 39% of them did so partly by the "geographic relocation of depots" (Kearney, 1980). By analysing, at a much more general level than previous research, the geography of manufacturers', wholesalers' and retailers' distribution systems, this study may assist firms in the formulation of their future plans for distribution.

Note:

1. Definitions of technical terms can be found in the glossary.
Previous Studies of Freight Distribution.

To date, geographical studies of freight flows have failed to satisfy the demands of transport planners and policy makers working at the local, regional and national scales for accurate and reliable forecasts. This is largely because their limited data base, high level of generalization and heavy dependence on theoretical models that have consistently yielded disappointing results. The inadequacy of these studies lies in their failure to produce authentic spatial models of freight flow and in their neglect of the way in which the distribution of goods is organised. In their quest for simplified models, planners have lacked much of the detailed information that would be necessary for a deeper understanding of freight distribution.

This chapter has two main aims: to consider the demands for a greater knowledge and more thorough explanation of the pattern of freight flow, and to examine the deficiencies of previous studies on this subject. This will set the scene for the proposal, put forward in chapter 3, of an alternative approach to the study of freight movement.

The Demand for Information about the Pattern of Freight Flow.

In the 1970s, planners working at various spatial scales began to take a greater interest in freight transport. Their interests can be examined under three general headings:

(a) Forecasting
(b) Environmental Concern
(c) Rationalising the pattern of freight movement

(a) Forecasting: Freight forecasts are needed to indicate future demand for infrastructural capacity in the transport system, energy and vehicles. They are also used to
estimate the future level of environmental costs arising from freight transport. In the case of energy and vehicle usage, national aggregate forecasts can suffice. The planning of transport infrastructure and the operations of transport undertakings requires forecasts disaggregated by product and route.

Freight forecasting has been undertaken at two levels:

1. At the national or "macro" level, the Department of Transport provides forecasts of how freight volumes may be expected to grow in the country as a whole. These forecasts are not disaggregated either spatially or by commodity type. Attempts have been made to develop macro-level spatial models of freight flow, but the models so far produced have not been able to simulate past patterns of flow with sufficient accuracy to warrant their use as forecasting tools.

2. At the local level, many planning authorities have produced forecasts of future volumes of commercial vehicle traffic. These forecasts have invariably been disaggregated spatially, either predicting flows on individual links on the road network or interzonal flows (Barber, 1971). It has been common practice to use the official macro-level forecast as the growth factor in local freight traffic models, despite the fact that freight traffic volumes are unlikely to grow uniformly throughout the country. Some areas, such as West Yorkshire, Greater London and Berkshire, have derived their own growth factors tailored to local forecasts of population, employment etc. (Eastman, 1980).

Up to the late 1970s, macro-level freight forecasting was based on the close correlation between tonne-kilometres moved and GDP (fig 2.1). Faith in the stability of this relationship was reinforced by evidence drawn from many many other countries (Tanner, 1974). As set out in Tanner (1974), the method of forecasting involved simply extrapolating the linear relationship between GDP and tonne-kilometres. On this basis, Treasury estimates of
Figure 2.1: The Relationship between the Volume of Freight Movement and G.D.P. (1975 = 100)
future levels of GDP could be translated into traffic forecasts. (To convert the forecast volume of freight movement measured in tonne-kms into a traffic volume measures in vehicle kilometres, it was necessary also to extrapolate past trends in vehicle carrying capacity, load factors and average distance travelled per vehicle per annum.) Adams (1974) seriously questioned the credibility of this extrapolatory forecasting, particularly as "the lorry traffic forecast has no upper limit" (p553).

Tanner (1974) was fully aware of the weaknesses of this method:

"...the uncertainties in various steps of this forecasting process are so great that the final result can be little better than guesses (sic). The amount of road traffic and the kind of vehicles in which it will travel are extremely subject to external factors such as the quality of the road system, the various legal and fiscal controls that may be applied and the relationship between the growth of freight and growth of GDP. The forecasts that are reached are, therefore, not regarded as reliable indicators of what will actually happen but as just one attempt to quantify this."

Doubts about the continuing stability of the relationship between GDP and tonne-kms were well founded because from 1974 onwards this relationship began to depart from the straight linear trend it had followed for over a decade (fig 2.1).

In 1973, two government statisticians, Brown and Maultby expressed dissatisfaction with the method of freight forecasting later outlined in Tanner (1974). They claimed that:

"It is clear now that a "broad brush" method of forecasting transport demand which previously had the advantage of simplicity can no longer be used without awkward and unreliable assumptions about the way the relationship between freight demand and economic activity is moving." (p25)

This method was unreliable they believed "because it could not take into account the different rates of growth of individual industries and the changing structure of the economy. Another shortcoming of the method was that it failed to provide forecasts in any commodity detail" (p25).

Brown and Maultby went on to devise an alternative method of
forecasting that disaggregated freight by commodity type. Having identified seven general commodity classes which together accounted for 85-90% of inland freight tonnage, they found that over the period 1963-1973 the activity level in each of the corresponding industrial sectors (measured by "output, consumption etc") correlated highly with the tonnage of freight they generated. It was argued, therefore, that if forecasts of future activity levels in these industries could be obtained, they might provide a more reliable basis for freight forecasting than a general projection of the level of GDP.

To investigate more fully the transport demands of those industries that give rise to a large proportion of total freight tonnage, the DTp commissioned (in 1975) a series of major flow studies on the following products: iron ore, general steels, coal, petroleum products, bricks, paper and board, milk, beer and sugar (Pike and Gandham, 1981). As explained in chapter 1, most of the information supplied, however, was regarded as being confidential, and, as a consequence, few of the results have been made public. In these more detailed studies it has been possible to analyse the spatial patterns of freight movement quite explicitly. If the results of these spatial analyses can be used for forecasting purposes, then separate forecasts may be made for individual trunk routes or "corridors". This would constitute a significant advance on the current method of forecasting freight flows on the strategic road and rail networks. At present, this involves simply scaling up existing traffic volumes on these links by the growth factor calculated nationally. As in the case of the local forecasting of commercial vehicle traffic, this practice can be faulted on the grounds that growth rates are likely to be subject to wide spatial variation (Eastman, 1980). It has been suggested that, were these national growth rates disaggregated by commodity, local forecasters might select factors in accordance with the mix of commodities produced in their areas (Eastman, 1980). This, however, would be a poor substitute for intrinsically spatial forecasts based on an analysis of the pattern of freight flow. The problems of developing spatial models capable of providing accurate freight forecasts are discussed later.

The Leitch Committee on Trunk Road Assessment (1977) acknowledged that the methods of freight forecasting set out in
Tanner (1974) were inadequate and recommended that more attention be given to revising these methods. In its response to the Leitch Committee report, the DTp (1980) outlined a new method of freight traffic forecasting which extended that put forward by Brown and Maultby (1973). The new procedure was as follows:

1. Forecast (largely on the basis of previous trends) output weight of individual industries.

2. Relate these output weights to the corresponding weight of goods transported or ("lifted" onto vehicles), again using previous trends. The ratio of weight produced to weight lifted has been termed the "handling factor". By the use of "handling factors" for each commodity class, one can convert output weights into weights lifted.

3. Allocate weights lifted to transport modes, in accordance with modal split projections.

4. Forecast average length of haul for each commodity class (with reference to previous trends.)

5. Forecast the amount of freight movement (in tonne-kms) by multiplying predicted values for weights lifted and average length of haul.

6. Translate the amount of freight movement into vehicle distance by making assumptions about the composition of the vehicle fleet, average distance travelled per vehicle and average size of load carried.

The principal advantage of this revised method of forecasting is that it is based on a more detailed examination of the freight generating properties of particular industries. It still suffers, however, from the major shortcoming of being essentially extrapolatory. The general extrapolation of the GDP - tonne-kms trend has been replaced by a series of lower level extrapolations of trends in industrial output, average length of haul, handling factors etc. There remains little appreciation of how changing circumstances in the future may cause these trends to deviate from their past course. Adams (1981, p152) is very sceptical about the value of this new forecasting method. He claims that "the only thing likely to be gained by this complicating of the forecasting method is an increase in jobs for forecasters and decrease in the number of people who will understand the result".
In concluding a review of current freight modelling practices, Eastman (1980) states that:

"It must ... be recognised that in this very complicated field it is highly unlikely that a fully explanatory model will ever be produced; however, it is desirable to extend our knowledge as much as possible."

Within the context of the freight forecasting procedure employed since 1979, there is clearly a need to "extend our knowledge" of the following topics:

i) Relationship between weight of goods produced and weight transported i.e. the "handling factor".
ii) Factors affecting the average length of haul.
iii) The translation of aggregate flows into vehicle movements.

At present there is scant justification for extrapolating recent trends in these variables. Very little is known about the processes of change in the industrial and distributive systems that have produced these trends. This thesis presents an alternative framework for the study of freight movements which permits a more detailed examination of these processes, most of which have an important spatial dimension.

(b) Environmental Concern: In the 1970s, there has been growing public concern over the impact of lorries on the environment. Since receiving official recognition in the early 1970s, the problem has been widely investigated and discussed (Civic Trust, 1970 and 1979; Pettit, 1973; Sharp, 1973; Transport 2000, 1978; Armitage, 1980; Wood Committee, 1983). Several measures have been proposed to alleviate the ill-effects of freight transport on the environment. Foremost among these was the provision made in the 1973 Heavy Commercial Vehicles (Controls and Regulations) Act, commonly known as the Dykes Act, for lorry routeing schemes. This legislation required local authorities to survey lorry traffic in their areas and assess its environmental effects, with a view to designating some roads as lorry routes and
restricting access to other roads that were considered to be more environmentally sensitive. The Act made it incumbent upon local authorities, for the first time, to examine closely the movements of road freight in their areas.

It was also recognised that restricting the movements of larger goods vehicles would make necessary a greater amount of transhipment between different sizes of vehicle, particularly, it was thought, on the outskirts of towns and cities. It was, therefore, suggested that transhipment depots be set up on the urban periphery where large loads carried there by heavy lorries would be disaggregated into small consignments for delivery to various destinations within the urban area in smaller, less environmentally offensive vehicles. This concept of "peripheral transhipment" was thought by many planners to offer an effective means both of alleviating some of the environmental problems posed by heavy vehicles and of rationalising the pattern of freight distribution. The idea was promoted, however, in almost total ignorance of the logistics of existing distribution operations and without consulting the companies that it would affect (Smith, 1976).

The numerous studies that were undertaken between 1972 and 1976 to assess the feasibility of peripheral transhipment drew attention to the complexity of existing distribution systems and almost unanimously reached the conclusion that the implementation of such a scheme would be costly and fraught with operational difficulties (PE Consulting Group ltd., 1975; Lichfield and Partners, 1975; CIDP, 1975; Wytconsult, 1975; Battilana and Hawthorne, 1976). It was also claimed that the environmental benefits of the scheme would not be as great as originally thought (Lorries and the Environment Committee, 1976).

Several of the assumptions made by these feasibility studies can be challenged, however. It was assumed, for example, that peripheral transhipment depots would be essentially urban phenomena, located on the outskirts of towns or on the edge of the inner areas of cities. The geography of peripheral transhipment has never been fully investigated, though, and it is quite possible that, to operate viably, it would have to be organized at a larger
spatial scale. The Lorries and the Environment Committee (1977b), for example, believed that there is considerable scope for the development of regional "freight complexes" where transhipment, in addition to a host of other functions, might be undertaken. It was also assumed that a peripheral transhipment depot would act as an additional node in the chain of distribution, whereas, as Plowden (1977) has pointed out, it could be substituted for an existing node. To measure the scope for nodal substitution of this kind, one would need to examine the spatial structure of existing distribution systems. Such an examination could well reveal that many firms have already developed fairly sophisticated systems of transhipment of their own accord.

More recently, the study by the Wood Committee (1983) of the social, economic and environmental effects of banning heavy lorries in Greater London has been impaired by a lack of detailed information on the structure of distribution in and around the city. While acknowledging that many firms already operate transhipment depots on the outskirts of the capital, the Committee did not indicate how widely available these facilities are or how firms generally might have to restructure their distribution systems to accommodate a heavy lorry ban (Times, 19/12/83). Furthermore, the Committee's calculation of the cost increases resulting from the substitution of small vehicles for heavier ones prohibited by the ban is based on questionable assumptions about vehicle utilization (Cooper, 1983). Like previous studies of the feasibility of restricting lorry movements for environmental reasons, that of the Wood Committee fails to demonstrate an adequate awareness of the physical structure and day-to-day operation of the distributive system.

(c) Rationalising the Pattern of Freight Movement: Rising transport costs and increasing road congestion principally in urban areas have in recent years prompted considerable research on ways of rationalising the movement of freight. In North America and Australia the principal goal of this work has been to raise the efficiency of the goods delivery
system (Highway Research Board, 1971). In the European context, greater emphasis has been given to the additional objective of reducing environmental costs. All these studies have identified consolidation of goods deliveries in fewer vehicles as the most promising means both of raising vehicle utilization and reducing vehicle kilometres generated per tonne delivered. It has been estimated that the savings in distribution costs accruing from consolidation could be as great as 50% (Lorries and the Environment Committee, 1979). The environmental effects would be more difficult to evaluate as the "benefits" of reduced vehicle movement would have to be set against the "costs" of using bigger vehicles.

To measure the potential for consolidation, it is necessary to obtain much more information about urban goods movements. For this purpose, data on goods vehicle trips, which in the past has been all that transport planners have had at their disposal, do not suffice. Much more must be known about the nature of the commodities, the types of premises between which they travel and the logistics of their delivery. Major studies of freight movements in Hull, Swindon and Greenwich/Lewisham commissioned by the Transport and Road Research Laboratory have gone some way towards meeting these needs.

Other measures that have been proposed to streamline goods deliveries and, to a limited extent implemented, are the rescheduling of deliveries (e.g. "Operation Moondrop" in London (Pettit, 1973)) and the use of demountable containers ("Direct Distribution") (Lorries and the Environment Committee, 1977a). It has also been suggested that it would be possible for road transport operators to make greater use of empty backhauls, thereby raising the efficiency of their operations and reducing their impact on the environment (Cundill and Hull, 1979). To assess the scope for such rationalisations requires much more detailed knowledge of freight distribution than is currently available.
The Limitations of Conventional Methods of Freight Flow Analysis

Geographical work on freight has traditionally been undertaken at the national scale and has been directed towards modelling the pattern of flow at a general level. Most of the work has produced fairly disappointing results. The models that have been constructed do not adequately simulate the existing pattern of flow and, therefore, cannot be used to predict future patterns. Following "initial attempts" to model 1962 road freight flows by means of gravity and linear programming models, Heyman (1971) concluded that:

"The results indicate that existing freight modelling techniques do not produce accurate estimates of either generation or distribution, suggesting either that existing models require considerable refinement, involving more detailed data than is currently available or could reasonably be forecast, or that a completely new approach needs to be adopted."

Chisholm and O'Sullivan (1973) elaborated upon and slightly updated Heyman's work, but still employed gravity and linear programming models. They were satisfied with the performance of these models when simulating patterns of aggregate flow; however, once the flows were disaggregated by commodity type, the models proved to be much less adequate.

More recent analysis of the national pattern of freight flow by Pitfield (1978a) for British Rail has been similarly unsuccessful:

"It is clear that, with the exception of ore, the model fits are absolutely poor irrespective of the mode of carriage."

Not only have these modelling exercises failed to achieve a satisfactory "goodness of fit", but some have also produced contradictory results. On the question of the spatial pattern of freight generation, Benheddi and Pitfield (1980) disagree quite markedly with Chisholm and O'Sullivan (1973).

Each of these analyses employed the same methodology. They divided the freight modelling exercise into two parts:
the first concerned with the generation and attraction of freight traffic by zones; the second with the distribution of that traffic between zones of generation and attraction. The failure of these studies to provide acceptable explanations can be largely attributed to the fact that the respective flow systems are enormously complex (Hay, 1979). They comprise a vast and chaotic pattern of flow that is extremely difficult to model in anything but the most general of terms. Students of freight transport have always been tightly constrained by a lack of data. In the case of road goods movements in the UK, for example, the DTP monitors only about 0.1% of the total number of lorry journeys each year and obtains only a few pieces of information about each. The great complexity of the pattern of flow coupled with these data limitations has made the freight transport system a natural candidate for a "black box" approach, where the internal workings of the system are poorly understood, and inferences made on the basis of a few of the more easily monitored system parameters, such as total weight carried or average length of haul. Researchers have traditionally had recourse either to stochastic models, of which the most popular has been that based on the analogy with gravity, or to a normative model derived from linear programming. Neither class of model contributes very much to our understanding of the freight transport system and both have been subject to criticism on both empirical and theoretical grounds (Reggie, 1969; Lowe and Moryadas, 1975).

It is generally agreed that the construction and application of these models is severely handicapped by the inadequacy of the data. There is a desire for greater disaggregation by commodity type and areal unit.

a) Disaggregation by commodity type:

The tendency for these models to perform poorly when simulating flows disaggregated by commodity type has been partly attributed to the crudeness of the commodity classification. It is widely acknowledged that there is a need for "a more detailed break-down of commodity and industry categories", which would make these categories
smaller and more "homogeneous" (Heyman, 1971). There has been little discussion, however, of the criteria that might be used to assess the degree of homogeneity. The classification of commodities used by the DTp is based more on their physical properties than on their handling or transport requirements. Pred (1964) has attempted a "geographical differentiation of commodity flows" taking into account "locational variation in length and volume" of different types of flow. This goes some way towards classifying goods with respect to their movement from factory to market, but stops short of considering their passage through storage and other distributive facilities en route. Moreover, Pitfield (1978a) recognises that it may be necessary to distinguish between identical commodities which are moving "for different purposes", such as assembly, storage and sale. Even where movements share the same purpose, however, such as the delivery of goods to point of final sale, the manner in which similar products are marketed and distributed may vary considerably. As Heggie (1969) has suggested, the modelling of freight flows ought to take more account of "marketing patterns". Further disaggregation of commodity types should be accompanied by a wider examination of the framework of marketing and distribution with which freight movement takes place.

b) Zonal Disaggregation:

Another reason that is commonly advanced to explain the poor performance of the freight models is that the ratio of intra-zonal to inter-zonal flows is too large. This could be remedied by further subdivision of the country into smaller traffic zones. The number of zones employed by Pitfield (134) and by Heyman and Chisholm and O'Sullivan (78) could probably be increased significantly without the models becoming unmanageable or increasing the demand for data too extravagantly.

More serious objections might be raised, however, to the whole practice of zoning. In the first place, because it collapses areal data onto a point, the zonal centroid, it suppresses detailed information about freight movements at the local scale which, as mentioned earlier, planners have
recently been seeking in connection with lorry routeing schemes. Furthermore, as Pike and Gandham (1981) have observed, "The choice of zonal centroid may be unrelated or misplaced with regard to the actual points of freight generation." Secondly, as Openshaw (1976) has demonstrated, the performance of spatial interaction models can be altered not only by varying the number of zones, but also by changing the configuration of zonal boundaries. Given the sensitivity of these models to the way in which zonal boundaries are drawn, one may challenge their generality and objectivity. Thirdly, the analysis of zonal flow data has tended to ignore the complex logistics of freight distribution. Underlying most freight modelling work is the assumption that goods are produced in the zone where they originate and are consumed in the receiving zone. It is for this reason that commodity flow analysts have shown a predilection for correlating traffic generation with employment or industrial output and traffic attraction with population or retail sales. To some extent the manner in which freight statistics are collected predisposes flow analysts to this view. These statistics have as their sampling unit the lorry journey, plotted either between or within traffic zones. No reference is made to the nature of the premises from which the vehicle originates or to which it travels, nor to the stage that this journey represents in the overall movement from point of production to point of consumption. As Chisholm and O'Sullivan (1973) explain (p32):

"...the origin and destination of goods means only the origin and destination for the particular movement: the same goods may appear again as a separate movement. For example, the goods moving into a wholesale warehouse will have that building as their destination; when a delivery is made thence, the warehouse will be recorded as the origin. Consequently, the freight flow data, while accurately representing the work done by the transport sector, do not faithfully reproduce the flows from first origin to final destination."

In the absence of information on the logistics of freight movements, it has been quite conveniently supposed that the plotting of journeys inter- and intra-zonally gives
a representative picture of the pattern of flow from production to consumption (Heyman, 1971; Chisholm and O'Sullivan, 1973). This supposition, however, appears to be based on an under-estimation of the number of intermediate links in the chain of distribution. This is illustrated in a statement made by Bayliss and Edwards (1970) with reference to the movement of food (p29-30):

"A high proportion of the movements would be from processing plants direct to retail outlet. Some inter-plant movements obviously occur, because, for example, the commodity group includes flour which would move mainly from the mill to bread or biscuit factories and there are also movements from processing plants to regional warehouses, or wholesale distribution centres, but in the main the distribution structure of many parts of the food and drink industry is such that many consignments probably flow direct to shops or public houses."

The extent to which Bayliss and Edwards seem to under-estimate the complexity of the distribution system can be measured by calculating the "handling factor" for food. As explained earlier, the handling factor is a measure of the number of times a quantity of goods is loaded onto a vehicle in its passage from raw material source to point of sale. Its calculation reflects the method of road goods survey employed by the DTp. To estimate the total tonnage of freight carried, the DTp's statisticians record the weight of goods loaded onto a vehicle at the beginning of a journey. If the movement of a consignment from a factory to a shop is broken into several discrete journeys each requiring a reloading operation, then its weight might be recorded several times. This leads to much multiple-counting and results in the tonnes carried statistic far exceeding the total weight of goods actually in the transport system. The extent of this multiple counting is measured by the handling factor, which can be expressed as follows:

$$\text{Handling Factor} = \frac{\text{weight of goods lifted}}{\text{actual weight of goods produced or consumed}}$$
As some weight is lost in the production process, the value of the handling factor will vary with the choice of denominator: a value calculated on the basis of raw material inputs would be lower than one based on the weight consumed. Handling factors were calculated (by the author) for food using figures for 1968 (around the time when Bayliss and Edwards were conducting their survey): (see Appendix 4)

Based on: i) Raw Material (input) weight: 5.14

ii) Weight consumed: 5.66

These handling factors can serve as a rough index of the complexity of the food distribution system. They indicate that on average there are approximately five links in the chain of food supply from raw material source to retail outlet. Many of the intermediate (or "relay") nodes in this chain are stockholding or transhipment points. Very seldom, however, does one find any reference to stockholding or transhipment in the literature on freight modelling, despite the fact that the locations of these activities act as important "hinge points" in the distribution system, largely determining the route a product follows. For example, the route followed by a popular brand of cake ("Kipling") has been plotted on fig. 2.2. Conventional methods of freight modelling make no allowance for such devious routeing, despite the fact that it is commonplace, certainly in the distribution of processed foods. The cake referred to in the example is neither produced nor consumed, but rather stored in the Southampton zone. The storage capacity of a zone might be correlated with some of the independent variables commonly used in freight flow studies such as employment and population. However, this is unlikely to yield a significant level of correlation. There is no ready source of employment data for warehouses and, as warehousing typically accounts for only a small proportion of an area's total employment, general employment data would be a poor surrogate (GLC, 1980). Any attempt to correlate, at a zonal level, the volume of freight generated by warehousing with the population it serves would be no
Figure 2.2: Route followed by a food product in its distribution from factory to shop
(source: personal survey)
Figure 2.3: Supply links from Retail Central Warehouses to Supermarkets in five towns in South Hertfordshire
(source: personal survey)
less problematical. Warehouses vary greatly in size and in the extent of the areas they serve. In many cases, goods originating in the warehouse would be distributed well beyond the boundaries of the traffic zone. For example, fig 2.3 gives some idea of the spatial scale on which food distribution is currently organized. It shows the links between a sample of five supermarkets in South Hertfordshire and the retail central warehouses that supply them. It can be seen that most of these links cross traffic zonal boundaries. It would be pointless, therefore, to try to correlate the traffic generated by warehousing in a traffic zone with the population residing in that zone. The same would apply to transhipment.

While it is clearly difficult to incorporate stockholding and transhipment within the traditional framework of the freight modelling exercise, its exclusion undermines the validity of this analysis and reduces its value. As mentioned earlier, the location of these activities largely determines the route a product follows. Stockholding and transhipment, therefore, have a crucial role in the logistics of the transport operation. As stockholding and transhipment have received little attention from freight traffic modellers, so these logistics have not been seriously examined. Heyman (1971), for example, is merely "hopeful" that multiple drop deliveries which she calls "milk-round" trips, will be confined to traffic zones and be entirely intra-zonal. This bases the validity of her work on an unfounded assumption.

Given the great difficulty of accommodating a more thorough consideration of the logistics of transport operations within the existing methodology of the freight flow study, it is necessary, as Heyman has suggested, to look for some possible alternative approach to the analysis of freight movement. Some possible alternative approaches are presented and discussed in the following chapter.
Chapter 3

An Alternative Approach to the Study of Freight Distribution.

Chapter 2 has established the need for more detailed spatial studies of freight movement and identified defects in the existing methods of analysis. These weaknesses stem from over-generalization on too limited a data-base and neglect of stockholding, transhipment and the logistics of freight distribution. They result partly from the practice of building up a generalized pattern of flow on the basis of a small sample of vehicle journeys. As each journey is considered separately, no attempt is made to trace the complete through-movement of products from point of production to point of sale.

An alternative approach would be to examine the passage of goods through the systems of production and distribution, plotting their movement between the production, storage and retail premises through which they pass. The value of such an approach has been highlighted by Chisholm and O'Sullivan (1973). In discussing the need for future research on the geography of freight movement, they conclude that, "Perhaps the most important need is to link freight flow data more directly with producing and consuming units. This would be moving towards the input-output kind of formulation. The key point about such an approach is the possibility that would then arise for obtaining better estimates of freight demands and supplies and providing a better interpretation of the observed pattern of freight movement" (p130). The use of input-output analysis, however, has so far been largely confined to linkages between productive enterprises (Dawson, 1979). There has, however, been an attempt at the regional level to analyse the links between producers and distributors within an input-output framework (South East Joint Planning Team, 1971). There are currently insufficient data available to permit a similar analysis at the national scale. Input-output tables compiled at this level have drawn upon Censuses of Production which exclude distributive agencies, and therefore, prevent the study of
flows along the vertical marketing channel from producer to retailer. Input-output data have, nevertheless, been used to simulate the past growth of the total volumes of freight traffic (Brown and Maultby, 1973). In the absence of input-output forecasts for the economy, it was not possible to use this as a basis for forecasting future freight traffic levels. Existing input-output data are also insufficiently disaggregated spatially to permit detailed analysis of the pattern of freight flow. An alternative approach to the study of freight flow therefore requires more information about the distributive sector and about the geography of the production and distribution than is currently found in national input-output tables.

It is likely too that data aggregated by industrial class or commodity type would not suffice, as flow patterns can vary considerably within each of these categories. To obtain a realistic picture of the pattern of freight flow it may be necessary to descend from the previous heights of generality to look in detail at the distribution operations of individual firms. By undertaking a "micro-level" survey of this kind it should be possible to measure the extent to which firms' distribution systems differ and to assess the scope for subsequent generalization. At this level of analysis one can also enquire about factors, such as marketing strategy, that affect the system of distribution and about the location of individual premises and vehicle routes.

The basic survey unit for this alternative line of investigation would, therefore, be the firm and, at a higher order of aggregation, the marketing channel formed by the combination of firms linked through trade. This then offers an holistic view of the system of freight distribution in contrast to the much narrower view afforded by the extrapolation of individual journey data. In looking at the overall system of distribution this alternative approach carries several important advantages.

Since the early 1960s, firms have increasingly come to see transport as a integral part of their distribution system and have reorganized their management structures to integrate all the functions such as transport, warehousing,
stockholding and handling that are involved in the "physical distribution" of goods (Brouwer, 1971; Murphy, 1978). It has been found that by closely coordinating these activities, it is possible to improve the quality of the distribution service and reduce its total cost. By adopting a "distributional" approach to the study of freight flows, one would be taking a view of transport similar to that of the transport decision-maker. The value of such an approach has been recognised by Meyer (1971) who has argued that, "In the case of forecasting inter-city freight transport, representation of firms' locational choice and the nature of their distribution process tend to be fundamental" (p181). The pattern of freight movement is not only determined by the internal structure of firms' distribution systems, but also by the way in which the systems of firms at different levels of the marketing channel knit together. As Thompson (1970) has observed, transport flows are "the expression of a deeper functional relationship in the linkage between the institutionalised channel participants".

A "distributional" approach also presents the opportunity of digging beneath the official, highly generalized freight statistics that have formed the basis of transport debate and policy-making for many years. It should also shed some light into what has long been regarded as a "black box". It will also offer an escape from the analogue (stochastic) and normative models whose use has been forced on researchers by the limited information available to them on the nature of the flows and the factors producing them. This will also be in keeping with the recommendation by the Leitch Committee (1977), made with reference to car traffic but equally relevant to freight, that forecasts be rooted in a deeper understanding of the causes of traffic growth. In the case of freight, this necessitates a much closer examination of the relationship between transport and the spatial structure of the economy, a relationship most clearly manifest in the way goods are distributed.

By studying the flow of goods through the distributive system, attention is inevitably given to all the nodes in
that system. It therefore satisfies the need expressed in chapter 2 to take stockholding and transhipment into account in an explanation of the flow pattern. By taking this more comprehensive view of the distributive system, one can plot the routes products follow from points of production to points of sale, revealing properties of the flow pattern such as the extent of cross-haulage or degree of circuity in product movement, that previous studies have ignored. One can also avoid using zonal data and thereby escape the limitations that this imposes. Instead, it is possible, as in the Commodity Flow Studies, to examine the individual points of origin and destination and thus relate traffic flows more closely to the operating characteristics of particular firms (Pike and Gandham, 1981).

**Previous Geographical Work on Distribution.**

The distribution of goods from points of production to points of sale is an inherently spatial process, yet one that has received little attention from geographers. As Dawson (1979) points out, economic geographers, in whose general field of interest the subject lies, have traditionally been preoccupied with the description and explanation of patterns of production. In the past thirty years efforts have been made to counter-balance this emphasis on production with geographical studies of the marketing system. These studies, however, have focussed on retailing and the spatial behaviour of consumers. There has been no comprehensive geographical investigation of the intervening system of distribution that connects factories and farms with shops. Becht (1970) used the terms "business logistics" and "physical distribution" in the context of a general description of the American freight transport system, but his work sheds little light on the relationship between transport and the distributive system.

In most theories of industrial and agricultural location considerable importance is attached to the attraction of the market. The study of firms' market areas is, however, only weakly developed (Watts, 1975), and has progressed little from the preliminary theoretical work of Lösch (1954). Even less empirical work has been done on
the way in which goods are distributed throughout the market area. Among geographers studying industry and agriculture there has been a reliance on fairly idealised and over-simplified notions about the logistics of distribution.

In a review of research on distribution, Levy (1948) commented that:

"It is regrettable that public investigations into distribution ... have been lately limited to retail distribution. Distribution... begins when the commodity leaves its place of original production and all the following stages should be included, retailing being in fact only one, the final stage of this process."

In drawing up a prospectus for geographical studies of marketing, Applebaum (1954) took this wider view of the subject seeing a role for geographers in the "delimitation and measurement of market areas and in the study of the channels of distribution through which goods move from producers to consumers". Writing seven years later Murphy (1961) observed that only the first of these topics, the study of market areas was receiving attention from geographers. This was subsequently confirmed by Berry (1967) who claimed that, "The prime concern of marketing geographers....is in how to measure a trade area." Since then some geographical work has been undertaken on other parts of the channel of distribution. Vance, for example, has produced a general study of American wholesaling, while in the United Kingdom the Retail Outlets Research Unit (RORU) has examined various aspects of the retail supply system. Nevertheless, the field of marketing geography remains dominated by spatial studies of market potential, store location and consumer behaviour. It is still widely acknowledged, however, that marketing geography should, like marketing science, examine the backward linkages from shops to their suppliers as well as the forward links to their customers (Thorpe, 1978; Dawson, 1980).

Transport geographers likewise have shown little interest in the wider distributive framework. The backward linkages from shops to their suppliers are more than simply transport connections; they are "channels" comprising both lines of movement and points of storage and transhipment.
By studying freight flows separately, transport geographers have tended to overlook the important relationships between transport and other elements in the distribution system such as storage and handling.

The Study of Distribution Systems

To date the study of distribution systems has been dominated by operations research, marketing science and business management. Much of this work, particularly that of the operations researchers, has tended to be either normative and highly theoretical (Eilon et al., 1971) or to be in the form of detailed case studies of particular companies (Mercer et al., 1978; Whitehead Consulting Group Ltd., 1970). It has, nevertheless, been noted that "detailed studies of the rationale of individual distribution systems are few" (Urquhart, 1976). The few general and positive (as opposed to normative) surveys of distribution strategies that have been undertaken have neglected the spatial dimension (Industrial and Commercial Techniques Ltd., 1966; Whitehead Consulting Group Ltd., 1974; Kearney, 1980). There have been no general studies of the spatial structure of actual distribution systems upon which the freight flow analyst could draw.

Most of the work done on the subject of physical distribution has been directed at particular aspects of firms' distribution systems, such as the location of depots or routeing of vehicles. According to Schary (1970), this fragmentation of the research effort has inhibited a broader conceptualization of the distribution process. Several attempts have, nevertheless, been made to devise comprehensive models of a distribution system (Heskett, 1966; Schary, 1970; Bowersox, 1972; Geoffrion, 1974). Heskett devised a temporal model of a distribution system composed of a series of "inventory cells" which he classified as "transit" or "static". Schary's model is essentially normative, and, by concentrating on the elements of time and risk, tends, like Heskett's model, to play down the importance of the spatial dimension. Bowersox's simulation model and the various optimising models reviewed by Geoffrion are intended to offer firms more practical
guidance on the design of a distribution system. As these models require a considerable amount of data on firms' distribution operations, much of which is generally regarded as being confidential, their use is confined to internal company planning. It was learned too from consultations with distribution staff in the course of this research that there have been few instances of these comprehensive models being applied in practice.

It would be foolhardy in a research project of this sort to attempt to develop a model of a distribution system that was both positive and comprehensive, and which could simulate the spatial pattern of freight traffic. Such an exercise would require the collection and analysis of vast amounts of data. This would require considerably more resources than those available to this project and demand a high level of cooperation from firms in the industry. Moreover, a general model of a distribution system constructed on too limited a data base would be likely to suffer from defects similar to those of the general freight flow models discussed in the previous chapter.

This research has three more modest objectives:

1. To present an alternative framework for the analysis of patterns of freight flow that takes much more account of the marketing environment and the logistics of distribution.

2. Within this framework, to examine in detail the factors that affect the movement of one group of products (packaged groceries).

3. To use the results of this study to help explain recent trends in freight transport, examine the problems of modelling the pattern of freight flow, and assess the scope for rationalizing the movement of grocery products.

This new approach directs attention to the route that goods take in moving from points of production to points of sale. Broadly speaking, this route may be divided into three segments:
a) Raw material source (farm, quarry, port etc.) to first processing plant.
b) Inter-hauls between processing plants while in unfinished state.
c) Distribution of finished product from final processing plant to retail outlet.

This study is mainly concerned with the last of these - the distribution of finished goods from factories to shops. The schema it employs could, with slight modification, be applied to studies of the other route segments. This schema has six stages:

i) Marketing channel allocation.
ii) Logistical channel allocation.
iii) Number of nodes at each level of the logistical channel.
iv) Locations of these nodes.
v) Areas served by these nodes.
vi) Routeing of flows between these nodes - both at the strategic and tactical (local delivery) levels.

As in the case of the Commodity Flow Studies (Pike and Gandham, 1981), the intention is not to "gross-up" the data collected in this survey to produce a global picture of the pattern of food movement. Indeed, very little actual flow data was collected. In this respect, the objectives of the present study clearly differ from those of previous macro-scale freight modelling exercises. By examining the structure of distribution systems at the micro-scale, this study should complement this earlier work by providing a deeper insight into the planning and management of firms' freight transport operations.

A distinction must also be drawn between this work and earlier studies of the distribution system, such as those of Jefferys (1950), Thompson (1970) and NEDO (1971a), which were based on information collected principally at the retail level. More recent studies of the potential for peripheral transhipment have similarly concentrated their attention on the inward flow of goods to shops (Metra, 1976;
Urquhart, 1976). While the retail outlet is a natural and convenient place at which to enquire about the supply system, the view backwards from this point along the distributive channel is usually limited to the last link in the chain. To get a broader view of the distributive system it is necessary to conduct surveys at the upper levels of the marketing channel controlled by manufacturers, wholesalers and the central offices of multiple retail organizations. This has been the approach adopted here.

The Choice of Food Products.

Although the proportion of national income spent on food has declined as people have become more affluent, it still accounts for around 20% of consumer expenditure (Ministry of Agriculture, Fisheries and Food, 1982) and gives rise to a roughly similar proportion of the total volume of freight movement (measured in tonne-kilometres) (DTp, 1982). Food, drink and tobacco products have accordingly been identified as one of seven major traffic-generating commodity groups (Brown and Maultby, 1973). National freight forecasts are, therefore, particularly sensitive to estimates of the future transport demands of this sector of the economy. In recent years the volume of food movement, measured in tonne-kms, has been increasing broadly in line with total freight movement, despite the fact that the volume of food consumed has remained fairly stable. This makes this sector of the economy particularly interesting as its freight demands appear to be growing almost entirely as a result of changes in the way in which its production and distribution is organized.

Food is a relatively expensive commodity to transport because of its bulky nature, its need for fast, high quality delivery and its distribution to large numbers of wholesale and retail outlets. In terms of the ratio of transport costs to the value of net output, the food industry may be regarded as being very transport-intensive (Edwards, 1970).

Food is also unusual in being transported almost exclusively on the road network. Less than 2% of the total number of tonne-kilometres generated by food, drink and
tobacco products is carried by rail (DTp, 1982). This enables one to concentrate on the way in which distribution is organized with respect to the road network and, by removing the modal split variable, somewhat simplifies the analysis.

The movement of food has a disproportionate impact on the urban environment. This is mainly because food products have to be distributed widely to a relatively large number of shops. This means that a large proportion of the total amount of freight movement generated by these products takes the form of dispersed deliveries to retail outlets and is, therefore, highly intrusive in the community. It has been estimated that food accounts for roughly 80% of the total weight of goods delivered to shops (GLC, 1976). Much of this weight is delivered too in larger than average vehicles. This is reflected by the fact that vehicle deliveries to food shops account for only 20-25% of total shop deliveries (Thorpe et al., 1973; GLC, 1976). Roughly 60% of the total weight of "food and allied products" consumed in Britain is sold by supermarkets, most of which receive a large proportion of their supplies in consolidated deliveries by vehicles of over 16 tonnes gross weight (Financial Times 22/11/77).

As food traffic is voluminous, intrusive in sensitive urban environments and highly conspicuous, it has come to be regarded as a prime candidate for the application of various rationalization schemes. All the major studies of peripheral transhipment, for example, agreed that for such a scheme to be effective it would be essential for food supplies to be routed through the transhipment depot (CIDP, 1975; PE Consultants, 1975; Battilana and Hawthorne, 1976). Other studies on the potential for direct distribution (using demountable containers) (Lorries and the Environment Committee, 1977a) and the possible development of freight complexes (Lorries and the Environment Committee, 1977b) have identified the food industry as the main source of traffic, in each case expected to contribute around 37% of the prospective throughput. All these studies, however, take a very narrow view of the system of food distribution which they are proposing to modify.
They under-estimate the complexity of this system and ignore many of the factors likely to constrain the implementation of these new schemes. It should be recognised that the food market is fairly static (Institute of Grocery Distribution, 1982), and that this affects the way in which food is distributed in several ways. As most firms can only expand their volume of sales by increasing their share of this static market, competition is intense at all levels of the distributive channel. Great importance is, therefore, attached to the marketing of products, and considerable managerial power vested in those responsible for marketing and sales. In most firms, distribution is organised in accordance with marketing requirements (Schary and Becker, 1973; Freight Management, 1975), and this can both increase its complexity and reduce its efficiency. A marketing policy may dictate, for example, that goods be delivered direct to shops rather than channelled through wholesale or retail warehouses; it may specify a high service level (i.e. fast delivery) and, by promoting goods more heavily at particular times of year, may cause costly fluctuations in the throughput of the distribution system. Proposals to rationalize the food distribution system must, therefore, take account of firms' commitment to broader marketing strategies.

The food distribution system has, nevertheless, undergone enormous change in recent decades and been the testing ground for many techniques that have subsequently been adopted by other trades. It has been highly responsive to such developments as increasing personal mobility, road improvements and the introduction of new materials handling methods, and been substantially reorganized in adherence to the principles of physical distribution management. It must be asked, therefore, in what ways these changes have affected the volume and pattern of food movement, and to what extent they have yielded economic and environmental benefits.

Although discussed so far in fairly general terms, the food distribution system is effectively divided into several discrete parts which merge mainly at the retail level, and to a lesser extent further back along the distributive
The main reason for this fragmentation lies in the wide variation in perishability between food products. As it is beyond the scope of this project to examine in depth all the various parts of the food distribution system, attention will focus on those products with a longer shelf-life referred to in the trade as "dry" or "packaged" groceries. These products all experience some form of processing or preparation. They are estimated to account for around 40% of total food expenditure (Tanburn, 1981) and between 60 and 70% of the sales of the average supermarket.

The Survey

Most of the information on grocery distribution presented in this thesis was collected from surveys of large food manufacturers, wholesalers, multiple retailers and distribution contractors in 1978 and early 1979. Forty of the largest food manufacturers in the UK were approached, all supermarket chains with more than twenty stores, the six largest voluntary groups and six distribution contractors specialising in the storage and transport of grocery products. Firms and organizations co-operating with the survey are listed in Appendix 1. Information was also collected from the Co-operative Wholesale Society, the Co-operative Union and a large Co-operative retail society. In the majority of cases where organizations cooperated, information was obtained by interview with the distribution director or manager. Some firms supplemented the interviews with further information recorded on a postal questionnaire. A small number of firms supplied all the information they provided on postal questionnaires. Copies of the questionnaires and introductory letters can be found in Appendix 2. Additional data was obtained from published sources both on the firms participating in the survey and others which were either not approached or which refused to cooperate. These published sources included case studies compiled by the Institute of Grocery Distribution (Hemingway, 1979), articles in the trade press, annual reports and other company literature.

Although not so highly concentrated as the industries surveyed by the Commodity Flow Studies commissioned by the
DTp, trade is sufficiently concentrated at the different levels of the grocery distribution system to make it possible to collect information on a large proportion of the total volume of grocery flow from comparatively few firms. Table 3.1 shows the market shares in a variety of products held by firms in the sample. These figures relate only to branded products, and exclude "own label" products (i.e. products carrying the name of the distributor rather than the manufacturer's brand name), which can account for a large proportion of total sales (Table 3.2). Although many firms in the sample were heavily engaged in the manufacture of "own label" products, most refused to divulge information about the scale of this operation or about the retailers and wholesalers commissioning this production. The survey of multiples covered over 80% of the volume of trade handled by this sector, that of voluntary groups covered around 50% of their total business. Overall, it is estimated that the survey covered the distribution of between 50 and 60% of the output of grocery products from factories in the UK and between 60 and 65% of the grocery supplies delivered to shops (excluding the collection of supplies from cash and carry warehouses).

Most of the interviews had a similar form. The early stages were structured around a questionnaire which was designed to elicit background information about the history, extent and nature of the firm's operations and various items of "hard" data on its distribution system. This formal questioning usually developed into a more general discussion from which it was possible to assess firms' attitudes to a range of issues, such as the concentration of stockholding, the growth of direct delivery and the coordination of marketing and distribution strategies. Only through the medium of an personal interview would it have been possible to explore the thinking behind various aspects of a firm's distribution operation. This survey method also permitted a more wide-ranging investigation of firms' distribution systems than would have been possible if only postal questionnaires had been used. It also yielded a relatively high response rate for an industrial survey of this type. Against these advantages must be set some of the problems
Table 3.1: Market Shares of Food Manufacturers in the Sample. (branded products only.)

<table>
<thead>
<tr>
<th>Product</th>
<th>Date of Survey</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biscuits</td>
<td>1977</td>
<td>75%</td>
</tr>
<tr>
<td>Breakfast Cereal:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot</td>
<td>1977</td>
<td>68%</td>
</tr>
<tr>
<td>Cold</td>
<td>1977</td>
<td>66%</td>
</tr>
<tr>
<td>Crisps</td>
<td>1978</td>
<td>72%</td>
</tr>
<tr>
<td>Tea</td>
<td>1976</td>
<td>71%</td>
</tr>
<tr>
<td>Coffee</td>
<td>1976</td>
<td>64%</td>
</tr>
<tr>
<td>Margarine</td>
<td>1977</td>
<td>57%</td>
</tr>
<tr>
<td>Processed Cheese</td>
<td>1977</td>
<td>56%</td>
</tr>
<tr>
<td>Sugar</td>
<td>1977</td>
<td>55%</td>
</tr>
<tr>
<td>Flour</td>
<td>1977</td>
<td>54%</td>
</tr>
<tr>
<td>Marmalade</td>
<td>1976</td>
<td>53%</td>
</tr>
<tr>
<td>Jam</td>
<td>1977</td>
<td>43%</td>
</tr>
<tr>
<td>Canned Products:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasta</td>
<td>1976</td>
<td>85%</td>
</tr>
<tr>
<td>Soup</td>
<td>1976</td>
<td>65%</td>
</tr>
<tr>
<td>Baked Beans</td>
<td>1977</td>
<td>58%</td>
</tr>
<tr>
<td>Processed Peas</td>
<td>1977</td>
<td>45%</td>
</tr>
<tr>
<td>Milk Pudding</td>
<td>1978</td>
<td>75%</td>
</tr>
<tr>
<td>Fruit (imported)</td>
<td>1978</td>
<td>27%</td>
</tr>
</tbody>
</table>

Source: Mintel and Economist Intelligence Unit Reports.
experienced in collecting information in this way. The distribution staff interviewed often did not have readily available all the quantitative data requested. Under these circumstances, many interviewees promised to forward the required data by post. It often proved difficult, however, to obtain this "missing" data subsequently. Interviews also varied in length and content, with some interviewees sparing only half an hour of their time and providing only a minimum of factual information; others described their distribution operation over a period of several hours. Some of the distribution staff took advantage of the interview to talk at length about particular grievances, such as the theft of pallets or labour relations problems in their depots, which, though interesting, had little direct relevance to the research project.

Attempts to obtain a comprehensive data set for all the firms surveyed were frustrated for several reasons. In the first place, firms differed in what data they regarded as being confidential. Most manufacturers, for example, provided details on the nature of their deliveries to the larger supermarket chains, while others refused to do so on the grounds that all aspects of their dealings with customers were considered secret. In some cases, firms claimed that they either did not record the information requested or did not collect it in the required form. Moreover, much of the data that was provided for some of the variables was not strictly comparable. Firms differed markedly, for example, in the units with which they measured vehicle utilization and drop sizes. The manufacturers also adopted different procedures to estimate the proportion of output distributed direct from the factory. As a result of these inconsistencies, it was necessary to discard much of the data collected. The failure of firms to provide comparable data on all the aspects of their distribution systems being investigated prevented the compilation of a comprehensive data set. Sample sizes therefore vary between indices, though, in the case of most of the important variables, are of sufficient size to give a representative picture and to permit some quantitative analysis.
Table 3.2: Proportion of "Own Label" Sales in Various Grocery Products (1976-77).

<table>
<thead>
<tr>
<th>Product</th>
<th>% of Total Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garden Peas</td>
<td>50</td>
</tr>
<tr>
<td>Processed Peas</td>
<td>45</td>
</tr>
<tr>
<td>Jam</td>
<td>44</td>
</tr>
<tr>
<td>Canned Fruit</td>
<td>41</td>
</tr>
<tr>
<td>Baked Beans</td>
<td>33</td>
</tr>
<tr>
<td>Dry Pasta</td>
<td>30</td>
</tr>
<tr>
<td>Hot Breakfast Cereal</td>
<td>26</td>
</tr>
<tr>
<td>Marmalade</td>
<td>24</td>
</tr>
<tr>
<td>Margarine</td>
<td>21</td>
</tr>
<tr>
<td>Biscuits</td>
<td>20</td>
</tr>
<tr>
<td>Flour</td>
<td>17</td>
</tr>
<tr>
<td>*Crisps</td>
<td>10</td>
</tr>
<tr>
<td>Cold Breakfast Cereal</td>
<td>10</td>
</tr>
<tr>
<td>Canned Soup</td>
<td>10</td>
</tr>
</tbody>
</table>

* figure relates to 1978.

Source: Mintel and Economist Intelligence Unit Reports.

Table 3.3: "Own Label" Sales as a Proportion of Total Turnover: Sample of 8 Large Grocery Multiples (1979).

<table>
<thead>
<tr>
<th>Multiple</th>
<th>% of Total Turnover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sainsbury</td>
<td>55%</td>
</tr>
<tr>
<td>Waitrose</td>
<td>42%</td>
</tr>
<tr>
<td>Keymarket</td>
<td>21%</td>
</tr>
<tr>
<td>Tesco</td>
<td>21%</td>
</tr>
<tr>
<td>International</td>
<td>17%</td>
</tr>
<tr>
<td>Fine Fare</td>
<td>15%</td>
</tr>
<tr>
<td>Allied Suppliers</td>
<td>14%</td>
</tr>
<tr>
<td>ASDA</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: The Grocer 17/4/82.
Three types of information were found to be very difficult to obtain. The first related to the volume of goods a firm produced and/or distributed. Very few firms were either willing or able to provide data on the output of factories, depot throughput, shop turnover or the volume of flow between premises. In the absence of this data, it is not possible to undertake a commodity flow analysis similar to those commissioned by the DTp in 1975. It is likely that most firms would only provide the necessary flow data for such an analysis if legally compelled to do so. A study of this type cannot, therefore, analyse the pattern of flow directly but must instead make inferences about this pattern from data collected on the physical and organizational framework within which the movement occurs.

Firms were also very unwilling to divulge information about the production and distribution of "own label" products. This was unfortunate as these products were estimated to account for around 21% of total grocery sales at the time of the survey. This average also concealed wide variations between products and supermarket chains in the relative importance of own label sales (Tables 3.2 and 3.3). In most cases, firms aggregated data on their own label business with that for branded products. This prevented own label distribution from being given the separate consideration which, strictly speaking, it deserves and made it impossible to establish the complete network of manufacturer-retailer linkages.

It also proved difficult to obtain historical data on the development of firms' distribution systems, even in more recent times. The dearth of time-series data limits the extent to which one can establish quantitatively trends in such variables as depot numbers, drop sizes and the amount of direct delivery. The lack of detailed records on distribution can be largely attributed to the fragmentation, until recently, of managerial responsibility for this sphere of company operations, and to the fact that its component functions, such as storage and transport, have traditionally been held in low regard by company management. Several of the distribution departments consulted had experienced a fairly rapid rate of staff turnover and, as a result, some
of those interviewed had been in post for only a short time and had a very limited knowledge of past operations.

Despite these various constraints, it has been possible to amass a considerable wealth of information on the way food manufacturers, wholesalers and retailers organize the distribution of grocery products. This information will be analysed in the following chapters to explore in depth the factors influencing the routeing of grocery products from factories to shops.

**Chapter Outlines:**

The following chapters examine each of the factors identified earlier (p.18) as affecting the pattern of grocery flow factory to shop.

**Chapter 4** examines the network of marketing channels within the grocery trade. The institutional structure of these channels provides the framework within which physical distribution is organized. Various marketing principles are invoked to explain the present allocation of grocery sales between the various channels. This explanatory section is followed by a brief outline of the way in which these channels have evolved.

**Chapter 5** looks at the logistical channels of the three main agencies in the marketing channel: manufacturers, multiple retailers and wholesalers. An investigation is made of the factors affecting each agency's choice between direct and indirect channels.

**Chapter 6** examines the links between the sections of these channels under the control of manufacturers and multiples and asks how these firms jointly decide which mode of delivery to use.

**Chapters 7 and 8** examine the physical structure of the indirect (or echelon) channels, which contain intervening stockholding and transhipment nodes. Chapter 7 suggests reasons for variations in the number of depots that firms operate, while chapter 8 analyses the spatial distribution of these depots and considers the theory and practice of depot location.

**Chapter 9** investigates the strategic routeing of bulk (or primary) flows from factories to depots.
The size and shape of the areas served by the various types of depot is examined in the first section of chapter 10 and this leads on to a brief consideration of the routeing of delivery vehicles through these areas on their way to retail outlets. The Co-operative movement's involvement in the production and distribution of groceries is the subject of Appendix 3. The structure of this organization is considered to be sufficiently different from those of the other agencies to justify giving it separate attention. In Chapter 11 an attempt is made to incorporate the main findings of chapters 4 - 10 into an explanation of recent trends in the movement of food indicated by official transport statistics. The concluding chapter assesses the value of this approach to the study of freight flows and discusses the implications of the main findings of this research for freight forecasting and the rationalization of goods movements.

Notes:
1. The Semantics of Channel Structure: It is important at the outset to clarify the definitions of three terms that will appear frequently in the forthcoming chapters: they are marketing channel, distribution channel and logistical channel. In the marketing literature different authors use the expressions "marketing channels" (e.g. Guirdham, 1972) and "distribution channels" (e.g. Gattorna, 1978) synonymously to refer to the different stages in the transfer of goods from producer to retailer. In some cases this transfer entails the physical movement of goods between the premises of the different agencies. In others it results merely in the shift of ownership and risk-taking. Where actual movement is involved it is common to describe the route followed as a "logistical channel". This route can either be plotted via organizations of via the premises they operate. This is an important distinction because some organizations operate nodes at more than one stage in the logistical channel. As our interest here lies principally in the physical pattern of flow, "logistical channels" will hereafter be taken to mean the route linking premises through which goods pass on their way from factory.
to shop, or a section of this route under the control of a single organization.

2. The definition of "groceries" will not be as broad as that of Briggs and Smyth (1967).

3. Although the threshold of 20 shops is larger than the conventional definition of a multiple (more than 10 stores), it can be partly justified on the grounds that "economies of scale in retailing only become noticeable at the 15-20 branch level" (Hall et al., 1961).
Chapter 4

Marketing Channels in the Grocery Trade

The manner in which a product is distributed is determined largely by the way in which it is marketed. The investigation of the structure of the food distribution system must, therefore, encroach upon the science of marketing. Much of the literature on marketing is devoted to classifying channels on an institutional basis and examining the trading activities of the agencies they connect. Differences in the organizational structure of a channel need not, however, be manifest in differences in the physical distribution of goods. As this thesis is concerned principally with the actual patterns of storage and transport, the main interest lies in the logistical consequences of assigning goods to particular marketing channels. First, however, one must examine the network of marketing channels.

This chapter considers the range of channels used in the grocery trade, reviews the theoretical arguments that have been advanced to explain the relative importance of these channels and outlines their historical evolution over the past century.

The Choice of Marketing Channels

Of the numerous definitions proposed for the term "marketing" that of Dawson (1979) is probably the simplest and most comprehensive; it states that it is "concerned with the transfer of goods from the producer to the consumer". This transfer is seldom direct. In most cases, the goods pass through one or more distributive agencies. These agencies are linked by a series of trading arrangements into a marketing channel. In addition to transporting and storing goods, these agencies must decide which products to stock, promote these products and assume the risks of temporary ownership. The distributive system should not simply be seen, therefore, as a "mechanistic system" of transport and storage (Thorpe, 1978). To understand the workings of this system, one must give due attention to
other, less tangible marketing considerations.

Marketing channels have two dimensions (Guirdham, 1972):

1. INTENSITY: The number of separate transactions made at each level of the distributive system - particularly at the retail level.

2. DIRECTNESS: The number of separate agencies linked together in the vertical channel from producer to consumer.

Intensity and directness vary inversely. If there are many buying points to contact at a particular stage in a channel, the number of transactions can be reduced by dealing through a much smaller number of intermediaries. As illustrated in figure 4.1, in the absence of an intermediary, producers must trade directly with retailers, giving rise to a large number of transactions, equivalent to the product of the numbers of producers and retailers (Artle and Berglund, 1959). The presence of an intermediary can streamline the distributive network by reducing the number of transactions to the sum of the numbers of producers and retailers. The use of intermediaries thereby reduces the number of trading links, but at the expense of lengthening the vertical channel. Given a certain number of producers, the demand for a wholesale intermediary will depend on the number of retail outlets that must be supplied. The hierarchical structure of the marketing system is, therefore, largely shaped by the number of outlets at the retail level.

Broadly speaking, the number of retail outlets through which a product is sold depends on two factors:

i) Size and spatial distribution of the population.
ii) Shopping behaviour of the population (distance travelled to shops, frequency of shopping, amount of searching and comparison.)

If one takes the size and distribution of population as given and focusses attention on shopping behaviour, one finds that the manner of purchase varies considerably
Figure 4.1: Structure of a Marketing System.

Without Wholesale Intermediary:
no. of transactions = \( P \times R \)
\[ = 2 \times 4 \]
\[ = 8 \]

With Wholesale Intermediary:
no. of transactions = \( P + R \)
\[ = 2 + 4 \]
\[ = 6 \]

With 10 producers and 100 retailers:
without wholesaler: 1000 transactions
with wholesaler: 110 transactions
Presence of wholesaler reduces the no. of transactions by 89%.
between different types of product. Attempts have been made to classify products on the basis of their pattern of consumption and to relate the resulting product types to the structure of the marketing channels through which they are distributed. The first of these attempts by Copeland (1924) classified goods into three categories:

**Convenience Goods**: (e.g. groceries) purchased frequently and generally of low value. People are not prepared to expend much time or effort in shopping for them and willing to accept substitute brands.

**Shopping Goods**: (e.g. clothing, footwear) are less frequently purchased and of higher value. The decision to buy them is based on more searching and comparison. More effort goes into "shopping around" for the preferred brand or model.

**Speciality Goods**: (e.g. jewelry, furniture) are generally expensive, infrequently purchased goods for which people will expend considerable time and effort in shopping.

Copeland's simple classification was intended to offer manufacturers guidance on how best to market their products. A manufacturer of convenience goods would be well advised to distribute his products through a large number of retail outlets, because, if they were not available in a shop many shoppers would make do with an alternative item or brand in preference to trying elsewhere. Convenience goods are therefore marketed "intensively" at the retail level. In contrast, the sale of shopping and speciality goods could be confined to a smaller number of retail outlets as consumers would "shop around" for them.

Christaller incorporated Copeland's product classification into his Central Place Theory, ordering goods according to the distances people travelled to obtain them (Christaller, 1933). Outlets for convenience goods which he described as "low order", would, he argued, be widely dispersed throughout the settlement hierarchy, higher order goods would be available only in the large centres.
As the science of marketing evolved, it was realised that Copeland's classification was too crude to be of much use in the formulation of marketing strategies. An important refinement of Copeland's discrete classification was made by Aspinwall (1958).

He arranged goods along a continuous scale based on five marketing characteristics:

- a) Replacement Rate
- b) Gross Margin
- c) Service required by customers
- d) Time involved in consumption
- e) Searching time

Relative measurements based on these five criteria could be used to calculate an overall index $I$ as follows:

$$I = b + c + d + e - a$$

The intensity with which a product is marketed tends to vary inversely with this index. Low values correspond to Copeland's "convenience" goods, higher values to "shopping" and "speciality" goods. Although more recent work has suggested further improvements to this product classification, Aspinwall's scheme will suffice in the present context.

In Copeland's scheme, food was classified as a convenience good. This is confirmed by an assessment of food on the basis of Aspinwall's five marketing characteristics:

- a) High replacement rate: food products, especially perishable ones, are bought very frequently. Almost all households make at least one major shopping trip for food per week and several minor ones. The frequency of these trips is declining, however.
b) Low gross margin: as shown on Table 4.1, the gross margin for grocery products is lower than that of most other products.

c) Few services required by customers: most food sales require little service as demonstrated by the fact that self-service shopping has developed most extensively in the food trade.

d) Little time involved in consumption: Most food products have a comparatively rapid consumption rate. Most households carry only small stocks of most foodstuffs, though these stocks are increasing as the frequency of shopping trips diminishes and greater use is made of home freezers.

e) Little searching time: most shoppers will devote little time to searching for particular brands of food product. Shoppers will tend to purchase only what is available in one or two stores. Table 4.2 indicates how customers react when unable to obtain their preferred product in a shop. In the case of immediate use food products, fewer than a third would look elsewhere for the desired item. Slightly more (45%) would search for an "extended use" product elsewhere.

Food is, therefore, marketed very intensively at the retail level. This is indicated by the relatively large number of retail outlets selling food (Table 4.3). This great dispersal of retail food sales has been conducive to the development of an intermediate wholesaling stage in the distributive system.

Great care must be taken, however, in defining this wholesaling stage. Many of the traditional functions of the wholesaler have been taken over by multiple retailers and to a decreasing extent, the larger food manufacturer. As these firms consolidate, store and sort goods in their own warehouses and provide shop delivery, they may be considered part of the "wholesale structure" (Mossman and
Table 4.1: Gross Margins of a Variety of Product Groups (1971). (expressed as a % of turnover.)

<table>
<thead>
<tr>
<th>Product Group</th>
<th>Gross Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grocery and Provisions</td>
<td>19.9%</td>
</tr>
<tr>
<td>Confectionery, Tobacco and Newspapers</td>
<td>20.4%</td>
</tr>
<tr>
<td>Books and Stationery</td>
<td>30.6%</td>
</tr>
<tr>
<td>Hardware, China, Wallpaper, Paint</td>
<td>31.2%</td>
</tr>
<tr>
<td>Drugs, Cosmetics, Photography</td>
<td>33.8%</td>
</tr>
<tr>
<td>Furniture and Allied Products</td>
<td>34.6%</td>
</tr>
<tr>
<td>Electrical Products</td>
<td>34.7%</td>
</tr>
<tr>
<td>Jewellery, Leather and Sports Goods</td>
<td>35.3%</td>
</tr>
<tr>
<td>Clothing and Footwear</td>
<td>36.4%</td>
</tr>
</tbody>
</table>

Source: Census of Distribution (1971).

Table 4.2: Customer Reactions to Desired Product Being Out of Stock.

<table>
<thead>
<tr>
<th>FOOD</th>
<th>Extended Use</th>
<th>Immediate Use</th>
<th>NON FOOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bought Substitute</td>
<td>32%</td>
<td>48%</td>
<td>26%</td>
</tr>
<tr>
<td>Returned to Buy in</td>
<td>23%</td>
<td>21%</td>
<td>33%</td>
</tr>
<tr>
<td>Same Store Later.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bought Elsewhere</td>
<td>45%</td>
<td>31%</td>
<td>41%</td>
</tr>
</tbody>
</table>

Source: Neilsen Researcher (1979)

Table 4.3: Numbers of Retail Outlets Selling Different Types of Product (1971).

<table>
<thead>
<tr>
<th>Product Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Grocery and Provisions</td>
<td>108,282</td>
</tr>
<tr>
<td>Confectionery, Tobacco, Newspapers</td>
<td>52,751</td>
</tr>
<tr>
<td>Furniture and Allied Products</td>
<td>22,777</td>
</tr>
<tr>
<td>Electrical Products</td>
<td>18,216</td>
</tr>
<tr>
<td>Men- and Boyswear</td>
<td>15,722</td>
</tr>
<tr>
<td>Chemists</td>
<td>14,746</td>
</tr>
<tr>
<td>Footwear</td>
<td>14,326</td>
</tr>
<tr>
<td>Jewellery, Watches, Clocks</td>
<td>8,013</td>
</tr>
<tr>
<td>Wallpaper, Paint</td>
<td>6,754</td>
</tr>
<tr>
<td>Books, Stationery</td>
<td>6,239</td>
</tr>
<tr>
<td>Toys</td>
<td>3,521</td>
</tr>
<tr>
<td>Cycles, Motor Accessories</td>
<td>2,232</td>
</tr>
<tr>
<td>Photographic, Optical</td>
<td>1,924</td>
</tr>
<tr>
<td>China, Glassware</td>
<td>1,737</td>
</tr>
</tbody>
</table>

Source: Census of Distribution (1971).
Morton, 1965). In terms of the organizational structure of marketing channels, they have effectively eliminated the independent wholesale stage in the distribution of most processed foods. As McClelland (1966) has pointed out, the multiples have converted the link between the shop and the warehouse that supplies it from a "market" relationship to an "organizational" one. Whilst this has made the marketing channels more direct in an institutional sense it has not normally had the same effect on the corresponding logistical channels. The extension of the producers' and retailers' control into the realm of wholesaling has generally resulted in the substitution of a manufacturer's distribution depot or retailer's central warehouse for what was previously a wholesale warehouse. Where this has happened, the number of nodes in the logistical channel has remained the same. As will be explained later, however, these different types of warehouse vary significantly in their operating characteristics.

Historical Development of Marketing Channels in the Grocery Trade.

Although the origins of several of today's large food manufacturers, such as Cadbury, Huntley-Palmer and Birds (now part of General Foods) can be traced back to the early 19th Century, the main growth of the food processing industry occurred after 1850. As income levels rose so the population could afford to include more, higher-value processed foods in their diets (Oddy and Miller, 1976). The nascent food processing industries also took advantage of the flood of cheap food imports that arrived in Britain in the latter half of the 19th Century (Mathias, 1967).

The new food products placed new demands on the system of food distribution. There is some disagreement over the state of food distribution around the middle of the 19th Century, particularly over the proportions of trade held by market stalls and "lock-up" shops (Scola, 1975). There is general agreement, however, that the latter increased rapidly in importance in the second half of the 19th Century and began catering for a much wider public. The Victorian revolution in grocery distribution methods, therefore,
coincided with, and was undoubtedly promoted by, the development of food manufacturing.

Until the 1850s, the food processing firms "were still generally small scale and unrevolutionised, supplying a narrow market in much the same way as they had done in centuries past" (Burnett, 1968). From then on, however, the scale of production increased sharply, concentrating food manufacturing in a smaller number of larger factories and lengthening the average distance products had to travel to the point of sale. This extension of the supply line between producer and retailer created conditions conducive to the emergence of intermediaries:

"In most trades up to the turn of the century at least, any widening of the gap in time and space between the producer and the retailer tended to result in the intervention of an intermediary, and the widening of this gap was one of the main characteristics of economic development in these years." (Jefferys, 1954)

This "gap in time" to which Jefferys refers, was not simply the time goods spent in transit, but also the time spent in storage at various points along the chain of distribution. Haberler (quoted in Isard (1956)) has noted the close analogy between transport and storage, the former effecting movement through space, the latter a movement through time. The "intermediaries" which Jefferys described assumed responsibility for the movement of goods in both dimensions. The principal type of intermediary who flourished over this period was the wholesaler.

The principal raison d'être for wholesaling, that of greatly reducing the number of trading links in the marketing system, has been outlined earlier. In addition to raising the "transactional efficiency" (Gattorna, 1978) of the system, the wholesaler could also enhance the efficiency of the supporting transport operation by encouraging the movement of goods in bulk loads. Incoming goods could be received in bulk consignments from suppliers; orders being dispatched to retailers in consolidated mixed loads. By storing goods locally, the wholesaler could also satisfy retailers' needs at much shorter notice than distant suppliers, particularly as long distance transport at this
time (late 19th Century) was relatively slow and unreliable (Vance, 1970).

Multiple retailing also developed rapidly in the grocery trade from the 1870s onwards. This trade was particularly suited to the growth of multiples. As food was a "convenience" good for which people preferred not to travel very far, it made more sense for the expanding food retailer to open new branches, thereby, competing on the basis of proximity to customer, rather than simply enlarge his existing premises (Jefferys, 1954). Groceries were also suited to chain store retailing by virtue of their relatively low perishability, high level of standardization and easy bulk handling (Braithwaite and Dobbs, 1932). It was common practice for multiples at an early stage in their growth to receive a high proportion of their supplies at the main and often original shop in the chain. There these goods were stored and sorted, before being transported, usually in the retailer's own cart to the outlying premises. As the number of branches and the total volume of trade grew, it generally became necessary for the multiple retailer to establish a separate warehouse where storage, sorting, packaging and even some processing could be centralized. The multiple retailer, thereby, effectively took upon himself the functions of wholesaler, the large scale of his operations enabling him to deal direct with manufacturers. This absorption of the wholesaling function by the multiple can be considered a major advantage as it led "to the reduction or elimination of some wholesaling costs, notably a reduction in risk-taking and selling costs" (Fulop, 1964).

The third type of organization to play a major role in the distribution of processed foods in late Victorian times were the Cooperative Societies. Following the success of the Rochdale Society, founded in 1844, many others sprang up around the country providing unadulterated food and good quality clothing for the working classes. With the formation of the Cooperative Wholesale Society in 1864 (in England), the retailing societies obtained collectively their own wholesaling and production agency. CWS factories were set up to manufacture some staple foodstuffs, while CWS
warehouses were heavily engaged in the distribution of processed foods. The institutional structure of the Coop, however, prevented the retailing and wholesaling functions from being integrated to the same degree as in the multiples (see Appendix 3).

The growing trade in processed foods helped transform traditional methods of retailing. Formerly the "fixed shop" retailer had catered for the wealthier classes, using specialist skills to select, grade, prepare and package groceries to suit his customers' tastes. Many factory-produced foods came standardised, ready packaged, branded and advertised, removing the need for the retailer to do much more than place the goods on display. Food manufacturers, therefore, took an active role in marketing their products. Jefferys' comments on the marketing of "consumer goods" could have applied equally well to processed food:

"The growing complexity of the production of consumer goods, the increased amounts of capital laid out in machinery and buildings and the greater volume of output meant that the large scale producers could not afford, while planning their production, to leave the distribution of their goods unplanned and dependent on the whims and fancies of wholesalers, retailers and consumers" (Jefferys, 1954, p12).

With the growth in the scale of food manufacturing, the intensification of competition among food producers and the proliferation of product lines came an increasing dissatisfaction, on the part of food manufacturers, with the quality of service provided by wholesalers. Many wholesalers, it was felt, paid too little regard to brand names and often failed to bring new products to the attention of their retail customers. They were also failing to meet the high standards of stock control and delivery service demanded by more perishable products, such as margarine.

Manufacturers of these products were quick to take advantage of the concentration of food sales in the hands of multiple retailers. Many of these grocery multiples had expanded rapidly selling limited ranges of cheap, imported food such as bacon, butter and tea to the working classes.
As demand grew for processed foodstuffs, however, the multiples began to diversify into these products and soon became major customers of the food manufacturers. The concentration of sales through multiples reached a particularly high level in the case of margarine. In 1912, one large multiple alone (the Maypole Dairy Company) accounted for a third of national margarine sales (Mathias, 1967).

The desire to exert more control over the marketing and supply of their products encouraged the larger food manufacturers to establish their own systems of distribution capable of delivering goods direct to the retailer. Although some manufacturers made early moves in this direction before the first world war, the practice of dealing direct with the retailer developed mainly in the inter-war period. Manufacturers were keen to promote their products at store level and ensure that they were available through as many outlets as possible.

Over the inter-war period the number of grocery outlets increased substantially. Between 1919 and 1940, the number of multiple branch stores rose by 65-70% and Cooperative Society branch stores by 55-60% (Jefferys, 1954). Although there are no comparable figures for the number of independent grocery stores, it appears that, despite having suffered a slight decline immediately prior to 1914, this sector expanded and prospered in the inter-war period, largely as a result of food manufacturers' efforts to maximise the number of outlets for their products. In addition to offering direct delivery to these stores and assistance with merchandising, many manufacturers also protected the small independent against competition from larger scale retailers by enforcing retail price maintenance. This prevented the larger operators from translating their lower unit costs into lower prices and effectively eliminated price competition (Yamey, 1966; Jefferys, 1954). By 1939, over a third of grocery sales were subject to retail price maintenance (Kuipers, 1950). Nevertheless, the growth in food sales in the inter-war period was sufficient to enable the multiples and Cooperative Societies to expand without a major displacement
Figure 4.2: Changing Shares of Grocery Sales Held by Independents, Multiples and the Co-operative Societies, 1900-1979.
of trade from the independents (fig. 4.2).

As a result of the changes that occurred in food distribution between the wars, the wholesalers suffered a loss of business. Their share of the trade was squeezed from both ends of the marketing channel. On the one hand they were bypassed by those manufacturers who began offering their retail customers a direct delivery. On the other, their trade was eroded by multiples and Cooperative Societies, which undertook their own wholesaling. By 1938, only about 35% of groceries were being channelled through wholesalers, the remainder passing direct from producers to retailers (Jefferys, 1954). This average figure, however, conceals variations in the channel allocations of particular food products (Table 4.4).

The inter-war trends in food distribution were interrupted by the imposition of war-time controls on food consumption (rationing), manufacturing (concentration of production programme) and distribution ("sector" and "zoning" schemes) (Hammond, 1954). The rationing of some food products continued into the 1950s. In this early postwar period there were also restrictions placed on the construction of new shops and warehouses. Official policy at this time of reconstruction was initially to regenerate the nation's industrial base (Hill, 1966). Only from the mid-1950s onwards did distributive facilities receive significant investment.

By then the inter-war trends in distribution had begun to reassert themselves. The multiples and Cooperatives increased their share of the grocery market, now at the expense of the smaller independent stores as well as their wholesale suppliers (Stacy and Wilson, 1958). The larger retail organizations strengthened their competitive position by introducing self-service into their stores. This method of selling was first employed in Britain in 1938, but only developed on a large scale in the 1950s. In 1947, there were ten self-service stores in Britain; by 1962 this number had grown to 11,850. The introduction of self-service was spurred by the rising cost of labour in the period of near full employment in the 1950s. It was also found to be a way of increasing turnover per unit of sales area (Duft,
Figure 4.3: Reduction in the Number of Grocery Stores, 1951-1979.

Table 4.4: Variations in the Proportions of Selected Grocery Products Channelled Through Wholesalers (1938):

<table>
<thead>
<tr>
<th>Product</th>
<th>% of Total Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canned Evaporated Milk</td>
<td>57.5</td>
</tr>
<tr>
<td>Canned Soup</td>
<td>45</td>
</tr>
<tr>
<td>Canned Peaches</td>
<td>45</td>
</tr>
<tr>
<td>Jam</td>
<td>37.5</td>
</tr>
<tr>
<td>Tea</td>
<td>22.5</td>
</tr>
<tr>
<td>Chocolate Biscuits</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Source: Jefferys (1950).

Table 4.5: Distribution of Groceries to Independent Stores.

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Voluntary Group Shops</th>
<th>Unaffiliated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voluntary Group Wholesaler</td>
<td>66%</td>
<td>-</td>
</tr>
<tr>
<td>Cash and Carry</td>
<td>18%</td>
<td>68%</td>
</tr>
<tr>
<td>Traditional Wholesaler</td>
<td>-</td>
<td>10%</td>
</tr>
<tr>
<td>Producer</td>
<td>16%</td>
<td>22%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>100%</th>
</tr>
</thead>
</table>

Sources: Bates (1976), Economist Intelligence Unit (1980).
1967). The rapid and widespread application of the self-service principle in food retailing was made possible by the extensive branding and prepackaging of grocery products (National Board for Prices and Incomes, 1971). It was also readily accepted by the public which at the time sought a faster and more convenient method of shopping (Hill, 1966). The success of the early self-service stores prompted their enlargement into "supermarkets". These larger retail units (>2000 square feet of sales area) offered the operator numerous economies of scale and the consumer the attraction of a wider range of products. The Cooperative Societies pioneered both self-service stores and supermarkets in Britain and operated the largest number of these stores until the early 1960s when they were overtaken by the multiples which went on to exploit the advantages of self-service retailing more fully.

Although the development of larger and less labour-intensive stores enabled the multiples and Coops to reduce their unit costs, retail price maintenance initially prevented them from lowering many of their prices. It did, however, increase their profitability and, particularly in the case of the multiples, provided the financial resources to set up new stores. There was a major relaxation of retail price maintenance in the grocery trade in 1957-8, and this helped the multiples to increase their market share from 22% to 27% between 1957 and 1961. The passing of legislation in 1964 to eliminate r.p.m. from the grocery trade heralded a new era of price competition when the smaller independent retailer was increasingly undercut by the larger operator.

The independents were, nevertheless, supported in their struggle against the multiples by two wholesaling innovations introduced in the 1950s. The formation of voluntary groups established closer links between wholesalers and retailers, enabling them to share some of the benefits of bulk buying and collective advertising enjoyed by the multiples (Fulop, 1962; NEDO, 1971b). Early reluctance on the part of food manufacturers to deal centrally with voluntary groups was soon overcome (Duft, 1967). The development of "cash and carries" extended the
practice of self-service into wholesaling, offering retail customers lower prices by cutting back on such traditional wholesale services as order picking, delivery and the provision of credit.

Despite these initiatives, small scale retailing continued to decline, not only because of competition from the multiples, but also partly as a consequence of other developments such as urban renewal and the introduction of Selective Employment Tax (Dawson and Kirby, 1979). Many small shops also suffered from the growing tendency in the 1960s and 1970s for food manufacturers to stop delivering small orders direct to the small retail outlet.

The contraction of manufacturers' delivery networks was partly a cost cutting exercise and partly a result of a change in marketing policy. Many manufacturers recognised that, for several reasons, it was no longer essential to trade direct with smaller retailers. The collective share of the grocery market held by these retailers had, after all, shrunk through their loss of sales to the multiples and the Cooperative Societies (figure 4.2). The manufacturers were also quite confident that by terminating deliveries to these shops they would not be seriously jeopardising their sales. This confidence rested partly on the knowledge that alternative channels existed in voluntary group wholesaling and "cash and carries" through which the small retailer could still obtain their products. Many manufacturers also believed that the brand loyalty they had so desperately sought to build up earlier in the century was now sufficiently strong to guarantee sales through these outlets even in the absence of a direct promotional link. Moreover, alternative methods of marketing were now available in the form of television and newspaper advertising, which could enable the food manufacturers to stimulate consumer demand more directly. By the early 1970s food manufacturers accounted for almost a quarter of total advertising expenditure (Wardle, 1977).

The withdrawal of manufacturers' deliveries to small independents created in the early 1970s a resurgence of demand for the services of wholesalers (National Board for Prices and Incomes, 1971; Smith, 1975). This increase in
business was short-lived, however, as the independent sector continued to contract and as the wholesalers, like the manufacturers, found it necessary to cut back on the uneconomic delivery of small orders (White, 1973).

In the 1960s and 70s the multiples also began to win sales from the Cooperative Societies. The dispersal of the Coop's food retailing activities among hundreds of autonomous retail societies and the failure to coordinate its wholesaling and retail wings more closely prevented the organization from marshalling its huge buying power and fully exploiting economies of scale. Much of its profit was also distributed in dividends when it could have been invested in more modern facilities (Davies, 1976).

As the multiple sector has expanded, its share of the market has become increasingly concentrated in the hands of a small number of large supermarket chains. Metcalf (1968) concluded that "at the national level the retail grocery industry is one of low concentration.\" though he acknowledged that the concentration of trade through the multiples had reached a high level in some regions. In the 1970s, the levels of concentration, nationally and regionally, have greatly increased conferring on the larger multiples enough bargaining power for them to demand larger discounts from the producers, considerably extend their ranges of "own label" products and dictate to the manufacturers conditions for the delivery and promotion of their branded goods (Howe, 1983).

Through the development in the 1970s of superstores and limited range discount stores, the multiples have taken advantage of the increased mobility and purchasing power of shoppers to intensify their competition for grocery sales. The concentration of sales through fewer, larger retailers and in a smaller number of larger stores has since 1961 led to a steady reduction in the number of grocery outlets (Hunt, 1983) (fig. 4.3). In addition to the closure of many small independent shops, the multiples and Cooperative Retail Societies have, in the 1970s, been shutting many of their smaller branches and consolidating their sales area in larger premises (Institute of Grocery Distribution, 1982). This concentration of grocery retailing has, however, helped
Figure 4.4: Changes in the Relative Importance of Marketing Channels in the Grocery Trade, 1938-78.

Sources: Jefferys (1950), Mintel (1979), Tanburn (1981), personal survey.

Notes: i) figures for the supply of groceries from wholesalers to Co-operative shops include goods travelling via Co-op Retail Society depots as well as CWS depots.
ii) the chart excludes the flow of supplies to multiples via wholesalers. No data is available for this flow in 1938. Tanburn (1981) estimates that 5.5% of grocery multiples' supplies came from "general food wholesalers" in 1979. It is likely, however, that only a small fraction of these would be grocery products.
iii) the chart also excludes sales of grocery products in variety and department stores.
to create a new role for the small independent store. Many people today make "top up" purchases from these local shops between relatively infrequent, bulk buying visits to the superstore.

Figure 4.4 shows how the allocation of grocery turnover between the main marketing channels has changed over the period 1938 to 1978. Although, overall, the proportion of grocery sales channelled through wholesalers was very similar in the two years (at 35-6%), this general figure conceals several important developments over the intervening period. In the first place, it conceals significant changes in the relative importance of the wholesale channel to particular grocery products (NEDO, 1971a). Second, there has been a sharp reduction in the number of direct links between producers and unit retailers. This has been offset, however, by the large increase in the proportion of sales through multiples, which almost invariably deal directly with producers. In 1938, the multiples accounted for around 38% of the direct flow of groceries from producer to retailer; by 1978-9, this proportion had risen to 82%. Third, in 1978-9, the majority of supplies channelled through wholesalers were collected by the retailer from cash and carry warehouses, which did not exist in 1938. There has been a very large reduction in the proportion of groceries delivered by the wholesaler. Changes in the allocation of grocery flows among marketing channels, therefore, partly reflect variations in the relative importance of the different types of retail organization, but are also the result of producers and wholesalers curtailing deliveries to small unit retailers. The distribution of groceries to small independent shops is discussed in greater detail in the next section.

Supply of Groceries to Independent Stores.
Independent grocery stores can obtain their supplies from four possible sources: cash and carry, voluntary group wholesaler, traditional wholesaler or the producer. Few up-to-date statistics are available on the proportions of independents' supplies obtained from these sources. A
survey by Thorpe et al. (1973) provided the following estimates:

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash and Carries</td>
<td>42%</td>
</tr>
<tr>
<td>Voluntary Groups</td>
<td>35%</td>
</tr>
<tr>
<td>Traditional Wholesaler</td>
<td>4%</td>
</tr>
<tr>
<td>Producer</td>
<td>19%</td>
</tr>
</tbody>
</table>

Some of these figures can be updated with the results of more recent surveys. On the basis of a sample of 800 shops in 8 areas, Bates (1976) estimated that 48% of independents' supplies were obtained from cash and carry warehouses. This apparent increase in the importance of the cash and carry was confirmed by an Economist Intelligence Unit survey (1980), which established that independents acquired roughly half their supplies from this source. Some of this additional cash and carry trade appears to have been displaced from voluntary group wholesalers, some of which have raised their minimum drop sizes. The survey of four large voluntary groups in 1978-9 suggested that their relative importance had declined. On the basis of this survey, the voluntary group wholesalers share of the independent market should be revised downward to around 27%.

It is also likely that some of the growth in cash and carry sales is the result of manufacturers curtailing an increasing number of deliveries to independent stores. Although most manufacturers had stopped delivering supplies to the smaller independents prior to 1972, minimum drop sizes continued to rise after this date forcing larger independents to obtain their supplies from alternative sources. Also after this date two large food manufacturers (one of tea and the other of crisps) abandoned van sales operations and replaced them with systems of pre-ordered deliveries to much smaller numbers of independents. The growing popularity of cash and carry warehouses may also be partly attributed to the fact that they tend to hold a wider range of stock than delivered trade warehouses, particularly of non-food products (Tanburn, 1981).

These average channel allocation figures conceal wide variations between independent shops in their use of the various sources. A major distinction can be drawn between stores belonging to voluntary groups and "pure independents" that are not affiliated to a voluntary group. Independents
are fairly evenly divided between these two categories. Table 4.5 shows the approximate channel allocations for these two types of independent store, again using data compiled by Thorpe et al. (1973). The survey of voluntary groups in 1978-9 revealed that on average independents affiliated to voluntary groups have been reducing the proportion of supplies obtained from group wholesalers. It is likely that there has been a corresponding increase in the use of cash and carries by voluntary group affiliated retailers. Between 80 and 90% of these retailers are believed to use cash and carries.

Few reliable statistics could be found on the supply of goods to unaffiliated retailers. According to Thorpe's estimates, it would appear that the proportion of their supplies obtained from producers may be slightly higher than that which voluntary group retailers acquire from this source. This is a surprising finding as the ability of stores to qualify for direct delivery is closely related to shop size and as the unaffiliated stores have been shown to be significantly smaller than their voluntary group counterparts in terms of both sales area and turnover (Bates, 1976). Deliveries from traditional wholesalers are estimated to account for around a third of their supplies (Tanburn, 1981). As this represents less than 5% of total grocery sales, no separate survey was done of this sector of the market. Attention is confined to voluntary group and cash and carry operations.

Summary

As a convenience good, food is marketed intensively through a comparatively large number of retail outlets. This has created a demand for an intermediate wholesaling stage in the distribution of grocery products. In the latter half of the 19th century, most of the wholesaling work was undertaken by separate agencies. Over the past 50 years, however, the role of the independent wholesaler has considerably diminished. The wholesaler has been bypassed on the one hand by manufacturers keen to promote their products more heavily at the retail outlet and, on the other, by those multiple retailers who, by operating their
own warehouses and transport fleets, have assumed responsibility for the traditional wholesale functions of bulk storage and shop delivery. The growth of the multiples' market share from around 20% in 1950 to 56% in 1982 (Monopolies and Mergers Commission, 1981; Nielsen Researcher, 1983) has resulted in a major erosion of trade from the wholesaler and increased the importance in the grocery trade of direct links between producer and retailer. To help stem this loss of business, wholesalers have changed their trading practices and the nature of the services they offer. This has partly involved transferring responsibility for the transport of supplies to small independent retailers.

The displacement of grocery business from indirect to direct marketing channels has been promoted by a host of factors, the most important of which can be summarised under the following headings:

1. **Economic factors:**
   a) as a result of increases in the scale and capital intensity of production, food manufacturers sought greater control over the final sale of their products.
   
   b) economies of scale in food retailing and the benefits of self-service selling have been more fully exploited by the multiples, giving them a more competitive cost structure.
   
   c) the multiples accumulated the capital necessary to set up storage and delivery systems.

2. **Technological factors:** improvements in food processing, packaging and materials handling facilitated direct bulk delivery from manufacturers to retailers and the adoption of self-service in supermarkets.

3. **Social factors:** the greater affluence and mobility of shoppers, coupled with a desire to shop less frequently and for larger amounts, has permitted a spatial concentration of grocery sales in fewer, larger outlets, the vast majority of which are operated by multiples which deal directly with manufacturers.
4. **Legal factors:** the relaxation and ultimate abolition of retail price maintenance freed the multiples to compete on the basis of price and thereby win sales from smaller, less efficient, independent outlets.

As the importance of the wholesaler as a separate agency in the distribution of groceries has diminished, the functions of localised storage and store delivery have been taken over increasingly by food manufacturers and multiple retailers. To assess how this change in the organizational structure of the marketing channel has affected the way in which groceries are physically distributed, one must examine the systems of distribution that the manufacturers and multiples have substituted for that of the traditional wholesaler. The nature of these alternative systems, which today account for around two thirds of the total sales of processed foods (Tanburn, 1981), is discussed at length in the following chapters. In the next chapter it is shown that these systems comprise different logistical channels, and that as a result of various factors, the relative usage of these channels by manufacturers and multiple retailers can vary widely.
Chapter 5
Logistical Channels

Like marketing channels, logistical channels can be considered to have two dimensions:

i) VERTICAL: the number of nodes and links that comprise the route from factory to shop.

ii) HORIZONTAL: the number of similar nodes at each stage in this route (or supply line).

This chapter will examine the various components in the sections of the vertical channel controlled by manufacturers, multiple retailers and wholesalers. Chapter 6 will consider the way in which these are integrated into complete logistical channels, extending from factories to shops.

FOOD MANUFACTURERS

Before analysing the present structure of manufacturers' distribution systems, it will be useful to examine the way in which these systems have evolved.

Historical Development of Manufacturers' Distribution Systems:

A simple, four-stage evolutionary model has been devised to illustrate the development of food manufacturers' distribution systems (figure 5.1):

Stage 1: Extension of the Market Area

As the larger food manufacturers extended their market areas in the latter half of the 19th century, they were heavily dependent on the railways for long distance transport and on wholesalers for localised stockholding, merchandising and delivery. It was common for firms to use their own vehicles to distribute products to customers in the vicinity of the factory. Cadbury, for example, employed its own carts and later motorised vans to serve
STAGE 1: Expansion of Market Area

STAGE 2: Development of own Depot and Delivery System

STAGE 3: Modal Shift and Gradual Concentration of Stock

STAGE 4: Contraction of Delivery Network and Concentration of Stock:

- Factory/central storage
- Railway depot
- Wholesale warehouse
- Manufacturers stockholding depot
- Transhipment point
- Shop
- Rail movement
- Road movement

Stockholding Depots only

Centralized Stockholding with Transhipment Depots

Stockholding and Transhipment Depots

Figure 5.1: Stages in the Historical Development of Food Manufacturers' Distribution Systems.
the Birmingham area from its Bourneville factory (Rogers, 1931). The size of area served direct from the factory was tightly constrained at this time by the poor state of the road network and the technical limitations of road vehicles. This similarly restricted the hinterland of the railway depots through which the remainder of the company's business passed. The railway cartage services, for example, provided road delivery only within a radius of two or three miles of the railway terminal (Reader, 1969). In many cases, however, wholesale or large retail customers would use their own vehicles to collect supplies from the railhead.

Distribution at this time was characterised by small consignment size, slow carriage and limited stockholding at or near the point of sale. Because local delivery by road was difficult and costly, goods generally travelled to the rail depot nearest to the customer before being transferred onto a road vehicle. The flow of these goods through the railway network was, therefore, highly dispersed, distributing small, individually wrapped consignments through a vast number of rail depots. Frequent marshalling and sorting of this traffic en route greatly lengthened the transit time. More distant customers might have to wait several weeks for supplies they ordered direct from the producer. Given the long lead times, the wholesaler had an important function in holding stocks locally and satisfying retailers' needs at comparatively short notice.

As time passed, however, the food manufacturers became increasingly dissatisfied with this system of distribution. They realised that the growth in their volume of sales was being inhibited by long lead times, poor stocking practices and the general failure of intermediaries to promote their particular brands (Corley, 1972). As the manufacturers were investing heavily in new plant, they were anxious to ensure that this investment yielded a good return (Jefferys, 1954).

As explained earlier, most criticism was levelled at the wholesalers who, it was felt, paid too little regard to brand names and often failed to bring new products to the attention of their retail customers. This became less tolerable as competition between manufacturers, whose market
areas in many cases now completely overlapped, intensified and as they tried to increase sales by developing new types of processed food.

**Stage 2: Development of Depot and Delivery System**

In an effort to extend their control over the marketing and supply of their products many of the larger food manufacturers established their own distribution systems, principally in the inter-war period. This involved the dispersal of stocks to depots around the country, the vast majority of which were located at rail terminals. Some companies operated their own fleets of delivery vehicles from these stockholding points; others employed the services of local hauliers.

The tendency for food manufacturers to operate decentralised distribution systems can be largely attributed to the fact that food is a convenience good, characterised by fast rates of turnover. Products such as food which "turnover" rapidly require speedy delivery to the point of sale. If stocks are not replenished quickly enough and "stock-outs" occur then, food being a convenience good, customers are much more likely to buy a substitute product or shop elsewhere than await the arrival of fresh supplies. As the time when food manufacturers were extending their distribution operations, the railways were unable to provide a fast and reliable delivery service over long distances. If the manufacturers were to ensure that retail outlets remained adequately supplied, therefore, they had little choice but to hold stock within easy reach of these outlets.

Like stockholding, the sales operation was also decentralized, with the distribution depots commonly serving as bases for the local sales force. For manufacturers to trade directly with a vast number of retail outlets and promote their goods at point of sale, it was essential for them to expand and decentralize their sales activities. Peek Frean, in 1922, was able to distribute biscuits to 40,000 outlets through a system of 23 depots (Corley, 1972). By 1938, Cadbury was supplying around 100,000 outlets from 17 depots (Cadbury Bros. Ltd., 1945).

The development of distribution depots by food
manufacturers was not motivated solely by their desire to market their products more intensively. It also enabled them to reduce their transport costs by making more efficient use of the railway trunk haul. Instead of dispatching goods in small consignments through a large number of railway depots, the manufacturers could now send loads in considerable bulk to a much smaller number of their own stockholding points (Cadbury Bros. Ltd., 1945). By consolidating trunk flows into larger loads, the manufacturers were able to obtain more favourable rates from the railway companies. One important consequence of this rationalization of the pattern of trunk movement, was that local delivery distances were lengthened. Goods were no longer carried by rail as close as possible to their final destination. The concentration of traffic on a smaller number of rail terminals altered the relative distances goods moved by road and rail, extending the former and shortening the latter. Some of the reduction in railway trunking costs was, therefore, offset by an increase in local delivery costs.

In some cases the area served by a depot was delimited by the distance that a road delivery vehicle could travel within a driver’s daily work shift, allowing time for the unloading of supplies en route. Some firms extended this range, however, by establishing sub-depots (also known as "transhipment depots", "transit depots" and "transfer sheds") in areas beyond the delivery range of the nearest stockholding depot (Attwood, 1971). For example, in 1929, Huntley and Palmer, the biscuit manufacturer, supplemented its network of 26 stockholding depots with a further 21 non-stockholding "transfer sheds" (Corley, 1972). Usually these satellite depots acted merely as break-of-bulk points and bases for small fleets of delivery vehicles. They had no stockholding role. Supplies trunked in from the parent depot would be disaggregated and delivered within several days. By thus divorcing the transhipment function from the stockholding function, it was possible for companies to relax the logistical constraint imposed by the daily range of delivery vehicles. This offered scope for a further expansion of the hinterlands of storage depots and
lengthening of road delivery distances. It also introduced firms to the practice of trunking goods by road, a practice which became widespread in the postwar period.

The lengthening of road delivery distances and the efficiency of the delivery operation were also promoted by advances in road vehicle technology and improvements to the road network. The introduction of the motor vehicle permitted an expansion of local delivery areas, as the lorry had a range roughly three times greater than the horse and cart (Jefferys, 1954).

The new system of distribution permitted economies in the packaging of goods. Previously when goods were distributed in small, individual consignments each order had to be securely wrapped. Now they could be transported in bulk from factory to depot in returnable containers, and dispatched from the depot in cheap, and often fairly flimsy, wrapping. Cadbury, for example, by developing its own distribution system, was able to reduce packaging's share of total distribution costs from 14% to 5% between 1927 and 1937 (Cadbury Bros. Ltd, 1945).

Cadbury was the only large food manufacturer to publish a detailed record of its distribution operations in the interwar period. Although it is not known how representative Cadbury's experience in distribution was at this time, the information the company has provided offers a good indication of the scale of benefits that manufacturers could obtain by developing a depot system. Between 1922 and 1938 Cadbury was able to reduce its distribution costs per unit by almost 50% while increasing its total sales by around 650%. (figure 5.2) Between about 1925 and 1931, savings in transport and packaging costs were largely offset by the heavy capital costs of setting up the new depots. From 1932 onwards, however, the rapid growth in sales volume, fostered by the new system of distribution, permitted the spreading of these overhead costs across a much larger depot throughput, bringing down the unit cost of distribution quite sharply (Cadbury Bros. Ltd., 1945).

The actual manner in which food manufacturers developed their distribution systems, and the character of these systems, varied quite considerably. It is possible to
Figure 5.2: Variations in Distribution Costs and Sales during the Development of a Depot System: case of Cadbury Bros. (after Cadbury Bros., 1945)
indentify four general approaches:

i) Development of an exclusive "own use" system: Companies adopting this strategy, well exemplified by Cadbury's, gradually established a system of depots each with its own fleet of delivery vehicles and used exclusively for the distribution of their own products.

ii) Development of a "for hire" distribution system: The best example of a company following this course was Lever Brothers. In 1918 they set up SPD ("Speedy Prompt Delivery") as a subsidiary company whose primary duty was to handle the local delivery of Lever Bros products but which could also provide a distribution service for other firms (Reader, 1969).

iii) Acquisition and expansion of local haulage service: Not all firms developed a distribution system of their own from scratch. Tate and Lyle, for example, began by contracting out their delivery work to local hauliers who offered both a storage and a transport service. In 1936, they acquired the largest of these hauliers, Pease Transport, who operated from a base in London, and used this as a nucleus for the subsequent development of a depot system of their own (Tate and Lyle Transport Ltd., 1974).

iv) Continued reliance on local hauliers: Some firms have preferred to this day not to invest scarce capital in depots and vehicles, nor to encumber management with additional responsibility for distribution. Instead, they have contracted out their local delivery to haulage companies that can both store and deliver their goods. This has been a common practice among American firms such as Kellogs and Quaker Oats which set up factories in Britain in the inter-war period.

Stage 3: Modal Shift and Associated Depot Closure

In the 1950s and 60s, the railways lost large volumes of freight traffic to road transport, particularly in those commodities which were being penalised by the railway's
"value of service" pricing scheme (Thompson and Hunter, 1973) and those which demanded a faster and more reliable service. Processed foods fell into both these categories and so were natural candidates for a modal shift from rail to road. This change in the modal split can be only partly attributed to an "actual transfer of custom" between the two modes (Ministry of Transport, 1965). The increasing dominance of road transport largely reflected its success in attracting the large volumes of new traffic being generated over this period. Between 1952 and 1962, the output of the food manufacturing industry increased by roughly a third (Annual Abstract of Statistics, 1963) and a large proportion of this increment was transported by road. Indeed, by 1958, foodstuffs accounted for a fifth of all tonnage carried by road (Ministry of Transport, 1959).

Freight was attracted onto road transport by improvements both to the operating performance of lorries and to the road network, particularly after 1959 with the construction of motorways. These improvements not only promoted a transfer of longer distance trunk movements from rail to road; they also permitted a further lengthening of local delivery distances and consequent expansion of depot service areas. This expansion of depot service areas enabled companies to distribute throughout the country from a smaller number of depots. Large reductions in depot numbers occurred in the late 1960s and 1970s and these will be discussed in stage 4 of the model. It is important to note at this stage, however, that some companies gradually began to thin out their depot networks in the 1950s and early 1960s and that this process was partly associated with the modal shift from rail to road.

Stage 4: Contraction of the delivery network and concentration of stockholding:

Since the mid 1960s, many manufacturers have quite radically altered their distribution systems, putting into practice many of the ideas of physical distribution management. Many of these ideas can be traced back to the second world war, when they were applied in the context of military logistics (Smykay, 1964). The later upsurge of
Figure 5.4: Relationship between Order Size and Profitability. (after Willis, 1975)
interest in the commercial application of these ideas has been attributed partly to the fact that other sectors of company business had been overhauled leaving distribution as the "last cost-saving frontier" (Drucker, 1962) and partly to the upward trend in the real cost of distribution (Pettit, 1976). Many firms subjected their distribution activities to close scrutiny for the first time. A common finding was that the upper margin of sales, comprised usually of small orders delivered direct to small outlets, was being won at high cost in distribution terms (Willis, 1977). For example, of the Associated Biscuit Manufacturers' 76,000 customers (in the late 1960s), 34,000 bought less than 100 cases "and, therefore, hardly recompensed the company for the cost of representatives' visits and deliveries" (Corley, 1972). It has been shown that delivery costs vary inversely and exponentially with order size (Bowen and Mundy, 1972; Williams, 1975) (fig. 5.3). Once the cost of distributing these small orders was taken into account, it often appeared that maximum sales did not yield maximum profit (fig. 5.4). Many companies reacted to these findings by cutting back on the delivery of small amounts (Hussey, 1972). This they did either by raising "minimum drop size" (the minimum amount they were prepared to deliver) or by imposing prohibitive surcharges on small orders (Walters, 1976). Heinz, for example, raised its minimum drop size from 5 cases to 15 cases in 1970 (Self-Service and Supermarketing, 1970).

Table 5.1 shows how a group of large food manufacturers have, in recent years, reduced the number of outlets they supply. This contraction of food delivery networks effectively reversed the inter-war policy of these manufacturers which was to trade directly with as many retailers as possible. The severance of many of these direct trading links was now considered acceptable for reasons that have been outlined earlier (p.75). The number of food delivery points was also diminishing as a result of other developments outside the manufacturers' control. Many small independent shops were closing down as a result of competition from the multiples, redevelopment schemes and fiscal policies (Dawson and Kirby, 1979). In the more
Table 5.1: Reductions in the Numbers of Outlets Served by a Sample of 8 Large Food Manufacturers.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>90,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30,500</td>
</tr>
<tr>
<td>Margarine</td>
<td>31,000</td>
<td></td>
<td>23,000</td>
<td></td>
<td></td>
<td>10,300</td>
<td></td>
</tr>
<tr>
<td>Biscuits</td>
<td>19,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11,000</td>
</tr>
<tr>
<td>Confectionery</td>
<td></td>
<td>32,000</td>
<td></td>
<td>22,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biscuits</td>
<td></td>
<td>170,000</td>
<td></td>
<td></td>
<td></td>
<td>60,000</td>
<td></td>
</tr>
<tr>
<td>Breakfast Cereal</td>
<td></td>
<td></td>
<td>12,000</td>
<td></td>
<td>7,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canned Vegetables</td>
<td></td>
<td></td>
<td></td>
<td>11,000</td>
<td></td>
<td></td>
<td>5,600</td>
</tr>
<tr>
<td>Tea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>85,000</td>
<td>17,000</td>
<td></td>
</tr>
</tbody>
</table>

Source: personal survey
recent period, the multiples and Cooperative Retail Societies have also been closing many of their smaller branch stores (Institute of Grocery Distribution, 1982).

In the 1960s and 70s, the supermarket chains have expanded their distribution activities, constructing and enlarging central warehouses, acquiring and augmenting vehicle fleets. This has enabled them to increase the volume of supplies they receive in bulk loads into their warehouses and to extend their control over the delivery of goods to their branch stores (Walters, 1976). A small but increasing proportion of supplies are now transported from factory to superstores and hypermarkets which have both large enough turnover and sufficient storage space to receive direct deliveries.

The decline in deliveries to smaller outlets and the increase in the proportion of output distributed direct from the factory has tended to reduce the volume of supplies passing through manufacturers' depot systems. This has left many food depots with excess storage, handling and transport capacity. The desire to reduce this surplus capacity is one of several motives food manufacturers have had for reducing depot numbers and concentrating stock in fewer locations. Other factors that have promoted the concentration of stocks (which will be discussed in chapter 11) include variations in the relative costs of transport and stockholding, and the extension in the range of delivery vehicles made possible by road and vehicle improvements.

In response to these changing circumstances, food manufacturers have centralised their distribution systems to differing degrees. Some firms have concentrated their stocks in one or two locations and make heavy use of large numbers of transhipment depots. At the other extreme are firms that retain the traditional pattern of dispersed stockholding in as many as 25-30 depots. As this high level of dispersal permits the subdivision of the country into delivery areas that are small enough to be served direct from the nearest depot, these firms have little or no need for satellite transhipment depots. The majority of food manufacturers' distribution systems fall between these two extremes of highly dispersed and completely centralized
stockholding (Beattie, 1973). The present structure of distribution systems can, therefore, vary considerably. This is discussed in more detail in chapters 7 and 8.

The next section will consider why firms vary in the proportions of output they channel through their distribution systems. Later chapters will investigate variations in depot numbers and the use of transhipment depots.

The Classification of Manufacturers' Logistical Channels.

The simplest and most widely used classification of manufacturers' distribution systems, that of Bowersox et al. (1968), rests on the distinction between delivery direct to customers from the factory and indirect delivery via intervening depots operated or contracted by the manufacturer. This three-fold classification is based on the relative location of inventories with respect to points of production and sale:

1. ECHELON SYSTEMS: In these systems, as the name implies, stocks are held at one or more intermediate locations on the supply line from factory to shop. The intermediate nodes can serve either as break-bulk points or points where flows converging from various origins are consolidated.

2. DIRECT SYSTEMS: In these systems, stocks are centralized, often at or near the factory and from there distributed direct to the customer.

3. DUAL SYSTEMS (also known as "Combination" or "Flexible" systems): These are hybrid systems, combining some direct delivery from a central store with decentralized distribution from dispersed stockholding points.

Although this distinction between direct and indirect logistical channels is of crucial importance in the analysis of the routeing of product flows, the classification itself is of limited value in the present context as all the food manufacturers surveyed operated dual systems. As shown in
Figure 5.5: Variations in the Proportion of Food Manufacturers' Output Distributed Direct from the Factory.
(source: personal survey)
figure 5.5, however, the dual systems operated by the 23 manufacturers in the sample varied enormously in their relative use of direct and indirect channels. These variations may be related to several factors.

Factors affecting the choice of logistical channel

a) **Product Type:** Processed foods, although generally assigned to a single category in the compilation of transport statistics, differ widely in their physical form and marketing characteristics. It is likely, therefore, that product type will be a major factor determining the mode of distribution. The relationship between these two variables is, however, partly obscured by the presence in the sample of several large firms which produce a variety of dissimilar products. By eliminating these firms and grouping those remaining on the basis of the dominant, or in some cases only, product they manufacture, it appears that product type is a significant factor (Table 5.2).

It is difficult, however, to relate the choice of logistical channel to specific product characteristics, such as value, weight, volume, perishability, turnover rate and substitutability, because this choice can be influenced in different directions by different characteristics. These characteristics can be classified to produce a set of major factors that largely determine the way in which a product is distributed (Ballou, 1978):

(i) **Weight-Volume Ratio** (i.e. density): As shown in figure 5.6, transport and storage costs are both inversely related to the density of the product. The bulkier the product, the less efficiently vehicle capacity and storage space can be used. Direct channels generally have lower storage and transport costs than echelon channels, by virtue of the greater centralization of stock and greater bulk of the freight movement. One might, therefore, expect low density products, that are prodigal in their use of storage and transport capacity, to follow more direct channels than high density ones. There is little evidence of this happening in the grocery distribution system, however. Much of the traffic in low density products, such as biscuits, crisps and breakfast cereals, travels along
### Table 5.2: Logistical Channel Allocation of a Sample of Grocery Products.

<table>
<thead>
<tr>
<th>Product(s)</th>
<th>No. of Firms</th>
<th>% of Output Distributed</th>
<th>Mean %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crisps</td>
<td>2</td>
<td>3.5, 5</td>
<td>4.3</td>
</tr>
<tr>
<td>Biscuits</td>
<td>2</td>
<td>5, 7</td>
<td>6.0</td>
</tr>
<tr>
<td>Tea/Coffee</td>
<td>2</td>
<td>10, 15</td>
<td>12.5</td>
</tr>
<tr>
<td>Breakfast</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cereal</td>
<td>3</td>
<td>9, 15, 25</td>
<td>16.3</td>
</tr>
<tr>
<td>Margarine/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese Spread</td>
<td>2</td>
<td>25, 35</td>
<td>30.0</td>
</tr>
<tr>
<td>Canned Pasta/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td>3</td>
<td>46, 56, 64</td>
<td>55.3</td>
</tr>
<tr>
<td>Canned Fruit</td>
<td>3</td>
<td>50, 60, 60</td>
<td>56.7</td>
</tr>
</tbody>
</table>

**Source:** personal survey

### Table 5.3: Proportion of Grocery Stores Stocking Three Best-Selling Brands of Grocery and Related Products.

<table>
<thead>
<tr>
<th>% of Grocery Stores</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 Brands</td>
</tr>
<tr>
<td>No. 2 Brands</td>
</tr>
<tr>
<td>No. 3 Brands</td>
</tr>
</tbody>
</table>

**Source:** Nielsen Researcher no. 3 (1975)

[ based on the following products: baked beans, instant cereals, ready to eat cereals, coffee, canned evaporated milk, soup, chocolate biscuits, cat food, dog food, toothpaste, household cleaner, detergents, men's hairdressing, shampoos, soap. ]
indirect channels, while high density items like, canned foods and sugar, are more directly distributed from centralized storage premises. It would seem, therefore, that, in the choice of logistical channel, more importance is attached to other product attributes.

(ii) Value-Weight Ratio (or value density): As shown in figure 5.7, as value density increases, storage costs rise while transport costs fall. From this one might deduce that the direct channel would be the most appropriate for products with very high and very low value densities because this would minimize the sum of transport and storage costs. Without empirical data on the value densities and transport and storage cost profiles of a range of products, one cannot test this hypothesis rigorously. There, nevertheless, seems to be some correlation between value density and choice of logistical channel as products with low value to weight ratios such as canned fruit and vegetables tend to be stored centrally and transported as far as possible in bulk loads, whereas some with higher ratios, such as coffee and tea, are distributed through more dispersed stockholding systems to large numbers of outlets. There are, however, some major exceptions to this rule, such as biscuits (Crawford, 1972a) and sugar, which, though of relatively low value density, mainly travel along indirect channels. To account for these apparent anomalies, one must also take into account the turnover rate of the product.

(iii) Turnover Rate: This is partly determined by the physical characteristics of the product, chiefly its perishability, and partly by the nature of consumer demand, in particular the frequency and size of purchases. It has been observed that there is a correlation between a product's turnover rate and its pattern of stockholding (Ballou, 1973). Products with a high turnover rate tend to be dispersed in local depots close to the customers from which orders can be swiftly supplied. Although this dispersed pattern of stockholding is expensive both in the physical cost of storage and in the financial cost of maintaining the large volume of stock it requires, the fast rate of turnover ensures that products spend comparatively little time in storage, keeping the unit costs of
warehousing and stockholding acceptably low. At the opposite extreme, those products with a low turnover rate are generally stored centrally as they can tolerate a slower delivery to the market and as concentrated stockholding is more cost-effective for products which spend a longer time in storage. Distinguishing products with a low value density, such as biscuits and canned fruit, on the basis of turnover rate may help to explain their differing channel allocation. Biscuits, with a faster turnover rate, tend to be distributed through echelon channels, whereas slower moving canned fruit tend to be stored more centrally and delivered directly in bulk loads.

(iv) **Substitutability:** This may be defined as the degree of similarity (in the consumer's mind) between one firm's product and that of a competing supplier. It can affect the choice of logistical channel in two ways. First, the more "substitutable" the product, the greater the importance attached to product availability, for if stock should run out at the retail level, customers would more readily accept an alternative product or brand. By having localised storage, echelon channels are generally considered capable of replenishing retail stocks more rapidly than direct channels, making them more suitable for highly "substitutable" products. However, in the case of some products of this kind, such as canned vegetables and rice pudding, which also have a low value density, the high cost of distribution via an echelon channel would seriously reduce their price competitiveness relative to other very similar items. Where these products have a slower turnover rate, though, as in the case of those mentioned, more direct channels may be able to replenish retail supplies quickly enough. Second, the more "substitutable" the product, the greater is the need to promote it intensively at retail level, and usually this is only possible where the manufacturer deals direct with the shop-keeper or branch store manager and agrees to deliver direct to the shop. Widespread shop delivery generally requires the use of an echelon channel. The effect of marketing policy on choice of logistical channel is discussed more fully below.

(v) **Risk:** In the distribution of grocery products, the
main risk is of products losing their freshness or perishing. As this deterioration can effectively render the product worthless, the dominant characteristic of perishable products, in distribution terms, is their perishability, and this generally over-rides other considerations. The more perishable the product, the greater the emphasis on the fast, frequent and widespread shop delivery that echelon channels can provide.

It can be seen, therefore, that different product attributes affect the choice of logistical channel in different ways, making it difficult to establish a clear relationship between product type and method of distribution. This relationship is further distorted by other factors, related more closely to the nature of the firm. These are considered below.

b) Marketing Policy: The way in which a product is marketed influences its mode of distribution largely through the choice of marketing channel and sales outlets. Reduced to its simplest terms, this choice is between indirect marketing via the warehouses of wholesalers and multiple retailers or direct marketing at the retail outlet. The vast majority of supplies received by wholesalers and retail warehouses are transported there direct from the factory. By far the greater proportion of manufacturers' store deliveries are made from local depots. Direct distribution can, therefore, be roughly equated with distribution to warehouses, indirect distribution with deliveries to shops. One might, therefore, expect the allocation of product flow between direct and indirect channels to correlate with the relative numbers of warehouses and shops supplied.

Unfortunately, although able in most cases to state the total number of outlets served by their distribution systems, none of the manufacturers could disaggregate these figures by outlet type. A Spearman Rank test of the relationship between total number of outlets and the extent of direct delivery, nevertheless, yielded a correlation
coefficient of -0.484 that was significant at the 99% level. This relationship, though weak, was thought to merit further examination.

Number and Type of Outlets Served: The food manufacturers surveyed differed widely in the number of outlets to which they delivered their products (fig. 5.8). The number of outlets served by a manufacturer's distribution system will depend on four factors:

1. The spatial extent of the market area.
2. The density of wholesale and retail outlets in this area.
3. The degree of market penetration at the wholesale and retail levels.
4. The relative proportions of output distributed to warehouses and shops.

As all the manufacturers in the sample market their products nationally, the first and second factors are of little concern here. The wide variations in the numbers of outlets served are, therefore, a function of factors three and four. In respect of the third factor, one may conclude that the manufacturers sampled all achieve a high level of market penetration as they all produce at least one leading brand. As Table 5.3 shows, top brands of grocery products are typically sold through roughly three quarters of the total number of retail outlets. One may speculate, therefore, that differences in the numbers of outlets supplied by the manufacturers are attributable more to variations in the ratio of warehouse to store deliveries than to variations in the degree of market penetration.

Table 5.4 presents estimates of the numbers of grocery stores and warehouses operated by the main distributive organizations and estimates of the proportions of grocery trade they handle. It can be seen that a producer, such as those of canned food, wishing to obtain complete market coverage via indirect channels would require to distribute his products to roughly 1000 food warehouses. On the other hand, to achieve a similar coverage through direct channels,
Figure 5.8: Variation in the Number of Outlets Served by Food Manufacturers' Distribution Systems.
(source: personal survey)
Table 5.4: Numbers of Grocery Warehouses and Shops and the Proportions of Trade Handled, 1978-9.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Approx. No. Warehouses</th>
<th>% of Grocery Turnover</th>
<th>Approx. No. Direct from Stores</th>
<th>Approx. No. Direct from Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiples</td>
<td>100</td>
<td>26%</td>
<td>7000</td>
<td>27% (53%)</td>
</tr>
<tr>
<td>CWS</td>
<td>10</td>
<td>4%</td>
<td>1650</td>
<td>4% (8%)</td>
</tr>
<tr>
<td>Co-op Retail Societies</td>
<td>140</td>
<td>3%</td>
<td>4350</td>
<td>4% (7%)</td>
</tr>
<tr>
<td>Wholesalers (Delivery Trade)</td>
<td>240</td>
<td>11%</td>
<td>21000a</td>
<td>3% (17%)</td>
</tr>
<tr>
<td>Cash and Carry</td>
<td>590</td>
<td>11%</td>
<td>52000b</td>
<td>3% (15%)</td>
</tr>
<tr>
<td></td>
<td>1080</td>
<td>55%</td>
<td>86000</td>
<td>41% (100%)</td>
</tr>
</tbody>
</table>

a-independent stores affiliated to voluntary groups.

b-unaffiliated independent stores (or "pure" independents).

Note: Sales of Groceries through Variety Chains and Department Stores are excluded. These represent 4-5% of the total.

a manufacturer, of say biscuits, might have to distribute his products to around 50,000 outlets. In this respect, the ratios of stores: warehouses in table 5.5 give a measure of the extent to which a manufacturer can reduce the density of his distribution network by delivering to warehouses rather than stores. This helps to explain the wide range in number of outlets served.

Companies which distribute to numbers of outlets between the extremes of 1000 and 50,000 are likely to make significant use of both direct and indirect channels, though the relative proportions of warehouse and shop deliveries may vary widely. Few producers make deliveries to the 52,000 unaffiliated independents which are generally very small and have a low turnover. Only suppliers of products that are perishable and require fast and frequent delivery tend to deal direct with these independent stores, often by means of a van sales operation. Similarly, many voluntary group stores are too small to receive direct deliveries. Through a combination of pricing policies and the imposition of minimum drop sizes, many of the large food manufacturers have reduced the total number of shops eligible for direct delivery to around 20,000. These 20,000 stores, however, account for over three quarters of total grocery sales. It is necessary, therefore, not only to consider the total numbers of outlets in each category, but also the proportions of grocery turnover they handle.

There is a marked concentration of grocery turnover in a comparatively small number of both warehouses and shops. Madigan (1980) has estimated that roughly 70% of grocery sales are channelled through around 4000 outlets. The multiples, for example, in 1980 operated only 9% of grocery stores but held 55% of the grocery market (Institute of Grocery Distribution, 1982). The multiples' similar 8% share of the total number of grocery warehouses is also greatly exceeded by the proportion of indirect flows channelled through them (44%). On the other hand, the 60% of grocery stores that fall into the "unaffiliated independent" category generate only 15-16% of grocery sales and the 590 cash and carry warehouses, from which they draw most of their supplies, account for less than a quarter of
Table 5.5: Approximate Ratios of Shops to Warehouses for Different Types of Retail/Wholesale Organization.

<table>
<thead>
<tr>
<th>Type of Organization</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiples</td>
<td>70:1</td>
</tr>
<tr>
<td>CWS</td>
<td>165:1</td>
</tr>
<tr>
<td>Co-op Retail Societies</td>
<td>31:1</td>
</tr>
<tr>
<td>Voluntary Group Wholesalers</td>
<td>87:1</td>
</tr>
<tr>
<td>Cash and Carry*</td>
<td>99:1</td>
</tr>
</tbody>
</table>

* assumes that 80% of independent stores use cash and carries (Mintel, 1979).

Sources: same as table 5.4

Table 5.6: Concentration of Selected Food Manufacturers' Sales:

<table>
<thead>
<tr>
<th>Firm</th>
<th>Product(s)</th>
<th>No. of Large Retail Customers</th>
<th>% of Total Sales to These Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tate and Lyle (1)</td>
<td>Sugar</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>Cadbury Typhoo (2)</td>
<td>Tea, Jam etc.</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>*</td>
<td>Biscuits</td>
<td>18</td>
<td>80</td>
</tr>
<tr>
<td>*</td>
<td>Cakes</td>
<td>1</td>
<td>15</td>
</tr>
</tbody>
</table>

Sources: (1) Price Commission, 1978a  
(2) Price Commission, 1978b  
* personal survey (firm's name confidential)
all food warehouse turnover (Economist Intelligence Unit, 1980).

This concentration of grocery turnover is reflected in the pattern of sales by individual manufacturers. Few firms were prepared to divulge information about their sales profile. What little data was collected on this subject is presented in table 5.6, and reveals a very high concentration of sales through a small number of major customers (cf. Howe, 1973). A more complete picture of market concentration (which includes sales through wholesalers) is provided by the Nielsen Researcher (1979), which estimated that in 1979 grocery suppliers sold 81% of their output through 285 "buying points" (i.e. wholesale and retail head offices). Food manufacturers can market their products most effectively and economically by confining their direct trading links to major retail and wholesale customers (Grant, 1968). The total number of outlets to which a firm delivers, therefore, depends largely on the manner in which the major retail customers are supplied. The supply links between manufacturers and their large retail customers are examined in detail in Chapter 6.

c) Size of Firm: One might hypothesize that small firms would be more dependent on direct distribution than larger ones partly because they lack the financial resources to develop their own systems of depots and partly because the volumes they distribute are of insufficient size to make the use of an echelon system economical. In its study of the grocery distribution system, Mintel (1977) found evidence to support this hypothesis. Weigand (1963) too has established that a relationship exists between a firm's size and its dependence on particular marketing channels. Of the smaller firms in the sample in terms of turnover, however, only one appears to support this hypothesis. Two of the other "smaller" firms, manufacturing, significantly, products with a shorter shelf life and higher turnover rate, distributed these products to relatively large numbers of customers by contracting out their local storage and delivery work. The motives for this arrangement lay first in the firms' inability to put together loads of sufficient bulk to
justify direct customer deliveries over long distances and secondly in a desire to obtain more favourable rates from distribution contractors by increasing the volume and drop size of goods channelled through their depots. Clearly therefore in considering the effects of firm size, one must also take into account the turnover rate of the products manufactured.

To analyse this relationship between firm size and the relative usage of direct and indirect distribution more fully, one would require a cross-sectional sample of firms varying much more widely in their magnitude.

d) Economics of the Transport Operation: One of the main advantages of trunking large loads direct to customers is that it permits savings in unit transport costs. The economics of bulk delivery, however, dictate that the utilization of the trunk vehicle must be maintained at a high level. This was confirmed by the finding that 10 (71%) of the 14 firms which provided information on this subject required customers to take a full lorry load to qualify for direct delivery and the associated discounts. Three others (21%) fixed the lower limit at half a lorry load, while one fixed it at a third of a full load. In some cases, notably that of canned food, the capacity of the vehicle was defined in terms of the maximum weight it could carry. In the case of lighter products, such as breakfast cereals, tea and crisps, the limit was one of volume. It was not possible, therefore, to compare minimum drop sizes for direct bulk delivery as some firms provided this information in tonnes, others in pallet loads or numbers of cases. The tendency for firms to define this minimum drop size relative to vehicle capacity nevertheless establishes the size of trunk vehicle as another factor influencing the proportion of output distributed direct.

Those firms that were prepared to consider direct delivery of less than full vehicle loads also attached importance to the length of the delivery and the opportunities for combining bulk loads for neighbouring destinations. The shorter the distances involved and the greater the scope for the grouping of loads, the greater was
the likelihood of these firms agreeing to distribute smaller loads directly.

e) Geography of Production: Several firms were constrained in the extent to which they distributed direct to customers by the dispersal of their production in more than one factory. In some instances, customers' orders which in aggregate were large enough to qualify for direct delivery comprised goods drawn from several plants in amounts that could not be economically distributed direct. Some firms mix the stock ranges of their various factories in special warehouses or, by means of inter-plant transfers, at one or more of these factories. Although the orders thus consolidated may be large enough to bypass distribution depots and be delivered "direct" to the customer, at least some of the goods travel indirectly via an intervening mixing point. Firms, nevertheless, consider these mixed bulk orders to be distributed direct and this is reflected in the figures they provided on channel allocations. Several multi-plant firms, however, have found it difficult to operate a system of bulk mixing efficiently and as a result only distribute mixed orders through local distribution depots. Their dependence on the echelon channel is likely to be greater, therefore, than it would have been had the entire range been produced at a single factory. The logistics of bulk distribution from several plants is discussed at greater length in Chapter 9 in the context of the "strategic" routing of flows.

Summary

In examining logistical channels, one must first distinguish direct from echelon channels. With the expansion of their market areas and intensification of their sales promotion, food manufacturers increased their dependence on echelon channels, characterised by highly dispersed systems of stockholding and store delivery. Firms, nevertheless, differed widely in the manner in which they developed these systems. The growth in the volume of their business, the concentration of retail and wholesale trade in fewer, larger outlets and improvements in transport
and materials handling have encouraged a shift away from echelon channels to more direct distribution over longer distances.

Both types of channel were used by all the food manufacturers in the sample, though in varying proportions. Their relative use of these channels is influenced by a series of inter-related factors. As these factors cannot be suitably quantified, it is not possible to measure precisely their effect on a firm's choice of logistical channel or the extent to which they are inter-correlated. There are close inter-relationships between these factors and the strength of these inter-relationships will vary between firms. Some of the firms, for example, take more account of the economics of the delivery operation in determining their marketing strategy than do others. A fuller explanation of channel usage would require a more accurate assessment of the relative importance of these factors and detailed study of the decision-making process.

**MULTIPLE RETAILERS**

**Choice of Logistical Channel**

Like food manufacturers, multiple retailers in the food trade have a choice of logistical channels. They can receive goods direct from the supplier into their shops (direct delivery) or channel them through a "central warehouse" operated either by themselves or a distribution contractor ("centralized" or "consolidated" delivery). As far as groceries are concerned, all but one of the firms sampled employed both these channels. These firms varied enormously in the proportion of supplies channelled through a central warehouse. This confirmed the findings of earlier writers on the subject (Walters, 1976; Thorpe et al., 1973). A comparison of the average proportion of turnover channelled through the central warehouse as calculated by this survey with those of two earlier surveys indicates a decline in the importance of centralized deliveries:
Supermarket Association (1967) 60%
Thorpe et al. (1973) 58%
Present Survey (1978-9) 47%

These figures should be treated with caution, however, as they are calculated on the basis of samples differing in their size and composition. Given the high concentration of grocery trade in a few large firms and the wide variation between them in their use of centralized deliveries, the averages will be sensitive to the selection of larger firms in the sample. The present survey included all but one of the ten largest supermarket chains (in terms of turnover).

A decline in the relative use of central warehouses may be explained in the following ways:

1. Some firms may have reduced the proportion of supplies handled by the central warehouse. This would accord with the policy of some chains to develop superstores that can receive a higher proportion of direct deliveries, and to close down smaller branches that are more dependent on centralized delivery. The survey results were also significantly influenced by the exceptional circumstances of the Tesco chain following its "Checkout" campaign of 1977 (Tree, 1978). As a result of this campaign, Tesco increased its turnover by 40% over a very short period, putting great strains upon its distribution system. This system lacked the capacity to maintain the proportion of centralized delivery at its previous level (Powell, 1978). The proportion of supplies channelled through the central warehouses therefore fell temporarily while the firm expanded its warehouse and transport facilities.

2. There may have been a net shift of trade to firms making less use of centralized deliveries. For instance, one of the fastest growing chains over the period 1967 to 1978 was ASDA, whose exclusive operation of superstores enabled it to receive all grocery supplies into its branches. The recent growth of Tesco's market share also
constitutes a net displacement of trade to a less centralized chain.

3. There may have been a relative growth in the demand for products that are generally delivered direct to the store. Fresh foods and provisions, for example, have increased their share of retail expenditure on food and are typically delivered direct. This, however, must be set against the decline in the consumption of other direct delivery products such as sugar, bread and eggs (Ministry of Agriculture, Fisheries and Food, 1981).

While these average figures for channel allocation in the multiple sector give a broad indication of general trends, they conceal wide variations in the use of the different channels by individual retailers. It is necessary, therefore, to explore in some depth the factors affecting the division of product flow between direct and centralized channels.

Reasons for Centralized Storage and Delivery.

The firms surveyed were asked why they channelled some of their supplies through central warehouses. Their replies can be summarised under eight headings:

1. **Buying terms:** By receiving goods in bulk loads into their warehouses multiple retailers can qualify for bulk discount. These discounts will be discussed in more detail in chapter 6. It should be noted at this stage, however, that these discounts are never large enough to finance multiples' warehouse and transport operations. To justify incurring the additional distribution costs, the multiple retailer must, therefore, derive other benefits from centralized delivery. These are listed below.

2. **Product availability:** By holding large central stocks and operating their own store delivery, they can reduce the risk of "stock-outs" (i.e. shops being out of stock in particular products). By offering more frequent deliveries, multiple retailers can reduce lead times and
accelerate the replenishment of fast-moving lines. Walters (1976) notes, however, that although most grocery multiples claim to provide a superior delivery service from their central warehouses than manufacturers offer, very few have made a quantitative comparison of the two types of delivery.

3. Use of shop space: By relieving shops of the need to hold large amounts of cycle and safety stock, much of the space otherwise used for storage can be used as selling space, thereby raising the productivity of the retail floorspace. It is more cost effective to concentrate stocks in central warehouses located usually in peripheral areas where site costs are lower.

4. Stock control: The profitability of retailing is critically dependent on the rate of "stock-turn". This is defined as the ratio of annual sales to the value of stocks held at the end of the financial year. It is important, therefore, not only to maximise sales, but also to minimise stock levels. The centralization of inventory reduces the total volume of stock that must be held to ensure a given level of service (Maister, 1976). In addition to this, stockholding can be more easily monitored and controlled when it is centralized (Millar, 1983). Where delivery is direct from the manufacturer, it is usually the store manager who decides how much to order. This dispersal of responsibility for ordering is particularly inefficient in a trade, such as the grocery trade, where product lines abound and differ greatly in their turnover rates. The grocery trade, like many others, is subject to the so-called "80:20" rule i.e. roughly 80% of the turnover is generated by only about 20% of the product varieties (Walters, 1976; Ballou, 1978). Under these circumstances, it is necessary to operate a tight ordering and stockholding policy, and this is best achieved through centralization. Chains with highly centralized distribution systems generally have large turnovers per square foot of sales area (Allan, 1980).

5. Labour costs: These costs comprise around 50% of average supermarket operating costs (Dawson, 1982, p111).
According to one large supermarket chain these labour costs can be disaggregated as follows:

- Management 10%
- Customer service 10%
- Check out 30%
- Goods handling 40% (i.e. unloading vehicles, shelf-filling, price marking)
- Personnel/miscellaneous 10%

Of these activities, management and goods handling, together representing around half the total labour costs, can benefit most from centralized distribution. In the case of management, less of the manager's time need be spent meeting sales representatives, drawing up orders and processing invoices. Madigan (1980) describes the case of one supermarket at which 79 separate calls were made by salesmen, taking up 26 hours of the manager's time and requiring the processing of 79 invoices. Goods handling can also be rationalized by the arrival of supplies in fewer, larger loads. The scope for rationalization of this type was indicated by a survey of deliveries to a supermarket in Edgeware reported by one of the distribution directors interviewed. Fifty per cent of this supermarket's supplies arrived in the form of large consolidated loads from a central warehouse and took 45 minutes to off-load. The remainder came in 132 small drops directly from suppliers and took in total around 25 hours to unload. There are numerous references in the literature to similar patterns of supermarket delivery. The GLC Freight Unit, for example, also quote an example of a supermarket receiving 60% of its throughput from a central warehouse in five consolidated deliveries (average load size = 740 cases) (GLC, 1975). The remaining 40% was received in 95 direct deliveries from suppliers (average load size 26 cases). The extent of possible cost and time savings from consolidation have been indicated by Kirby (1975). He notes that one order of 500 packs is 31% cheaper and 47% quicker to assemble and unload than 5 orders of 100 packs.
Furthermore, many manufacturers' direct deliveries are less able to adhere to a tight schedule as their vehicles make many deliveries per trip and spend much of their time on congested urban roads. The unscheduled arrival of these delivery vehicles at various times during the day make it difficult to deploy staff efficiently to handle these deliveries and check invoices. Many manufacturers also use less efficient handling systems than the "roll pallets" now almost universally employed by multiple retailers for centralized deliveries.

6. **Drop quantities:** In some cases, distribution via central warehouse is made necessary by a manufacturer's refusal to deliver less than a certain amount direct to the store. Some alternative channel is needed, therefore, to provide small branch stores with supplies in amounts of less than this. This was a point made mainly by the smaller chains. Larger chains, it would seem, often wield sufficient bargaining power to force manufacturers into waiving minimum drop size restrictions for their smaller branches. This has the effect of discriminating unfairly against small shops operated independently or by smaller multiples.

7. **Security:** It is widely acknowledged that the loss of stock through theft (euphemistically termed "shrinkage") correlates closely with the number of separate deliveries to the shop and "number of times the back door is opened". By greatly reducing the number of deliveries and making it possible to supervise the delivery operation more closely, the centralization of deliveries can significantly reduce pilferage.

8. **Product range:** Many suppliers are too small to be able to offer direct delivery economically. This is particularly true in the recently developed frozen food industry. By making it possible for the small supplier to deliver in bulk to a central warehouse, the multiple retailer is able to include more specialised goods and lesser brands in his product range.
Variations in the proportion of centralized deliveries within chains

The proportion of a branch store's supplies delivered from a central warehouse might be expected to vary within a chain in relation to the shop's size, location and method of trading. Four hypotheses were drawn up to test these relationships.

1. The larger the shop, the greater will be the proportion of supplies received direct from the manufacturer. Bigger shops, by virtue of their higher turnover and greater amount of storage space available, may be more likely to place orders for supplies in excess of manufacturers' minimum drop sizes and perhaps of a size large enough to qualify for special discounts.

It proved impossible to test this hypothesis independently as firms would not provide the necessary data. Instead the retailers were asked directly if such a relationship existed. From their replies it appears that this relationship applies only to a limited extent, at the extremes of the shop size range. At the top end of the range, those stores that can receive direct bulk loads from suppliers and thereby qualify for discounts (i.e. superstores) tend to take a smaller proportion of supplies from the central warehouse. At the bottom end, very small stores may sell a smaller range of goods, excluding some products such as fresh food, provisions and frozen foods, that are typically delivered direct. This may partly reflect a lack of space and partly a failure to generate orders of the minimum size necessary to qualify for direct delivery. Groceries delivered from the central warehouse may then represent a higher proportion of these shops' turnover. The disparities in the proportion of centralized delivery were greatest in the case of one large national chain that operates stores varying in size from small, counter-service shops (< 2000 square feet) to superstores. The proportions for different size categories were as follows:
small counter-service shop (<2000 sq.ft.) 60%
small self-service shop (<2000 sq.ft.) 50%
supermarket (5000 - 20000 sq.ft.) 30-40%
superstore 20%

This firm, however, was exceptional. Most firms operated stores within the range 2000 - 15000 sq.ft. and claimed that across this size range they standardised the proportion of centralized delivery. Eight of the twenty-three multiples operated superstores, however, which drew a higher proportion of supplies direct from manufacturers than the rest of the chains.

2. The further a shop is from a central warehouse, the smaller will be the proportion of goods it will receive from this source. Such a distance decay relationship could reflect the increase in the cost of delivery and deterioration in quality of service over greater distances.

No such relationship was found. With a few minor exceptions, the proportion of centralized delivery was unaffected by distance from central warehouse. The absence of a relationship of this kind may be explained in the following way. The majority of central warehouse deliveries are of large, consolidated loads transported direct to one or two shops. For bulk deliveries such as this the marginal cost of each additional unit of distance is small, so long as the daily range of the delivery vehicle is not exceeded. The "friction" of distance is also considered to be low because the unit cost of consolidated direct delivery represents only a small fraction of the gross margin for grocery products. Multiples, furthermore, have little difficulty in providing the same level of delivery service to shops within the daily range of delivery vehicles. There are even instances of shops lying well outside this range still receiving the same proportion of supplies from central warehouse as those within it, despite the fact that unit delivery costs to these stores are significantly higher. These long distance deliveries can take one of three forms:
a) two-day delivery within driver staying away overnight
b) outbasing of drivers and exchange of vehicles at "staging points"
c) use of contractor (Freightliner or road based distribution contractor)

There were a few isolated examples of shops on the periphery of chains receiving less frequent deliveries of larger loads. To compensate for this less frequent service these stores devoted a larger proportion of their floorspace to storage than other shops in the chain.

One multiple claimed that it had closed a higher proportion of its small shops in areas distant from the central warehouse, partly because of the difficulty of delivering supplies to them efficiently. Many of these shops required comparatively small loads and were most efficiently served by multiple drop deliveries. These, however, were costly to operate at long distances from the central warehouse. In contrast, shops of a similar size in the vicinity of the central warehouse could be served more cheaply and had tended to survive in greater numbers. This indicated that a relationship was developing between shop size and distance from the central warehouse which, theoretically, would accord with the policy of standardising the proportion of supplies shops received from the central warehouse. The greater size of more peripheral stores would mean that the unit cost of delivering consolidated loads to them would be relatively low and hence unlikely to exert a downward pressure on the level of centralized delivery they received. In practice, the relationship between shop size and distance was only weakly developed in the chain in question and was reported by other multiples not to hold for their particular chains. Shop size and location are determined much more by local market conditions than logistical considerations.

3. The proportion of central warehouse delivery will depend partly on the siting of the store. The more central the location within the urban area, the higher will be the site costs and the greater will be the incentive to use shop
space as productively as possible. This would entail maximising the area devoted to selling goods and minimising the back storage area. Shops in expensive locations might, therefore, be expected to hold less stock and be more dependent on central warehouse deliveries:

While this may be a factor in determining overall the average proportion of centralized deliveries for a chain as a whole (discussed in the following section), it does not appear to cause variation between stores within a chain, except insomuch as site correlates with size of store and the nature of the retailing operation. Superstores, for example, are generally located in peripheral sites where land costs are lower and this makes it economically feasible to allocate a higher proportion of floorspace to storage. The relationship between site and type of retailing is discussed below.

The difficulty of separating the effects of site from those of related variables and the inability to obtain data on site sites, store turnover and delivery patterns makes it impossible to test this hypothesis independently. One must rely, therefore, on the assurances of the multiples consulted that the proportion of supplies coming from central warehouse is not directly affected by site costs.

4. The proportion of centralized delivery will be affected by the nature of the retail operation:

It has already been seen how, in one chain, small counter-service shops received a higher proportion of supplies from central warehouses than self-service stores. Only about 0.5% of the branch stores operated by multiples in the survey were of this type, however. A more important distinction can be drawn between two different types of self-service operations. These are typified by the conventional supermarket and the discount store.

Discount stores are characterised by a small number of lines, minimal service and low prices. Of the eight multiples (out of 23) that operated discount stores, only three were firmly committed to this mode of retailing. The others still considered "discounting" ventures to be at an experimental stage and operated only a few stores of this
type. Most discount stores are located in or around town centres and were formerly small supermarkets. Their conversion to a discount operation has been designed to help them compete with the new generation of larger supermarkets and superstores that have a more favourable cost structure and are more accessible to the motorised shopper.

In all cases, the discount stores received a higher proportion of their supplies from central warehouse than other stores in the chain. Only two firms, the two largest operators of discount stores could offer separate figures for them (table 5.7).

Two of the firms that had well developed chains of discount stores had designated central warehouses for the exclusive storage and handling of discount store supplies. These separate systems of centralized distribution had been created for the discount stores because their product ranges differed markedly in size and composition from those of the other conventional supermarkets in the chain.

The high dependence of discount stores on centralized distribution reflects the desire to hold store costs to a minimum. Labour costs are held down by the very high level of consolidated delivery. Unit site costs are also kept low by reducing the back store room area and maximising the sales per unit area.

Summary:

The level of centralized delivery appears to be fairly uniform across individual retail chains. Neither distance from central warehouse nor siting has a significant effect on the proportion of consolidated deliveries a branch store receives. This proportion does vary at the extremes of the shop size range (> 25,000 sq. ft., <2000 sq. ft.), but not significantly across the broad intervening range. A growing number of small to medium stores are being converted to the discount style of retailing which demands a much higher degree of centralized delivery than conventional supermarkets.
Table 5.7: Proportion of Supplies from Central Warehouse.

<table>
<thead>
<tr>
<th>Discount Stores</th>
<th>Average for Whole Chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm 1</td>
<td>90%</td>
</tr>
<tr>
<td>Firm 2</td>
<td>95%</td>
</tr>
</tbody>
</table>

Source: personal survey.

Figure 5.9: Variations in the Proportion of Turnover Channelled through Central Warehouse by Grocery Multiples.
(source: personal survey)
Variations in the proportion of centralized deliveries between chains

Despite the numerous advantages of centralized delivery, firms differ widely in the proportion of turnover they channel through their central warehouse(s) (fig. 5.9). This is a variation that many people within the trade find baffling. Walters (1976) lightheartedly suggests that there are as many views on why this should be so as there are retailers. The variation is sometimes ascribed rather vaguely to differences in "business philosophy" or "trading behaviour", expressions that need clarification. Thorpe et al. (1973) identify eight factors thought to influence the choice of distribution strategy:

1. Number of branches
2. Dispersal of branches
3. Size of branches
4. Growth history
5. Commodity mix
6. Vertical integration
7. Sales density
8. Rent (cost of occupancy)

They do not adequately explain the role of these factors, however, and represent the relationships between them and the level of centralized delivery in a series of graphs, several of which show trends that are neither self-evident nor substantiated by empirical evidence.

In the light of the present survey, four major factors have been identified, three of which combine some of Thorpe's variables.

(i) Number and size of shops: There is no significant relationship between the number of shops in a chain and the proportion of centralized deliveries (fig. 5.10). The number of shops and their sizes (measured in turnover) will together determine the aggregate turnover that will have to exceed a certain threshold level to justify the establishment of a central warehouse. Even chains that are too small to operate a separate warehouse, though, organize
Figure 5.10: Proportion of Turnover Channelled through Central Warehouse and Number of Branch Stores (1978-9).
(source: personal survey)
some centralized delivery by concentrating the stocks of some products at one, usually the original, store in the chain and supplying other stores form this base. As all the retailers surveyed were large enough to operate at least one central warehouse, it is not possible here to comment on the minimum viable size of a centralized delivery system. Above this lower size limit, there is no significant relationship between the degree of centralization and turnover (fig. 5.11).

The relationship between the proportion of centralized delivery and the sizes of shop in the chain is complicated by the fact that most chains comprise shops varying widely in size (measured both in floorspace and turnover). Despite this, most chains claim to standardise the proportion of supplies each store receives from central warehouse. While the shop size profile is likely to influence the level at which this proportion is standardised, in the absence of shop floorspace and turnover data it is not possible to test this relationship. Nevertheless, it is important to note that some chains, notably those that include superstores, vary the proportion of warehouse delivery with shop size. This is discussed further in the next section.

(ii) Spatial distribution of shops: Thorpe suggests that the level of centralized delivery falls with increasing dispersal of branch stores. Although not made explicit, this is probably based on the reasoning that more dispersed chains would be more costly to supply from a central warehouse (for a given level of service). This would be particularly so where shops lay beyond the daily range of a delivery vehicle (Baker, 1976). This delivery range does not impose an absolute limit on the geographical extent of a chain, as was explained earlier.

Deliveries beyond this range, however, are very exceptional, and apply to very few of the shops operated by the firms surveyed. Most chains, with a centralized grocery delivery system had all their branches within the daily delivery range. Indeed, for a group of eight chains for which store location data were available, 94% of the
Figure 5.11: Proportion of Turnover Channelled through Central Warehouse and Total Turnover (1978-9).
(source: personal survey)
branches were within 100 miles of the central warehouse that supplied them (fig. 5.12). These chains were much more compact than that of ASDA (firm 9 in fig. 5.12) whose superstores are not dependent on a central warehouse for grocery deliveries. The spread of ASDA superstores shows that its store location policy has not been constrained by the need for branches to be within easy reach of a central warehouse (Jones, 1981). In 1978, for example, ASDA opened stores in such widely dispersed locations as Aberdeen, Plymouth, Norwich and Birkenhead (ASDA Annual Report, 1979).

The spatial distribution of branch stores is, therefore, partly related to whether or not the firm operates centralized distribution. There was no evidence to show, however, that in the case of those multiples that engaged in centralized distribution (firms 1-8 in fig. 5.12), there was a significant relationship between the proportion of centralized deliveries and the dispersal of branch stores. Figure 5.12 shows, for the multiples providing store location data, the cumulative proportion of branch stores over increasing distances from the central warehouses that supply them. There is little relationship between the configuration of these cumulative frequency curves and the proportions of supplies received from central warehouse. A widely dispersed chain such as 7, with stores scattered widely up to a distance of 140 miles from the central warehouse can achieve the same level of centralized delivery (60%) as a very compact chain, such as 1, with all its stores concentrated within a 50 mile radius of the central warehouse. It was also found in the case of two of the larger multiples which operated more than one central warehouse, that dispersal of stores around each warehouse could differ markedly despite the fact that the level of centralized delivery was uniform across the whole chain. No evidence was, therefore, found to support the contention of Thorpe et al. (1973) that the importance of centralized delivery declines gradually with the increasing dispersal of branch stores.

At a smaller spatial scale, Thorpe et al. (1973) claim that shop occupancy costs will affect the relative use of central warehouses. Chains composed of stores located in
Figure 5.12: Distances from Central Warehouses to Branch Stores:
Selected Grocery Multiples.
(source: personal survey)

*distances measured from head office.

<table>
<thead>
<tr>
<th>Firm</th>
<th>No. of Stores</th>
<th>% of Supplies Through Central Warehouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>57</td>
<td>62</td>
</tr>
<tr>
<td>4</td>
<td>65</td>
<td>38</td>
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<td>5</td>
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<td>6</td>
<td>86</td>
<td>98</td>
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<td>7</td>
<td>43</td>
<td>60</td>
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<td>8</td>
<td>93</td>
<td>65</td>
</tr>
<tr>
<td>9</td>
<td>77</td>
<td>0</td>
</tr>
</tbody>
</table>
town centres where land costs are high might be likely to make heavier use of central warehouses, reducing the amount of premium space in shops devoted to storage. By comparison, chains of neighbourhood stores would not be under the same pressure from retail land costs to centralize stocks in a peripheral depot. Although all the chains with highly centralized distribution (affecting in excess of 75% of their turnover) are "high street" retailers, it is difficult to confirm this hypothesis, for several reasons. First, several of the chains operate stores in different parts of the urban area. Second, land costs can vary as much between urban areas as within them. To test this hypothesis rigorously, one would require land cost data which most firms are reluctant to provide. Third, the siting of a store is usually closely related to its size, neighbourhood stores generally being smaller than "high street" supermarkets. It is difficult, therefore, to separate the effects of size from those of siting.

3. Growth history: As they have grown, grocery multiples have differed in their allocation of investment between retail outlets and the supporting system of distribution. In the early stages of their growth, those multiples which failed to establish their own warehousing and transport facilities often ran into difficulties (Jefferys, 1954). In later stages of their development, they began to differ in the emphasis they placed on these facilities. Reliance upon centralized distribution has been partly conditioned by the way in which chains have expanded. There have been two modes of expansion (Winslet, 1956):

a) Organic or "unitary" growth: where the chain expands gradually by setting up new stores from scratch.

b) Growth by acquisition or merger.

Organic growth has enabled multiples to expand their distribution facilities in phase with the spread of the chain. It is not possible, however, to expand the capacity of these facilities gradually in line with the addition of individual shops, as a central warehouse represents a large indivisible investment. A newly opened central warehouse
will have excess capacity to accommodate future growth in turnover and, possibly, plans to centralize the delivery of more products. Bowen and Mundy (1972) have suggested that firms take advantage of this situation to centralize the delivery of a higher proportion of their supplies. As turnover increases, this proportion is gradually reduced until it reaches the minimum level acceptable to the firm. Warehouse capacity would then be expanded and the same cycle would be repeated. This implies that the proportion of a chain's supplies passing through central warehouse(s) fluctuates through time. This was not confirmed by the survey. Most firms claimed that the trend over the previous decade had been towards increasing the proportion of supplies coming through central warehouse and that in many cases this proportion had now stabilised. It is very unusual for a supplier to be asked to revert to direct branch store delivery. The one major instance of this happening was in the aftermath of Tesco's Checkout campaign when the firm's distribution system became seriously overstretched in a very short time. If the evolutionary process that Bowen and Mundy describe were widespread, suppliers would be regularly called upon by multiples to switch their deliveries from shops to warehouses and vice versa, causing much disruption to their distribution operations. The survey revealed, however, that this was not the case. Bowen and Mundy's idealised model also presupposes that the chain grows gradually and organically. In practice, however, very few chains have developed entirely in this way: only two, for example, out of the total sample of 23. The remainder have grown partly and in varying degrees by acquisition.

The scale of an acquisition can vary enormously from the purchase of a single shop to that of a chain of hundreds of shops complete with supporting distribution system. Usually, small numbers of shops can be quite easily integrated into the existing system of distribution. Larger scale takeovers, however, have usually been followed by a process of rationalization. This often entails the closure of many of the smaller stores in the acquired chain. The distribution director of one large multiple, which had
been formed by a long series of takeovers, estimated that on average 40% of the shops in an acquired chain would be closed down. These need not all be small, inefficient stores. Where the areas served by the acquiring and acquired chains overlap, it would necessary to eliminate competitive stores. The geography of the chains could, therefore, be radically altered by such a takeover, making it essential to reorganize the system of centralized distribution. This reorganization would, in many cases, be further complicated by the associated acquisition of central warehouse or warehouses. There have been several instances in the past decade of these warehouses either being sold off separately or being disposed off following the acquisition of the chain. However, roughly a third of the central warehouses currently operated by the sample of 23 grocery multiples were obtained through the acquisition of chains. The integration of these warehouses into the acquiring firm's existing distribution network has sometimes been further complicated by the fact that the chains they previously supplied provided a significantly different level of centralized delivery. All this has made it difficult for those chains growing principally by acquisition to plan carefully the long term development of a centralized system of delivery. It is not surprising, therefore, that those large national chains that have expanded mainly by acquisition over the past 20 years channel a relatively small proportion of supplies through their central warehouses. In contrast, those chains that are most dependent on central warehouses are characterised by a long period of organic growth.

4. Commodity Mix: The overall proportion of supplies passing through the central warehouse is the net result of the retailer's policy on the reception of many different classes of product. As some product classes are more suited to centralized handling by the retailer than others, the relative importance of central warehouse deliveries will depend upon the range of goods stocked and their relative contribution to total turnover.
Some products are typically distributed via central warehouse:

Imported goods (esp. canned fruits) - transported in bulk loads from the ports at particular times of year reflecting overseas growing seasons.

Own label products - almost all own label supplies are channelled through central warehouses. In a survey of 23 food manufacturers, Thorpe et al. (1973) found that roughly half delivered all their own label production to central warehouses, while almost 75% distributed more than 80% of own label output in this way. A multiple's policy on the development of own label products can, therefore, carry important implications for distribution. As figure 5.13 shows, for a sample of 8 firms, there is a reasonably close correlation between the importance of own label products and the level of centralized delivery.

The decision on which of the remaining products to take through central warehouse is usually based on a consideration of the following criteria:

(i) **Value density**: Many multiples prefer to stock less bulky, higher value lines.

(ii) **Rate of turnover**: There is some disagreement between chains over the desirability of centralizing the delivery of fast-moving lines. Some firms preferred to take these products through their central warehouses so that they could ensure a fast and regular delivery to shops. Other chains, however, had distribution systems that were not geared up for such a rapid through-flow of supplies and they generally had products with a faster rate of turnover delivered direct to the shops (Christopher et al., 1977). There was a greater consensus on the desirability of centralizing slower moving lines to reduce stock levels in these products (Madigan, 1980).

(iii) **Perishability**: The majority of firms had highly perishable products delivered direct. Some of the more centralized chains, however, had distribution systems
capable of handling fresh and frozen foods and provisions. Broadly speaking, as sales of these products constituted an average of around a third of a chain's total turnover, chains that had not incorporated in their systems of centralized distribution could channel a maximum of only 60-70% of their total turnover through the central warehouse.

(iv) Ease of handling: Most multiples avoid taking products such as eggs and biscuits through their central warehouses partly because their greater fragility makes handling difficult.

(v) Product Compatibility: Some products were excluded from multiples' central warehouses on the grounds that they could contaminate other products. Soap powder and toiletries, for example, cannot be kept with various types of food.

Summary

The larger retail grocery chains buy almost all their processed food products direct from manufacturers. These products can either be delivered direct to branch stores by the manufacturer or distributed via the retailers' central warehouse. Retail chains in the grocery trade vary widely in their relative dependence on these two modes of store delivery. Numerous factors affect the proportion of goods channelled through the central warehouse, making generalization difficult. Some of these factors such as the spatial distribution of branch stores and the commodity mix can be subjected to quantitative and fairly objective measurements; others, such as growth history and "business philosophy", are more abstract and their influence is more difficult to assess.

There is considerable uniformity within chains in the proportions of supplies received from the retailer's central warehouse. Significant variations in this proportion tend to occur only where there are pronounced differences within a chain in shop size and manner of selling. The rationalization of retail chains has narrowed shop size differentials, making it easier to standardize distribution arrangements within these chains.
Among the larger retail chains, the (weighted) average proportion of supplies channelled through the central warehouse appears to have declined during the 1970s. This is likely to have resulted mainly from the disproportionately large growth of turnover in chains of low central warehouse dependence, such as those that have grown primarily by acquisition and those largely comprising superstores. Only one firm claimed to have reduced significantly the proportion of supplies flowing through its central warehouse and this was in response to an exceptional surge in its volume of business following a successful sales campaign. Indeed, the majority of the multiples surveyed (54%) said that they had been increasing the proportion of supplies channelled through their warehouses. In all but two cases, however, future increases in this proportion were expected to be marginal (less than 5%). Roughly a third (32%) of the retailers aimed to hold their level of centralized delivery stable. Only three of the firms (14%) claimed that their policy was to reduce this proportion, and in two of these cases this reflected a growing emphasis on larger stores that could receive more direct, bulk deliveries.

It would seem, therefore, that most grocery multiples anticipate little change in their relative dependence on the two main modes of store delivery. The wide disparities between chains in their relative use of central warehouses are likely to remain and changes in the overall proportion of groceries channelled through these warehouses determined more by the allocation of trade between multiples than by individual multiple's efforts to increase or reduce their dependence on centralized deliveries.

WHOLESALERS

The vast majority of grocery supplies handled by wholesalers pass through a single warehouse, either a "delivered trade" or a cash and carry facility. In most cases, therefore, wholesalers have no choice of logistical channels. It is worth considering, however, some of the exceptional circumstances under which such choice exists.

There are two types of voluntary group. The most
important in terms of turnover and numbers of affiliated retailers are the "wholesaler sponsored" groups, such as Spar, Mace and VG. As the wholesalers belonging to these groups only earn revenue on the supplies they handle in their warehouses, they channel their entire trade through at least one of their premises. "Retailer sponsored" voluntary groups, in contrast, have been set up by consortia of retailers, either by acquiring a wholesale business (e.g PGMA-Bob) or by establishing their own depots from scratch (e.g. Londis). As their main aim is to maximise retail sales rather than the profitability of the wholesale operation, these groups are willing to arrange for producers to deliver some supplies direct to the larger shops (i.e. provide a "drop shipment"). The retailer sponsored group, unlike its wholesale counterpart can offer its affiliated shopholders the benefits of centralized buying without requiring them to receive their supplies via its depot(s). Only a small proportion of these retailers' supplies are delivered direct from producers, though, as their demands are usually too small to qualify for drop shipment.

A few instances were encountered of flows channelled via wholesalers passing through more than one depot. One large wholesaler belonging to a voluntary group had until a few months before the interview operated a central warehouse where stocks of longer shelf-life products had been concentrated. This facility did not serve shops directly but supplied mixed, bulk loads to a second tier of local wholesale depots. This centralization of the stocks of slower-moving lines had reduced stockholding and storage costs and enabled the wholesaler to receive goods from producers in large enough loads to qualify for discounts. These benefits, however, had been insufficient to justify the continued existence of the central depot. The firm had decided instead to use the surplus storage space in the local depots and to raise additional capital by selling the central depot site. Somewhat ironically, this wholesaler's parent company, which was engaged in several different forms of food distribution, was seriously considering, at this time, setting up a very large central warehouse to supply groceries not only to the local wholesale depots but also to
cash and carry warehouses and retail depots operated by other subsidiaries. This would rationalize stockholding and distribution within the organization and strengthen its bargaining power vis-a-vis suppliers. It was thought that the resulting savings might outweigh the capital cost of establishing this new facility and the additional transport and handling costs that would be incurred by inserting another node in the chain of distribution. Such a development would be unique within the grocery trade in integrating the distribution systems of wholesale and multiple retail firms.

Links already exist between wholesale voluntary group and cash and carry operations. Many wholesalers are engaged in both these activities, sometimes on the same site. Some of the smaller cash and carries are too small to qualify for a direct delivery of a bulk load from suppliers, in which case these bulk supplies are often centralized at the main voluntary group warehouse and transported out in smaller, sometimes mixed, loads to the cash and carries. As cash and carries have grown in size, however, the need for this break-bulk operation has diminished. By far the greater part of cash and carry supplies come direct from producers.

Notes:
1. It has been decided not to create a separate stage in the evolutionary model for the radical restructuring of the food distribution system that occurred during the 2nd World War, on the grounds that this is best seen as a response to very exceptional circumstances. The wartime situation is discussed in McKinnon (1981a).

2. It is possible to calculate the turnover rate (or rate of "stockturn") for various classes of food product on the basis of the data provided by the Census of Production. The product classification employed by this Census, however, is not compatible with that used in Table 5.2, preventing an assessment of the strength of correlation between the proportion of output distributed directly and the turnover rate. One can use the Census of Production data,
nevertheless, to compare the rate at which stocks of biscuits and fruit and vegetable products "turnover". Finished stocks of biscuits are estimated to "turnover" about 20 times per annum, whereas those of fruit and vegetable products about 8 times per annum (Census of Production, 1979, Summary Table).

3. Against these disadvantages of direct delivery should be set the "merchandising" often done by manufacturers' staff in some sections of the trade e.g. petfoods, cakes.
Chapter 6

The Links between Manufacturers' and Multiple Retailers' Distribution Systems.

Types of Linkage

The previous chapter examined those sections of the logistical channel controlled by food manufacturers and multiple retailers separately. It is necessary now to look at the way in which these two channel sections connect. The four possible delivery arrangements are shown in figure 6.1. Very little flow passes along channel 1. Retailers' central warehouses are generally of a size (in storage capacity and turnover) to receive bulk loads direct from the factory. Indeed, a major reason for multiple retailers operating central warehouses is to obtain the favourable buying terms associated with direct ex-factory delivery. It was not possible to measure this amount of flow, but it is reckoned to be under 5% of total grocery sales.

Channel 4 is estimated to carry around 5% of total grocery turnover, almost all of it passing through superstores.

Over 90% of grocery flow passes along channels 2 and 3. Attention focuses, therefore, on the division of flow between these two channels. The pattern of warehouse and branch store deliveries is presented in matrix form (fig. 6.2). This shows how a sample of 18 food manufacturers distribute their products to a sample of 22 multiple retailers. Each of the multiples purchased goods from each of the multiples, generating a total of 396 trading links. Data was received for 374 of these links. (Where data was unobtainable, the cell remains vacant.)

The delivery arrangements were classified into five categories. Table 6.1 shows the proportions of "arrangements" in each category. There was a slight preponderance of warehouse only deliveries. When the "all" and "most" categories are combined for warehouse and store deliveries, the aggregate proportions (50.9% and 48.8% respectively) closely resemble the corresponding proportions of grocery turnover channelled through each channel. These
Figure 6.1: Manufacturer-Multiple Retailer Logistical Channels.

Table 6.1: Relative Importance of Various Delivery Arrangements.

<table>
<thead>
<tr>
<th>% of all arrangements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All supplies to central warehouse(s)</td>
<td>44.7</td>
</tr>
<tr>
<td>2. All supplies direct to branch stores</td>
<td>41.4</td>
</tr>
<tr>
<td>3. Most supplies to central warehouse(s)</td>
<td>6.2</td>
</tr>
<tr>
<td>4. Most supplies to direct to branch stores</td>
<td>6.4</td>
</tr>
<tr>
<td>5. Even split between warehouse and store deliveries.</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Source: personal survey.
Figure 6.2: Manufacturer-Retailer Linkages in the Grocery Trade
(source: personal survey)
transactional data, therefore, tally with the data on channel throughput, confirming the earlier estimate that roughly half the grocery turnover of the food multiples passes through their central warehouse. (see p. 113)

Roughly 14% of the trading links fall into categories 3, 4 or 5 and hence yield "mixed delivery arrangements". These warrant more detailed comment.

Thorpe et al. (1973) defines mixed delivery with respect to product type, where multiple retailers receive some of their supplies of a product into their central warehouse and the remainder into their branches. For a sample of 11 grocery products (excluding provisions, fresh foods and non-foods), mixed delivery was much more common than exclusive warehouse or store delivery (% figures show the proportion of multiples receiving supplies in this way):

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed delivery</td>
<td>56%</td>
</tr>
<tr>
<td>All to warehouse</td>
<td>29%</td>
</tr>
<tr>
<td>All to branches</td>
<td>16%</td>
</tr>
</tbody>
</table>

Mixed delivery can occur for two reasons:

1. **Goods supplied by two or more producers who have made different delivery arrangements with the same retailer.** Competitive brands then arrive at the shops via different channels. The delivery arrangements of manufacturers producing a sample of ten products were compared. Table 6.2 shows for each of these ten products, cases where suppliers differed in their mode of delivery to the same retailer. It can be seen that in the case of some products such as tea, jam and breakfast cereal, it was very common for competing suppliers to provide different types of distribution. In others, such as those of coffee and canned fruit, there was much greater similarity. Overall, an average of about a quarter of the transactions between competing suppliers and multiples differed in the type of delivery they produced.

2. **Where a single supplier delivers some goods to the central warehouse and some direct to the stores.** All the
Table 6.2: Extent to Which Food Manufacturers Differ in the Method of Delivery to Multiple Retailers.

<table>
<thead>
<tr>
<th>Product</th>
<th>No. of Food Manufacturers</th>
<th>No. of Retailers</th>
<th>% of Retailers Receiving Different Types of Delivery from Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jam</td>
<td>2</td>
<td>19</td>
<td>53</td>
</tr>
<tr>
<td>Tea</td>
<td>3</td>
<td>14</td>
<td>43</td>
</tr>
<tr>
<td>Breakfast Cereal</td>
<td>3</td>
<td>14</td>
<td>43</td>
</tr>
<tr>
<td>Canned Desests</td>
<td>2</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>Biscuits</td>
<td>2</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>Crisps</td>
<td>2</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>Flour</td>
<td>2</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>Salad Cream</td>
<td>2</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Coffee</td>
<td>2</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Canned Fruit</td>
<td>2</td>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: personal survey.
mixed delivery arrangements shown in figure 6.2, (i.e. types 3., 4. and 5. in the five-fold classification) are of this kind. As was pointed out earlier, most multiples tend to standardise the proportion of goods their stores received from the central warehouse. However, exceptions are often made for shops at the extreme ends of the size range which are either too small to receive the minimum size of drop or large enough to accept a direct, bulk delivery from the factory. Of the 14% of trading links that produced mixed delivery arrangements, the vast majority (> 90%) were biases either toward warehouse or store delivery, the biases being evenly divided between the two.

In view of the relative proportions of mixed delivery arrangements stemming from these two sources, it would seem that mixed delivery for a particular product results more from different suppliers of that product using different methods of delivery than from individual suppliers providing retail chains with both central warehouse and store delivery.

Analysis of the Pattern of Linkage.

The organization of figure 6.2 is based upon two statistically significant relationships:

a) between the extent to which a manufacturer distributes goods to the central warehouses of his retail customers and the proportion of his output delivered direct from the factory \(r = .722, \text{sig. level} = 0.999\)

b) between the proportion of a retail chains's supplies passing through its central warehouse and the proportion of suppliers delivering into its central warehouse \(r = 0.479, \text{sig. level} = 0.95\)

The data in figure 6.2 is arranged in such a way as to test the hypothesis that the nature of the delivery will largely reflect the strength of these two relationships. Manufacturers are aligned along the vertical axis in order of the proportion of output they deliver direct from the factory. Multiple retailers are set out along the
horizontal axis in descending order of the proportion of supplies channelled through their central warehouses. Both samples present a wide variation in these proportions, the values in both cases grading reasonably gently over a wide range.

One might expect to find a preponderance of store deliveries above the leading diagonal and a preponderance of warehouse deliveries below it. While there are concentrations of store and warehouse deliveries in the top right and bottom left corners respectively, the central section of the matrix does not display any clear pattern. Making allowances for the subjectivity of the analysis and the limitations of the samples, one may tentatively conclude that the pattern of logistical linkages in the grocery trade shows some regularity, but that there are, nevertheless, numerous anomalies. It would not be possible, therefore, to predict accurately the delivery arrangement between a particular manufacturer and a particular retailer simply on the basis, respectively, of the proportion of total output distributed direct from the factory and the proportion of total turnover channelled through central warehouse.

To explain why no clear pattern has emerged, one must examine the factors that influence the choice between warehouse and store delivery. There are advantages and disadvantages in the two types of delivery for both the supplier and the retailer. These have been discussed in chapter 5. Although the choice of delivery mode rests with the retailer, the supplier can influence this decision by adjusting the following variables:

i) prices - i.e. the level of discounts offered
ii) minimum drop size
iii) service level - lead times for respective deliveries

The way in which these factors affect the delivery arrangements is very difficult to discover as the question of delivery is usually resolved in the confidential, and often complicated, trade negotiations between supplier and retailer. Using information collected in the course of the
survey and culled from published sources it is, however, possible to shed some light on this subject.

Factors Affecting the Mode of Delivery

i) Pricing

Losch (1954) considered the pricing system to be "the most important regulator of a rational spatial arrangement". Similarly, one might expect that if price differences reflected distribution costs, this would generate a "rational" pattern of freight flow. For this to be achieved the price mechanism would have to operate effectively at various levels of decision-making. At the highest level it would have to promote an efficient allocation of flow between logistical channels. In the foregoing analysis of the logistical relationships between food manufacturers and retailers it was not possible to assess the efficiency of the channel allocation; however, a reasonable proportion of the delivery arrangements did appear irrational in the sense that, for example, some multiples with highly centralized distribution systems received branch store deliveries from manufacturers that overall distributed a large proportion of their output directly in bulk loads. It must be asked, therefore, to what extent the pattern of linkage has been influenced by suppliers' pricing policies and if their prices reflect distribution costs.

Distribution costs:

Before a firm can relate prices to distribution costs, it must first ascertain how these costs vary between different types of delivery. There is evidence to suggest, however, that many companies have only a scant knowledge of their distribution costs. A survey undertaken by the Department of Employment found that approximately 70% of firms questioned could not provide a detailed break-down of distribution costs. According to Murphy (1978), a significant number of firms have not even calculated the total cost of their distribution. This he attributes to the fact that responsibility for distribution has
traditionally been divided between different branches of management and so, for the purposes of cost accountancy, distribution costs have not been calculated "in consolidated form". Even where firms do estimate their total distribution costs, they often differ in the range of activities they include in the cost calculation, thereby complicating inter-firm comparisons. These differences in accounting schemes result partly from disagreement among firms over what actually constitutes distribution. A survey of industrial attitudes to physical distribution revealed widely differing views of the scope of distribution (Whitehead Consulting Group Ltd., 1974). From the present survey and recently published case studies of food manufacturers distribution systems (Hemingway, 1979), it appears that the main areas of disagreement are over the inclusion of stockholding, order processing and packaging in the distribution cost calculation. The addition of these items can effectively double the distribution cost estimate (McKibbin, 1982b).

It proved difficult to obtain comparable figures for total distribution cost from the food manufacturers consulted and almost impossible to get this data in disaggregated form. Almost half the firms in the sample were unable or unwilling to provide the distribution cost data requested. Of the remainder, six firms offered estimates that were not strictly comparable. This left nine estimates that had been calculated on a broadly similar basis. These excluded stockholding, order-processing and packaging costs.

The estimates of total distribution costs ranged from 3% to 5% of net sales revenue, and averaged 4.4%. These values appear low by comparison with the cost data compiled by a Mintel survey of food manufacturers in 1977, though it is not clear which items Mintel's respondents included in their cost calculations. They are also significantly lower than cost estimates made on the basis of a more recent survey by the Centre for Physical Distribution Management (McKibbin, 1982a). It has been shown that the ratio of distribution costs to sales revenue varies widely for firms in the grocery trade (Williams, 1975; McKibbin, 1982a).
This variation can reflect differences in such things as product type, size of range (McLaren, 1980), speed of delivery and the allocation of output between different distributive channels (Sawdey, 1972). Given this wide variation in the level of distribution costs, average figures will be very sensitive to the particular combination of firms sampled, especially where, as in the case of the surveys referred to, the sample size is small. These three sets of figures strongly suggest, however, that the majority of food manufacturers expend between 3 and 6% of net sales revenue on the transport and storage of finished products. These proportions will be compared later with variations in the prices at which manufacturers sell their goods to retailers.

Whilst inventory, administration and order-processing costs will vary to some extent with the choice logistical channel, the main sources of variation in total distribution costs will lie in the transport and storage of the goods. Partly for this reason and partly because of the inadequacy of the disaggregated cost data received from firms in the survey, attention will focus on the transport and storage elements in the distribution process.

Only three firms provided separate expenditure figures for transport and storage. One of them, however, excluded factory warehousing from the cost estimate for storage rendering its figures incomparable. The way in which the other two firms divided their expenditure between transport and storage quite closely resembled the cost allocations averaged by Kearney (1980) from a survey of food and drink manufacturers. This identifies transport as the major cost component by a significant margin, a finding corroborated by a Mintel study (1977) of physical distribution in the grocery trade.

Variations in transport costs: Transport costs are subject mainly to two dimensions of variation:

a) variation with distance travelled
b) variation with consignment size - (determining the transport rate per unit distance)
Figure 6.3: Relationship between Transport Cost per Mile and Journey Length: "Other Food, Drink and Tobacco Products" (1966). (after Chisholm, 1971)

terminal cost = 44.72p
linehaul cost = 0.54p
The British processed food industry employs almost universally an "equalised delivery" (or "single zone") pricing scheme (Price Commission, 1975b). This means that prices do not vary with the distance between factory and customer. To some extent, therefore, customers located near the factory cross-subsidise the more costly deliveries to customers further afield. Coates et al. (1977), nevertheless, contend that under such a spatial pricing system the amount of cross-subsidy will be small, partly because transport costs generally represent a small proportion of final selling prices and partly because unit transport cost "taper" as journey lengths increase. The first of these points is borne out by the distribution cost estimates presented above. These figures suggest that the transport (of the finished products) represents around 2% of the final selling price of processed food. The second point relates to the structure of transport rates. These rates may be divided into terminal and movement costs. As only the latter increase with distance, total transport costs "taper" as terminal costs are spread over longer distances. Figure 6.3 employs data presented by Chisholm (1971) to illustrate the tapering transport cost profile for a general category of food products (assuming fixed movement, or "linehaul", costs/mile).

Although transport costs vary less than proportionally with distance, the costs of delivery can still vary significantly between customers. Table 6.3, for example, shows how the costs of delivering canned fruit in bulk from a manufacturers' warehouse to three retailers' central warehouses can vary substantially over a comparatively short distance range, despite a pronounced tapering of the transport rate per ton-mile. It is likely too that branch store delivery costs and the cost differential between branch and warehouse deliveries will be subject to a marked geographical variation as delivery costs are largely a function of drop density, and hence population density (Williams, 1975) (fig. 6.4). If these cost variations were translated into price differences, it is possible that they could affect a retailer's decision on whether or not to
Table 6.3: Bulk Delivery Rates: Canned Fruit Company.

From warehouse at Feltham to multiple's central warehouses at:

<table>
<thead>
<tr>
<th>Warehouse</th>
<th>Distance (miles)</th>
<th>Cost/ton (£)</th>
<th>Cost/ton/mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farnborough</td>
<td>17</td>
<td>2.70</td>
<td>15.9p</td>
</tr>
<tr>
<td>Waltham Cross</td>
<td>27</td>
<td>3.40</td>
<td>12.6p</td>
</tr>
<tr>
<td>Aylesford</td>
<td>44</td>
<td>4.00</td>
<td>9.1p</td>
</tr>
<tr>
<td>Winsford</td>
<td>150</td>
<td>10.20</td>
<td>6.8p</td>
</tr>
</tbody>
</table>

Source: personal survey.
channel supplies through his central warehouse. For example, a multiple operating a widely dispersed chain of stores in a region distant from a supplier's factory might be quoted a high rate for direct branch store delivery and thereby encouraged instead to take bulk deliveries into his central warehouse. The spatial uniformity of delivery costs ensures, however, that retailers are not subject to such geographically discriminating pressures.

When asked how much weight was attached to distribution costs in the determination of prices, several of the distribution executives interviewed used the geographical standardization of prices to substantiate their claims that there was little or no relation between distribution costs and prices. Such responses, however, concealed the fact that food manufacturers' price structures often allow for transport cost differences that result from variations in the size of order to be delivered (Pettit, 1976). These cost variations can be very wide; one large manufacturer has estimated that the cost of distributing a palletised load of 7000 units to a central warehouse represented 2.3% of the average selling price of his products while the cost of delivering 5 units to a shop represented 15.2% (Monopolies and Merger Commission, 1981). It is widely acknowledged that delivery costs vary inversely and exponentially with drop size (Bowen and Mundy, 1972; Jones, 1976; Thorpe et al., 1973) (fig. 5.3). There was general agreement among firms in the survey, however, that it was impractical to vary prices in accordance with the size of individual branch store deliveries. Indeed it is virtually impossible for suppliers to establish accurately and objectively the costs attributable to particular consignments (Buxton, 1975). Two manufacturers admitted, though, that they took the average size of drops to a multiple's branch stores into account in deciding what levels of discount to grant. It was much more common for manufacturers' pricing schemes to distinguish between local deliveries of relatively small quantities from depots (to which fig. 5.3 relates) from large bulk deliveries direct from the factory. Table 6.4 shows an idealised sequence of deliveries in declining order of distribution costs. Figure 6.5 extends the cost
Table 6.4: Size of Order, Nature of Delivery and Distribution Cost.

<table>
<thead>
<tr>
<th>Distribution Cost</th>
<th>Ex-factory Maximum Vehicle Capacity - Trunk Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>single drop</td>
</tr>
<tr>
<td></td>
<td>decreasing 2-drops</td>
</tr>
<tr>
<td></td>
<td>utilization 3-drops</td>
</tr>
<tr>
<td></td>
<td>diminishing 4-drops</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex-depot Maximum Vehicle Capacity - Delivery Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>single drop</td>
</tr>
<tr>
<td>decreasing</td>
</tr>
<tr>
<td>utilization/ diminishing no. of drops</td>
</tr>
<tr>
<td>diminishing vehicle size</td>
</tr>
</tbody>
</table>

Figure 6.5: Relationship between Drop Size and Unit Delivery Cost over a Wide Size Range.
curve depicted on figure 5.3 to show how drop size eventually becomes large enough to qualify for direct delivery from the factory. The switch from ex-depot to ex-factory delivery is represented as a discontinuity on the cost curve because these larger direct deliveries avoid the costs of storage and handling at distribution depots. Direct delivery from the factory is, therefore, much cheaper per unit than distribution in smaller consignments via depots. Two firms supplied enough information about the logistics and costs of their distribution operations to make possible a cost comparison between the two types of delivery. The costs of direct delivery were calculated to be 32% and 35% of the cost of "indirect" distribution via depots. Such large cost savings could give manufacturers a strong incentive to promote direct bulk deliveries by means of their pricing (i.e. discounting) policy.

Thorpe et al (1973) have devised a generalized cost model to establish the critical volume required for direct ex-factory delivery:

<table>
<thead>
<tr>
<th>Critical Volume</th>
<th>Extra costs for branch delivery incurred by Supplier per £'000 of Supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Retailer's distribution costs per £'000 of supplies</td>
</tr>
</tbody>
</table>

This model is of theoretical interest, but has little practical relevance for several reasons. In the first place, suppliers and retailers do not have access to each others cost information nor, as will be seen later, does the price mechanism permit an effective trade-off between these cost elements. Although NEDO (1976) argued that "the probing of total distribution costs from the factory itself needs to be an essential part of the customer/supplier relationship;" and that "the probing should be a joint effort in the interests of both" (p6), there is no evidence of firms in the grocery trade responding to this advice. Second, it can be extremely difficult for a supplier to isolate the costs of delivering his products to the branch stores of a single retailer. Third, this cost model makes no allowance for the various marketing considerations that
often dominate the choice of delivery type.

Enquiries were made to find out the extent to which discounts actually reflect differences in distribution costs between warehouse and store delivery. For several reasons, however, many firms were unable to give simple, direct answers to these enquiries. A common response was that prices are agreed in complicated negotiations between the sales department and customers. The distribution department would submit the relevant cost information to the sales team which they would then take into account in their negotiations (cf. Crawford, 1972b). The actual amount of weight attached to these distribution costings could not be easily ascertained. Several firms delivered only to retail and wholesale warehouses and so had no need to draw up a separate scheme of prices for store deliveries. Many companies delivered products both to retailers' central warehouses and to some of their larger stores. In these cases it was impossible to say how the ratio of goods supplied to these two types of premises affected the levels of discount awarded.

Only four companies gave figures for the percentage discount granted to multiples requesting central warehouse delivery. These ranged from 1% to 3%. One distribution director stated that the larger multiples generally expected a 3% discount for warehouse delivery, though seldom received so much. The general view of distribution managers was that it was almost impossible to say what proportion of a retailer's total discount was attributable to his acceptance of warehouse delivery. Three firms said that they offered a fixed discount of 1% to firms that took a full lorry load regardless of whether it was delivered to a store or a warehouse. Discounts for bulk, central warehouse delivery are generally regarded as being insufficient to offset fully the retailer's distribution costs, which are estimated to average around 3-4% of turnover (Monopolies and Merger Commission, 1981; Thorpe and Shepherd, 1977).

Of all the companies responding to the question on discount levels, including those that did not specify a % discount for warehouse delivery, three-quarters (15) claimed that the prices charged made little or no allowance for
differences in distribution costs. The five companies which said that they did tailor prices to distribution costs delivered less than 10% of their output to retail outlets; two of them made no deliveries direct to stores. By far the greater part of their output was delivered to warehouses and the prices charged were closely related to the bulk of the loads delivered. A survey conducted by the Monopolies and Merger Commission (1981) found that fewer than half the manufacturers consulted had even attempted to assess differences in their distribution costs.

As the majority of food manufacturers do not appear to relate prices closely to distribution costs, one must ask what factors do dominate decisions on pricing. Most firms have a price list which quotes prices on the basis of product type and quantity purchased. The "quantity" rates set out in the published price list are "non-cumulative" in the sense that they relate to each order separately. It is these bulk rates which generally correspond most closely to distribution costs. Those firms that claim to gear prices to distribution costs are those that adhere rigidly to the published price list. The majority of manufacturers in the sample, however, supplement this price list with a series of trade discounts. Some of these discounts are "cumulative" or "patronage" discounts (often referred to as "over-riders"), being related to the total purchases a customer makes over a period of time. These are designed to encourage the customer to maximise his total purchases and are not affected by the frequency or size of individual orders. Sometimes the supplier will set a target for annual sales to particular customers and if this is reached the customers receive an additional discount. Other trade discounts are associated with promotions and compensate wholesale and retail customers for promotional efforts they have undertaken, sometimes involving a temporary reduction in their margins (Monopolies and Mergers Commissions, 1981).

These supplementary discounts may considerably exceed the bulk related discounts inherent in the published price list. With many large retail chains the lowest published bulk rate is the starting point in the price negotiations. Table 6.5 gives a rough indication of the orders of magnitude of
Table 6.5: Approximate Level of Discount Granted by Suppliers to Retail and Wholesale Customers.

10 - 15% largest 5 - 6 supermarket chains
7 - 10% large voluntary group wholesale organizations and middle range supermarket chains
3 - 7% smaller supermarket chains
0 - 5% voluntary group shops taking direct store delivery

Source: personal survey.

Table 6.6: Minimum Drop Sizes by Product Type.

<table>
<thead>
<tr>
<th>Product</th>
<th>No. of Firms</th>
<th>Minimum Drop Size</th>
<th>Average Drop Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biscuits</td>
<td>2</td>
<td>6, 6</td>
<td>6</td>
</tr>
<tr>
<td>Crisps</td>
<td>2</td>
<td>10, 10</td>
<td>10</td>
</tr>
<tr>
<td>Tea</td>
<td>3</td>
<td>10, 20, 25</td>
<td>18</td>
</tr>
<tr>
<td>Canned Fruit</td>
<td>2</td>
<td>40, 70</td>
<td>55</td>
</tr>
<tr>
<td>Breakfast Cereal</td>
<td>3</td>
<td>25, 40, 50</td>
<td>38</td>
</tr>
</tbody>
</table>

Source: personal survey.
discounts won by various sizes of retail and wholesale customers (over and above listed prices) (cf. National Board for Prices and Incomes, 1971).

Although the delivery arrangements made with customers are often taken into consideration in deciding the size of over-riding discount offered, this decision is, in most cases, dominated by the total quantity purchased. This is confirmed by the evidence that the cheapest form of delivery, that of bulk, direct delivery to central warehouse attracts a discount of at the most 3%, and usually only between 1% and 2%, out of total discounts of between 10% and 15% for the larger supermarket chains. It appears too that manufacturers vary considerably in the levels of discount they offer for the more economical forms of delivery to central warehouse and larger branch stores. The proportion that these discounts represent of the total "quantity" discount can also vary widely. There is, therefore, no clear and direct relationship between the prices a food manufacturer quotes and the type of delivery he provides. This observation has recently been confirmed by a Monopoly and Merger Commission (1981) study which concludes that "over-riders tended to be regarded by manufacturers as a tool of marketing and not to be cost-related in any tangible way." (p 25)

Of the firms that offered little or no discount for central warehouse delivery, several gave reasons for this policy:

i) **Marketing reservations:** Three manufacturers sought to discourage delivery to central warehouses and retain an extensive system of direct delivery to branch stores so that their sales representatives could continue to market their products intensively at store level. These firms were afraid that the switch to centralized buying which generally accompanies the change to central warehouse delivery would result in a loss of sales, particularly where a competitor continued to deal with and deliver direct to branch stores. Through this contact with store managers, salesmen could, it was claimed, ensure that the shops held adequate stocks and secure more shelf space and more prominent displays for
their products. Evidence to the contrary, however, was provided by one retail chain which showed that in many cases sales volumes rose significantly following the centralization of buying and delivery.

To preserve their systems of branch store delivery, some food manufacturers have had to concede to their larger retail customers levels of quantity discount for store delivery more appropriate to bulk warehouse delivery. Their bargaining position has been weakened by the retailers' knowledge that they wish to continue delivering to branch stores and the retailers' willingness to changeover to central warehouse delivery. By granting similar levels of discount for deliveries to warehouses (of wholesalers, for example) and branch stores, these manufacturers prevent prices from reflecting differences in distribution costs and give the multiples in question an unfair advantage over their retail competitors.

ii) Perishability/Fragility: Manufacturers of biscuits, crisps and snacks, foodstuffs of comparatively short "shelf-life" and high fragility, preferred to deliver orders direct to the customers' shops to ensure freshness and reduce damage to their products.

iii) Variability of distribution costs: Four firms pointed out that their depot delivery systems were encumbered with a large element of fixed cost which could not, in the short run, be adjusted to changes in the volume of throughput. One firm, for example, asserted that distribution facilities accounted for 35% of its total overhead costs. Another food manufacturer, giving evidence to the Monopolies and Mergers Commission (1981), claimed that 80% of its distribution costs were fixed. It is frequently stated that around 80% of distribution costs are fixed (Crawford, 1972a; Barber, 1976) The redirection of a multiple's supplies from branch store to central warehouse delivery might, therefore, in the short term, yield only a small net saving in distribution costs. Small discounts for central warehouse delivery would reflect this very limited cost reduction (Millar, 1983). In the longer term, a firm might wish to reduce the capacity of its depot system, thereby increasing the ratio of fixed to variable costs and
releasing capital previously tied up in distribution. Such a firm might want to encourage bulk deliveries direct from the factory by offering more generous discounts for this type of delivery. The level of discount awarded for bulk delivery can, therefore, be related to the manufacturers' longer term distribution objectives.

Two of the firms which contracted out most of their local delivery work cited short term variability of distribution costs as one of the major benefits of doing so. In most cases, a contractors' delivery charges correspond to the volume of a customer's throughput. Some contractors, however, require fixed payments over a certain period, especially where whole depots or large parts of depots are used exclusively by particular manufacturers.

Official Concern over Current Trading Practices.

The scale of special discounts has increased in recent years as problems of over-capacity in the food industry have grown more acute and as retail sales have become concentrated in the hands of fewer, larger retailer organizations. The extent of this concentration was described earlier (p109) in relation to the entire range of grocery products. An examination of the sales profiles of particular manufacturers reveals an even greater concentration on a small number of retailers (Table 5.6). Where twenty or fewer multiples absorb around 80% of a company's output, they can exert considerable bargaining pressure, particularly the largest multiples that may each take 10% or more of a firm's production.

The concentration of buying power in the retail grocery trade in the 1960s and 70s and the consequent enlargement and proliferation of special discounts raised fears in government circles that this might be squeezing manufacturers' profit margins unduly (Madigan, 1980), creating unfair competition for smaller retailers and wholesalers and thereby reducing the efficiency of the distribution system.

As explained earlier, large retail organizations can secure discounts that relate principally to the total volume purchased and not the purchases of individual stores. Most
of these organizations comprise hundreds of shops which vary considerably in size. Despite numerous closures of smaller branch stores in recent years, many of their stores are still of comparable size to those of the larger independent retailers. Two stores of the same size and turnover, one a branch of a large supermarket chain, the other an independent supermarket, might be treated very differently by a supplier. A supplier might relax minimum drop size restrictions for the large retail chain, deliver a comparatively small load direct to his store, yet still offer the chain as a whole a very large discount on total purchases, say, in the order of 10-15%. The independent store would be in a much less favourable position. Being unable to generate an order of minimum drop size, it would have to obtain its supplies via a wholesaler. Even if this wholesaler belonged to a voluntary group, it would be unlikely to receive any more than an 8-10% discount from the supplier, and once it had deducted its operating margin, the independent retailer might be sold the goods for 2-3% off the list price. This situation therefore discriminates against the independent in two respects. In the first place, although it costs less to distribute supplies to the wholesaler than the multiple's branch store, the latter secures a larger discount (Dore, 1980). Second, once the wholesaler deducts his gross margin for storage and shop delivery, the differential between what the multiple's branch store and the independent retailer pay for the goods widens further.

In July 1977, the Secretary of State for Prices and Consumer Protection asked the Monopolies and Mergers Commission to examine "the general effect on the public interest of discounts, rebates and allowances agreed between suppliers and retailers where the reduction or value of benefit could not be attributed to savings in suppliers' costs". A concern for current discounting practices was also expressed by the Price Commission in its reports on Tate and Lyle (1978a), Cadbury-Schweppes Foods Ltd. (1978b) and CPC (UK) Ltd (1978e). This official disapproval of trading practices in the food trade led some to suggest (e.g. Hill, 1978) that legislation similar to the
Robinson-Patman Act in the US might be enacted in the UK "to prevent large buyers from securing excessive advantages over their smaller competitors by virtue of their size and purchasing power". The Robinson-Patman Act of 1936 required that any discounts offered to customers must be cost-related, thus outlawing discrimination between customers simply on the basis of total quantity purchased. Suppliers had to demonstrate that price differentials were justified with respect to differences in manufacturing, marketing and distribution costs. As Matz et al. (1967) explain, however, the opportunities for discriminating between customers "fall chiefly in the field of distribution cost". It is on the pricing of distribution services, therefore, that the Robinson-Patman Act has had the greatest impact. The Act has inspired a great deal of interest in distribution cost analysis and is generally believed to have succeeded in bringing prices more into line with distribution costs.

In anticipation of legislative moves in this direction in Britain, some of the main beneficiaries of the existing discount schemes, the large multiples, argued that the large, regular orders they place bring the manufacturer savings in terms of production efficiency and that their large centralized transactions also enable it to economise on marketing and sales. Some food manufacturers, nevertheless, responded to official criticisms by revising their trading policies and adhering more closely to cost-based price lists (Grocer 24/6/78, Walters, 1978). Such reforms are inhibited, however, by the intense competition in many sectors of the grocery trade. Under the oligopolistic conditions prevalent in many sections of the industry, individual companies are reluctant to jeopardise sales by acting unilaterally (Price Commission, 1978c). There are, nevertheless, some sections of the trade in which pricing is not an important factor in competition. The Monopolies Commission (1973) identified the "ready-to-eat breakfast cereal" market as one in which many of the products were not in direct competition. Cross-elasticities of demand for the products were, therefore, low. This may largely explain why one company,
Weetabix, could successfully compete in the market despite the fact that unlike its three main competitors, it offered no "overriding" discounts (Price Commission, 1978c). Across the greater part of the grocery market, however, competitive conditions are such as to deter suppliers from unilaterally making prices more sensitive to distribution costs. Furthermore, the opposition of the Monopolies and Mergers Commission and Office of Fair Trading to collusion between competing manufacturers would seem to outrule any possibility of collective action on this matter. A fundamental reform of trading practices would probably, therefore, require legislation.

In its report on "Retail Discounts" published in 1981, however, the Monopolies and Mergers Commission denies that there is a need for such legislation. It broadly approves of current trading practices in the grocery trade, arguing that they have "not in general had an adverse effect on competition among suppliers to the retail trade" and that highly competitive conditions in the retail trade have "so far ensured that the benefits of this competition have in the main been passed on to the consumer in one form or another." The Commission recognises how difficult it is for manufacturers to quantify differences in the cost of distributing their products to different customers and concedes that other types of discount may be just as appropriate as those related to delivery costs.

**Minimum Drop Sizes**

A retailer's choice between branch store and central delivery can be partly constrained by a supplier's stipulation of minimum order sizes for the two types of delivery. The first of these minima applies to bulk delivery direct from the factory. This is defined by suppliers in various ways. It can be specified as a number of cases, a number of pallet loads or a weight. To standardise this minimum bulk order size for the purposes of comparison firms were asked to express this value in relation to vehicle capacity. Just over 70% of the firms require a customer to take a full lorry load to qualify for direct ex-factory delivery. The remainder are prepared to
deliver a fraction of a full load, but never allowed a trunk vehicle to make more than two or three drops. Two of the firms that stipulated that a minimum bulk order size of half a vehicle said that they were contemplating reducing this minimum to encourage more direct distribution from the factory. Those firms which make bulk deliveries of less than a full lorry load sometimes mix customers' orders with supplies for their own distribution depots.

Minimum drop sizes for shop delivery from a distribution depot showed a much greater degree of variation (fig. 6.6). It is difficult to assess the extent to which these variations are product-related because many of the firms manufacture diverse product ranges yet stipulate the same minimum size for orders regardless of their composition. It is, nevertheless, possible for those manufacturers whose output is exclusively or principally composed of a particular type of product to compare minimum order sizes by product class (Table 6.6). To some extent this variation will reflect differences in the weight and handling characteristics of the products sold. It is mainly determined, however, by the manufacturer's marketing objectives. A firm which wishes to market its products intensively at the retail level (such as biscuit manufacturers) must be prepared to deliver comparatively small amounts to a very large number of shops. This is particularly so where the product has a short-shelf-life and deliveries must be made frequently. In contrast, a manufacturer who does not value direct trading links with shops so highly (such as canned food producers) would tend to discourage small, relatively uneconomical branch deliveries by imposing a higher minimum order size. A retail chain containing branch stores too small to accept orders of this minimum size, might then be forced to channel this manufacturer's supplies through its central warehouse. There have been instances, however, of manufacturers relaxing their order size restrictions for those larger supermarket chains that wield great bargaining power. Minimum order size is also related to the size of the manufacturer's product range and the rate at which its products sell. This may partly explain the differences in
Figure 6.6: Minimum Drop Sizes of a Sample of 24 Food Manufacturers. (source: personal survey)
minimum order sizes between firms manufacturing the same general class of products. In the case of breakfast cereals, for example, the firm with the largest product range and fastest turnover rate has fixed its minimum order size at a significantly higher level than its competitors.

Service Level

Many retailers gave as a reason for centralizing supplies their desire to minimise the risk of branch stores running out of stock. This was based on their belief that they could provide their stores with a better level of delivery service (in terms of order lead times) than suppliers. Thorpe et al. (1973) suggests that where the frequency of a manufacturer's delivery is less than once a week, most multiples can offer a superior service from their central warehouse. The "lead time" and reliability of manufacturers' deliveries will, therefore, influence the retailer's choice between warehouse and store delivery. Conversely, however, those manufacturers that are keen to continue distributing goods direct to branch stores partly justify this preference on the grounds that through direct store delivery they can ensure a higher level of stock availability.

No data was collected in the survey to test the validity of these conflicting arguments. Thorpe et al. (1973), however, compared direct and centralized deliveries in relation to the frequency with which branch stores ran out of stock in particular products. No clear relationship emerged, across a range of 81 products, between the amount of direct branch store delivery and the frequency of "stock-outs". This led Thorpe et al. to conclude that "although sales, through the influence of lack of stock, can be affected by distribution arrangements, the relation is by no means clear cut. Indeed it varies substantially from one retailer to another and is likely to vary from one product to another." (p 137) It is, therefore, impossible to generalise about the affect of service level on the choice of delivery type. Its bearing on delivery arrangements will depend on the particular pairing of supplier and retailer, and on the product concerned.
Use of Distribution Contractors by Food Manufacturers and Multiples.

Although in the case of linkages examined in this chapter ownership passes directly from manufacturer to retailer, it is quite common in the grocery trade for intermediate storage and final delivery to be contracted out to a third party. As a result of their preoccupation with the transfer of titles, conventional marketing studies often under-estimate the importance of agencies, such as distribution contractors, which provide storage and transport services but do not assume ownership of the goods they handle (Bowersox et al., 1968). The use of these agencies can influence both the nature of the supply linkage and the logistics of the shop delivery. It is important, therefore, to examine manufacturers' and retailers' motives for using contractors, to assess the extent to which they do so and to consider in what ways this affects the pattern of grocery movement.

There has been a substantial growth since the late 1960s in the number and size of specialist distribution contractors (Firth, 1976). Various factors have contributed to this growth. By abolishing the A, B, C system of vehicle licensing, the 1968 Transport Act enabled "own account" operators to carry goods for others. Since then several food manufacturers have begun to distribute other firms' (non-competing) food products on a contract basis. In most cases this third party work generates only a small fraction of the total throughput of these firms distribution systems (Cooper, 1978) and is regarded merely as a way of filling excess capacity in depots and delivery vehicles, and thereby helping to cover overhead costs. Other manufacturers, however, such as Imperial Foods and Tate and Lyle, have created separate subsidiaries to provide a general distribution service for outside customers while meeting their own "in-house" demands. In the case of two such firms, third party traffic accounts for roughly a third of total system throughput. This has represented a major diversification of some manufacturers into the field of "for hire" distribution and appears to have been prompted by a recognition of the fact that, as the demand for food is
fairly stagnant, food manufacturing alone offers little potential for future company growth. Other distribution contracting businesses have grown out of haulage firms (Firth, 1976) which, faced with a static demand for general haulage, have extended their range of services and begun to offer specialist distribution packages at premium rates.

The growth in the volume of grocery traffic handled by specialist contractors has reflected an increased willingness on the part of manufacturers, and to a lesser extent multiple retailers, to contract out all or part of their distribution (Fielding, 1972; Firth, 1976). Numerous reasons have been suggested for this change of policy (Barber, 1976; Firth, 1976; Latta, 1977; Kelly, 1979). The main reasons may be summarised as follows:

i) The use of contractors offers greater flexibility in the sense that firms can usually change contractors more quickly and easily than they can restructure an own account distribution system. This flexibility was particularly attractive in the 1970s when distribution planning was surrounded by many uncertainties about such things as oil price increases, the imposition of environmental controls, the reduction in drivers' hours and the future trend in interest rates.

ii) By combining the storage and delivery of several firms' products the contractor can take advantage of economies of scale and often provide a more cost-effective service, especially in areas of low demand. The substantial increase in distribution costs in the 1970s (Pettit, 1976) and growing realization of the high cost of delivering small orders encouraged a greater use of contractors.

iii) By contracting out its distribution a firm could release capital that would otherwise be tied up in depots and vehicles for investment in the its main activity (manufacturing or retailing) or to help keep it solvent during periods of low liquidity.

iv) The use of contractors could also reduce the risk of the distribution operation being disrupted by industrial action, especially where more than one contractor was used
or where, as in the case of Sainsbury's, a contractor complemented an own account operation (Barber and Payne, 1976).

v) Contractors provide more variable capacity than an own account operation. This made them well suited to food manufacturers whose throughput volumes fluctuated widely as a result of seasonal variations in demand or sporadic bursts of promotional activity.

In the grocery trade it is mainly the manufacturers who employ distribution contractors. Fifteen (68%) out of a sample of twenty-two food manufacturers made use of outside contractors for shop delivery, though to widely differing degrees. In contrast, only three out of twenty-three multiples used contractors. As illustrated in figure 6.7, when a distribution contractor is used, its depot replaces that of either the manufacturer or the retailer. It very seldom constitutes an additional node in the logistical channel (Plowden, 1977). These contract depots generally offer storage, break-of-bulk, consolidation and store delivery services. All their manufacturing and retail clients take advantage of the store delivery function, but, as outlined in Table 6.7, vary in their use of the ancillary services.

It was not possible to obtain information on the proportions of firm's grocery traffic channelled through contractors' depots. The extent to which manufacturers depend on contractors can only be measured in relation to the number of contract depots they use. It should be noted, however, that the proportion of contract depots in a manufacturer's distribution system is likely to exceed the proportion of traffic handled by contractors as these depots are likely to serve areas of lower demand. In examining these depot statistics, one must distinguish stockholding depots, where goods are stored for periods of several days or weeks, from transhipment depots where goods are only held long enough for consignments to be disaggregated or consolidated and for forward delivery to be arranged. Roughly 43% of the stockholding points used by the sample of food manufacturers are operated by contractors. A much
Table 6.7: Uses of Distribution Contractors.

<table>
<thead>
<tr>
<th>Services Used</th>
<th>No. of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturers</strong></td>
<td></td>
</tr>
<tr>
<td>1. Storage and break-of-bulk at all the contract depots used.</td>
<td>6</td>
</tr>
<tr>
<td>2. Only break-of-bulk at all the contract depots used.</td>
<td>4</td>
</tr>
<tr>
<td>3. Storage and break-of-bulk at some contract depots, break-of-bulk alone at others.</td>
<td>5</td>
</tr>
<tr>
<td><strong>Multiple Retailers</strong></td>
<td></td>
</tr>
<tr>
<td>1. Storage of centralized stocks, consolidation and delivery of branch store orders (i.e. contracting out entire system of centralized storage and delivery.)</td>
<td>1</td>
</tr>
<tr>
<td>2. Use of contractors to provide a parallel system of centralized stockholding and consolidated delivery to complement the retailer's own account operation.</td>
<td>1</td>
</tr>
<tr>
<td>3. Suppliers instructed by the retailer to deliver branch store orders to the depot(s) of a specified contractor. This contractor then assembles the orders for each branch store and delivers them in consolidated loads.</td>
<td>1</td>
</tr>
</tbody>
</table>

*Source:* personal survey.
higher proportion (86%) of the transhipment depots these firms use are operated by contractors. In the case of the multiple retailers, it would not be meaningful to measure dependence on contractors in terms of depot numbers, as two of the three firms employing contractors operate an own account system in parallel. It is important to note, however, that, although only three of the multiples in the sample used contractors, these three firms account for around 30% of total grocery sales.

It appears, therefore, that, overall, distribution contractors play an important role in establishing many of the physical links between food manufacturers and retailers. It is necessary now to consider the ways in which the use of contractors influences the allocation of grocery flows between different logistical channels. These have both an economic and a logistical dimension:

1. Economics of Contract Services: When a manufacturer or retailer contracts out its distribution, the cost of the operation is clearly manifest in the distributors' charges. Most firms, therefore, have more accurate and readily available data on the cost of contracted services than on their own distribution operation, and this can increase the amount of weight attached to distribution costs in trade negotiations between manufacturer and customer. The particular pricing scheme the contractor adopts can also affect the mode of delivery. These pricing schemes vary in their sophistication, with some calculating the appropriate level of charges on the basis of a series of parameters such as average drop size, cases per pallet and total throughput; whereas others resort to a more simple averaging of charges per unit (Firth, 1976). Contractors commonly offer clients bulk discounts, however, and, by holding down average delivery costs, these can make manufacturers less willing to reduce the number of shops to which they (via the contractor) distribute their goods. On the other hand, in comparison with manufacturers operating their own distribution systems, those using third party carriers on a short term contract basis can more easily and economically alter the balance between branch store and central warehouse
delivery in response to multiples' wishes. As mentioned earlier, the flexibility with which manufacturers can vary the mode of delivery sometimes affects their bargaining position in negotiations with multiples. The use of contractors does not always offer manufacturers short term flexibility, however. Usually larger clients must enter into longer term contracts to secure the exclusive use of a contractor's premises. Of the 72 contract stockholding points employed by the sample of food manufacturers (excluding those with a separate "in-house" distribution business) just over half (52%) were depots used on an exclusive basis. One firm acknowledged being "tied-in" to using a particular contractor and claimed that it would take several years to disengage itself from that contractor and carry heavy cost penalties. The use of contractors, therefore, does not always greatly enhance the manufacturer's ability to switch traffic between delivery modes.

Two distribution directors of supermarket chains criticised some contractors' practice of averaging charges across different sizes of consignment. As delivery costs per case vary inversely with the size of drop, they alleged that their larger than average drops were being over-charged and thus effectively cross-subsidising the delivery of small consignments to smaller outlets operated by other multiples or independent retailers. If this is so, then these contractors, through their policy of average pricing, may be helping to preserve manufacturers' deliveries to smaller shops. Too little is known, however, about contractors' pricing policies or their impact on trade negotiations between manufacturers and retailers to measure the extent to which this occurs.

2. Logistics of Contract Delivery: Many of the smaller manufacturers do not distribute large enough volumes to justify the establishment of an own account system of shop delivery throughout the country (The Director, 1978). The use of contractors enables these firms to provide shop delivery more extensively than would otherwise be possible. This maintains the proportion of branch store deliveries
vis-a-vis central warehouse deliveries. It also helps smaller manufacturers to compete more effectively, first, by enabling them to promote their goods at shop level, and, second, by increasing the chances of their products being stocked by those supermarket chains that require suppliers to deliver to all their branches. For all sizes of manufacturer, the use of a distribution contractor can reduce the minimum economic drop size (Walters, 1974), and thereby help to preserve direct deliveries to smaller outlets.

On the other hand, the use of contractors has enabled Sainsbury to maintain a high level of centralized delivery over a period when its total volume of business has grown substantially and its chain expanded geographically. Tesco's use of contractors in the wake of the dramatic growth in its business in the late 1970s was quite different. In this case the contractors did not provide a supplementary central warehouse service similar to Sainsbury's, because they were not required to hold large amounts of bulk stocks on which branch stores could draw as the need arose. Instead, they had merely to assemble consignments received from manufacturers destined for particular branch stores and deliver them to these shops in consolidated loads (Harvey, 1982). This then reduced the number of individual delivery vehicles visiting Tesco's shops and relieved severe problems of "backdoor congestion". By using contractors in this way Tesco was able to increase the proportion of branch store supplies arriving in consolidated form without channelling them through its own central warehouses, which were already overstretched. Manufacturers also gain from this arrangement as they can now deliver all the orders bound for Tesco stores in an area in consolidated loads to the appropriate contractor's depot. This aggregate delivery is more economical partly because of its bulk and directness, and partly because unloading can be carried out more quickly and efficiently at the contractor's depot than at Tesco's shops.

While it was innovative for a retailer to pressure manufacturers into directing their suppliers through contractors, consolidation operations such as this are the
mainstay of the contractor's business. It is through grouping small consignments bound for the same destination that contractors can provide cost-effective delivery. Indeed the growth of contract distribution over the past 10-15 years has contributed greatly to the increased consolidation of shop deliveries. As these firms serve all types of retail outlets (multiple branch stores, independents and Co-operative stores), they have extended the network of consolidated services and supplemented the consolidation traditionally done by wholesalers and those multiple retailers with centralized delivery systems. The effects of this increased consolidation on the routeing of vehicles between depots and shops is discussed in Chapter 10, the wider implications of this growth in consolidation in the concluding chapter.

Summary

As both manufacturers and multiple retailers have a choice between direct and indirect logistical channels, goods can follow one of four possible "routes" from factory to shop. Around 90% of the groceries sold by multiple retailers pass through at least one intermediate node i.e. along one indirect section of logistical channel, employed by either manufacturer or retailer. In the previous chapter it was shown that multiple retailers and manufacturers differ widely in their dependence on indirect channels. One might expect to find an inverse relationship in each manufacturer-multiple retailer link between the firms' respective dependence on indirect channels. For example, a multiple channelling a large proportion of its supplies indirectly via its central warehouse would be expected to take bulk direct deliveries from a manufacturer, especially from one that distributes a large share of its total output straight from the factory. Whilst the logistical connections between the distribution systems of manufacturers and multiples do broadly conform to this general rule, there are too many exceptions to permit the accurate prediction of the type of link between a particular manufacturer and a particular retailer simply on the basis, respectively, of total output distributed direct from the
factory and the proportion of total turnover travelling via central warehouse.

The choice of delivery mode rests with the multiple retailer, though this can be influenced by the manufacturer, principally by means of pricing, the imposition of minimum drop sizes and the provision of a particular standard of delivery service. It is very difficult to ascertain how much importance is attached to these factors in the trade negotiations between manufacturer and retailer, as these discussions are normally shrouded in secrecy. It would seem, however, that, in most cases, price differentials do not reflect differences in the costs of physical distribution. The effects of this upon the efficiency of the grocery distribution system as a whole are very hard to assess, partly because of the serious dearth of price and cost data, and partly because the concept of "efficiency" itself is difficult to define in this context. The unit costs of distribution are, after all, a function of the total volume of goods distributed and this volume is sensitive to the instruments of marketing policy such as pricing, sales promotion and service level, all of which have a bearing on the method of delivery. The objectives of maximising sales by effective marketing and of minimising distribution costs are, therefore, inextricably linked (Bartels, 1976). This frustrates any attempt to measure the efficiency of physical distribution independently of the framework of marketing policy.

The pattern of linkage between manufacturers' and multiple retailers' distribution systems appears reasonably stable. Manufacturers and multiples reported very few switches from one mode of delivery to another in the previous year. The majority opinion of both groups was that there would be a further net diversion of grocery flow from manufacturers' distribution depots to multiples' central warehouses, but that this long term process was nearing its conclusion. One manufacturer suggested that the allocation of flow between manufacturers' and retailers' warehouses had entered a phase of "dynamic equilibrium". A similar view was expressed by Beale (1974). In recognition of the projected growth in the number of superstores and
hypermarkets, most firms also anticipated an increase in the importance of direct bulk deliveries from factories to retail outlets. As many of these large stores will be additions to existing chains of small and medium sized supermarkets, mixed delivery arrangements are likely to become more common (Beckman, 1977).

In many cases, the logistical link between manufacturer and retailer is formed by a distribution contractor with the result that the contractor's level of charges and quality of service will affect the choice of delivery mode. It is difficult, however, to assess the net effect of these agencies on the ratio of branch stores to central warehouse as they have exerted conflicting pressures upon it. On the one hand, they have enabled manufacturers, particularly the smaller ones, to provide more extensive and often more economical branch store deliveries, while, on the other hand, the greater flexibility they offer can afford suppliers greater freedom to switch from shop to retail central warehouse delivery. There is no doubt, however, that distribution contractors have considerably augmented the volume of groceries delivered to branch stores in consolidated loads.

Chapters five and six have been concerned with the allocation of flows between logistical channels. The following two chapters will examine the physical structure of these channels.

Notes:

1. For a sample of 18 manufacturers, excluding unknown linkages and including "part warehouse" with "all warehouse" deliveries.

2. This figure includes depots operated by "in-house" subsidiaries handling a large volume of third party business.

3. One firm also distinguished retail chains on the basis of their goods reception performance i.e. the amount of delay delivery vehicles experienced at their premises and the
frequency with which delivery was refused.

4. Of the food manufacturers surveyed by Mintel (1977), equal numbers (44% in each case) anticipated increases and reductions in the proportions of their output delivered in bulk to retail warehouses. The remaining 12% did not express an opinion on the subject.
Chapter 7

The Number of Intervening Nodes in the Logistical Channels

Manufacturers' Distribution Depots

This section looks more closely at the structure of food manufacturers' echelon channels through which roughly 30-35% of grocery production flows. In particular, it examines variations in the numbers of depots through which manufacturers distribute their output to retail and wholesale customers. To some extent the number of depots required will depend on the size of the firm's market area. All the food manufacturers in the survey, however, marketed their goods nationally. Variations in the numbers of depots operated by firms in the sample cannot, therefore, be explained with respect to differences in the extent of their market areas.

For a sample of 29 manufacturers, variations in the number of stockholding depots were found to be large (fig. 7.1). In their survey of 48 food manufacturers, Thorpe et al. (1973) discovered a higher degree of variation, though not all the firms in their sample distributed their goods nationally. Even when those firms with national coverage are excluded, the remaining sample (of 44) contains firms varying widely in the number of depots they employ. Thorpe does not offer an explanation of why depot numbers should vary so much. He, nevertheless, acknowledges that these variations cannot simply be the result of differences in the handling characteristics of the products distributed. In fact, the number of stockholding points in a manufacturer's distribution system is determined by a series of inter-related factors. These will be discussed under five headings:

1. **Stockholding Policy**: Echelon channels are characterised by the presence of one or more intervening storage point(s) between the factory and the retail or wholesale customer. The number of storage points in a channel of this type will depend partly on how the manufacturer chooses to arrange his pattern of stockholding. As outlined in Chapter 5, stocks
Figure 7.1: Numbers of Stockholding Points in the Distribution Systems of a Sample of 29 Food Manufacturers.
(source: personal survey)
of products with a fast turnover rate are generally dispersed throughout the market area, while those with a slow rate of turnover tend to be concentrated, often in the vicinity of the factory (Ballou, 1973). Even within a single commodity class, such as groceries, turnover rates can vary significantly. Products such as biscuits and crisps, for example, with a relatively fast rate of stockturn are distributed through much larger numbers of depots than slower moving products such as canned fruit and vegetables. There are numerous instances, however, of the same types of product being distributed through widely differing numbers of depots, suggesting that other factors are also involved. Foremost among these are the costs and logistics of the transport operation.

2. Trade-off between transport and stockholding/storage costs: In the theoretical literature of operations research it is often argued that the optimum number of stockholding points is determined mainly by the trade-off between stockholding/storage costs and transport costs (e.g. Christopher, 1971). Similar reasoning has been employed to explain the dispersal of production in more than one plant (Magee, 1968). Like production costs, the costs of stockholding and storage vary inversely with transport costs as the number of locations increases. The optimum number of depots is that which minimises the sum of stockholding/storage costs and transport costs (fig. 7.2). The configuration of the stockholding/storage and the transport cost curves are likely to vary between products thereby altering the shape of the resultant total distribution cost curve and the optimum number of depots. Furthermore, as many firms distribute a variety of products through the same depot system, the shape of these curves and optimum number of depots will also be influenced by the total number and particular mix of products handled (Buxton, 1975). It has been found that the larger a firm's product range, the greater are the benefits of concentrating stocks in fewer locations (British Road Federation, 1978).
Figure 7.2: Relationship between Distribution Costs and Depot Numbers. (after Wentworth and Ramm, 1976)

Figure 7.3: Potential Reductions in Inventory Resulting from Centralization. (after Maister, 1976)
a) **Stockholding/storage costs**: Although combined for the purposes of this trade-off analysis, stockholding and storage represent two separate cost elements. Most distribution cost break-downs list them as separate items.

(i) **Financial costs of holding stock.** It has long been recognised that the total amount of inventory in the echelon system is proportional to the square root of the number of stockholding points (Starr and Miller, 1962):

\[
\frac{S_d}{S_c} = \sqrt{n}
\]

where \( S \) is the total volume of stock in the system

- \( c \) denotes complete centralization of stocks in a single location
- \( d \) denotes a decentralized stockholding system
- \( n \) is the number of stockholding points in the decentralized system.

The formal proof of this exponential relationship has been provided by Maister (1976). In theory, a warehouse handling 1000 units per annum should, *ceteris paribus*, require only half as much stock as a system of four small warehouses with a throughput of 250 units each per annum. In practice, however, stock reductions are seldom so great, though they can still be large. Newson (1978), for example, reports on an office equipment supplier which, by closing 12 depots and centralizing stock in a single location, was able to reduce its inventory investment by 40%. Figure 7.3 shows how, *ceteris paribus*, the total volume of stock decreases as stockholding becomes more concentrated. The actual amounts of stock held will depend on such things as the turnover rate, average order size, variability of demand and seasonality of production, all of which vary with product type (Fielding, 1972).

The holding of stock carries a financial cost either in the interest that must be paid on capital borrowed to finance the inventories or in the interest foregone on that
part of the firm's own working capital tied up in stocks. The actual costs involved depend partly on the level of interest rates, which should affect all firms similarly, and partly on the value of the product being stored.

(ii) Physical costs of storage. These costs are also a function of the total amount of stock held; however, the storage cost per unit varies with the size of the premises and the characteristics of the product being stored. There are economies of scale in warehouse construction and operation. This is illustrated by the results of a survey of food wholesaling undertaken by the National Centre for Materials Handling (Williams, 1975) (fig. 7.4). The unit costs of storage fall sharply as warehouse throughput increases. The centralization of stock in large facilities therefore carries the double benefit of reducing total stock levels and the physical storage cost for each unit of stock.

Storage costs also depend on the physical characteristics and environmental needs of the product. Food products, for example, vary considerably in their fragility, their packaging, in the height they can be stacked and in the ambient temperature and humidity they require.

(b) Transport Costs: The transport cost curve, like that of stockholding/storage is also a "composite" curve in the sense that it combines two separate relationships between depot numbers and i) local delivery costs and ii) trunking costs.

i) Local delivery costs are affected by a host of factors including distance, drop density, the physical characteristics of the products and the nature of the reception facilities at delivery points (Sawdey, 1972). In examining the general relationship between local delivery costs and distance, the other factors may be assumed to be constant. Delivery distances comprise a "stem" component (distance from the depot to the zone in which drops are made) and a "zonal" component (distance travelled between delivery points within this drop zone) (fig. 7.5). The
zonal distance is a function of the drop density and hence is proportional to the square root of the catchment area required to produce a day's load for a delivery vehicle (Wentworth and Ramm, 1976). Thus defined, a drop zone will be small relative to the total area served by a delivery depot. For this reason, the zonal distance is usually considered to be unaffected by variations in depot numbers. In contrast, the "stem" distance is very sensitive to differences in depot numbers. The smaller the number of depots, the larger will be the hinterlands and longer the stem distances, and vice versa. The addition of depots to an echelon system has the effect, therefore, of reducing stem distances and thus local delivery costs. The size of this marginal reduction declines, however, as the number of depots increases producing the cost curve illustrated in figure 7.6. The actual configuration of a local delivery cost curve would be influenced by the other factors listed earlier, principally the drop density and the nature of the product.

Drop density: The higher the drop density, the greater is the potential for combining loads on each delivery run, the smaller is the average distance per drop and so the lower are the costs of the zonal section of the delivery journey (Dore, 1980). The drop density is a function of the number and size of outlets served by a firm's distribution system which, as was explained in Chapter 5 are related both to the firm's marketing strategy and various characteristics of the product.

Physical characteristics of the product: These will affect transport costs in several ways. They will determine the nature of the vehicle (e.g. it may require temperature and humidity control), the manner in which it is loaded and the energy it consumes. The costs of unloading will also depend partly on product handling characteristics.

ii) Trunking costs: Variations in depot numbers have a much greater effect on local delivery costs than on the cost of trunking goods out to the depots from the factory. This
can be demonstrated by a simple example. Figure 7.7 shows a region containing 24 randomly located and randomly weighted delivery points (shops) being served by a single, optimally located depot. This depot receives all its supplies from a factory 100 kilometres away. This generates 15521 tonne-kilometres of local delivery movement and 33220 tonne-kilometres of trunk movement. By splitting the region in two and establishing a depot at the optimum locations in each part, it is possible to reduce the volume of local delivery movement by 40%, while increasing trunk movement by only 6%, producing an overall reduction in tonne-kilometres of 8%. Generally speaking, all the transport cost savings that accrue from an increase in depot numbers are the result of increases in the efficiency of local deliveries. As the number of depots increases, trucking costs usually rise, though, as Table 7.1 shows, the increase is relatively small and declines as the distance increases between the factory and the region where an additional depot is set up. Although the addition of depots can have the effect of increasing the average length of trunk movements, bulk freight costs do not increase in proportion as a result of the "tapering" of transport costs with distance (fig. 6.3). These trucking costs rise only marginally, therefore, as depot numbers increase (fig. 7.8) and these small cost increments are far exceeded by savings in delivery costs. In fact, so limited is the sensitivity of trucking costs to the number of depots, that they are often excluded from the cost trade-off calculations (Wentworth and Ramm, 1976).

Flexibility in the choice of depot numbers.

It is found in practice that the total distribution cost curve produced by the summation of transport, storage and stockholding costs is fairly flat along its central section, indicating that there is no single, optimum number of depots, but rather a range of optima. One large food manufacturer (of breakfast cereals), which had undertaken a detailed cost trade-off analysis, found little variation in total distribution costs across the range 9 to 16 depots, though other firms believed that the optimal range was
Table 7.1: Effect of Depot Numbers on Volume of Freight Movement.

<table>
<thead>
<tr>
<th>Distance between factory and single depot (kms) (X)</th>
<th>Increase in amount of trunk movement resulting from use of two depots</th>
<th>Overall reduction in freight movement resulting from use of two depots</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>6.1%</td>
<td>8.4%</td>
</tr>
<tr>
<td>200</td>
<td>1.4%</td>
<td>6.8%</td>
</tr>
<tr>
<td>300</td>
<td>0.6%</td>
<td>5.2%</td>
</tr>
<tr>
<td>400</td>
<td>0.4%</td>
<td>4.1%</td>
</tr>
<tr>
<td>500</td>
<td>0.2%</td>
<td>3.5%</td>
</tr>
</tbody>
</table>
narrower than this. Cadbury-Schweppes, for example, found that the difference in cost between operating 7 depots and 10 depots (in both cases, all optimally located) was only about 0.2% of total distribution costs (Beattie, 1973). The presence of such a range of optima offers firms some flexibility in the design of their distribution systems and allow other factors, excluded from the cost analysis, to influence the actual number of depots finally chosen.

3. Service Level Considerations

In addition to reducing distribution costs, the use of outlying depots can also have the effect of increasing sales revenue. The dispersal of stocks throughout the market area can enable firms to supply customers' orders more rapidly and, possibly, as a result secure additional sales. A fast delivery service can be of particular importance in the grocery trade where turnover rates are relatively high, the shelf life of products short and competition fairly intense (Buxton, 1975). Where a firm employs few depots, the areas they serve may be of a radius greater than the daily range of a delivery vehicle. This could effectively add a day to the order lead time of deliveries to customers located beyond this range, perhaps jeopardising sales to them.4

An attempt was made to assess the extent to which the level of service a firm offered was dependent upon its number of stockholding depots. (fig. 7.9) For the purposes of this analysis, service level was defined as the average number of days taken for goods to be delivered from the receipt of the customer's order at the appropriate depot. Six of the firms achieving service levels of under 5 days operated "specified day" schemes, whereby customers obtain a faster delivery by adhering to a timetable for the submission of orders (see p.329). Even allowing for the slight bias that this introduces, it can be seen that there is little relationship between service level and depot numbers. It is noticeable that the seven firms with the lowest service level (over five days) operate comparatively few depots. Across the range 1 to 5 days, however, within which the average delivery times of 70% of the firms fall,
Figure 7.9: Relationship between Average Service Level and Number of Stockholding Points.
(source: personal survey)
there appears to be no significant relationship. This sheds some doubt on the frequent claim that a wide dispersal of stocks is necessary to provide customers with fast delivery. Improvements in transport and communications seem to have made it possible for some firms to distribute their goods relatively quickly from a few locations.

The importance of service level objectives in decisions on depot number has also been questioned by Powell (1976). He argues that depots should be justified only on cost-minimization grounds, as it is very difficult for a firm to establish in advance that by adding a depot it would generate more sales and that the additional revenue would exceed the costs of setting up the new facility. It is, nevertheless, acknowledged that many depots have been set up primarily to achieve a particular service level (Murphy, 1978; Powell, 1976). As shown on figure 7.10, the numbers of depots required to offer very high levels of customer service are normally inefficient in terms of distribution cost. Ballou (1973) has suggested that distribution cost and service level considerations might be reconciled by incorporating into the distribution cost calculation a figure for the likely variation in sales revenue resulting from a change in depot numbers. It is extremely difficult, however, to predict accurately the impact of such a change on the level of sales and even to monitor this impact after the event. So many factors affect the level of sales that it is very hard to isolate and measure the effect that changes in service level have upon sales volumes (Beattie, 1973).

4. Use of Transhipment Depots:
As explained in Chapter 5., it has long been a common practice for firms to use "satellite" transhipment depots (often known as "sub-depots") to extend the delivery range of stockholding points. Despite the fact that improvements in road transport since the war have eased the logistical constraints on the concentration of food stockholding, many manufacturers have centralized their stocks to such an extent that a high proportion of their deliveries must now be made via transhipment depots (Webb, 1972). These depots
usually perform only a break-bulk operation, transferring goods from large trunk vehicles to smaller delivery vans. They hold no "cycle" or "safety" stock; goods are kept there only until forward transport can be arranged, usually about 48 hours at the most. They should not, therefore, be regarded as "stockholding" points. By splitting the storage and break-bulk functions of conventional "stockholding" depots and performing them in different locations, firms have been able to reconcile the conflicting transport and stockholding cost objectives outlined earlier. This spatial separation of storage from the breaking of bulk has effectively added another node to the (vertical) logistical channel. Transhipment depots can, however, in logistical terms, serve as substitutes for stockholding depots. It is possible, therefore, that the numbers of transhipment depots firms employ might vary inversely with the numbers of stockholding depots, thereby cancelling out observed variations in the latter.

Some difficulty was experienced in compiling information on the numbers of transhipment depots used by firms which contracted out some or all of their distribution to professional carriers. Some of those which employed hauliers conceded that the haulage firm might, without their knowledge, tranship goods through its own depots. Similarly, some of those employing national distribution contractors might have their goods stored at only a few of the contractor's depots but transhipped through others. Manufacturers whose distribution operations were subject to either of these special circumstances and could not describe the pattern of transhipment in detail were excluded from the analysis. This reduced the sample size to 20. A comparison of the numbers of stockholding and transhipment points shows only a weak relationship between these two variables (fig. 7.11). These 20 firms can, however, be divided into four categories on the basis of the use they make of transhipment depots:

1. **Centralized stockholding and extensive transhipment:**
   (Firms 1 and 2) These firms have completely centralized their stockholding on single locations, but still supply
Figure 7.11: Relationship between Numbers of Stockholding and Transshipment Points. 
(source: personal survey)
goods to comparatively large numbers of outlets (18-20,000). To serve such a large number of outlets economically and with a competitive service level from a single stockholding point, these firms must make heavy use of transhipment points around the country. Both firms contracted out all of this transhipment to professional carriers. This system of distribution (also operated by at least two other major food manufacturers outside the sample) is known by various names, such as "throughput carrier system", "order throughput system" and "embulk with order system". The numbers of transhipment points used by firms 1 and 2 considerably exceeds the average numbers of conventional stockholding depots employed by other firms in the sample. This is partly the result of the desire of those firms centralizing their distribution to spread the risks of service disruption at the local level around as many different hauliers as possible, and to strengthen their bargaining position vis-a-vis individual carriers. The pattern of transhipment is not, after all, subject to the same pressure for spatial concentration that affects stockholding. The constraints on the fragmentation of the transhipment function are the need to ensure adequate levels of flow on each link of the trunk network and exceed the minimum economic throughput levels set by local carriers.

(2) Dispersed stockholding with limited and isolated use of transhipment depots. (firms 6 to 20) This constitutes the traditional decentralized system containing upwards of 10 stockholding depots and requiring only a small number of transhipment depots to facilitate deliveries in peripheral areas where the road network is poor and sales densities low. This category contains firms differing widely in their degree of stock dispersal. There is no clear relationship, however, between their numbers of stockholding and transhipment depots. This may be due to the fact that the number of supplementary transhipment depots a firm requires will be determined not only by the number of stockholding depots it operates but also by the locations of its stockholding depots, the spatial distribution of its sales outlets and the level of service it offers in remoter areas.
(3) Concentrated stockholding with numerous "satellite" transhipment depots: (Firm 5) This represents an intermediate stage between categories 1 and 2 and applies to firms which disperse their stocks in a small number of depots (3 - 8) yet serve comparable numbers of outlets to firms in category 2 (10 - 20,000). This necessitates the use of numerous transhipment depots which act as "satellites" to stockholding depots. These "sub-depots" need not be distributed equitably between the stockholding depots. The assignment of sub-depots to depots depends on the spatial distribution of the latter and the division of the country into depot hinterlands. The seven satellite transhipment depots operated by firm 5, for example, are shared between only two of its seven stockholding depots.

(4) Highly concentrated stockholding with little use of transhipment: (Firms 3 and 4) This arrangement is typical of firms that channel the greater part of their sales through direct channels and use a depot system only for the limited distribution of smaller amounts to wholesale and retail warehouses. They concentrate their stocks on three or four locations, using a similar number of transhipment depots for less than trunk load deliveries outside the delivery range of the stockholding points. These firms (canned fruit producers) rely on bulk distribution to a comparatively small number of outlets (< 2000).

Although the very small sample makes any conclusions on this subject very tentative, it would seem that an inverse relationship between the numbers of stockholding and transhipment depots does exist among firms with highly concentrated stockholding patterns. This is particularly so if one excludes the firms in category 4 whose heavy dependence on direct delivery and small number of outlets distinguish them from the rest. The absence of a relationship in the case of the majority of firms which disperse their stocks in ten or more depots (category 2), however, establishes that the variation in the numbers of stockholding depots has not been produced simply by the substitution, in varying degrees, of transhipment depots.
5. **System Throughput:**

The number of stockholding depots a firm employs is also likely to be related to the volume of goods it channels through its echelon system. The greater this volume, the more economical it will be to distribute goods through a large number of depots. A highly dispersed pattern of stockholding will require a large throughput to ensure that the loading of trunk vehicles and the turnover of individual depots is above a minimum viable level. The size of this minimum turnover will depend on whether the firm operates its own depots, in which case it will want to spread overhead costs across a large volume of traffic, or whether it contracts out its local storage and distribution, in which case smaller traffic volumes are likely to be acceptable. The minimum volumes a firm channels through a contractor's depots is usually determined by the latter's rate structure.

It was not possible to test directly the relationship between depot numbers and system throughput because very few firms provided information on throughput in a suitable form. Two surrogate measures for throughput were used, however, to investigate this relationship:

i) **The proportion of output distributed through the echelon system.**

As almost all the firms in the sample could be classed as large volume producers, it was hypothesized that the number of depots they operated might correlate with the proportion of output distributed via these depots. This was based on the reasoning that the greater a firm's reliance on this mode of distribution, the more likely it would be to operate an extensive depot system. A Spearman Rank test was performed on the sample of 23 firms that supplied the necessary information (fig 7.12). This revealed that there was no significant relationship (at the 95% level) between the relative extent to which firms use a depot system and the number of depots that system contains. 

\( r = -0.21 \)
Figure 7.12: Relationship between the Proportion of Output Distributed in Bulk Loads Direct from the Factory and the Number of Stockholding Points. (source: personal survey)
Several reasons may be offered for this absence of a significant relationship. Some of the firms in the sample were subsidiaries of large conglomerates and had access to the extensive depot system of the parent company. The overhead costs of such systems were, therefore, borne by several subsidiaries and, in two cases, by "third party" clients outside the company. The number of depots available to a subsidiary need not, therefore, be related to its individual use of the echelon channel, but rather to the overall dependence of the parent organization on this method of distribution. Firms employing a "throughput carrier system" are also unlikely to conform to the hypothesized relationship as their centralization on a single location is not a consequence either of small total output or limited use of the echelon channel, but rather of a conscious decision to organise their distribution in a manner very different from the majority of other food manufacturers. A special case must also be made for a large sugar refining firm in the sample which supplies a substantial proportion of its output in bulk loads to other manufacturers for use in their production processes. The proportion of his firm's output channelled through its echelon system is not, therefore, strictly comparable with that of the other firms which supply their products almost entirely in a finished state to wholesalers and retailers. If one removes from the sample those firms affected by these three sets of exceptional circumstances, the correlation coefficient falls to -0.62, indicating a strengthening of the inverse relationship between depot numbers and relative use of the depot system. This coefficient value is significant at the 95% confidence level.

ii) Number of outlets supplied:

A relationship was established in Chapter 5 between the number of outlets to which firms deliver and their dependance on echelon systems of distribution. One might expect, therefore, that firms supplying large numbers of customers would do so from numerous depots. Where a firm had a high density of sales outlets, large enough delivery volumes would be generated in comparatively small areas to justify, or even encourage, the proliferation of local
depots. A sparse distribution of outlets, on the other hand, would impose a tight constraint on the number of depots a firm could economically operate. For the entire sample of firms providing the necessary data, however, a Spearman Rank test revealed that there was no significant relationship between depot numbers and the total numbers of sales outlets. (fig. 7.13) To some extent, the use of total sales outlets is unsatisfactory as this number includes not only customers served via echelon systems but also those supplied direct from factories. It is doubtful, however, if this imperfection in the data alone could account for the absence of a significant relationship.

If one excludes from the sample the firms identified in the previous section as exceptional cases, the correlation coefficient rises to 0.725, a value significant at the 99% confidence level. It would seem therefore that the inclusion in the full sample of subsidiaries supplying different numbers of outlets through the same distribution system and firms employing a "throughput carrier system" largely obscures what now appears to be a significant relationship between depot numbers and numbers of sales outlets.

A firm's dependence on the echelon system of distribution does, therefore, with some important exceptions, have a bearing on the number of stockholding depots it employs.

6. Recent History of Depot Closure:

The arguments advanced under the previous headings cannot explain all the variation in depot numbers. Much of this variation is the result of the particular circumstances of individual firms and does not conform to the general relationships discussed earlier. It is necessary, therefore, to supplement the theoretical considerations with an examination of the way in which depot systems have recently evolved. As explained in the section on the historical development of manufacturers' distribution systems (chap. 5), the number of stockholding depots operated by these firms has fallen over the past 20 years as
Figure 7.13: Relationship between Number of Outlets Served and Number of Stockholding Points.
(source: personal survey)
the proportion of output distributed direct from the factory has increased and as stockholding has become more concentrated. The vast majority of firms have, therefore, arrived at their present number of depots as a result of the contraction of larger depot system. The number of depots they currently operate partly reflects the way in which this contraction has been achieved.

Table 7.2 has been compiled from desultory historical data on the numbers of depots employed by twenty large food manufacturers at various times since 1945. Bands of line shading represent the main periods over which depot contraction has occurred; those of stippled shading represent the recent period during which depot numbers have remained stable. Apart from the large scale closure of temporary facilities in the immediate post-war period, the recent history of depot closures can be divided into two periods. Six of the firms pruned their depot systems substantially in the 1960s and followed this with only marginal reductions in the 1970s. This confirms the observation by NEDO (1967) that the spatial concentration of stockholding was well underway. For the majority of firms, though, the main phase of depot closure was in the 1970s and these firms usually compressed the programme of closures into a shorter time period. Several of the firms that rationalized their depot systems in the 1960s or early 1970s have since then made further, more marginal reductions in depot numbers. To obtain an overall indication of the reduction in the number of depots during the 1970s one can compare the average numbers of depots operated by food manufacturers in the survey undertaken by Thorpe et al. (1973) (16.1) with the average calculated on the basis of the present survey (10.6). A Mann-Whitney U test confirms that the numbers of depots employed by firms in the present sample are significantly smaller than those of Thorpe's sample (at the 99% level).

Of a sample of 23 firms, for which adequate historical data is available, 13 (57%) have built up completely new systems of depots since 1960, 5 (22%) of them since 1970. The other 10 firms still operate some depots constructed before 1960, though several of them have, nevertheless,
Table 7.2: Reductions in Depot Numbers 1945-78: Sample of 20 Food Manufacturers.
(source: personal survey)

|    | 19 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| M1 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M2 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M3 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M4 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M5 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M6 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M7 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M8 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M9 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M10|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M11|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M12|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M13|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M14|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M15|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M16|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M17|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M18|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M19|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| M20|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

M Manufacturer
Main phase of reduction in depot numbers
Depot numbers constant
company merger
substantially re-organized their distribution systems over the past 20 years. The rationalisation of depot systems has, therefore, entailed a considerable amount of new warehouse construction. As table 7.3 shows, over 80% of the stockholding depots operated by food manufacturers and distribution contractors have been built since 1960.

Those firms adopting a "clean slate" approach and setting up a new system of depots from scratch free themselves of the legacy of past depot numbers and locations. Of the 13 firms that have closed and/or replaced all their pre-1960 depots, 6 have adopted this approach and redesigned their distribution systems in their entirety. In five of these cases, the organizations followed company mergers and were motivated principally by a desire to integrate the distribution of the combined firm's products (Mercer et al., 1978). In the remaining case (that of Brooke Bond Oxo), the complete redesign of the distribution system was made necessary by a changeover from a system of van sales via 140 small depots to one of pre-ordered deliveries from a much smaller number of larger stockholding points (Barnett, 1978). The optimum number of depots in the newly planned systems appears to have fallen over this period, though, as the firms in this small sample vary in the products they manufacture and in their marketing policies, these depot numbers are not strictly comparable. A more legitimate comparison is of the numbers of depots calculated to be optimal for national distribution contractors specialising in food on three occasions since the war. These numbers have fallen sharply from 46 in 1947 (SPD) to 12 in 1967 (Lowfield) and 7 in 1971 (Cory). Given that new depot systems once established have a resistance to change, the number of depots a firm currently operates may be partly related to the date at which the distribution system was last restructured.

The majority of food manufacturers have re-organized their distribution systems gradually, often rationalizing the pattern of stockholding in one region at a time, sometimes in response to changes in local circumstances, such as a road improvement or the switch of a major local customer's supplies from store to warehouse delivery. The
Table 7.3: Ages of Distribution Depots Operated by a Sample of 14 Food Manufacturers and 2 Distribution Contractors (1978-9).

<table>
<thead>
<tr>
<th></th>
<th>No. of Depots</th>
<th>Total Storage Space (sq.ft.)</th>
<th>Ave. Storage Space (sq.ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre - 1945</td>
<td>13 (9%)</td>
<td>459,000 (5.7%)</td>
<td>35,307</td>
</tr>
<tr>
<td>1945 - 1959</td>
<td>13 (9%)</td>
<td>233,900 (2.9%)</td>
<td>17,992</td>
</tr>
<tr>
<td>1960 - 1969</td>
<td>65 (43%)</td>
<td>3,685,750 (46.1%)</td>
<td>56,704</td>
</tr>
<tr>
<td>1970 - 1979</td>
<td>61 (40%)</td>
<td>3,618,200 (45.2%)</td>
<td>59,315</td>
</tr>
<tr>
<td></td>
<td>152</td>
<td>7,996,850</td>
<td></td>
</tr>
</tbody>
</table>

Source: personal survey.
timing of these closures is often determined by the expiry of a lease.

Some depot rationalizations entail no new capital investment. These commonly involve the closure of a marginal depot and the transfer of its stocks and delivery work to one or more neighbouring depots. In some cases, the depot may not be closed but simply downgraded to a transhipment point. Such changes have occurred quite frequently and with considerable ease. Where the capacity of the depots is too limited to permit the concentration of stocks within the existing system, firms must invest either in new, larger premises or in the expansion of some of the existing ones. Larger scale rationalizations of this type take longer to plan and implement and have occurred less frequently. Whilst distribution systems are generally regarded as being more mutable in the short term than systems of production (Cleary and Thomas, 1973), it may, nevertheless, take some time for the number of stockholding depots a firm employs to adjust to changing circumstances. If one takes this dynamic view of manufacturers' distribution systems, one can see that some of the observed variation in depot numbers may be due to the fact that firms in the sample are at different stages in the process of depot reorganization.

There can be considerable inertia in a depot system (Ballou, 1968). Some firms acknowledged that they operated more depots than they needed or depots in sub-optimal locations, but believed that it was more economical to continue to do so than to incur all the costs associated with depot reorganization. Some of their older depots are, after all, fully depreciated and have low rateable values. In many areas the sale of these older premises could prove difficult. One distribution director declared that it was company policy to use existing distribution assets, many of which had been acquired as a result of company takeovers, to the full and not to divert investment into distribution from the firm's main activity i.e. production. Other firms attached considerable importance to the good labour relations that had been fostered over many years in some of their depots. If these depots were closed, it might prove
costly to make these staff redundant and to recruit other staff to operate larger, more centralised facilities elsewhere (GLC, 1977).

It is often argued that the use of distribution contractors affords greater flexibility than own account operations. This would make it easier to reduce the number of stockholding points in the short term. Whilst this is to some extent true, it should, however, be recognised that there are numerous instances of food manufacturers having the exclusive use of a contractor's depot and consequently being tied into longer term contractual agreements.

Several of the firms contracting out their distribution also preferred to disperse their traffic through more depots than was necessary logistically, to reduce the possible ill-effects of any one carrier's operation being disrupted and to limit its bargaining power in rate negotiations. These perceived benefits of increased security of supply and an improved bargaining position must, therefore, be set against the benefits of concentrating stocks in fewer depots.

It was predicted in the late 1970s that increasing fuel prices and reductions in drivers' hours would alter the trade-off between transport and stockholding costs and promote a return to more dispersed depot systems (Financial Times 22/11/1977; Smith, 1979a). It has also been acknowledged that in many firms, underlying these cost factors, is a pressure from sales staff to hold stock as close as possible to customers (Bevington, 1979), and a desire to reduce the vulnerability of the distribution system to industrial action by dispersing depot storage and delivery work (Smith, 1979). There has been no evidence, however, of the trend towards more concentrated patterns of stockholding being reversed. It appears that those predicting such a change under-estimated the possible savings in stockholding and storage costs accruing from concentration and over-estimated the increases in transport costs. It has been shown that it is quite common for a delivery driver to be idle for between a fifth and a third of his daily shift (Bevington, 1979). Reductions in drivers' hours need not, therefore, impose a serious
constraint on the delivery range and hence on depot numbers. It has also been found that, despite increases in fuel prices in 1973-4, total vehicle operating costs declined by 5% in real terms between 1974 and 1977 (Cundill and Shane, 1980). Furthermore, as explained earlier, it has been possible for firms to maintain the economic efficiency of concentrated patterns of stockholding by increasing their use of transhipment depots (McKibbin, 1972; Newson, 1978).

**Multiple Retailers' Central Warehouses.**

Although the main factors affecting the number of stockholding depots manufacturers employ also influences the number of warehouses multiple retailers operate, important differences between the two types of organization make it necessary to adopt a different approach to the analysis of central warehouse numbers. In the first place, unlike large food manufacturers, the grocery multiples, individually, do not serve the national market and do not aim to bring their goods within easy reach of the entire population. At the time of the survey, the largest grocery multiple in Britain comprised roughly 1100 stores, the average multiple operated only around 90 stores (Retail Directory, 1979). By comparison, the sample of large food manufacturers delivered their products to an average of 15,330 outlets. The multiples surveyed vary greatly in size, as measured by turnover and number of branch stores. (Table 7.4) The number of central warehouses a firm operates, however, is not simply a function of size, however measured. Second, the range of variation in central warehouse numbers is much less than that of manufacturers' depots. Almost half the retailers operated only one depot, though these single warehouses varied enormously in size. Third, the retailer has much greater control than the manufacturer over the number and locations of outlets to be supplied. Indeed, it is possible for the multiple to coordinate closely the development of his warehouses with the expansion of his retail chain. Fourth, unlike manufacturers, which could in many cases be distinguished on the basis of product type, the grocery multiples channel a very wide variety of products through their central warehouses. Most multiples' warehouses handle between 1000 and 2000 lines. As noted earlier, the retailers
Table 7.4: Grocery Multiples: Depot Numbers, Shop Numbers and Turnover (1978-9).

<table>
<thead>
<tr>
<th>Code no.</th>
<th>No. of Central Warehouses</th>
<th>Approx. No. of Branch Stores</th>
<th>Turnover (£M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>9</td>
<td>1100</td>
<td>490</td>
</tr>
<tr>
<td>2.</td>
<td>9</td>
<td>600</td>
<td>506</td>
</tr>
<tr>
<td>3.</td>
<td>8</td>
<td>650</td>
<td>543</td>
</tr>
<tr>
<td>4.</td>
<td>5</td>
<td>700</td>
<td>953</td>
</tr>
<tr>
<td>5.</td>
<td>4</td>
<td>220</td>
<td>811</td>
</tr>
<tr>
<td>6.</td>
<td>4</td>
<td>143</td>
<td>214</td>
</tr>
<tr>
<td>7.</td>
<td>4</td>
<td>156</td>
<td>193</td>
</tr>
<tr>
<td>8.</td>
<td>3</td>
<td>83</td>
<td>213</td>
</tr>
<tr>
<td>9.</td>
<td>2</td>
<td>67</td>
<td>90</td>
</tr>
<tr>
<td>10.</td>
<td>2</td>
<td>78</td>
<td>112</td>
</tr>
<tr>
<td>11.</td>
<td>2</td>
<td>77</td>
<td>70</td>
</tr>
<tr>
<td>12.</td>
<td>1</td>
<td>66</td>
<td>170</td>
</tr>
<tr>
<td>13.</td>
<td>1</td>
<td>174</td>
<td>73</td>
</tr>
<tr>
<td>14.</td>
<td>1</td>
<td>105</td>
<td>-</td>
</tr>
<tr>
<td>15.</td>
<td>1</td>
<td>94</td>
<td>65</td>
</tr>
<tr>
<td>16.</td>
<td>1</td>
<td>70</td>
<td>85</td>
</tr>
<tr>
<td>17.</td>
<td>1</td>
<td>46</td>
<td>62</td>
</tr>
<tr>
<td>18.</td>
<td>1</td>
<td>45</td>
<td>61</td>
</tr>
<tr>
<td>19.</td>
<td>1</td>
<td>45</td>
<td>-</td>
</tr>
<tr>
<td>20.</td>
<td>1</td>
<td>36</td>
<td>80</td>
</tr>
<tr>
<td>21.</td>
<td>1</td>
<td>32</td>
<td>-</td>
</tr>
<tr>
<td>22.</td>
<td>0</td>
<td>60</td>
<td>450</td>
</tr>
<tr>
<td>23.</td>
<td>0</td>
<td>39</td>
<td>64</td>
</tr>
</tbody>
</table>

Sources: Company Annual Reports, Retail Directory (1978/9), personal survey.
vary both in the proportion of supplies they store centrally and in the composition of these supplies. The number of central warehouses operated by multiple retailers cannot, therefore, for these various reasons, be compared in the same way as the number of manufacturers' depots.

Nevertheless, some of the general principles of stock distribution that were established earlier in connection with manufacturers' depots also apply to retail central warehouses. These will be examined under the same headings as in the previous section.

1. Policy on Stock Dispersal: As the turnover rates of products handled by grocery multiples differ markedly between, for example, fresh foods which "turnover" daily and some non-foods which do so only four or five times a year, one might expect to find some spatial segregation of stocks within retailers' distribution systems. According to the principle advanced by Ballou (1973), slowly moving stocks of non-food products would be centralized, while stocks of faster moving lines would be more widely dispersed. Only two instances were found, however, of multiples operating warehouses specialising in particular types of product, in one case non-foods, in the other fresh foods. Most of the firms in the survey did not handle centrally enough products in these categories to justify establishing separate warehouses for them. Furthermore, the systems of central warehouses that have developed, principally to handle groceries, can also, in most cases, meet the logistical needs of those products with turnover rates significantly faster or slower than groceries. As almost all branch stores are within the daily delivery range of their central warehouse, fresh foods can be delivered quickly and regularly from these bases. In the case of slow moving lines, there is evidence of those retailers with more than one warehouse concentrating their bulk stocks of non-foods at a single location.

2. Trade-off between Transport and Stockholding/Storage Costs: Given the "uniform delivered pricing" scheme of food manufacturers, the multiples do not need to take the costs of trunking goods from the factory into account in planning the locations of their warehouses (GLC, 1977). In deciding upon the
number of warehouses to use, however, they must ensure that each is big enough to receive supplies in sufficient bulk to qualify for quantity discounts. NEDO (1967) reports on the case of one supermarket chain that found it could gain a "purchasing advantage" of 0.5% of net sales revenue by concentrating its operations in one rather than two central warehouses. Usually, however, the desire to receive discounted bulk loads imposes such a low size threshold, that it rarely acts as a constraint on the larger multiples' warehouse policies. As in the case of manufacturers' distribution systems, therefore, ex-factory trunking costs can be said to have little bearing on the number of central warehouses a retailer operates. The transport side of the cost trade-off is, therefore, dominated by the cost of deliveries out from the warehouse to branch stores, for which the retailer has full responsibility. The unit costs of these deliveries are generally much lower than those of manufacturers. This is mainly because these are consolidated deliveries of large, mixed loads, often made by much bigger vehicles than those employed by manufacturers for local delivery. Twenty-eight of the firms surveyed, seventeen multiple retailers and eleven manufacturers (including two distribution contractors used by food manufacturers) provided sufficient information on their delivery fleets to permit a comparison of vehicle sizes. As shown on table 7.5, the manufacturers delivery vehicles were considerably smaller than those of the multiples, having an average gross weight of only 10 tonnes by comparison with a corresponding figure of approximately 25 tonnes for the retailers' vehicles. Indeed, roughly half the vehicles operated by the multiples were of maximum gross vehicle weight at the time of the survey (32 tonnes), though several of these firms conceded that, when loaded with a standard mix of grocery products, these vehicles, even with the maximum size of trailer, would seldom have a gross weight in excess of 20-24 tonnes.

The multiples' vehicles make on average only 2.5 drops per journey by comparison with around 12 for food manufacturers. Many of the firms operating large stores and channelling a high proportion of their supplies via central warehouse, have their vehicles deliver full trunk loads to individual shops. Branch store deliveries from multiples' central warehouses can, therefore, more closely resemble trunk hauls than manufacturers'
<table>
<thead>
<tr>
<th>Sample Size</th>
<th>Gross Vehicle Weight (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturers</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple Retailers</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: personal survey.
local deliveries. As these consolidated bulk deliveries have a relatively low unit cost per kilometre, and one which "tapers" with distance, they can be run efficiently over long distances. The careful scheduling of these deliveries and the use of specialised handling systems (most commonly "roll pallets") make it possible to off-load these large consignments rapidly. This fast "turn-around time" allows the vehicles to travel long distances within the "driving day". The nature of the multiples' transport operation thus makes it possible to serve widely dispersed branch stores reasonably efficiently from a single warehouse.

Whilst the multiple's unit delivery costs are generally lower than those of manufacturers, its unit warehousing costs are usually higher, principally for two reasons. In the first place, the retailer holds much more diversified stock. The greater the number of product lines stocked, the higher is the ratio of total stocks to total warehouse throughput. These relatively large stocks are more costly both to finance and to store. The physical costs of storing, sorting and order-picking also vary in relation in the number of lines stocked, making retail central warehouses comparatively expensive to operate. All these cost elements, however, can be reduced by concentrating stock in fewer, larger premises. With respect to stockholding/storage costs, therefore, multiples are under stronger pressure than manufacturers to centralize their stocks.

The structure of the multiple retailers' distribution costs favours larger, more centralized facilities, serving wide areas. This partly explains why their warehouses tend to be larger than manufacturers' distribution depots. (fig. 7.14)

3. Service Level: The level of delivery service provided by multiples to their branch stores cannot be compared in the same way as that of manufacturers. The multiples schedule the submission and delivery of orders much more tightly and routinely. Each branch store generally receives the same number of central warehouse deliveries each week at roughly the same time(s). The frequency of these deliveries, nevertheless, varies greatly between and within chains. The variations between chains largely reflects differences in the proportion of supplies delivered from central warehouse. Variations between
Figure 7.14: Sizes of Grocery Warehouse Operated by Wholesalers, Multiple Retailers and Manufacturers in the Food Industry. (source: personal survey)

1 includes 2 variety chains selling groceries.
branch stores within a chain is mainly the result of differences in shop size, measured by turnover. In the case of multiples, therefore, it is difficult to devise a meaningful measure of service level and impossible to establish a uniform basis for the comparison of service levels.

Nevertheless, some general observations can be made about the relationship between service levels and the number of central warehouses multiples operate. Warehouse numbers might be expected to influence service level in two ways. First, they could determine the proportion of branch stores within the daily range of delivery vehicles; the greater the number of warehouses, the more extensive would be their combined hinterland and the smaller the number of branch stores lying outside this area and therefore in need of a two day delivery. In practice, however, very few stores lie beyond the daily delivery ranges of the central warehouses that supply them. This can be attributed partly to the fact that the logistics of bulk consolidated delivery enable central warehouses to serve wide areas and partly to the constraining influence of daily delivery range on the spread of retail chains. Second, the frequency of delivery offered to stores within the daily service area might also be expected to vary with the number of central warehouses. The greater the number of warehouses, the shorter would be the "stem" distances of store deliveries and the smaller would be the marginal costs of providing branch stores with a more frequent delivery of smaller consignments. No evidence was found, however, of retailers dispersing their stocks to permit an increase in the frequency of delivery. Those chains channelling a high proportion of their supplies through central warehouse tend to operate large stores capable of receiving a large consignment daily. These loads are generally of sufficient bulk to make daily deliveries economical over long distances. Many of the less centralized chains, whose shops are less dependent on central warehouse deliveries and often smaller, are content to provide a once or twice weekly delivery. Indeed two such firms claimed that less frequent deliveries disciplined store managers into more carefully managing their stocks. Overall, it is doubtful if the benefits of increasing the frequency of branch delivery would outweigh the costs of dispersing stock in a greater number of smaller warehouses and of reducing the efficiency of the delivery operation.
4. **System Throughput:** Since the multiples vary greatly in size, it is likely that much of the variation in the numbers of central warehouses they operate can be attributed to size differences. As pointed out earlier, however, the number of warehouses is not simply a function of total turnover. It also depends on the proportion of supplies the firm channels through central warehouse, the rate at which stocks of these products "turnover" and the sizes of its warehouses. The first two factors determine the total amount warehouse space the multiple requires, the third reflects the distribution of this storage space between individual premises.

**Variations in Central Warehouse Capacity**

The amount of warehouse space a multiple retailer requires can be expressed as follows:

\[
T \cdot C
W = \frac{\text{Space}}{S}
\]

where \( W \) is the total amount of warehouse space required

- \( T \) is the total turnover of the chain
- \( C \) is the proportion of turnover channelled through central warehouse
- \( S \) is the warehouse turnover per unit area.

Both \( T \) and \( C \) have been shown to vary widely. Together they determine the volume of turnover passing through central warehouse. By dividing this volume (measured in monetary terms) by the total amount of warehouse space the multiples currently use, one can measure the "productivity" of this storage space i.e. the turnover rate per unit area \( S \). Like \( T \) and \( C \) this \( S \) value also varies considerably. This variation can be attributed to several factors:

(a) **The degree of stock concentration:** As already discussed in connection with manufacturers' depots, the extent to which stocks are concentrated partly determines the total volume of stock that need be held at any given time to ensure a specified level of product availability. The greater the degree of
concentration, the smaller will be the volume of stock relative to sales, the greater, by definition, will be the turnover rate. Multiples centralizing their stocks in a few large premises should, therefore, be able to secure a higher ratio of turnover to storage area than those dispersing stocks through several smaller warehouses.

(b) The particular mix of products channelled through the central warehouse: As products can differ markedly in the rate at which they sell and in the amount of space they occupy, a multiple's choice of products for centralized storage and delivery will partly determine the turnover rate per unit area. This rate will be particularly sensitive to the relative amounts of fast and slow moving lines, such as fresh foods and non-foods, the retailer directs through his warehouse(s).

(c) Warehouse dimensions: Floorspace can be an unreliable measure of warehouse capacity as the height of the premises can differ markedly, particularly between the conventional single storey warehouses (between 20 and 30 feet "to the eaves") and the "high bay" warehouses that have sprung up in recent years, of a height equivalent to a five or six storey building, but with a floorspace measured only in relation to ground plan (Thorne, 1977). At the time of the survey, however, only one "high bay" warehouse was operated by a grocery multiple and the firm operating it was not included in the present sample. Even the more modest variations in the height of the conventional warehouses operated by firms in the sample can, however, affect the turnover to floorspace ratio.

(d) Internal warehouse organization: The actual amount of space required to store a given volume of goods also depends on the internal layout of the warehouse which in turn is affected by the choice of racking systems, methods of order picking and provision of space for ancillary activities.

(e) Stage in warehouse development process: Reference was made in chap.5 to Bowen and Mundy's model of central warehouse development which suggests that following the opening of a new warehouse, multiples will seek to fill excess capacity by increasing, temporarily, the proportion of supplies channelled via central warehouse, reducing this proportion again as total turnover increases. As little evidence was found of this cyclical process actually operating it must be concluded that
Central warehouses will carry varying amounts of surplus capacity, depending upon the stage they are at in the long term programme of warehouse development. This situation is further complicated by the addition of warehouse space that accompanies the growth of a chain through acquisition. This mode of expansion makes it even more difficult to tailor the amounts of storage space available to the volume of warehouse throughput.

Despite the variations in turnover per unit area, when total warehouse throughput is plotted against total warehouse floorspace for the sample of 16 grocery multiples (fig. 7.15) there appears to be quite a close relationship between these variables. A simple regression analysis of total warehouse space \( W \) (in '000 sq.ft.) on throughput volume \( TV \) (in £ million) produced the following equation:

\[
W = 1.96TV + 58,600
\]

As throughput volume explained almost 96% of the variance in warehouse space, and the relationship was significant at the 95% level, this equation could form the basis of a predictive model of the demand for warehouse space among grocery multiples. It suggests that for every increase of 10 million pounds (at 1978 prices) in the value of turnover channelled through central warehouse(s) an additional 5100 sq.ft. of storage space is required. A downward extrapolation of the trend line also indicates that the minimum amount of warehouse storage space a grocery multiple would be likely to operate is around 60,000 sq.ft. One of the firms in the sample, however, operated slightly less than this amount. A more accurate calculation of the minimum viable size of a central warehouse operation would require a study of the smaller multiples (with fewer than 20 branch stores) that were excluded from this survey.

Three of the major residuals from the best-fit regression line require comment. Firms 1 and 2, which lie some distance to the left of the trend line have a lower turnover rate per sq.ft. than predicted. This might be partly related to the fact that these firms operate dispersed systems of nine and six central warehouses respectively, serving chains of widely scattered branch stores. Much of these firms growth has also been through
Figure 7.15: Relationship between Value of Turnover Channelled through Central Warehouse and Total Warehouse Space. (source: personal survey)
acquisition. Firm 3 is at the opposite extreme, with a turnover per sq.ft considerably in excess of that predicted. This firm was exceptional in having experienced, shortly prior to the survey, an increase in total turnover of around 40% over a short period. By the time of the survey it had not been possible for this firm to expand its warehouse capacity accordingly and, as a result, it was channelling exceptionally high volumes of supplies through its existing premises.\(^\text{10}\)

Apart from these exceptions, there appears to be a reasonably close relationship between total amount of warehouse space and the volume of supplies a retailer channels via central warehouse. It is now necessary to examine the distribution of this storage space among individual premises.

### Central Warehouse Sizes

The central warehouses operated by grocery multiples in the sample ranged from 19,000 to 450,000 sq.ft. though almost two thirds of them were between 50,000 and 150,000 sq.ft.. In the case of those firms operating only one warehouse, sizes correlate quite closely with the volume of throughput, as demonstrated by the earlier regression analysis. An analysis of variance test of those firms with more than two warehouses, revealed that the variation in central warehouse size is greater between retailers' distribution systems than within them. The largest warehouses, in excess of 200,000 sq.ft. were all operated by large chains with highly centralized distribution systems, handling over 75% of their supplies. On the other hand, the smaller warehouses (under 100,000 sq.ft.) were operated by less centralised chains, either small ones or national chains that had grown by acquiring smaller chains and associated warehouses. There were also several instances of warehouses sizes varying widely within chains. This variation was greatest in the case of two national multiples that had obtained most of their central warehouses through a process of 'acquisitive' growth. In contrast, however, the other large national multiple that has expanded mainly by a series of takeovers completely restructured its distribution system in the early 1970s, closing the assortment of central warehouses it had acquired over the years and replacing them with six large warehouses of almost identical size in strategic locations. Of the multiples that have grown
organically, only one has standardised the size of its grocery warehouses. The others operate warehouses widely differing in size, their dimensions largely reflecting the potential for store development in the areas they serve.

Summary

Relative to the respective volumes of groceries they deliver to shops, the multiples operate fewer and larger distributive warehouses than food manufacturers. The displacement of grocery flows from manufacturers' distribution depots to multiple retailers' central warehouses has, therefore, produced a further spatial concentration of grocery stocks. The multiples, nevertheless, vary in the extent to which they concentrate their warehouse stocks. It is difficult to compare multiples in terms of the number of central warehouses they operate, however, because their chains vary greatly in size and areal extent. For a group of sixteen multiples, a fairly close relationship was found between the value of supplies channelled through central warehouse and the total amount of warehouse space. Half of the chains surveyed operated only one warehouse and, in the case of those providing adequate turnover data, warehouse size correlated quite closely with the value of central warehouse supplies. Many of the regional multiples have continued to concentrate their stocks in one warehouse while expanding their chains. The wide geographical extension of some of these chains (such as Wm. Low in Scotland) outward from a single central warehouse has been facilitated by road improvements and the development of larger shops capable of receiving large consolidated loads that can be transported economically over long distances. In the case of chains operating more than one central warehouse, it was found that warehouse sizes varied more between firms than within them. The range of warehouse sizes was much narrower in the case of multiples that had mainly followed an "organic" pattern of growth. These chains tend to operate fewer, larger premises. Those growing principally "by acquisition" tend to disperse their stocks more widely in a larger number of smaller and more variably sized warehouses. The rationalization of these firms' distribution systems over the past 10-15 years has concentrated stocks in fewer, larger premises and reduced the variations in warehouse size.
Voluntary Groups:
The number of wholesale depots in each of the voluntary groups is the product of the number of wholesalers belonging to the groups and the numbers of depots they operate. At the time when the first voluntary groups were formed, most wholesalers had comparatively small trade areas. To obtain national coverage, therefore, it was necessary to affiliate large numbers of wholesalers to the organizations (Fulop, 1962). The two largest voluntary groups launched national systems of distribution from the start, others achieved national coverage over several years by gradually incorporating more wholesalers into their organizations. In 1964, the major national voluntary groups consisted of between 25 and 35 wholesalers several of which operated more than one depot. In that year, these groups served the whole country from an average of 37 depots. Since then, the numbers of wholesalers and depots have fallen sharply. (Table 7.6) While a few wholesalers have withdrawn from voluntary groups, most of the reduction in their numbers has been due to numerous amalgamations and takeovers in the wholesale sector. Mergers have occurred at two levels. They have occurred at the level of voluntary groups as a whole, as exemplified by the union between Spar and Vivo. There have also been numerous mergers of wholesalers within voluntary groups. In the case of the two largest national groups, this process has concentrated ownership in a few large firms. Both types of merger have resulted in a reduction in depot numbers. Following the integration of Spar and Vivo, the combined depot system was rationalized and many depots lost their voluntary group function. The merger of individual wholesalers has also frequently resulted in the closure of depots. Depot closure has not only been a consequence of merger activity. There have also been some instances of individual wholesalers concentrating their operations in fewer depots.

These reductions in depot numbers have been made possible by several factors:

1. Transport improvements, particularly to the road network, have permitted an extension of depot hinterlands.
Table 7.6: Major Voluntary Groups: Numbers of Wholesalers, Depots and Affiliated Retailers 1964 – 79.

**Wholesale Voluntary Groups:**

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Wholesalers</th>
<th>No. of Depots</th>
<th>Affiliated Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>136</td>
<td>274</td>
<td>24,578</td>
</tr>
<tr>
<td></td>
<td>-36%</td>
<td>-30%</td>
<td>-19%</td>
</tr>
<tr>
<td>1979</td>
<td>94</td>
<td>193</td>
<td>19,800</td>
</tr>
</tbody>
</table>

**Retailer-Sponsored Voluntary Groups:**

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Buying Combines</th>
<th>No. of Depots</th>
<th>Retail Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>53</td>
<td>53</td>
<td>2872</td>
</tr>
<tr>
<td></td>
<td>-28%</td>
<td>-43%</td>
<td>+50%</td>
</tr>
<tr>
<td>1979</td>
<td>28</td>
<td>30</td>
<td>4300</td>
</tr>
</tbody>
</table>

_Sources: Fulop (1964), Mintel (1979)_

Table 7.7: Average Floorspace and Turnover of Wholesalers' and Retailers' Warehouses in the Grocery Trade.

<table>
<thead>
<tr>
<th>Type</th>
<th>Average Size (sq.ft.)</th>
<th>Average Turnover (£M annum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Retailers'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Warehouse</td>
<td>106,125</td>
<td>42.5</td>
</tr>
<tr>
<td>CWS Regional Distrib. Centre</td>
<td>76,600</td>
<td>32.9</td>
</tr>
<tr>
<td>Voluntary Group Wholesale Depot</td>
<td>39,600</td>
<td>8.5</td>
</tr>
<tr>
<td>Cash and Carry Warehouse</td>
<td>25,310</td>
<td>2.9</td>
</tr>
</tbody>
</table>

_Sources: same as for Table 5.4_
2. Reduction in the number of smaller retailers in the groups: This has resulted from the closure of unprofitable shops, the deliberate policy of some groups to exclude shops unable to place orders of a certain minimum size and the growth of some of the smaller retailers. Between 1964 and 1979, there was a fall of 20% in the number of retailers belonging to voluntary groups (Fulop, 1964; Mintel, 1979). Over the same period there was a significant increase in the average size of the remaining stores. One large voluntary group in the survey estimated that the average turnover of its shops had increased (in real terms) by 50% between 1960 and 1979. Despite the reduction in the average proportion of supplies retailers purchase from voluntary group wholesalers (often referred to as the "loyalty factor"), the increase in outlet size has resulted in an increase in average size of order delivered by these wholesalers. The reduction in the number of small shops coupled with the increase in average drop size has made deliveries over longer distances more economical.

3. Investment in new single-storey warehouses, often in locations more central to the wholesaler's trade area. One of the largest voluntary groups reported that almost all the 28 depots it currently employed had been constructed since the group was formed. Many of these had replaced several smaller, multi-storey depots in inner urban locations.

Even after these reductions in depot numbers, voluntary groups with national or near-national coverage in 1979 still employed an average of 28 depots, each serving on average an area of about 30 miles radius (Retail Directory, 1978/9). This constitutes a much higher degree of stock dispersal than that of the larger multiples. The wholesale warehouses are also significantly smaller than those of multiples both in floorspace (fig. 7.14) and turnover. This greater dispersal of stock will be partly responsible for wholesalers' higher ratio of stocks to turnover (Mintel, 1979) and also their lower turnover rate per square foot than multiples' central warehouses. Only one voluntary group provided sufficient data on turnover and depot floorspace to permit the calculation of an average turnover/sq.ft. figure. This average value (for 28 depots) was 38% lower than the average for the central warehouses of
multiples in the sample. Voluntary group wholesalers, therefore, have more storage space relative to turnover than the multiples and this is more widely dispersed. Such a dispersed pattern of stockholding is more suited to the delivery of smaller orders to larger numbers of smaller outlets.

Cash and Carry Warehouses:

No separate survey was undertaken of cash and carry wholesaling. Detailed information on the sizes, spatial distribution and ownership of grocery cash and carries has, however, been compiled by Thorpe and Thorpe (1976), Crofts (1972) and the Economist Intelligence Unit (1980).

The number of cash and carry warehouses grew rapidly in the late 1950s and 1960s to reach a maximum in the early 1970s. Webb (1972) argued that the development of cash and carries in the 1960s and early 1970s went against the prevailing trend towards more concentrated patterns of stockholding, as these premises were generally much smaller than depots operated by manufacturers, retailers and other types of wholesaler (table 7.7). Since then their number has remained fairly stable at around 600. The total amount of floorspace devoted to this type of wholesaling has, nevertheless, continued to increase substantially. Many smaller depots have been expanded or closed down and replaced by new much larger premises. Some 45% of cash and carry floorspace in use in 1975 was less than four years old (Thorpe and Thorpe, 1976). By the mid-1970s, grocery cash and carry operations had clearly outgrown many of the older wholesale premises in which they had originated. Unlike the other types of depot considered in this chapter, the creation of a new generation of larger cash and carry warehouses has not been accompanied by a significant reduction in their total numbers. This is because the development of these new, larger premises is not the result of a policy of stock concentration but rather the provision of additional floorspace to accommodate the increasing volume of trade handled by cash and carries. (fig. 7.16) New cash and carry warehouses have tended, therefore, to replace older premises on a one-to-one basis rather than centralize the operations of several.

The cash and carry sector needs more warehouse floorspace relative to turnover than both the multiples and the voluntary
Figure 7.16: Size Distribution of Cash and Carry Warehouses: 1971 and 1975. (after Thorpe and Thorpe, 1976)
groups. It had an average turnover per square foot of around £130 in 1979 by comparison with £400 for the central warehouses of a sample of 18 multiples and £214 for a large national voluntary group. The higher ratio of floorspace to turnover can be explained partly by the fact that cash and carry warehouses need wider aisles for order picking by retailers and additional space for check-outs and displays. It is also likely to be the result of the more dispersed pattern of stockholding in cash and carries. By comparing figures 7.14 and 7.16, one can see that, even allowing for the enlargement of cash and carries during the 1970s, they are still generally smaller than the other main types of grocery warehouses. They also serve smaller areas, the extent of their catchment areas being limited by the distances retailers are prepared to travel to collect supplies.

These generalizations, however, conceal wide differences between cash and carry warehouses in size, turnover, turnover per square foot, and catchment area. In 1979, for example, warehouse sizes ranged from 24,000 sq.ft. to 137,000 sq.ft.; turnover per sq.ft from £97 to £234. Turnover per sq.ft tended to increase with depot size, though, it was also affected by the product mix and the firms' trading characteristics (Economist Intelligence Unit, 1980).

Chapter Summary

Stockholding depots act as "hinge-points" in a distribution system. For a market area of given size, the number of depots partly determines the pattern of trunk movement and the nature of the local delivery operation. The smaller the number of depots, the greater will be the concentration of flow on particular routes, the wider will be the depot hinterlands and the larger the average distance between depot and customer. To distribute goods economically over these longer distances, firms must minimize the number of drops per delivery. This generally entails restricting deliveries to larger outlets, employing heavier vehicles and placing greater emphasis on the consolidation of orders.

Over the past 20 years, there has been a major concentration of grocery stocks in fewer, larger premises. The motives for this concentration of stockholding are discussed in chapter 11. This has been achieved partly by manufacturers, wholesalers and
some multiple retailers rationalizing their depot systems, but also partly by stocks being displaced from the dispersed stockholding systems of manufacturers and wholesalers to the more centralized systems of multiple retailers. The effects of these changes in the pattern of stockholding on the logistics of shop delivery are discussed more fully in chapter 10.

Despite the rationalization and concentration of stockholding at all levels of the distributive channel, the disparities in the numbers of depots operated by firms at each of these levels remain wide. This makes it difficult to generalize about the pattern of grocery movement as the route a product takes depends largely on the stockholding policies of the particular combination of manufacturer, wholesaler and/or retailer handling it. Moreover, these stockholding policies are not simply related to the physical and marketing characteristics of the product; they also depend on several other factors, such as the scale and geography of production, the way in which the firms' distribution systems evolved and the particular mix of products with which the firm deals.

Knowledge of the number of intermediate stockholding points in a distribution system allows one to make general deductions about the length of "local" deliveries from depots or central warehouses to shops. Before one can study the actual logistics of these deliveries and the pattern of trunk movement "upstream" of the stockholding depots, one must examine the spatial distribution of these depots.

Notes:

1. Smith (1979) has also found wide variations in the numbers of stockholding points in the distribution systems of confectionery manufacturers.

2. A distinction may be drawn between a centralised echelon system and a direct system. In the former case, centralised storage would be located away from the factory or factories; in the latter case, it would be based at the main production site.

3. The optimum location was taken to be the "ton-mile centre",
found by employing the algorithm devised by Kuhn and Kuenne (1962).

4. The various methods of overcoming this logistical constraint, such as the use of transhipment, the out-basing of drivers or the provision of overnight accommodation for drivers, also add significantly to unit delivery costs.

5. One cannot test this relationship rigorously as the data do not satisfy the conditions of any of the correlation tests. It should also be noted that the averages conceal differences in the range of a firm's delivery lead times.

6. Idealised examples of categories 1 to 3 were illustrated in figure 5.1 as stage 4 in the historical model of distribution system development.

7. Some firms distribute significant quantities of their products to caterers. The methods of distributing supplies to these customers are generally similar to those used for wholesale and retail customers.

8. a) In planning a new depot system in the early post-war period SPD under-estimated the future trend toward direct delivery and so by the late 1950s found it had more depot space than it required (Reader, 1969). b) Three of the Lowfield depots are used mainly for transhipment purposes. c) By operating a comparatively small number of depots Cory has tried to exploit the trend towards more concentrated patterns of stockholding. A managing director of Cory has claimed that, by transferring their distribution to Cory's seven-depot network, many of the firm's potential clients, operating at that time between 12 and 20 depots of their own, would be able to achieve a much higher degree of stock concentration (Barber, 1976).

9. The additional costs would result from a decrease in average drop size and increase in the number of drops per journey.

10. It was also renting some warehouse space temporarily, though this has been included in the figure for total warehouse space.
Chapter 8

The Location of Stockholding Points

For the majority of grocery consignments which travel indirectly along echelon channels to the retail outlet, the locations of intermediate depots will largely determine the route followed. The spatial distribution of these intermediate nodes strongly influences the aggregate pattern of food movement. A clustering of these premises in particular locations would concentrate flows along particular corridors, whereas a more even distribution would produce a more dispersed pattern of movement. The spatial distribution of intermediate stockholding points is, therefore, of crucial importance to the forecasting of freight traffic, and to plans for rationalizing the pattern of freight movement.

The location of distribution depots is also a topic in which several local planning departments have become increasingly interested as they have come to see warehousing as an alternative source of employment to manufacturing. The decline in manufacturing investment and slow take-up of structure plan allocations of industrial land in recent years have encouraged some local authorities, such as those of Warrington (Ince, 1977), Thamesdown and Peterlee, to take a more positive attitude towards distributive premises (McKinnon, 1983). To assess the potential for warehouse development in their areas, however, local authorities require more information on the factors influencing firms' choice of depot locations.

This chapter examines the spatial distribution of depots operated by food manufacturers, multiple retailers and wholesalers, reviews the analytical techniques available to optimise depot location and considers the factors that actually influence depot location decisions. It is concerned primarily with the type of depots classified by Bowersox et al. (1968) as being "market oriented". The location of these depots is determined principally by the spatial distribution of the outlets they supply, in contrast to "production-" and "intermediate-oriented" depots, whose
location is tied more closely to points of production and which are used much more for the storage and mixing of bulk stocks. Reference is made to these types of depot in Chapter 9.

Food Manufacturers' Distribution Depots

Analysis of the Aggregate Pattern

Figure 8.1 shows the spatial distribution of the 306 stockholding depots employed by the full sample of 29 food manufacturers. There is a high degree of concentration around the major settlements. Some 62% of the depots are within 20 miles of the centres of nine cities. This concentration confirms the view frequently expressed in the literature (Braithwaite and Dobbs, 1933; Sussams, 1969; Beattie, 1973; Coley, 1977) that there are several well recognised locations around the country to which distribution depots gravitate. Sussams (1971, p92) contends that this concentration of depots in particular locations "illustrates the fact that most traders have, over the years, arrived at good, if not optimal, solutions by a process of trial and error and that a process akin to natural selection has removed most of the errors". The clustering around major towns and cities is, however, more pronounced in some regions than others. In Scotland, the North East and Yorkshire there are reasonably tight concentrations around the main population centres, of Glasgow, Newcastle and Leeds, respectively. In the South East, North West and Midlands there is a more dispersed pattern. Such inter-regional comparisons, however, ignore the size and shape of the areas served by the depots. The wide scatter of depots in the South East, for example, results partly from firms serving the large London market from more than one location. One cannot, therefore, analyse the spatial distribution of individual firms' stockholding depots without also considering the numbers of depots they operate and the associated subdivision of the country into depot service areas. The number and locations of distribution depots are essentially interacting variables (Stasch, 1968) As depot numbers have been shown
<table>
<thead>
<tr>
<th>City</th>
<th>No. of Stockholding Points within 32kms</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>31</td>
</tr>
<tr>
<td>Bristol</td>
<td>27</td>
</tr>
<tr>
<td>Glasgow</td>
<td>26</td>
</tr>
<tr>
<td>Birmingham</td>
<td>21</td>
</tr>
<tr>
<td>Manchester</td>
<td>20</td>
</tr>
<tr>
<td>Newcastle-upon-Tyne</td>
<td>20</td>
</tr>
<tr>
<td>Leeds</td>
<td>16</td>
</tr>
<tr>
<td>Nottingham</td>
<td>15</td>
</tr>
<tr>
<td>Southampton</td>
<td>14</td>
</tr>
</tbody>
</table>

190

(62% of the total)

Figure 8.1: Spatial Distribution of Food Manufacturers' Stockholding Points: Sample of 29 Firms. (source: personal survey)
to vary considerably, it is not possible to make a direct comparison of manufacturers' choices of depot locations. One must instead explore the relationship between depot numbers and locations, to see if there is any regularity in the sequence in which depots are added to a distribution system and in the ways in which the country is progressively subdivided as depot numbers increase.

A careful, though subjective, study of the distribution maps of the 29 firms revealed considerable regularity in the order in which new locations were added as depot numbers increased. This confirms claims by Stoker (1976) and Sussams (1971) that there is a well ordered sequence of depot locations. Stoker established that the optimality of an existing set of depot locations was unlikely to be affected by the siting of additional depots. It is not necessary, therefore, for firms to restructure their entire depot systems when adding new depot locations. This makes it possible to "decompose" the multiple location problem and, thereby, optimise each additional location separately without fear of reducing significantly the optimality of the system as a whole (Sussams, 1969). Sussams (1971) has argued, that not only is there general agreement among firms on what are the main strategic locations for distribution depots, but there is a similar consensus on the order in which these locations are added to a depot system. The preliminary study of the 29 food manufacturers' depot maps tended to support this view, but, nevertheless, revealed a significant amount of irregularity. An attempt was therefore made to devise a more rigorous method of measuring the degree of regularity and of generalising the sequence of depot locations. The method used bears some resemblance to that devised by Rosenhead et al. (1972) to test the "robustness" of a range of possible locations for new branch plants. It involved identifying the areas where depots were concentrated and examining the relationship between the number of depots a firm operated and the likelihood of it having a depot in each of these locations. The following method of analysis was used:

1. A list was drawn up of all the urban areas with three or
more depots. Three was chosen as an arbitrary cut-off value. The list contained 25 towns and cities. (Table 8.1)

2. The total number of depots within 30 miles of the centre of each town was enumerated and assigned to that town. This choice of a 30 mile radius can be justified partly by the fact that the search for a suitable depot site typically extends over this range (NEDO, 1967; Loasby, 1973). It also makes allowance for the fact that many depots are today found in peripheral locations beyond the boundary of the urban authority and, particularly in the case of conurbations, at a considerable distance from the centre.

3. Several settlements were then removed from the list for two reasons:

i) As a result of their close proximity to other larger depot concentrations. There are very few instances (only 2 in this sample of 29 firms) of food manufacturers having two stockholding depots within 30 miles of each other. Settlements so close together would be regarded as possible alternative locations. Where two settlements were less than 30 miles apart, therefore, the one with the smaller number of depots (within a radius of 30 miles) was eliminated from the list.

ii) Even where settlements were more than 30 miles apart, they could still be used as alternatives. This was found to be the case in the North East of Scotland (with Aberdeen and Montrose), South Wales (with Cardiff, Newport and Swansea) and the South West of England (with Exeter and Plymouth). Only the firm with the largest number of depots operated depots in the vicinity of each of these pairs of locations, thereby dividing the three regions into separate service areas. As none of the remaining 28 firms split these regions between two depots, it was felt that by treating each of these settlements as separate depot concentrations one would not obtain a representative model of the sequence of depots locations. For this reason, the smaller depot concentration in each region was removed from the list.
Table 8.1: List of 25 Settlements with Three or More Food Manufacturers' Stockholding Points.

<table>
<thead>
<tr>
<th>Settlements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aberdeen</td>
</tr>
<tr>
<td>Inverness</td>
</tr>
<tr>
<td>Newport</td>
</tr>
<tr>
<td>Birmingham</td>
</tr>
<tr>
<td>Leeds</td>
</tr>
<tr>
<td>Norwich</td>
</tr>
<tr>
<td>Bolton</td>
</tr>
<tr>
<td>Liverpool</td>
</tr>
<tr>
<td>Nottingham</td>
</tr>
<tr>
<td>Bristol</td>
</tr>
<tr>
<td>London</td>
</tr>
<tr>
<td>Plymouth</td>
</tr>
<tr>
<td>Cardiff</td>
</tr>
<tr>
<td>Maidstone</td>
</tr>
<tr>
<td>Southampton</td>
</tr>
<tr>
<td>Colchester</td>
</tr>
<tr>
<td>Manchester</td>
</tr>
<tr>
<td>Spennymoor</td>
</tr>
<tr>
<td>Edinburgh</td>
</tr>
<tr>
<td>Montrose</td>
</tr>
<tr>
<td>Swansea</td>
</tr>
<tr>
<td>Exeter</td>
</tr>
<tr>
<td>Newcastle-upon-Tyne</td>
</tr>
<tr>
<td>Welshpool</td>
</tr>
</tbody>
</table>

Source: personal survey.

![Increasing No. of Depots](image)

Figure 8.4: Idealised Succession of Depot Locations.

Table 8.3: Idealised Successions of Depot Locations.

<table>
<thead>
<tr>
<th>Present Study</th>
<th>Sussams (1969)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. --</td>
<td>Birmingham</td>
</tr>
<tr>
<td>2. London</td>
<td>London</td>
</tr>
<tr>
<td>3. Merseyside</td>
<td>Manchester</td>
</tr>
<tr>
<td>4. Glasgow</td>
<td>Glasgow</td>
</tr>
<tr>
<td>5. Bristol</td>
<td>Bristol</td>
</tr>
<tr>
<td>6. Newcastle-upon-Tyne</td>
<td>Newcastle-upon-Tyne</td>
</tr>
<tr>
<td>7. East Anglia</td>
<td>Southampton</td>
</tr>
<tr>
<td>8. West Midlands</td>
<td>Leeds</td>
</tr>
</tbody>
</table>
iii) The remaining 19 settlements were plotted on a map and lines interpolated midway between them (fig. 8.2). These lines then served as idealised zonal boundaries. It was recognised that the results of the analysis would depend to some extent on the configuration of these boundaries. To give some indication of the likely sensitivity of the analysis to the boundary alignment a count was made of depots lying within 10 miles of the boundaries. These "marginal" depots represented only 6% of the total number of depots, reflecting the high degree of concentration around the "nuclei" of the 19 zones. Given the comparatively small proportion of depots in the vicinity of boundaries, it was concluded that marginal changes in the alignment of these boundaries would probably have little effect on the final outcome.

iv) Each zone was given a score of one for every food manufacturer that held stock there. This scoring system did not take account of the actual numbers of depots individual manufacturers used in each zone. The total numbers of depots in each zone were added up separately.

v) All the depot location data was collated in Table 8.2. The zones were ranked in relation to their scores and arranged in descending order of magnitude along the vertical axis. Where two or more zones had the same scores, they were ranked in relation to depot number. In the one instance where two zones had identical scores and depot numbers, the tie was broken arbitrarily. The 29 firms were arranged horizontally in ascending order by the total number of stockholding depots they operated. Where firms had the same numbers of depots, ordering was arbitrary. On the basis of this ranking, the country was successively subdivided into idealised depot hinterlands. Figure 8.3 shows the first sixteen stages of this zonal breakdown and indicates the "core area" within each zone where the stockholding points tend to cluster. The zonal boundaries have been generalised with respect to the actual pattern of depot area boundaries.
Figure 8.2: Zones Used in the Analysis of Depot Locations.
Table 8.2: Generalised Sequence of Depot Locations.
(source: personal survey)
Figure 8.3: Idealised Sub-division of Country into Depot Hinterlands: 16 Stages.
Under ideal conditions, where there was a clear ranking of areas in terms of their popularity as depot locations and where the number of depots operated by firms increased by a uniform interval along the horizontal axis, a perfect sequence of locations would produce the matrix pattern shown in figure 8.4. Every cell above and to the right of the leading diagonal would be occupied by a single depot symbol, and the leading diagonal would form a straight edge. In practice, there are numerous deviations from this ideal pattern. The boundary between the areas of occupied and unoccupied cells is ragged and several cells have more than one depot. These deviations are partly attributable to defects in the data set and methods of analysis, particularly:

a) imperfections in the zoning scheme
b) uneven intervals between the numbers of depots firms operate
c) the arbitrary ranking of zones with similar scores and firms with similar numbers of depots.

When one allows for these various shortcomings, it appears that there is still considerable regularity in the sequence of depot locations. Over the first six rankings, this sequence closely resembles that postulated by Sussams (1969) for the multiple location of production plants, though applicable also to distribution depots (Table 8.3).

It is difficult to generalise about those firms with completely centralized distribution systems as they often concentrate all their stockholding in the immediate vicinity of the main factory. In these cases, the depot locations are indirectly affected by the factors influencing the location of production. Furthermore, as no firms in the sample operated 2 or 5 depots, it was not possible to compare the second and fifth stages of the idealised sequence with real-world examples of such systems. At the opposite end of the sequence, those firms operating more than 15 depots had more than one depot in some zones. This was an inevitable consequence of limiting the analysis to 19
zones. Altogether roughly 10% of the occupied cells in the matrix contained more than one depot symbol, indicating a tendency for the corresponding zones to fragment into separate depot territories. As almost two thirds of these cells belonged to the five firms operating more than 19 depots, it was concluded that this did not seriously undermine the integrity of the 19 zones. If one were to extend the idealised sequence beyond 19 depots it would clearly be the most populous zones, of the South East, West Midlands and the North West, that would have to be subdivided first, as these account for most (61%) of the instances of depot duplication and triplication.

Wider departures from this general pattern are likely to reflect anomalies in the spatial distribution of some firms' depots. These anomalies or "residuals" can be classified into two categories:

**Type 1 Residuals:** Absence of a depot where one might be expected.

23 residuals of this type were identified. Firms avoided holding stock in these zones by various means: (numbers in brackets indicate the relevant number of residuals)

i) zone served by a large factory-based depot in an adjoining zone (6)

ii) distribution in the zone split between two or more depots in adjoining zones (5)

iii) zone served by a depot just beyond the zonal boundary (i.e. within 20 miles of the boundary) (5)

iv) presence of a transhipment depot in the zone (5)

v) incorporation of the zone within the extensive service area of a very large depot (2)

**Type 2 Residuals:** Presence of a depot where one would not be expected.

Only 5 such residuals were identified and all related to firms operating very few depots. In two cases the firms operated factories in the zones; in another the firm claimed
to have been attracted to the particular zone by the good service offered by a contractor based there. No special reasons were found for the remaining two anomalies of this type.

To attempt to explain these residuals, one would have to consider three types of variation. In the first place, the spatial distribution of firms' sales is likely to vary, reflecting regional differences in tastes, degree of market penetration etc. (Sussams, 1968). The optimum locations of depots might be expected to vary accordingly. As firms would not divulge information on their pattern of sales, it is not possible to compare them on this basis. Even if the demand for every firm's products were similarly distributed, however, depot locations could differ as a result of organizational factors such as the juxtaposition of factory and depot on the same site, the substitution of a transhipment depot for a stockholding depot or the use of contractors. Even if confronted with the same distribution of demand and if organized similarly, firms (using the same number of depots) could still choose different depot locations for a variety of reasons. These reasons are examined in a later section in the context of the "micro-level" study of depot location. Before then, however, it is necessary, while still at the aggregate level, to give more consideration to the relationship between patterns of production and stockholding in the food industry.

The Distribution of Production Facilities as a Factor in Depot Location

The trunking of supplies from the factory (or factories) is usually accorded considerably less importance in the choice of depot location than the pattern of delivery outward from the depot. As Hoare (1975) noted, the cost of local deliveries of small consignments is much more sensitive to distance than the cost of bulk, trunk movements. Nevertheless, as indicated in the study of "residuals" above, the factory location can have some influence on depot location.
Although it is beyond the scope of this research to investigate in detail the spatial distribution of food processing plants, it will be useful to outline in general terms the geography of food manufacturing.

As shown on figure 8.5, there are major concentrations of food factories around London and Merseyside, and lesser concentrations around Glasgow and Bristol. An important factor in their location has clearly been proximity to the ports through which raw foodstuffs are imported. The relatively limited development of food processing in the Midlands and West Yorkshire indicates that it has not simply emerged in the vicinity of large population centres. The spatial distribution of some types of food manufacturing largely reflects their dependence on particular forms of agricultural specialization. Areas of intensive fruit and vegetable cultivation, for example, such as East Anglia and Strathmore, support numerous canning factories; sugar beet refineries are confined to the limited area in Britain where sugar beet is grown; milk products are manufactured in areas such as Somerset and Devon, noted for their dairy produce.

All but three firms of the 29 firms in the sample operated more than one factory, the mean number of factories being five. In the majority of cases, the firms manufactured different products at different locations. Very few firms manufactured a similar range of products at more than one factory. Some dispersed the production of the largest selling line in more than one location and combined this in particular locations with the specialist production of different, lower-volume lines (Magee, 1968). Overall, however, there was little scope for firms dividing up the national market area between factories and assigning each an exclusive hinterland. Most factories feed their output into a national system of distribution and do not simply serve limited segments of the national market area. In addition to their stockholding and break-bulk roles, many distribution depots also act as mixing points where different products manufactured in separate locations are combined into consolidated orders.

The spatial distribution of a firm's factories can affect the locations of its depots in two ways:
Figure 8.5: Spatial Distribution of Factories Operated by a Sample of 26 Food Manufacturers. (source: personal survey)
1. Through the desire to reduce "back-tracking": It was stated earlier that the trunking of goods out from the factory has little bearing on the number of depots a firm operates. Its influence on the choice of depot location is similarly small, though there are some instances of depots being "pulled" towards factories to reduce the amount of "back-tracking" in the distribution system. This is illustrated in figure 8.6. Where depot 0 is located centrally within its hinterland, many of the local delivery journeys will "double-back" on the main trunk movement from the factory, making the routeing of products to the shops circuitous. Where the hinterland is comparatively small and demand fairly evenly spread across it, the amount of "back-tracking" will be small and the additional costs of trunking goods to the centre of the zone (rather than to point P) outweighed by the cost savings in delivering out from a central location. Where the hinterland is large, there can be a stronger case for locating the depot closer to the factory in an off-centre location, particularly where it is necessary anyway to use transhipment depots to serve peripheral areas. The actual position of the depot within the zone would depend on the distribution of demand.

2. Through the establishment of depot at the factory site: There are clear benefits in locating a depot adjacent to the factory. This effectively eliminates a trunk movement; it facilitates and accelerates replenishment of the depot's stocks and permits a sharing between factory and depot of various overhead costs. It can also enable a firm setting up in an assisted area to obtain government financial support for the development of a depot. Under the terms of the 1971 Industry Act, this support is only available for storage premises on the factory site. Against these advantages must be set a series of possible disadvantages. The establishment of the depot on a factory site reduces the amount of space available for the future expansion of production facilities. The factory location may also be a poor location for the depot relative to the distribution of demand and the locations of the other depots in the system. The optimum locations for factories and depots need not,
Figure 8.6: Influence of Factory Location on the Siting of a Distribution Depot Within its Hinterland.

- Trunk movement
- Local Delivery
+ Customer

Factory

Factory
after all, coincide. Patterns of stockholding are generally much more dispersed than those of production. The depot location is largely dictated by the geography of the sales area, whereas the factory location is also influenced by other factors such as access to raw materials and labour costs. The costs of locating depots sub-optimally at factory sites are compounded where a manufacturer operates several factories. Whilst it is not possible here to assess the degree of sub-optimality in depot location, there is some evidence to suggest that the location of depots beside factories causes little distortion of the general pattern of depot location observed earlier. Although almost a third (32.4%) of the factories operated by the firms sampled had adjacent depots, these represented only 13.4% of the total number of depots. Furthermore, of these 41 factory-based depots, only 8 were in locations that departed markedly from the idealised sequence of locations.

**Pattern of Recent Depot Closure.**

Reference has already been made to the large reduction in the numbers of food stockholding depots over the past 20 years. It is necessary to examine the geography of this recent contraction of depot systems. Unfortunately, only two firms were able to provide lists of the locations of depots they operated at dates prior to 1970. As considerable difficulty was experienced in obtaining information on past depot locations, it was decided to concentrate on the period since 1975. Twenty three firms provided sufficiently detailed information on the changes that had occurred in their depot systems since then. As shown in tables 7.2 and 8.4, the period since 1975 has been essentially one of marginal changes, the main phases of contraction having occurred in the 1960s and early 1970s. A total of 40 stockholding depots were closed over this period, 16% of the number employed by the sample of firms in 1975. (95% of the depots were closed completely; only 2 retained a transhipment function.) In 26 (65%) of these cases the stockholding and delivery work was redistributed among existing depots. In the remaining 14 cases, these functions were transferred to new depots elsewhere. There
Table 8.4: Reduction in Numbers of Stockholding Points Employed by a Sample of 23 Food Manufacturers, 1975-8.

<table>
<thead>
<tr>
<th>No. of Stockholding Depots Closed</th>
<th>No. of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>no change</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: personal survey.
were only two instances, however, of a new depot directly replacing one that had closed down. It was much more common for a new depot to centralize the stockholding of more than one closed depot.

Figure 8.7 shows the distribution of stockholding depots closed between 1975 and 1978 and the direction of the consequent shift in stockholding. Three elements may be discerned in this pattern of closure:

1. **Withdrawal of stockholding from "peripheral" regions** (North East Scotland, South West England, East Anglia, North Wales, Cumbria and Humberside). This may be related to the penetration of these areas by extensions to the motorway network in the 1970s: M5 to Exeter, M11 to Cambridge, M3 to Swansea, M62 to Hull, M94 to Perth. This process has increased the spatial concentration of food warehousing and reinforced the sequence of depot locations identified earlier.

2. **Depot reorganization in more central areas**, especially:
   1) within an area bounded by Birmingham, Nottingham, Leeds and Liverpool,
   2) in Severnside and South Wales.

1) depot changes in this area can be divided into two categories:

   a) closure of depots in the vicinity of the M1 and A1, at Sheffield, Dronfield and Lincoln. In the case of the first two of these locations, the depots were "pinched out" by the expansion of the service areas of neighbouring depots along the line of the M1. As the relevant sections of the motorway had been in existence for over 12 years, this adjustment to the road improvement has been long delayed.

   b) closure of depots east and west of the Pennines at Gainsborough and Doncaster, and Warrington and Haydock by two firms centralizing their distribution to Yorkshire and Lancashire at Pontefract and Reddish respectively. This may be partly attributed to the improvement in trans-Pennine road connections with the opening of sections of the M62.
Figure 8.7: THE CLOSURE OF FOOD DISTRIBUTION DEPOTS 1975-1978
Sample of 14 Firms.
(source: personal survey)

○ Depot Closure
★ Planned Depot Closure (1978)
→ Shift of Stockholding to other Depots
ii) depot reorganization in this area may be associated with the extensions of the M3 and M5, and, belatedly, with the construction of the Severn Bridge. There has been a tendency for stocks to become more concentrated in the Bristol area. Much of the movement of stockholding has been across the Severn Estuary, principally in the direction of Bristol. The main phase of depot reorganization in the area in the five years following the opening of the Severn Bridge has been thoroughly documented by Cleary and Thomas (1973).

3. Contraction of a major carrier's distribution system: Four of the depots closed over this period were operated by a large distribution contractor. Following the loss of a large client's business, which accounted for 40% of tonnage and 25% of turnover, this firm closed its depots in the Greater London and West Midland conurbations. These depots were selected for closure partly because they suffered the greatest loss of traffic, but also because of the high rates and labour difficulties in these areas. In dispersing the firm's operations away from the main conurbations, this rationalization runs counter to the prevailing trend, but should be seen as the response of a particular firm to exceptional circumstances.

Overall, therefore, the recent closure of manufacturers' distribution depots has resulted in a withdrawal of the stockholding function from more peripheral areas and an increased concentration of stockholding in a well-established set of strategic locations. Much of the redistribution of depot capacity can be attributed to improvements in the road network.
Multiple Retailers' Central Warehouses

Analysis of the Aggregate Pattern.

Figure 8.8 shows the locations of 66 central warehouses operated by a group of 25 major grocery multiples. It would not be appropriate to analyse this spatial distribution in terms of the sequencing of locations because, unlike the large food manufacturers considered earlier, the multiples surveyed vary widely in the size of area they serve. One must, therefore, confine oneself to a fairly general examination of the pattern of central warehouse location.

The most notable feature of this distribution is the pronounced clustering in the South East of England, with smaller concentrations in the North East and North West. The preponderance of central warehouses in the South East reflects the extensive development of multiple retailing in this region (Nielsen Researcher, 1974). The multiples share of grocery sales is significantly higher in the South East than in other parts of the country (fig. 8.9). In contrast, there are comparatively few central warehouses in the Midlands. This may be partly attributed to the fact that the multiples hold a smaller share of the grocery market in this area and partly to the fact that the region has comparatively few large indigenous chains. Many of the larger multiples operating branch stores in the Midlands, such as Tesco, Sainsbury and Gateway have expanded into the area from outside and continue to supply these shops from central warehouses in neighbouring regions.

Some of the apparent clustering is the result of some of the bigger chains with national or near-national coverage (Allied Suppliers, International, Fine Fare and Tesco) operating central warehouses in the same areas. Several of these firms' warehouses have gravitated to locations around Glasgow, Newcastle, Warrington and along corridors between Cheshunt and Harlow, and Maidstone and Swanley.

Roughly 90% of the central warehouses operated by retailers in the survey have been newly opened or taken over by them since 1960, over half of them since 1970. The pattern of central warehouse location existing at the time of the survey was therefore a fairly recent creation. It
Figure 8.8: Spatial Distribution of Grocery Multiples' Central Warehouses: Sample of 23 Firms. (source: personal survey)
is thus best examined in relation to the recent growth and/or rationalization of the grocery multiples. Unlike the large food manufacturers, few of the multiples have been reducing their numbers of stockholding points and concentrating stocks in fewer, larger depots. The majority of grocery multiples operate only one central warehouse anyway. Most of those operating more than one warehouse have been expanding their turnover while channelling an increasing proportion of this turnover through their central warehouses. This has, therefore, increased their demand for storage space. Two of the "organic" chains with highly centralized delivery systems have over the past 20 years established warehouses reckoned to be close to the maximum efficient size, leaving little scope for further stock concentration. In contrast, some of the large chains that have grown principally "by acquisition" have inherited smaller, often poorly located warehouses, some of which have been closed down and replaced, individually or collectively, by larger more centralized facilities.

It is possible to classify the grocery multiples in relation to the development of their central warehousing systems during the 1970s.

1. **Construction of new central warehouses to support the geographical expansion of the chain by "organic growth".**

   This policy is typified by Kwiksave, a major operator of discount stores, which has opened new warehouses at roughly 3 year intervals in phase with the rapid extension of the chain outward from its original base in North Wales. As the firm runs a limited-line discount operation, its stores receive a relatively large proportion of their supplies from a central warehouse, making it necessary to coordinate the development of warehouses closely with the spread of the chain.

2. **Construction of new central warehouse principally to accommodate the growth of sales through existing outlets and relieve congestion at existing warehouses.**

   In the case of Tesco, a 40% growth in its volume of business over a period of a few months exhausted spare
capacity in its existing warehouses. An additional warehouse was rapidly planned and constructed near the point where the service area boundaries of the existing central warehouses intersected. In this location (Crick) the warehouse was able to absorb traffic from each of the existing grocery warehouses.

3. Rationalization of central warehouse system following take-overs.

The larger chains formed mainly by acquisition have been rationalizing their distribution systems to differing degrees. One chain set up a completely new system of six depots in the early 1970s. Two others have gradually been replacing older, smaller depots with larger premises. Many of the older warehouses acquired by take-overs were in the towns where the absorbed chain originated. Following the integration of the chains and subsequent rationalization of outlets, these acquired warehouses were seldom of a size and situation to serve the combined chain efficiently. Over the past 10 years they have been replaced by a new generation of warehouses located more centrally relative to the shops they serve.

4. Short distance move to more modern premises.

Four of the smaller regional chains decentralized their warehouse operation from older, inner city building to larger, newly built premises on peripheral industrial estates. None of these firms employed locational models to test the efficiency of the new location and in each case the search for a suitable site was confined to the town of origin and its immediate surrounding area.

5. Use of contractors to supplement and extend the multiple's own distribution system.

In the late 1970s Sainsbury's began using distribution contractors to store some of its central supplies and deliver consolidated orders to its branch stores. As pointed out in chapter 6, the use of carriers enables the retailer to increase the capacity of its store delivery system without incurring the high cost of setting up new
warehouses and facilitates the geographical expansion of the chain into areas beyond the daily delivery range of its own warehouses.

**Voluntary Group Wholesale Depots.**

The spatial distribution of voluntary group depots owes much to the historical development of the affiliated wholesalers. The majority of these wholesalers still operate their main depots in their original trade areas. Many have expanded their operations geographically either by setting up new depots ("organic growth") or by acquiring wholesalers in adjoining areas. Where firms have replaced older, smaller depots, this has usually involved a decentralization from inner city locations. Depot shifts, however, have tended to be over short distances. In many cases, these have been constrained by the desire to retain the same management and labour force. In other cases, it has been due more to the conservatism of the owners of the firm. The senior executives of the voluntary groups that were consulted doubted if any of the smaller, independent wholesalers had made use of analytical models in the planning of new warehouse locations. The fragmentation of locational decision-making in a large number of independent wholesaling firms has prevented the rationalization of the system of voluntary group depots as a whole. The numerous mergers within voluntary groups in recent years, however, have brought large areas of the country within the franchise of individual firms and created conditions much more conducive for depot rationalization. The depot closures and relocations that have occurred in the wake of these mergers have had the effect of breaking local ties and re-organizing wholesale distribution on a larger spatial scale.

As figure 8.10 shows, the distributions of wholesale depots in three large national voluntary groups differ quite markedly. Most of the clustering of depots within particular groups results mainly from affiliated wholesalers serving the franchise areas from several depots. The uneven spread of depots can also be attributed partly to the
haphazard formation of the voluntary groups, which was dependent on the willingness of local wholesalers to participate in the scheme, and partly to variations in the extent to which the depot systems have been rationalized in different areas. It is generally agreed that voluntary groups are relatively poorly developed in the main conurbations, reflecting the fact that independents hold a smaller share of the grocery market in these areas (Nielsen Researcher, 1974).

In summary, therefore, the spatial distribution of multiple retailers' central warehouses and voluntary group wholesale depots do not exhibit the same degree of clustering as food manufacturers' depots, nor do they conform to a similar generalized sequencing of locations. As retail and wholesale firms distribute products over much smaller areas, their locational decision-making tends to be more localised and conditioned much more by factors peculiar to each organization, such as geographical origins, subsequent pattern of expansion and the present spatial distribution of branch stores in the case of multiples, retail customers in the case of wholesalers. It is more difficult, therefore, to generalise about the location of retail and wholesale grocery depots.

Implications for the Rationalization of Grocery Movement

It has been suggested that the concentration of distribution depots in strategic locations offers scope for the rationalization of the systems of long distance trunk movement and local delivery (Reed and Rees, 1972; Lorries and the Environment Committee, 1977b). The Lorries and the Environment Committee has proposed that "freight complexes" be established at these strategic locations to provide common storage and transhipment facilities, modal interchange between road and rail and a range of ancillary services. The use of such complexes by large numbers of manufacturers and distributors could, it is argued, yield substantial economic and environmental benefits by:
1) encouraging the consolidation of loads both for long distance and local delivery freight movements,

2) increasing the opportunities of finding return loads for backhauls (Cundill and Hull, 1979),

3) facilitating the transfer of consignments between road and rail.

In these ways, they could reduce transport costs per unit and total vehicle kilometres on the road network.

The study the Lorries and the Environment Committee commissioned on the potential for developing freight complexes focused attention on the movement of food products, considering the food industry to be the main source of traffic for such complexes. A survey of 67 food manufacturers and distributors undertaken during the course of this study revealed that food distribution depots (operated by manufacturers, wholesalers and retailers) were highly concentrated in particular areas. Roughly half the 652 depots operated by these firms were located within 10 miles of 13 cities or 30 miles of London. This pronounced clustering enabled the consultants to identify a set of strategic locations where they believed the demand for freight complexes would be high.

The inclusion of wholesalers' and retailers' warehouses in the survey raises the question of how much business freight complexes would be likely to attract from these agencies. Almost all wholesalers and multiple retailers, after all, already operate warehouses and already achieve high levels of consolidation in the delivery of goods to shops. Furthermore, as they have responsibility only for localised shop delivery, they would be unlikely to benefit directly from the increased availability of return loads and easier access to the rail network.

It would be manufacturers who would have most to gain from using freight complexes. In this respect, the nine strategic locations selected by the Lorries and the Environment Committee study as possible sites for the development of such complexes seem to accord well with the locational preferences of the group of 29 food manufacturers consulted during the present study. There is a close correspondence between these prospective freight complex
locations and areas with high rankings in the generalized sequence of depot locations. Of the first nine areas in this sequence, only East Anglia was not assigned a freight complex, while the London area was assigned two. This appears to confirm that, as far as grocery products are concerned, these would be areas in which freight complexes would be most likely to succeed. However, as most manufacturers holding stock in these areas either own depots there or hire depot space there on a long term basis, these freight complexes would be unlikely to capture much of their traffic in the short term. It is estimated that roughly 20% of firms "seek new depot space" within a five year period, 50% within fifteen years (Lorries and the Environment Committee, 1977b). Therefore, even if the freight complexes were to provide a large proportion of the new depot space, it would take many years for them to rationalize significantly the pattern of grocery movement.

Methods of Depot Location

Numerous analytical techniques are available to firms wishing to optimise the locations of stockholding points. These are reviewed in Buxton (1975), Murphy (1978) and Mole (1975). Some search for optimal locations across continuous space ("infinite set"), while others select optimal locations from a previously prepared list of possible locations ("feasible set"). Techniques in the former category are usually based on the algorithm devised by Kuhn and Kuenne (1962) to establish the "ton-mile centre" (or weighted mean distance centre), though vary in the nature of their transport and warehousing cost functions (Eilon et al., 1971). Of the feasible set techniques, the heuristic methods devised by Kuehn and Hamburger (1963) and Feldman et al. (1966) to evaluate pre-selected locations have gained widest currency.

There are several instances of these techniques being used in the food industry either by firms' own, in-house operations research departments, or by hired consultants. There is also evidence that the number of firms in the
grocery trade using computerised location models has been increasing (National Computing Centre, 1968; Robson, 1982). It has been estimated that the application of these models can yield potential savings of 5-15% over "good manual solutions" to the depot location problem (Atkins and Shriver, 1968). Nevertheless, many of the distribution staff consulted in the course of this research expressed considerable scepticism about the value of these techniques. Like Murphy (1978), many believed that "while the techniques developed were and are of undoubted value in the theoretical solution, they very often fall short in their practical application" (p229). It is necessary, therefore, to examine the shortcomings of these locational methods and consider the factors that cause actual depot locations to deviate from the theoretical optima.

**Limitations of Depot Location Models**

The most serious limitations of existing depot models may be summarised as follows:

1. Most infinite set methods fail to differentiate possible from impossible locations. During the survey, two firms, a large multiple and a food manufacturer, reported using an infinite set approach in the initial stages of a depot location exercise. The former found that it should serve the South East of England from a depot on Waterloo Bridge, the latter that it should serve the South West from Lundy Island. Distribution managers frequently cite such ridiculous results as "proof" of the futility of "scientific" depot location models. These results, however, are not as worthless as they may at first seem. Firms cannot expect to locate their depots at the locations pinpointed by the model. In practice, even when firms decide on a location subjectively, they must search within a reasonably wide area, often within a radius of 30-40 miles (Loasby, 1973). As the distribution cost function is generally very shallow in the vicinity of the minimum location, "some latitude in the choice of location is possible at little extra cost" (Willis, 1977, p150).
initial stage in a depot location exercise, therefore, involves establishing a weighted centre point around which one can conduct a reasonably wide search for possible sites.

2. As the models are based on the unrealistic assumption that all deliveries are direct and of a single consignment, they fail to take account of actual delivery logistics (Webb, 1968).

3. The models determine only "local" optimal locations and do not guarantee an overall optimum set of depot locations for the system as a whole (Baxter, 1981).

4. Cost functions are often over-simplified and inadequate attention given to discontinuities, non-linearities and combinatorial factors in the cost calculations. Furthermore, the cost functions are usually related to single product types, whereas many firms distribute diverse ranges of products through their depots. It would be very difficult to extend these models to accommodate multi-product distribution (Mole, 1975), particularly where the products differed widely in distribution costs and service level requirements.

5. Almost all these models take no account of local circumstances such as the quality of the transport network or the availability of labour. These are discussed in the next section.

Were depot location models expected to pinpoint optimal locations exactly, these would be serious limitations. Where they are employed in practice, however, expectations are generally much lower. As Sussams (1971) explains, "In practice, the optimum solution is usually of academic interest only because there is so much variability in the system that the conditions which make a particular solution optimal seldom ever apply" (p32). Indeed, many distribution executives in the food industry doubt the value of depot location models. Several firms indicated
that they had used these models to gain post hoc confirmation of the suitability of locations they had decided upon subjectively.

Problems of simulating the distribution of stockholding depots:

The attempts earlier to construct, inductively, a generalised sequence of depot locations provided only a very approximate basis for predicting where a firm operating a certain number of depots would be likely to locate them. The use of multiple location models could provide an alternative, deductive means of simulating the actual patterns of depot location. It is unlikely, however, that the actual distributions of depots would conform to the optimal or near-optimal distributions established by the models, partly because these models do not take full account of all the circumstances that affect depot location decisions and partly because this decision-making itself may be sub-optimal. It is also seldom possible for an independent researcher to obtain the sales information that would be a necessary input into these models. Few firms are willing to divulge information on their pattern of sales. Population could be used as a surrogate for sales data; however, population and sales need not correlate closely for several reasons:

i) Sales per head of a firm's products can vary significantly between different parts of the country (Sussams, 1968). These variations can reflect differences in affluence, tastes, strength of local competition and historical factors such as the long term effects of being prohibited by war-time zoning schemes from supplying some areas. (It should be noted, however, that in running a depot location model, one large firm used a uniform sales per head figure across the country on the grounds that it was a marketing objective, in the medium to long term, to bring sales in all areas up to the same level.)
ii) Sales data is collected where people shop, whereas population census data relates to their place of residence. The relationship between the population of an area and its level of retail sales will, therefore, depend on the distribution of retail outlets and the spatial pattern of consumer behaviour - what Sussams (1969) has called the "shopping centre factor". At a higher level, the relationship between population and the volume of sales through wholesalers is likely to be even more variable (Revzan, 1966).

iii) The proportion of a manufacturer's output distributed via depots is likely to vary geographically across its market area. This can reflect spatial variations in the firm's relative dependence on different distribution channels (Briggs and Smyth, 1967; Metcalf, 1968). For example, multiples account for a much larger share of grocery sales in the South East of England than in other regions (Nielsen Researcher, 1974), and most of the large chains supplying this area channel a relatively large proportion of their supplies via central warehouses. It is likely, therefore, that a larger proportion of manufacturers' sales in this area will be of goods supplied in direct, bulk consignments to retailers' central warehouses. They would then make comparatively less use of depots in this area. No data is available, however, to assess the extent to which the proportion of sales passing through distribution depots varies spatially.

Even if such data were available, however, it would be of limited validity because goods supplied direct from the factory to retail central warehouses or wholesale warehouses within the depot's service area might subsequently be distributed to shops in the hinterlands of adjacent depots. Indeed, as figure 8.11 illustrates, a manufacturer's market area can be broken down into a hierarchy of depot service areas and retail trade areas. This three dimensional representation of a distribution channel shows how the areas served by distributive nodes at different levels of the channel overlap. It can also be seen that different distributive channels produce different areal hierarchies.
Figure 3.11: Hierarchy of Service and Trade Areas in the Distribution System
In the light of the complex pattern of service and trade areas that emerges, it is doubtful that the capacity of a manufacturer's distribution depot would be closely correlated with the population of its hinterland. Furthermore, as the movement of goods between the various nodes is organized within this complicated framework of service and trade areas, it is hardly surprising that freight traffic distribution models based on fairly arbitrary zonations are unable to simulate accurately this pattern of movement.

Only two firms provided enough information to permit a measurement of the variation in the amount of depot throughput per head between different depot delivery areas. These variations will be the combined result of factors ii) and iii) above. It is not possible to separate the effects of these two factors. As shown in table 8.5, the variations were large, particularly in the case of company 2. This supports the view that information on the distribution of population is unlikely to give an accurate indication of the demand for depot capacity in different areas.

Factors affecting the siting of depots

While the location models reviewed in the previous sections can indicate a "search area", the actual siting of depots within this area is affected by numerous factors, not included in the model and usually evaluated subjectively:

1. Availability of sites: Several firms reported that they had found it impossible to obtain a suitable site in the preferred location. Some had had to make do with sites within 15 - 25 miles of this location. In most of these cases there were simply no suitably zoned sites or ready-built premises in the area at an acceptable price. In three cases, however, (out of twenty-five) firms were prevented from developing a warehouse on industrially zoned land because planning permission was withheld. In two of these cases, the local planning departments refused the developments on the grounds that they generated insufficient
Table 8.5: Variations in Depot Throughput Per Head Between Depot Service Areas (in Cases/Head/Annunum).

<table>
<thead>
<tr>
<th>Firm</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Coefficient of Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm 1</td>
<td>0.57</td>
<td>0.10</td>
<td>17.5%</td>
</tr>
<tr>
<td>Firm 2</td>
<td>0.51</td>
<td>0.17</td>
<td>32.7%</td>
</tr>
</tbody>
</table>

Source: Personal survey.
employment relative to the space they occupied. Low employment density has often been used by planning authorities to justify negative policies towards warehousing (Watts, 1977). It would seem from the recent experience of the food industry that, contrary to fears that have been expressed about restrictive planning policies impairing the efficiency of the distribution system (NEDO, 1976; Department of the Environment, 1978), planning controls have rarely acted as a serious constraint on depot locations decisions.

2. Road connections: These can influence the location of depots at different spatial scales. At the regional and national level, road network measures of distance, time and cost can be used in depot location models to make them sensitive to the structure of the road network. At a smaller spatial scale, within the area of localised search, firms prefer sites with good road access, often at intersections on the trunk road network.

It has been common practice for firms to take road development plans into account in deciding upon depot locations. One might, therefore, suspect that the contraction of the trunk road programme since the mid 1970s and the delay in the completion of many new road schemes may have rendered the locations of some depots sub-optimal. In fact, only one firm reported that the delay in the construction of a motorway link (M42) was significantly impairing the accessibility of one of its depots (at Tamworth).

3. Labour requirements: The majority of firms did not regard the availability of labour as a significant factor in the choice of depot locations. This may be attributed partly to the fact that a large proportion of depots are located in the vicinity of large population centres, and partly to the relatively small labour demands of most depots, in terms of numbers and skills. Nine food manufacturers provided employment data for a total of 85 distribution depots. At 74.6 square metres per employee, the average employment density of these storage premises is
well below the corresponding values for manufacturing premises in thirteen local authority areas around the country (Peterlee Development Corporation, 1980). Surveys in these areas found manufacturing employment densities to range from 16–48 square metres per employee. Only three firms (10%) claimed that they attached considerable importance to the availability and quality of labour. Seven firms expressed anxieties about labour relations problems in some areas, particularly the West Midlands, where the local Transport and General Workers' Union branch was felt to be exceptionally militant. As Westwood (1975) has acknowledged, industrial relations considerations can be a significant factor in depot location decisions. Three firms, for example, attributed the fact that they did not operate depots in the West Midlands and instead served the area from other regions, principally to West Midlands' poor industrial relations record in road transport. Two other firms closed depots, one in Cumbernauld, the other in London, because they suffered serious labour troubles. In both cases the replacement depots were located far enough away to discourage staff from moving to the new locations.

4. Choice of contractor: In the case of those firms that contract out some or all of their distribution, the stockholding location is determined by the choice of contractor. Firms employing a contractor to handle their distribution over a wide area commit themselves to using his system of depots. Those firms which divide their distribution geographically among a series of carriers can exercise more choice over the locations of depots they use in different areas. Usually, however, these firms select local carriers much more on the basis of their rates and quality of service than on the particular location of their depots. Indeed, two of the firms that make heavy use of contractors reported that they received quotations from carriers over a wide area before deciding where to base their distribution. On occasion, the chosen contractor's depot might be reasonably distant from the ton-mile centre of the area served. Jobson (1976) reports on the difficulty Cadbury-Schweppes experienced in finding a
suitable contractor for the distribution of its products in the North of England.

Firms which disperse their distribution among many contractors seem to change contractors, and thereby depot locations, more frequently and with greater ease than those which are dependent on a single contractor for distribution over an extensive area. As explained in Chapter 6, however, several food manufacturers have become "tied" into contract systems by long-standing agreements and even shared investment. Under these circumstances, it can prove costly and take several years to organize a change of carrier and corresponding change of depot locations.

Optimizing the Locations of Retailers' Central Warehouses

Multiple retailers can make use of the same techniques as manufacturers to establish optimal locations for their warehouses. Less than a third of the retailers surveyed, however, claimed to have used operational research methods for this purpose. The problem of warehouse location confronting the multiples differs from that of the manufacturers in several important respects.

In most cases, the problem is much less complicated, partly because the grocery multiples operate fewer warehouses and partly because these warehouses serve comparatively few outlets. The majority of the multiples operate only one central warehouse and, therefore, avoid the complexities of the multiple location-allocation problem inherent in the planning of most manufacturers' depot systems. As the multiples service many fewer outlets from their warehouses, they can use specific locational and turnover data for each store rather than the zonally aggregated sales data generally employed by manufacturers. This can enhance the accuracy of the calculation. The retailer also has much more control over the future distribution of the outlets to be served. In choosing a central warehouse location it can anticipate the future development of the chain. In the longer term, however, the extension of the chain can render a warehouse location suboptimal. One firm trading in the South East and the Midlands admitted that relative to the locations of its
central warehouses it had over-extended its chain and was having difficulty supplying some peripheral stores efficiently. Two other retailers claimed that new branches added to their chains since their central warehouses were opened, while well within the delivery range of these warehouses, had left these warehouses respectively 30 and 40 miles off-centre. In both cases, though, the additional costs this incurred were not considered great enough to justify relocating the central warehouses. There was a general consensus among the retail staff interviewed that in deciding to open a new branch store a firm would attach much more importance to the sales potential of the site than to the delivery of supplies. The observation made earlier, however, that very few multiples operate branch stores beyond the daily delivery range of their central warehouses, suggests that this range may constrain the search for promising retail sites in the first place.

The location of a multiple's central warehouse is not influenced by the cost of incoming deliveries, as suppliers generally employ a system of equalised delivery pricing (Chisholm, 1971). This location tends, therefore, to be optimised with respect to the shops the warehouse serves rather than the points from which its supplies originate (GLC, 1977). This situation is little different, however, from that of the manufacturer's distribution depot, whose location is determined primarily by the economics of the local delivery operation and very little by the costs of trunk inward movements (Wentworth and Ramm, 1976).

As multiple retailers' central warehouses are generally larger than manufacturers' distribution depots (fig. 7.14) and likely to generate greater volumes of goods traffic, it was hypothesized that retailers might experience more difficulty in finding suitable sites for these facilities and in obtaining planning approval. This might cause central warehouse locations to diverge from their theoretical optima. In fact, none of the retailers consulted reported any problems in this respect.

As in the case of manufacturers' depots, one cannot independently assess the proximity of actual central
warehouse locations to those established by the various locational models to be optimal. Such an assessment would require information on the locations and turnover of all the branch stores in a chain. While information on store locations can be obtained from trade and telephone directories and, in some cases, from the retail firms themselves, it is virtually impossible for an outside researcher to obtain turnover data for individual shops. For some chains it is possible to get floorspace data, but shop floorspace tends to be a poor surrogate for turnover. Even if one could acquire turnover figures for individual stores, these need not correlate closely with the physical volume of goods passing through them, as the composition of branch stores' sales can vary considerably.

Summary

This chapter has examined the locations of grocery stockholding points at both the macro- and micro-level. At the macro-level, it was found that there is considerable regularity in the spatial distribution of manufacturers' depots. This is manifest both in the clustering of depots around a well-recognized series of regional locations and in the order in which depot locations are added to a distribution system. The concentration of manufacturers' stockholding in particular areas has been reinforced by the recent pattern of depot closure. This concentration is likely to have the effect of channelling grocery flows along the network of arterial routes connecting these strategic locations with the main centres of food manufacturing. It also offers scope for the rationalization of grocery movements through the development of freight complexes. Multiple retailers' central warehouses and voluntary group wholesale depots are more evenly distributed and produce an aggregate pattern about which it is much more difficult to generalise. The trunk movement of supplies to these depots is likely to be more dispersed. For this, and other reasons (p 265), the development of freight complexes would be likely to have less impact on the distribution systems of retailers and wholesalers.

At the micro-level, a brief review was made of the range
of methods available to firms seeking to establish the optimum location for a distribution depot. It would seem that the enormous research effort that has gone into developing such methods has been inspired more by the intellectual challenge than by the practical needs of commercial enterprises. In addition to various analytical shortcomings, these models ignore many of the special circumstances that affect firms' final choice of location and are widely regarded as being impractical. It has been argued that by a collective process of trial and error industry has established a short list of strategic locations which approximate closely to those identified by more rigorous methods as being optimal (Sussams, 1971). Several factors, however, constrain the use of these methods to simulate the spatial distribution of individual firm's depots. These include the difficulty of obtaining sales data, and the problem of generalizing about the relationship between the population of an area and the throughput of its distributive facilities.

Notes:
1. Transhipment and bulk storage warehouses are excluded. A contract depot may be represented by several dots where more than one manufacturer holds stock there.

2. In this section the word "depot" will be used to refer to a "stockholding point". As several manufacturers may hold stock in the same contractor's warehouse, the term "depot" need not always refer to separate premises. One large contract warehouse in the North East of England, for example, holds stock for at least four of the food manufacturers surveyed.

3. This excludes contractors' depots partly used by these chains.

4. In the case of a "service area" (or "hinterland"), goods are distributed outwards from a central depot to dispersed outlets or customers. A retail "trade area" may be defined as an area from which a shop draws its customers.
Chapter 9

Bulk Distribution from Factories

The previous two chapters have examined various aspects of the physical structure of logistical channels: the number and locations of stockholding depots and the size of the areas they serve. They have outlined the static framework through which goods are transported. It is possible now to consider the routeing of flows within this framework. This chapter examines the bulk movement of flows outward from factories to distribution depots and larger customers, what might be described as the "strategic" routeing of primary flows. The following chapter is concerned with the logistics of local deliveries from intermediate stockholding points to shops.

Logistical Options.

The logistics of the bulk distribution of food from factories to depots (or direct to customers) were found to vary greatly, reflecting differences between manufacturers in the numbers and locations of their factories, the spatial organization of their production and their policies on direct bulk delivery. As the vast majority of the firms in the sample manufactured a variety of products at more than one factory, the routeing of product flows was strongly influenced by the strategies firms adopted for mixing the different product ranges into consolidated orders. The firms in the sample can be classified into three categories with respect to the complexity of systems of bulk distribution: (figures in brackets indicate the number and percentage of firms in each category.)

a) Single factory producing the entire product range: (3 ; 10%)

Under these circumstances, there is no need to mix product ranges and each depot is served direct from the factory.
b) More than one factory, each producing the major product lines, but also specialising in the production of lower volume lines: (5 ; 17%)

In this situation, the allocation of flows between factories and distribution depots depends on (1) the bulk transport costs on the various routes (2) the capacity and unit production costs of the factories and (3) the capacity and unit storage/delivery costs of the depots. In attempting to optimise this allocation firms encounter the classical "transportation problem". This problem can be defined as follows:

$$\text{minimize: } C = \sum_{ij} T_{ij} c_{ij}$$

where $C =$ total transport cost
$T =$ volume of flow
$c =$ transport cost per unit of flow

and $i$ and $j$ denote origins and destinations.

Various linear programming algorithms are available to solve this problem (Hitchcock, 1941; Hay, 1977). The practical application of linear programming in this context can be complicated by several factors:

(I) The heterogeneity of the product flow: While linear programming can easily optimise the flow of the "major products" from all the factories to all the depots, it cannot accommodate the flow of specialist lines originating from different factories. In practice, firms organize the mixing of these specialist lines in various ways. Some firms distribute bulk loads of these products from their separate points of production to each of the depots, effecting the mixing operation at the depots. Others use one or more of the factories as a mixing point and trunk consolidated loads out to the depot from there. The logistics of these operations are complicated by the combination of "major" and "specialist" products on many trunk routes to produce viably sized loads.
(II) The desire to maximise backhauls: To take advantage of backhauls, firms operating own-account vehicle fleets may route products indirectly via factories or depots. Merchant and Calcis (1974) have devised a form of linear programming that can make allowance for indirect routeing, though, their work may be criticised, firstly for its neglect of terminal costs and secondly for its treatment of vehicle capacity as a continuous variable.

(III) Non-linearities in the transport cost function: As explained earlier the unit costs of transport seldom increase as a linear function of the size of consignment and distance travelled. This infringes the main assumption underlying the application of linear programming, i.e. that the functions are "linear".

(IV) The combination in the same vehicle of bulk loads for depots and bulk orders for direct delivery to customers: Roughly two-thirds of the firms in the survey adopt this practice, though to widely varying degrees. Where this occurs a combinatorial element needs to be incorporated into the calculation of the trunk cost, as these costs are then shared between the two types of consignment. To make allowance for these multiple-drop, bulk deliveries in the allocation exercise would be extremely difficult, especially as the pattern of delivery is likely to vary from day to day. Nevertheless, as most firms stipulate a large minimum order size for bulk delivery (of at least a third of a trunk vehicle load), it is likely that a maximum of two will be made at customers' premises in addition to the delivery to the depot. It is also likely that deviations from the direct route to the depot will be marginal as bulk deliveries of this type are generally only made to customers with premises in the vicinity of the depot. Were the deliveries to these customers regular in their scheduling and of constant sized consignments, it might be possible, with little loss of accuracy, to aggregate the customers' demands with that of the depot and simply assume that all the flow went to the depot. In practice, however, customers' bulk orders can vary widely in their frequency
and magnitude.

c) Several factories manufacturing different product ranges: (21; 72%)

Firms in this category adopted one of three strategies:

(i) No mixing of bulk stocks. (6.24%) The only mixing of stocks was at the depots prior to local delivery. Customers wanting bulk deliveries had to obtain them from each factory separately by ordering large enough quantities of each factory's products.

(ii) Mixing of stocks through inter-factory transfers ("cross-shipment"). (10.34%) This allows some or all of the factories to hold mixed stocks and permits the distribution of mixed bulk loads direct to customers, usually from the nearest factory. The mixed stocks are seldom dispersed evenly among the factories. Instead they are often concentrated at those factories that have the greatest output, largest storage capacity and/or most central location.

(iii) Mixing of stock at one or more central storage points separate from the factories. (5.17%) The central mixing points are bulk storage depots. Some are used exclusively for the direct distribution of bulk loads to customers, others also serve as a base for local deliveries. These facilities usually receive supplies from all the factories, and thereby enable firms to dispense largely or entirely with inter-plant transfers. Central mixing points seldom supply local distribution depots as the latter generally receive their supplies direct from the factories.

It is important to distinguish the mixing of stocks for bulk, direct delivery from the prior mixing of supplies for depots. Most of the firms in categories c(ii) and c(iii) do the former, but not the latter. They, therefore, use their local depots as mixing points for smaller orders. There are, nevertheless, some interesting exceptions to this general pattern. One firm (in category c(iii) ) which did
not make a practice of mixing depot supplies in advance, routed deliveries from its main factory to some of its depots via a second factory. This second factory acted merely as a "staging post" to enable the firm to operate its long distance transport more efficiently within the restrictions on drivers' hours. Another firm used an "intermediate" factory (which had excess storage capacity) as a storage and mixing point for supplies destined for some of the depots. Depending on their locations relative to the factories, some depots received mixed supplies while others did not.

The spatial distribution of a firm's storage space can have a significant effect on the way in which it organises its bulk distribution. Three firms (all in category c(iii)), for example, had little bulk storage space at their factories. One of them only had enough space at the factories to store one day's production and so was forced to disperse their output almost immediately to stockholding depots. Most of this went to two of the firm's eight depots which had considerable bulk storage space and which acted as mixing points. The other two firms had greater amounts of storage space at their factories but still insufficient to permit the mixing of ranges or to accommodate the volumes of stock that would be necessary to support an extensive system of direct distribution. One of these firms wished to increase the proportion of output distributed direct to customers but was being prevented from doing so by the limited storage space available at the factory sites.

A simple distinction was drawn earlier (chap. 5) between direct and echelon channels. It can now be seen, however, that where a firm operates several factories manufacturing different products, the logistics of the distribution operation can be complicated by the need to mix bulk stocks. Goods leaving a factory need not be destined either for a depot or for a customer. Some may travel to another factory or to a central storage point for mixing purposes. Magee (1968) has suggested the following terms for these different types of movement:
"shipment" - direct delivery to customer

"transhipment" - indirect delivery via distribution depots

"cross-shipment" - inter-factory transfer prior to bulk distribution

The division of traffic between the direct and indirect (echelon) channels has been discussed. Attention now focusses on "cross-shipment" and the special form of "transhipment" involving the use of a central mixing point.

Cross-shipment.

Firms transfer finished products between factories mainly because this enables them to consolidate mixed orders for bulk delivery to customers. This has several advantages. In the first place, it raises the efficiency of direct distribution by reducing the number of bulk deliveries the customer receives. This permits a corresponding reduction in the amount of ordering and invoicing paperwork. It also makes it easier for customers to put together large enough orders for a bulk delivery, allowing these deliveries to be made with greater frequency. This improvement in service level, particularly for the lower volume lines in the product range, can both enhance sales and promote an increase in the amount of direct delivery.

Against these advantages must be set several disadvantages. As cross-shipment disperses the bulk stocks of each product line, it increases the total volume of stock in the system. In addition to increasing the financial costs of stockholding, this also creates a greater demand for storage space at each of the factories. Cross-shipment also adds another transport link to the logistical channel with additional handling at either end. To the extra handling costs must be added the difference in movement costs between the delivery of unmixed orders direct from each factory and the more circuitous, indirect delivery of a proportion of the mixed orders. Where a firm operates many factories, cross-shipment can give rise to a complex network
of trunk movements. A complete system of inter-hauls among X factories generates a network of \((X^2 - X)\) links (allowing for directionality). This can create a large demand for heavy goods transport and prove difficult to organise efficiently, especially where directional imbalances in inter-factory flows make it necessary to run vehicles on some journeys well below capacity. Firms operating many factories tend, therefore, to concentrate the mixing of products either at a few factory sites or at one or more central storage points.

The impression was gained from the survey that many firms do not plan the trunking of goods between factories very carefully. Only a few of the distribution staff interviewed had readily available data on their firm's cross-shipment operations. Three of the larger firms confessed that their trunking networks were in need of study and probably rationalization. It would seem that with many firms the practice of transporting goods between factories has developed in a rather ad hoc manner.

Over the past 20 years the demand for cross-shipment has been subject to two opposing forces. On the one hand, the formation of food manufacturing conglomerates has linked factories making diverse products into the same distribution system. Cross-shipment networks will have been extended to incorporate these acquired factories. The demand for cross-shipment has been further strengthened by the desire of large retail and wholesale customers to receive more of their supplies more economically in direct, bulk deliveries. On the other hand, the amount of cross-shipment is likely to have been reduced by the spatial concentration of production in fewer, larger factories. There have been several instances of firms closing smaller, often more specialist, plants and absorbing their production into larger factories. By concentrating the manufacture of more of the product range in fewer locations, these firms have reduced the number of nodes in their cross-shipment networks.
The five firms in the sample that made use of a central mixing point offered a variety of reasons for doing so. There was general agreement that the centralization of bulk stocks at such a location permitted a reduction in inventory levels. It also streamlined the network of trunk movements. Two of the firms, for example, justified their use of a central mixing point on the grounds that the dispersal of their production in numerous factories made it impractical to adopt a system of cross-shipment, especially as flows on many of the inter-factory links would have been too small to be transported efficiently. Two other firms had acquired, as the result of a takeover, a large depot whose storage capacity far exceeded that required for local distribution. These facilities had, therefore, taken on bulk storage and mixing roles, despite the fact that neither were centrally located relative to the factories that supplied them nor the large customers they served. One firm was compelled to make use of a separate bulk storage facility by the inadequacy of storage space at the factory sites. Another operated a large warehouse dedicated entirely to the bulk storage and mixing of own-label products. The firm manufactured own-label products at several factories but in too small amounts at each to justify separate direct deliveries. Most of the own-label production was, therefore, mixed at a central depot before being distributed direct to customers.

There are, nevertheless, some disadvantages in using a central mixing point. As there is little or no reverse movement of goods from this point to the factories, this arrangement can offer less opportunity for backhaulage than a system of cross-shipment. It is often possible, however, for lorries on their return journeys to the factories to deliver orders from the mixing point to customers on or near the route. The use of a separate mixing point also results in a net increase in the amount of handling required, because the proportion of each factory's production that would otherwise have been consolidated into mixed loads at the factory site must now be loaded onto vehicles and transported to the mixing point.
The extent to which the use of a central mixing point can improve the efficiency of the system of trunk movement depends largely upon its location. Ideally, it should be located at the "ton-mile" centre of the distribution of factories and those customers receiving mixed bulk orders. In the absence of data on factory outputs and bulk orders, it is not possible to measure the extent to which the mixing locations deviate from the mean weighted centres. However, as figure 9.1 indicates, only one of the bulk mixing depots operated by the firms in question appears to be located centrally relative to the factories supplying it.

Even if the bulk mixing were done at the mean weighted centre, it is likely that this would generate a greater volume of freight movement (measured in tonne-kilometres) than an alternative system of cross-shipment. As seen in the context of local deliveries, the more centralized the system of distribution, the greater is the average distance to customers. The routeing of bulk supplies through a central mixing point will be longer and more devious than distribution directly from or via one of several factories. This is clearly exemplified by the firm whose cross-shipment network is shown on figure 9.1(a). As a result of its bulk distribution strategy, fruit canned at its factory in Blairgowrie can be transported to the central mixing point at Spalding then shipped back to large customers in Scotland as part of consolidated bulk orders. Although the use of a central mixing point is likely to increase significantly the distances that products travel from factory to customer, it will enable firms to transport these goods in larger, more efficient loads. It will be possible, therefore, to move products over longer distances at a lower cost per mile. Any transport cost increases that result from this lengthening of hauls are thus likely to be small, and possibly outweighed by the benefits of centralizing the mixing operation.

**Summary**

It is difficult to generalize about the pattern of bulk grocery movements from factories to depots and large customers. This pattern is largely determined by the
Figure 9.1: Bulk Mixing Strategies of Three Large Food Manufacturers. (source: personal survey)
nature and variety of the products a firm manufactures, the spatial organization of its production and its policy on the supply of mixed bulk orders, all of which vary considerably within the food industry. Almost three quarters of the manufacturers surveyed operated several factories producing different types of products and roughly 70% of these firms mixed stocks either by means of inter-plant transfers or the grouping of product types at a central storage point. In most cases, the mixing of bulk stocks was undertaken solely to permit the dispatch of large, consolidated orders direct to customers. The sorting of smaller, mixed orders for local delivery is almost always carried out at distribution depots. As the proportion of manufacturers' output distributed in bulk loads direct to customers has risen, it has become increasingly necessary to assemble large mixed stocks. In most cases this has generated additional trunk movements among factories or between factories and central mixing points. In some cases, however, such an increase in bulk movement has been reduced or obviated by the concentration of production in fewer locations and/or the rationalization of product ranges.

Given the diversity of most food manufacturers' product ranges, the availability of mixed bulk orders has clearly been a major factor in the growth of direct deliveries. The need for prior inter-factory "cross-shipment" or "transhipment" via central mixing points has, however, reduced the benefit of the "direct" delivery to the manufacturer, by making the routing of products more circuitous, thereby raising transport costs, and by increasing material handling costs. These additional costs, however, must be set against the high costs the manufacturer would have to incur if, in the absence of mixed bulk deliveries, the retailer required branch store delivery of small consignments. Likewise in evaluating the relative costs and benefits of an increase in these trunk movements from the standpoint of the community as a whole, one would have to take into account related changes in other parts of the distribution system. This wider evaluation is postponed to chapter 12.
Notes:

1. The application of linear programming in this context should be distinguished from that outlined in chapter 2. This earlier reference to the technique considered its use in the modelling of aggregate freight flows between traffic zones. It is more commonly used, however, by firms seeking to optimise the internal distribution of bulk flows among factories and warehouses.

2. The term "transhipment" may cause some confusion. As used by Magee, "transhipment" refers to distribution via any type of intervening depot, such as a non-stockholding transit depot, a local stockholding depot or central mixing point. In this thesis, however, the more common usage of the word has been adopted meaning a transfer of goods between vehicles usually involving a disaggregation or consolidation of loads. A distinction has, therefore, been made between depots where goods are merely transferred and those that combine this operation with a storage and, often, mixing function.

3. Central mixing points should be distinguished from "buffer stores" which cater temporarily for stock overspill from firms' factory-based warehouses. "Buffer" storage space is generally rented in public warehouses close to the factory to accommodate short-term peaks in the volume of stock. It is most used by firms whose production or product demand are subject to large seasonal fluctuations. In most cases bulk loads of single product lines (or a small range of products) can be dispatched to customers direct from these "buffer" stores; however, they are seldom used as mixing points for bulk orders.

4. This factory has been closed since the time of the survey.
Chapter 10

Local Delivery to Shops

Areas Served by Stockholding Depots

1. Manufacturers' Distribution Depots

Before one can consider the routeing of local deliveries from depots to retail (and small wholesale) customers, one must examine the way in which customers are assigned to depots. This assignment is simplified by the fact that these outlets almost always receive their supplies of a manufacturer's goods from only one of his depots, usually the nearest. Customers can, therefore, be assigned to depots by dividing the market area into separate depot service areas. This section will examine the factors affecting this subdivision of the market area and the actual zonal patterns that have been produced.

Generally speaking, three factors affect the delimitation of depot hinterlands. The first is the logistical constraint imposed by restrictions on drivers' hours. As most food manufacturers' delivery operations are characterised by high drop densities and comparatively short "stem" and "inter-call" distances, the daily range of their delivery vehicles is constrained much more by the length of the driver's shift than by legal limits on driving hours. Whatever the nature of the restriction, however, one should be able to draw a "time-constraint boundary" around each depot. As discussed earlier (p. 120), the extension of deliveries beyond this boundary requires arrangements, such as the outbasing of drivers and the use of transhipment facilities, which can add substantially to transport costs and delivery times (Attwood, 1971). The time-constraint boundaries of neighbouring depots usually intersect, in which case the area of overlap is usually divided in relation partly to the capacities of the two depots and partly to their outward delivery costs. Given a uniform density of demand, a depot with a larger amount of storage and delivery capacity could serve a wider area. Where two
neighbouring depots have adequate capacity to serve the entire areas within their time-constraint boundaries, however, the intervening area is more likely to be divided on the basis of relative delivery costs. For this purpose, a "cost-equalization boundary" can be drawn using a method devised by Weber (1909) and later refined by Losch (1954). Iso-cost lines are drawn around each depot, connecting up points of equal delivery cost. The cost-equalization boundary is then interpolated between the points at which the iso-cost lines of neighbouring depots intersect. Several firms professed to using this method of partitioning the market area into depot service areas. Others were less specific about the methods they used. It is often found in practice that the two sets of iso-cost lines are widely spaced, allowing firms to vary the configuration of the cost-equalization boundary quite considerably without significantly affecting total delivery costs (Murphy, 1978). Firms often take advantage of this flexibility to make allowance for indivisibilities in vehicle numbers and drivers' shifts, thereby ensuring that each depot is assigned a whole number of vehicles and drivers and that these are fully utilized (Sussams, 1969; Attwood, 1971,).

Those firms which employ contractors to handle distribution in some areas should, theoretically, construct cost-equalization boundaries by comparing their own delivery costs with quoted haulage rates. Buxton and Quayle (1971a) have devised a procedure for delimiting the area served by an "own account" depot under these circumstances, and applied it to the case of Wander Foods Ltd (Buxton and Quayle, 1971b). This practical application is rather exceptional, however, in that the firm in question distributed only from its single factory. Only three firms in the sample confronted a similar problem. The majority of the firms employing contractors operated several depots of their own and, therefore, had the more complicated problem of drawing a series of boundaries between these depots and the territories served by contractors. Several of these firms claimed that they maximised the extent of the areas served by their own depots, pushing their boundaries out to the limit of the daily delivery range. Some firms
argued, first, that the marginal costs of extending the delivery range were small implying a wide spacing of the iso-cost lines around their depots and, second, that their unit delivery costs were significantly lower than those of contractors.

There were numerous instances of delivery area boundaries coinciding with the boundaries delimiting salesmen's territories (Magee, 1968). This is largely due to the fact that, as Smith (1979a, p46) observed in his study of the confectionery trade, distribution policy is usually "dictated by the need, or convenience, of the sales force". Many firms clearly prefer to have each salesman channel all his orders through a single depot and indeed often use depots as bases for local sales operations. There is evidence, however, of this practice impairing the efficiency of depot deliveries. NEDO (1967) reports on a manufacturer of "tinned products" which was able to reduce its delivery costs by severing the spatial relationship between distribution and sales, and allowing the size and configuration of depot areas to be determined mainly by the economies of the delivery operation.

In most cases depot delivery boundaries were clearly defined. Twenty-two of the twenty-nine manufacturers sampled provided maps showing boundaries, though to varying degrees of accuracy. Most firms claimed that these boundaries were subject to very little change in the short-term and only likely to be substantially redrawn in the event of a major re-organization of the depot system, such as the closure of a depot (or depots) or change of contractor(s). The redrawing of depot boundaries can enable firms to make short term adjustments to their distribution systems in response to changes in the patterns of demand and accessibility (Beattie, 1973) Very few firms, however, make a regular practice of reviewing their boundary maps. Several firms admitted that they would like to redraw the boundaries more frequently but could not afford the cost in time and resources.
Variation in the Sizes of Depot Hinterlands.

One cannot examine the sizes of depot delivery areas without also considering the number of depots firms use. The more depots a firm operates, the more fragmented will be the pattern of service areas. In the earlier analysis of the sequence of depot locations (chap. 8) an attempt was made to idealise the pattern of zonal subdivision. This pattern was highly generalized, however, and, even in the case of firms operating similar number of depots in similar locations, concealed wide differences in the sizes and shapes of hinterlands in some parts of the country.

In zoning their market areas for distribution purposes, firms do not attempt to equalise the population served by each depot. The logistics and economics of the delivery operation make it much more efficient to vary hinterland size and depot throughput in relation to population density and accessibility. Figure 10.1 shows that food distribution depots vary enormously in the amounts of population they serve. Whilst the average amounts of population in the hinterlands declines as the numbers of depots increases, there is a wide variation about the mean in the case of all the firms sampled. It can be seen, therefore, that hinterland size, measured in terms of population, is not merely a function of depot numbers.

It is also related to depot locations and to the particular way in which a firm delineates its hinterlands. The effects of these other factors are difficult to separate from the influence of depot numbers. Ideally, to measure these effects, one should compare the zonation of several firms operating the same numbers of depots. So few firms operated the same numbers of depots, however, that it was decided instead to compare the hinterlands of depots used by firms with similar numbers of depots. Six firms were chosen which employed between 10 and 14 depots (i.e. around the average number of depots for the sample as a whole) and had provided sufficiently detailed boundary maps to permit reasonably accurate comparison. It was found that these firms operated depots within 30 miles of each other in three areas: the North East, North West and South West. The hinterlands of the depots serving these areas are shown
Figure 10.1: Populations in the Hinterlands of Depots Employed by a Sample of Nine Food Manufacturers.
(source: personal survey)
on figures 10.2(a)-(c), the populations of the areas listed on Table 10.1. It can be seen that in all four regions, there is a wide variation in the sizes and shapes of the areas served. Little of this variation appears to be attributable to differences in depot numbers, as there is little correlation between the numbers of depots and the measurements of hinterland size. It would seem, therefore, that even where firms operate similar numbers of depots in similar locations, the size and configuration of their depot boundaries often differ markedly. The actual patterns of depot areas that emerges also bear little resemblance to the ideal hexagonal pattern postulated by Sussams (1969).

Where a manufacturer distributes his goods to shops through depots, the spatial relationship between the shops and the depots will be affected by three factors:

1. The number of depots the manufacturer employs
2. The locations of these depots
3. The delimitation of the areas served by these depots

To illustrate the combined effects of these factors on patterns of delivery, one may compare the distribution systems of three large manufacturers of breakfast cereals. Although these firms employ similar numbers of depots and although many of the depots are in the same place, the three regionalizations of the country into depot service areas produce distinctly different patterns (fig. 10.3). Only in Scotland is there close similarity. In other regions, notably the North East and South West, depots in nearby locations serve hinterlands of markedly different configurations. As a result of these differences in the geography of the firms' distribution many shops receive supplies of their products from different areas. Fewer than half the 25 largest population centres receive their supplies of the three firms' products from depots within 30 miles of each other. The firms differ particularly in the locations from which they serve the three major conurbations of Greater London, the West Midlands and South Yorkshire.
Figure 10.2: Hinterlands of Selected Food Manufacturers' Depots Located in Three Regions.

(a) North East England

(b) North West England
Figure 10.2: (c) South West England
Table 10.1: Populations Residing in Depot Service Areas.

(i) North East:

<table>
<thead>
<tr>
<th>No. of Depots Operated by Firm No.</th>
<th>Firms</th>
<th>depot location</th>
<th>Population (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10</td>
<td>Spennymoor</td>
<td>3.46</td>
</tr>
<tr>
<td>2.</td>
<td>11</td>
<td>New Herrington</td>
<td>5.12</td>
</tr>
<tr>
<td>3.</td>
<td>11</td>
<td>Newcastle upon Tyne</td>
<td>3.21 Range=3.2</td>
</tr>
<tr>
<td>4.</td>
<td>12</td>
<td>Greatham</td>
<td>2.67 Mean=3.3</td>
</tr>
<tr>
<td>5.</td>
<td>13</td>
<td>Gateshead</td>
<td>1.90</td>
</tr>
<tr>
<td>6.</td>
<td>14</td>
<td>Durham</td>
<td>3.36</td>
</tr>
</tbody>
</table>

(ii) North West:

<table>
<thead>
<tr>
<th>No. of Depots Operated by Firm No.</th>
<th>Firms</th>
<th>depot location</th>
<th>Population (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10</td>
<td>Haydock</td>
<td>7.24</td>
</tr>
<tr>
<td>2.</td>
<td>11</td>
<td>Eccles</td>
<td>10.91</td>
</tr>
<tr>
<td>3.</td>
<td>11</td>
<td>Kirkby</td>
<td>9.05 Range=4.2</td>
</tr>
<tr>
<td>4.</td>
<td>12</td>
<td>Middlewich</td>
<td>8.47 Mean=8.2</td>
</tr>
<tr>
<td>5.</td>
<td>13</td>
<td>Bolton</td>
<td>7.00</td>
</tr>
<tr>
<td>6.</td>
<td>14</td>
<td>Ashton</td>
<td>6.79</td>
</tr>
</tbody>
</table>

(iii) South West:

<table>
<thead>
<tr>
<th>No. of Depots Operated by Firm No.</th>
<th>Firms</th>
<th>depot location</th>
<th>Population (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10</td>
<td>Bristol</td>
<td>4.01</td>
</tr>
<tr>
<td>2.</td>
<td>11</td>
<td>Caldicot</td>
<td>4.50</td>
</tr>
<tr>
<td>3.</td>
<td>11</td>
<td>Bristol</td>
<td>8.75 Range=6.7</td>
</tr>
<tr>
<td>4.</td>
<td>12</td>
<td>Yate</td>
<td>5.04 Mean=4.8</td>
</tr>
<tr>
<td>5.</td>
<td>13</td>
<td>Bristol</td>
<td>4.38</td>
</tr>
<tr>
<td>6.</td>
<td>14</td>
<td>Brislington</td>
<td>2.07</td>
</tr>
</tbody>
</table>

Source: personal survey.
Differences in the spatial organization of food manufacturers' distribution systems proved beneficial (from the consumer's standpoint) in the 1979 lorry drivers' strike. As the strike was not uniformly enforced across the country, supplies of at least one brand of most products continued to be delivered to the shops (McKinnon, 1981b).

The Delimitation of Depot Hinterlands.

Some general patterns can be observed in the delineation of depot hinterlands in some areas:

a) Presence of physical barriers: The alignment of depot boundaries can be strongly influenced by poor road connections across mountains and estuaries. Many firms, for example, have divided service areas in the North of England along the line of the Pennines (Murphy, 1978). With the bridging of the main estuaries since the mid 1960s, their barrier effect has been reduced, though it has usually taken several years for firms to adjust their delivery systems to the new patterns of accessibility in these areas (Cleary and Thomas, 1973).

b) Effects of population distribution: The drawing of depot boundaries is facilitated by the uneven distribution of population (and sales). Firms commonly run depot boundaries across sparsely populated areas. The clearest examples of this are in the borderlands between Scotland and England, and in Mid-Wales. Eighteen of the firms in the sample had a depot boundary roughly collinear with the Scottish border.

At the other extreme, many firms have split distribution to the conurbations, particularly those of Greater London and the West Midlands, between several off-centre locations, and drawn the depot boundaries through densely populated areas. Firms justified this division of the conurbation on several grounds:

(i) A single depot serving these areas of high demand would be too large.
(ii) By employing several depots, they reduce the risk of the deliveries to these crucial areas of high demand being totally disrupted.

(iii) Road congestion rendered travel across the conurbations slow, making it easier and more economical to serve them radially from several different directions.

c) Inadequacy of London's road network: There was unanimous condemnation by firms in the sample of London's road system. The difficulties firms experienced in delivering goods in London encouraged the use of more than one depot in this area. Fewer than a third of the firms in the sample served London from a single depot. Of the ten that supplied the capital from two depots, six located them to the north and south of the city within triangular areas between Radlett, Barnett and Hatfield, and Crawley, Croyden and Swanley, respectively. The importance of this north-south division was confirmed by the fact that eleven of the sixteen firms that serve London from more than one depot have a service area boundary running along the Thames. The limited number of bridges on the Thames coupled with the high levels of congestion on their approach roads makes this river a natural dividing line.

d) Effects of the trunk road network: One might expect the pattern of depot boundaries to be distorted by differences in the ease of movement across the road network. Following similar reasoning to that employed by Von Thunen in his theory of agricultural location, one might hypothesize that depot service areas will be elongated along the line of major trunk routes, as a result of a corresponding distortion of iso-cost lines and time-constraint boundaries. It is difficult to test this hypothesis, however, for, although there are numerous irregularities in the configuration of depot boundaries, one cannot be sure that they are the result of differences in the quality of the road network. It seems likely, nevertheless, that the northerly extension to Carlisle of the hinterlands of depots located around Manchester and Liverpool is associated with the fact that firms can supply Carlisle faster and more
cheaply along the M6 from Merseyside than over the significantly shorter, but inferior A74 route from depots around Glasgow.

2. Multiple Retailers' Central Warehouses.

The service areas of multiple retailers' central warehouses must be viewed differently from those of manufacturers' distribution depots because they generally contain a much lower density of outlets and only in a few cases do they knit together to give the retailer national coverage. If one delimits these hinterlands by drawing the boundary line through the branch stores most distant from the central warehouse, then the shape and size of the area may be distorted by a small number of these peripheral stores. One grocery multiple, for example, which operated both supermarkets and food halls in a chain of department stores, had most of its branches concentrated in the South and Midlands of England, but had recently opened a new food hall in a department store in Stirling. It would not have been meaningful to extend the perimeter of this chain's warehouse service area from its previous most northerly point of Stockton to Stirling. The study of retail service areas must, therefore, take account of the spatial distribution of branch stores. It was beyond the scope of this research to examine in detail the geography of all retail chains included in the survey. A comparison was made earlier of the cumulative proportions of branch stores at different distances from the central warehouses of a group of multiples (fig. 5.12). This indicated that the average distance from central warehouse and the spatial distribution of branch stores around the central warehouse can vary considerably. As one might expect, chains composed mainly of smaller supermarket and self-service outlets (such as Express Dairies and Foodrite) tend to have smaller and more compact service areas than chains of larger supermarkets (such as Safeways or Lows). It has been estimated that the areas served by food retailers' central warehouses have an average radius of about 60 miles (GLC Intelligence Journal, 1978).
This picture is complicated, however, by several significant anomalies. In the case of the larger chains that have grown principally by acquisition, the sizes of the areas served by the central warehouses can vary markedly, reflecting differences in the spatial structure of the chains that they have absorbed. One of these chains which had recently set up many large supermarkets and superstores used a two-tier system of distribution to supply shops of widely differing size. Only the larger central warehouses held stocks of the wide range of goods sold in the bigger shops. These warehouses, therefore, had effectively two separate hinterlands; one, of more limited extent, comprising smaller branch stores, the other much wider and related to the larger outlets. This arrangement appears to be exceptional, however, and can probably be explained by the fact that in the case of this firm the range of shop and central warehouse sizes was unusually large. Special consideration must also be given to a rapidly expanding chain such as Kwiksave, whose warehouse service areas have recently been in a state of flux, involving both an outward expansion into new sales territory and realignment of the boundaries between adjoining service areas.

When asked how frequently they modified service area boundaries, most of the multiples (operating more than one warehouse) replied that this was done very infrequently ("every few years" was a common reply) unless some major change occurred, such as a warehouse opening or closing, a new chain being acquired or an important transport link being improved. As in the case of the large food manufacturers, it has been uncommon for firms to make marginal short-term adjustments to service area boundaries.

Central warehouses operated by the larger grocery multiples generally have more extensive hinterlands than food manufacturers' distribution depots. This is made possible by the fact that outward journeys from multiples' central warehouses usually take the form of large, consolidated deliveries to a comparatively small number of outlets. As few drops are made per trip, little time is expended travelling between shops or off-loading supplies, permitting long "stem" movements and pushing out
time-constraint boundaries. A more detailed comparison of the logistics of manufacturers' and multiple retailers' shop deliveries is made in a later section of this chapter. It must suffice at this stage to note that, while the hinterlands of manufacturers' depots and retailers' central warehouses vary considerably in size, the latter on the whole tend to be larger.

3. Wholesalers' Depots

Voluntary Groups: The major voluntary groups differ in the way they divide the country among affiliated wholesalers. Most have delimited wholesaler "franchise" areas with a series of clearly defined boundaries. In many cases, these boundaries were fixed at the time when the voluntary group was formed and have subsequently undergone little change. Some trade areas have coalesced as a result of mergers, but generally these have left the perimeter of the joint area intact. A more complicated and extensive adjustment of boundaries followed the Spar-Vivo merger, to reduce the amount of overlap between franchise areas.

One of the large voluntary groups does not give each wholesaler a designated "franchise" area. Instead it encourages affiliated wholesalers to compete for retail customers in the area of overlap between their depot territories. In addition to intensifying the efforts of neighbouring wholesalers to recruit new retail members, this policy is also claimed to make it easier for wholesalers to alter the size and shape of their trade areas to accommodate changes in road conditions and the distribution of population.

The radius of wholesalers trade areas varies between 20 and 50 miles and averages around 30 miles. This makes their depot hinterlands significantly smaller than those of grocery multiples and large food manufacturers, except those with upwards of twenty distribution depots.

Cash and Carries: The "catchment areas" of cash and carry warehouses differ fundamentally from the "hinterlands" of
delivery depots operated by manufacturers, multiples and voluntary wholesalers. Cash and carries are best regarded as "wholesale supermarkets" (Kirby, 1974) as the responsibility for transporting the goods purchased rests with the customer, who in this case is the small shopkeeper. It has also been found that around 70% of independent retailers obtain supplies from more than one cash and carry. One cannot, therefore, delimit the catchment area of a cash and carry warehouse in the same way as one delineates the hinterland of a delivery depot. Instead the allocation of retailers' purchases among neighbouring cash and carries would require the use of market potential models, such as those devised by Huff (1963) and Lakshmanan and Hansen (1965) to forecast the spatial distribution of retail sales. Although the relationship between independent retailers and cash and carries has not been modelled in this way, several studies have examined the factors that influence the retailer's choice of cash and carry (Thorpe et al., 1973; Bates, 1976). It is beyond the scope of this project to extend this work. The main concern here is, after all, with the movement of groceries by manufacturers, multiple retailers and wholesalers in goods vehicles.

The Routeing of Deliveries from Depots to Shops.

The survey upon which this thesis is based was conducted at the upper levels of company management and concerned with the general strategy of firms' distribution operations. Very little information was collected on the "tactical" aspects of local delivery operation. Most of the distribution staff consulted did not have data readily available on the pattern of local deliveries, though many were able to provide estimates of the average level of vehicle utilization. These figures were of limited use, however, partly because firms measured vehicle utilization in different ways, but mainly because they gave little indication of the logistics of depot deliveries. It has not been possible, therefore, to analyse in detail the routeing of local deliveries from depots to shops. It is, however, possible using information collected in the survey
and drawn from published sources to make some general observations about the different types of store delivery and recent changes in their relative importance.

Types of Local Delivery.

Of the six possible routeing systems listed by McClelland (1966) (fig. 10.4), only three are found in common use in the grocery trade. These are (1) direct deliveries from production points to shops, (2) movement via an intermediate depot at which loads are consolidated for direct delivery to shops, and (3) round trips from individual supplier's premises (usually distribution depots rather than production points in the case of packaged groceries). Of these (2) and (3) are by far the most commonly used and tend to be organised at a smaller spatial scale than the direct distribution of bulk supplies to large retail outlets from factories. This chapter is primarily concerned with delivery types (2) and (3). These types of localised delivery may be compared on the basis of the following criteria:

(i) journey length: This is constrained mainly by the limit on the number of hours per day a driver can work. The distance that can be travelled in a daily shift depends not only on the speed at which the vehicle travels but also the time required to off-load goods at each of the delivery points. Where the delivery is of a single consignment, the maximum distance that can be travelled out and back in the "driving day" will be the radius of the "time-constraint boundary". A distinction can be made between one-day journeys that lie entirely within a time-constraint boundary and those with longer stem distances that take two days to complete. The vast majority of grocery store deliveries are of the former type, but, as outlined earlier, some firms use transhipment via satellite depots (or sub-depots) or the outbasing of drivers to extend the service area of stockholding depots beyond the daily delivery range, especially in more peripheral areas with a low density of demand (Crawford, 1972b; Beattie, 1973).
Figure 10.4: Possible Route Systems (after McClelland, 1968).

1. Separate direct journeys
   No. of Loadings: X.Y
   No. of Drops: X.Y

2. Indirect movement via intermediate depot
   No. of Loadings: X+Y
   No. of Drops: X+Y

3. Complete round trip
   No. of Loadings: X
   No. of Drops: Y

4. Round trip by each supplier
   No. of Loadings: X
   No. of Drops: X.Y

5. Round trip by each recipient
   No. of Loadings: X.Y
   No. of Drops: Y

6. Round trips from intermediate depot
   No. of Loadings: X+1
   No. of Drops: Y+1
(ii) **drop density**: (i.e. the number of drops per unit distance) This depends upon the spatial distribution of the outlets to be served. The greater the density of outlets, the shorter will be the average distance per drop and the smaller the deviation from the direct radial route to each outlet. The unit delivery costs tend to fall, therefore, as drop density increases. This has been confirmed empirically by Williams (1975). (fig. 6.4)

(iii) **number of drops per journey**: This is constrained partly by the time limits mentioned in (i) and by vehicle capacity. Given these constraints, the number of drops that can be made on a journey will depend on the drop density, the consignment sizes and the times taken to off-load goods at each of the premises **en route**.

A major distinction can be drawn between the direct delivery of a single consignment and the multiple drop journey. As outlined earlier (p. 112), it is common for multiple retailers operating centralized delivery systems to supply their branch stores with direct, consolidated deliveries, often of full lorry loads. In contrast, deliveries from manufacturers' depots are generally of small quantities taking up only a small fraction of the capacity of the vehicles. These consignments are almost invariably combined in mixed loads and delivered to customers in the course of a multiple drop journeys. Such journeys are inevitably circuitous; only the delivery to the first customer on the round is direct. The degree of circuity increases with the number of drops.

Eilon et al. (1971) have examined the relationship between direct radial distance and minimum delivery round distance, using random distributions of customers within an area of given extent. Multiple drop journeys generate less vehicle kilometres than direct deliveries to each of the customers, and as the number of drops increases this differential widens. (This relationship forms the basis of Clarke and Wright's "savings criterion" method of finding the shortest path between a set of points, which is discussed later.) Although the multiple drop journey is more devious than the direct route to each customer, it dispenses with the individual backhauls that result from
direct deliveries.

The multiple drop delivery round and the direct radial delivery are not strictly comparable, however, as they differ in the sizes of consignment they can supply to each customer. A vehicle delivery to several customers en route will supply only a fraction of the full consignment, whereas a direct delivery could supply a whole lorry load, perhaps meeting the order in full. It will, therefore, require several delivery rounds to distribute the same quantity of goods as a series of direct deliveries.

This point may be illustrated by means of a simple example (fig. 10.5). Depot A serves ten customers distributed at equal distances around a circle of radius $r$ kilometres. Each customer demands ten tonnes of goods. The vehicles used for the deliveries have a maximum payload of ten tonnes and must always carry this full amount on outward journeys from the depot. Whole numbers will be used to simplify the calculation. The size of individual consignments must therefore, divide evenly into 10, restricting them to one of four values: 1 tonne, 2 tonnes, 5 tonnes or 10 tonnes. Consequently, the number of drops per journey can only be 10, 5, 2 or 1. It is also assumed that each customer receives his 10 tonnes in loads of similar size. Within these constraints, it is possible to devise ten patterns of delivery, ranging from direct deliveries to a series of multiple drops of one tonne. For each of these patterns the total number of tonne-kilometres has been calculated and plotted on figure 10.6. It can be seen that tonne-kilometres are minimised by direct "radiation" and increase as the size of drop diminishes and the required number of delivery rounds increases. In addition to reducing the total volume of freight movement measured in tonne-kilometres, the consolidation of supplies in fewer, larger drops carries other important advantages which are discussed later. The system of direct deliveries is more efficient despite the fact that it usually entails more empty running by vehicles. Although this example is highly idealised, it demonstrates the general point that for a given depot location and distribution of customers it is more efficient to deliver directly in consolidated loads.
Figure 10.5: Idealised Delivery Patterns

- Supply point (A)
- Customer

1. x1
2. x1
3. x2
4. x1
5. x1
6. x5
7. x3
8. x1
9. x2
10. x1

1. 6
2. 7
3. 8
4. 9
5. 10
Figure 10.6: Characteristics of the Idealised Delivery Patterns

- a) Average number of drops per customer
- b) Average number of drops per trip
- c) Average drop size

\( r = \text{radius of circle} \)
than in a series of multiple drop rounds.

In the light of these general, theoretical observations, one can now compare the types of grocery delivery currently operated by manufacturers and multiple retailers.1

Deliveries from manufacturers' depots are almost invariably multiple drop rounds. The number of drops per journey and their sizes can vary considerably, however. Only six manufacturers estimated the average number of drops on their local deliveries; these estimates ranged from 8 to 20 and averaged 12.6. As might be expected, firms supplying larger numbers of outlets make on average more drops per journey. Although the average size of drop also varies widely, it does not appear to correlate closely with either the total number of outlets served or the average number drops per journey. Little can be deduced from these figures, however, partly because of the very small sample size, and partly because the firms differ in the way in which they calculate these indices.

The logistics of the manufacturers' depot deliveries differ sharply from the consolidated deliveries the multiples operate from their central warehouses. For a sample of 18 multiples, the average number of drops per journey (weighted by turnover) was only 2.6. Eight of these chains reported that the majority of their ex-central warehouse deliveries were of a full lorry load to a single branch store. In the cases of the bigger chains operating large supermarkets, many of these lorry loads would comprise over 1000 cases. The size of consolidated drops is likely to vary widely, however, depending on the frequency of delivery, the proportion of supplies channelled through the central warehouse and the turnover, storage capacity and reception facilities of the branch. These variations in drop size are reflected in differences in the sizes of vehicle the multiples employ. As shown in Table 7.5, the size distribution of vehicles operated by the multiples is bi-modal. Roughly a third of them are "box-rigid" vehicles of around 16 tonnes gross weight, mainly for deliveries to smaller shops which, for reasons of low turnover, limited reception facilities or inaccessible location, are unsuited
to delivery by larger, articulated vehicles. About half
the vehicles operated by the multiples are articulated
vehicles capable of carrying the maximum permitted weight
and used to deliver consolidated loads to the larger
supermarkets. Most consolidated drops would be
substantially greater than consignments delivered by
manufacturers direct to the store. This is confirmed by a
survey undertaken by the GLC of deliveries to a supermarket
chain in the London area (GLC, 1975). This found that the
size of consolidated drops from the firm's central warehouse
averaged 740 cases as opposed to 26 cases for deliveries
direct from suppliers.

These differences in the number of drops per journey
and average size of drop can be related to the differences
between the multiples and the manufacturers in the number
and sizes of outlets they supply, their degree of stock
concentration and the size of the areas served by their
depots. The multiples deliver to a much smaller number of
larger stores. By consolidating supplies into large
consignments, they can deliver to stores economically over
long distances, thereby making it possible for them to
concentrate their stocks in large central warehouses. With
more dispersed stockholding patterns, manufacturers can
often have depots closer to branch stores than the
retailers' own central warehouses. The greater dispersal of
manufacturers stocks and the smaller size of their depot
hinterlands are likely to reduce the difference between
their multiple drop rounds and the direct consolidated
deliveries of the multiple retailers in terms of vehicle-
and tonne-kilometres. The simple model presented earlier
(fig. 10.5) to demonstrate the superiority of the latter
type of delivery was based on the assumption that all
deliveries would originate from the same depot location and,
therefore, that the distances between this location and the
customers remained fixed. In practice, however,
differences in the nature of the delivery are associated
with variations in the average distances between depots and
customers. This can be demonstrated by measuring the
direct distances to a chain's branch stores from depots
operated by a sample of manufacturers and comparing these
with direct distances from the multiple's own central depot. Table 10.2 summarises the results of such an exercise and shows clearly that, by operating larger numbers of depots, the manufacturers are able to reduce the aggregate direct distance from depots to branch stores. If distribution from all these depots were to take the form of direct radial deliveries, the retailer's system would generate much more vehicle and freight movement. To illustrate this point one might imagine a situation in which every branch store demanded one tonne of the products of each of the manufacturers in the sample. Were these orders to be supplied direct from the manufacturers depots, this would generate a total of 41,046 tonne-kms of freight movement. If these orders were consolidated at the retailer's central warehouse then delivered direct this would give rise to 76,824 tonne-kms of freight movement, an increase of 87%. This comparison assumes, quite justifiably, that bulk distribution from the manufacturers' factories to their depots generates similar amounts of freight movement to bulk distribution to the retailer's central warehouses. It ignores the fact, however, that the manufacturers would combine deliveries to this retailer's branch stores with drops to other customers in a multiple drop round, thereby reducing the number of vehicle- and tonne-kilometres per drop. It can be seen, therefore, that the greater centralization of multiple retailers' stockholding can more than offset the savings in vehicle- and tonne-kilometres made possible by consolidating loads and rendering deliveries more direct. This finding requires several qualifications, however. The evidence presented here relates to a single supermarket chain and small sample of food manufacturers. It is not known how representative these firms are of the grocery distribution system as a whole. The 86 branches of the supermarket chain in question (firm no. 6 in figure 5.12) are on average significantly further from the central warehouses that serve them (68 km) than the average distance (56 km) for the total of 482 branches operated by the sample of eight chains operating central warehouses whose spatial structure was examined earlier (fig. 5.12). Even this shorter average
Table 10.2: Depot Numbers and Distances to Branch Stores: Comparison of Multiple Retailer and Sample of Food Manufacturers.

<table>
<thead>
<tr>
<th>No.</th>
<th>Manufacturers:</th>
<th>No. of Depots</th>
<th>Average Distance to Branch Stores (kms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1</td>
<td>22</td>
<td>28.9</td>
</tr>
<tr>
<td>2.</td>
<td>2</td>
<td>19</td>
<td>23.2</td>
</tr>
<tr>
<td>3.</td>
<td>3</td>
<td>16</td>
<td>28.7</td>
</tr>
<tr>
<td>4.</td>
<td>4</td>
<td>14</td>
<td>31.5</td>
</tr>
<tr>
<td>5.</td>
<td>5</td>
<td>13</td>
<td>31.6</td>
</tr>
<tr>
<td>6.</td>
<td>6</td>
<td>12</td>
<td>38.7</td>
</tr>
<tr>
<td>7.</td>
<td>7</td>
<td>11</td>
<td>38.4</td>
</tr>
<tr>
<td>8.</td>
<td>8</td>
<td>10</td>
<td>38.3</td>
</tr>
<tr>
<td>9.</td>
<td>9</td>
<td>10</td>
<td>53.4</td>
</tr>
<tr>
<td>10.</td>
<td>10</td>
<td>8</td>
<td>39.1</td>
</tr>
<tr>
<td>11.</td>
<td>11</td>
<td>4</td>
<td>46.9</td>
</tr>
<tr>
<td></td>
<td>Multiple Retailer:</td>
<td>3</td>
<td>68.0</td>
</tr>
</tbody>
</table>

Source: personal survey.
distance for the complete sample of branch stores, however, is likely to be considerably greater than the average distance from manufacturers' depots to these stores, still largely offsetting the saving in vehicle- and tonne-kilometres accruing from the use of consolidated direct deliveries. The consolidation of loads, however, permits the use of larger vehicles, which reduces vehicle kilometres per drop, enables firms to schedule the deliveries more carefully and economises on the handling of goods at depot and shop. Furthermore, given the present spatial distribution of manufacturers' and retailers' warehouses, the size of the differential in vehicle- and tonne-kilometres between the multiple-drop round and the direct consolidated delivery depends heavily on the efficiency with which the former type of delivery is operated. Much importance must, therefore, be attached to the particular route a vehicle follows on a multiple-drop round. The planning of multiple drop routes is considered in a later section.

The Changing Pattern of Local Delivery

Over the past 20 years the logistics of the local delivery of grocery products have changed markedly. The average number of drops per delivery has fallen while average drop size has increased and "stem" distances lengthened. Multiple drop rounds have declined in importance, to be replaced increasingly by direct, consolidated deliveries to individual outlets. As Smith (1979a) has observed, this trend towards greater consolidation of deliveries has been promoted both by shifts in the allocation of trade between marketing channels and by changes in the internal organization of firms' distribution operations. The multiples have traditionally placed much greater emphasis on direct, consolidated deliveries to branch stores than manufacturers and wholesalers, and this emphasis has increased as chains have concentrated their sales in smaller numbers of larger outlets with high turnovers and better reception facilities. The growth in multiples' share of the grocery market and their growing involvement in distribution "upstream" of the shop have
effected a major shift away from multiple drop delivery rounds towards more direct forms of consolidated delivery. As outlined in Chapter 6, the increased use of distribution contractors by food manufacturers and retailers has also contributed to the consolidation of deliveries; so too has the large number of takeovers and mergers in the food industry (Lorries and the Environment Committee, 1979). Meanwhile, shop closures and increases in minimum drop sizes have been reducing the number of outlets manufacturers and wholesalers must supply, allowing them to reduce the number of drops per delivery and increase their average drop sizes. By stopping the delivery of small orders and thereby lowering the density of delivery points, these firms have also been able to reduce significantly total vehicle- and tonne-kilometres (Mercer et al., 1978). By refusing to deliver small quantities, food manufacturers have forced many independent retailers to increase the proportions of supplies they receive in consolidated loads from wholesalers. Hall (1979) sees the use of wholesalers as a means of rationalizing the pattern of shop delivery through the consolidation of retailers' orders and supplies. In addition to promoting the consolidation of deliveries, increases in minimum drop size, by both manufacturers and wholesalers, have also made small independent retailers more dependent on cash and carries, thereby displacing a significant proportion of food movements from goods vehicles to vehicles used mainly for personal travel by shopkeepers and their families.

Regardless of the means by which it has been achieved, the increased consolidation of deliveries has yielded large cost savings. These may be divided into a) savings accruing from the improved efficiency of the transport operation, and b) savings made possible in related activities:

a) **Efficiency of the transport operation:** As outlined above, for a given set of outlets with given demands and fixed depot location, the consolidation of deliveries reduces both total vehicle kilometres and total tonne-kilometres. Furthermore, as this consolidation is generally coupled with the use of larger vehicles, economies
of scale in vehicle operation permit a reduction in running costs per kilometre and per tonne delivered. It has been found, however, that only around a third of the benefits of consolidation stem from reductions in vehicle kilometres (Foulkes, 1979). Most of the economic benefits arise from other related improvements to the delivery operation. Consolidation reduces "backdoor congestion" and thereby the amount of time vehicles spend queuing at shops. It also facilitates the scheduling of deliveries to shops and warehouses. In recent years, there has been a large increase in the number and severity of restrictions on the timing of deliveries to these premises (McKibbin, 1982b). Retailers and wholesalers have been reducing the number of hours during the week when they are prepared to receive deliveries, and have in many cases implemented a booking-in system (Low, 1978). This has led to an increase in the number of "refusals" i.e. occasions when delivery vehicles are turned away (Bowen and Mundy, 1972). Access to these premises, especially those in town centres, has also become increasingly restricted at particular times of the day by local traffic regulations. In assessing the impact of these access restrictions, one must make allowance for the fact that the timing and duration of access restrictions can vary between neighbouring towns and even between different parts of the same town (Urquhart, 1976; Turner, 1978). In addition to all these formal restrictions, the movement of delivery vehicles in urban areas has also become increasingly inhibited by worsening road congestion. Approximately 80% of grocery deliveries are made between 8 and 12am, when urban traffic levels are high (Robson, 1982). This road congestion makes journey times both longer and more variable. All these constraints have strengthened the comparative advantage of the consolidated delivery over the multiple drop round. By travelling more directly to a small number of outlets, a vehicle making a consolidated delivery is less affected by access restrictions and can adhere more closely to customers' delivery schedules.

Overall, delivery costs per unit vary inversely and exponentially with drop size (McConkey, 1979; Williams, 1975), making large consolidated drops much more economical.
to deliver than numerous small, individual consignments.

b) Benefits for related activities: The consolidation of deliveries can improve the efficiency with which the dispatching node (the depot) and the receiving node (the shop) are operated. As consolidated deliveries generally have a much greater distance range than multiple drop journeys, they enable firms to serve wide areas from comparatively few locations, thereby yielding economies of scale in stockholding, storage and materials handling at depots. The arrival of supplies in large, consolidated drops at the shops also makes for more efficient off-loading of goods, a reduction in the amount of paper work and greater security. Shop managers can also deploy staff more efficiently when vehicles arrive at regular, pre-arranged times, as is generally the case with direct, consolidated deliveries.

Several reports by governmental and quasi-governmental agencies published over the past 13 years have strongly supported this trend towards an increased consolidation of deliveries (OECD, 1970; Pettit 1973; DTP, 1979; Lorries and the Environment Committee, 1979; Armitage, 1980). The report of the Institute of Food Distribution Working Party on Deliveries (1970) favoured a reduction in the delivery of small consignments direct to food shops and a large increase in the proportion of food supplies consolidated at retailers' and wholesalers' warehouses. In all these cases, support for increased consolidation has been justified mainly on economic grounds. In the mid-1970s it was recognised that there was a close link between consolidation and peripheral transhipment (PE Consultants, 1975); for if transhipment depots were to be established on the outskirts of towns, these could serve equally well as consolidation points and break-of-bulk points. While there would be a clear economic preference for using these facilities for consolidation purposes, there would be environmental opposition to the resulting use of large vehicles for urban deliveries (Plowden, 1981). Considerable concern has been expressed over the past 10 years about the increased use of heavy vehicles,
particularly in an urban delivery capacity (Civic Trust, 1970 and 1979; Wardroper, 1981). Official transport statistics suggest that the heavier classes of vehicle, which were formerly confined to long distance trunk movements, have been increasingly used for shorter distance delivery work. They show that between 1974 and 1981 the average length of haul for vehicles over 20 tonnes (gross weight) fell from 91.4km to 70.7km, while these vehicles increased their share of the total weight lifted from 42.5% to 70.7% (DTp, 1982). These heavy vehicles have been widely deployed in the delivery of groceries to shops. It was noted earlier that over half the delivery vehicles operated by the grocery multiples in the sample were of maximum legal size at the time of the survey. Margason and Corcoran (1978) have shown how a supermarket chain can substantially reduce unit delivery costs, fuel consumption and total vehicle mileage by using larger vehicles (table 10.3). Transport costs per ton were estimated to be 40% lower for 24 ton vehicles than for 8.5 ton lorries. It is likely, therefore, that there would be a strong pressure from firms in the food trade to use any new transhipment facilities for the consolidation rather than disaggregation of loads.

The environmental consequences of increased consolidation are difficult to assess because some environmental costs, such as those incurred by air pollution and traffic accidents, are a function mainly of vehicle numbers, whereas others, such as those associated with noise and vibration, correlate more closely with vehicle size (Smith, 1977a). It has also been shown that the public has no clear preference for either several small vehicles (c 6 tonnes gvw) or one large one (c 24 tonnes gvw) (Rosman, 1976). Sir Arthur Armitage in his report on "Lorries, People and the Environment" (1980) acknowledges that "any environmental advantage gained from consolidation as a result of lower lorry mileage has to be offset against the disadvantage brought by the use of the larger types of lorries for consolidation". Foulkes (1979), nevertheless, argues that consolidation brings net environmental benefits. On balance the environmental objections to consolidation do
not seem to outweigh the large economic benefits, and are unlikely to precipitate government action to curb the trend towards more consolidated delivery. In the grocery trade, as in many others, there is still considerable scope for further consolidation of retail deliveries (Wilson, 1979; Lorries and the Environment Committee, 1979). It should, nevertheless, be noted that, as established earlier (p316), much of the consolidation of deliveries has been associated with a concentration of stockholding and enlargement of depot hinterlands. It is likely that the additional vehicle and freight movement generated by this spatial concentration will, in many cases, have exceeded reductions in vehicle- and tonne-kilometres accruing from the consolidation of deliveries.

There are other ways in which the system of grocery delivery can be rationalised, however, which appear to offer less questionable economic and environmental benefits. These relate to the routeing of multiple drop deliveries. Despite the recent growth of consolidation, a substantial proportion of grocery products continue to be delivered to shops in the course of multiple drop rounds. This is still the dominant mode of delivery for many of the more perishable products and for products, such as biscuits, that have traditionally been marketed intensively at the retail level (Greater London Council, 1976). Although these multiple drop deliveries are generally made by vehicles of less than 16 tonnes (gvw) and, therefore, deemed more environmentally acceptable than the larger lorries used for direct consolidated deliveries, environmental, as well as economic, benefits can still accrue from a net reduction in the total distance they travel. Before examining ways of reducing the vehicle kilometres generated by multiple drop rounds, it is necessary to consider how these rounds are currently planned.

The Planning of Multiple Drop Journeys

In the case of multiple drop journeys, the search for an optimum route between a series of delivery points is an extension of the classical "travelling salesman problem", sometimes referred to as the "truck despatch problem"
(Dantzig and Ramser, 1959). Since this problem involves establishing the order in which customers on a route are to receive a delivery, it is often called a route or vehicle "scheduling" problem. Sussams (1971) estimated that 99% of Britain's vehicle fleet was subject to manual route scheduling, using one of a series of simple and practical methods. These generally divide the routeing exercise into 3 stages (Webb, 1972; Sussams, 1971; Attwood, 1971; Menzies, 1976):

1. **The formation of a "fixed" or "semi-permanent" system of delivery zones at intervals ranging from several months to several years.** In most cases this involves dividing the market area (or depot service area) into zones or "bricks". The size of these zones depends on the density of demand. Although they are usually square or rectangular in shape, the aim is to have the zonal boundaries delineate discrete clusters of customers. In practice, this is seldom possible and, as a result, many of the boundaries are drawn arbitrarily.

2. **Daily route scheduling.** The number of customers in a zone requiring delivery and the sizes of their orders will vary from day to day. The route planner will calculate the aggregate demands of a zone on a particular day and estimate the time required to deliver the various consignments within the zone. The aggregate weights are usually expressed as fractions of the maximum vehicle payload; the intra-zonal delivery times as fractions of the drivers' daily shift. Each vehicle is then allocated a series of zones in such a way that maximum use is made of the available vehicle capacity and drivers' time. By applying a few simple principles and his knowledge of road conditions in the area, the route planner decides in which order the zones should be visited.

3. **Intra-zonal routeing between customers (or "micro-routeing").** The driver is usually responsible for planning his movements within the zones, deciding in which order to call on customers and which roads to use. Where there are comparatively few customers in each zone, the route planner might recommend that they be visited in a particular sequence, though this still leaves the choice of
road to the driver.

The success of this procedure rests heavily on the route planner's knowledge of all the circumstances likely to affect the movement of delivery vehicles in the area and the driver's familiarity with the local road network. It is acknowledged, however, that such a procedure is very unlikely to yield an optimum pattern of routes that minimises total vehicle-kilometres (Sussams, 1971; Attwood, 1971). This is because, in the first place, there are inherent weaknesses in the planning of deliveries on a zonal basis. Even if zones are very small and zonal boundaries carefully interpolated between clusters of customers, this method is still inferior to one treating each customer location separately. The degree of approximation is increased further where zones are large and zonal boundaries drawn arbitrarily. Second, as the network of delivery zones is constructed on the basis of average sales data for each customer, and this network modified infrequently, firms cannot tailor vehicle routes to particular patterns of demand on a day to day basis. This tends to impair the efficiency with which vehicles and drivers are used (Drew and McConkey, 1981), and prevents firms from minimizing the distances vehicles travel on any given day.

The obvious solution to these problems would be to devise an optimum set of routes each day in the light of the actual demands arising at particular locations. This would be a much more complicated exercise, however, and require the use of much more sophisticated techniques than most route planners have at their disposal (Sussams, 1971).

Various algorithms have been developed to optimise the routeing of goods vehicles between a series of points (Christophides and Eilon, 1969; Eilon et al., 1971; Sussams, 1971). These differ in their precision and computational demands. Having tested five of the main algorithms, Gaskell (1968) concluded that, in terms of their ability to approximate an optimal solution, "none of the methods considered (was) uniformly better than any other." Over the past 20 years a number of computer packages have been developed, mostly on a commercial basis, to help firms put
these algorithms into practice (Mann, 1976; Robson, 1982). These packages differ in their method of optimization and in their geographical framework. The majority employ the "savings criterion" method devised by Clarke and Wright (1963). Some of the models use grid references and plot straight-line routes across continuous space; others plan optimal routes across a specified road network. More versatile packages offer a choice between these two referencing systems.

Despite the large range of such packages available and the strenuous efforts of consultancy agencies to market them, they appear to be very little used by food manufacturers and distributors. A general feeling was expressed that these models were unable to take into account the host of exceptional circumstances that can affect the route a vehicle takes. This confirms Sussams' observation that firms often regard the more sophisticated routeing algorithms as "abstruse and unrealistic" (Sussams, 1971, p26). The manufacturers in particular claimed that the computer packages could not cope with the variations in the pattern of delivery points from day to day. Several manufacturers contended that they were more suited to multiple retailers, whose pattern of delivery was much more stable. The managing director of one of the major supermarket chains has, nevertheless, declared that computerised vehicle scheduling is "wholly inappropriate to the food retailer" (Millar, 1983). One of the multiples in the sample had experimented with computerised route planning and obtained very disappointing results. The computer model in question had failed, after seven attempts, to improve upon manually planned routes. Many of the multiples' vehicles, however, make consolidated drops to only one or two shops per trip, making the routeing exercise elementary. A survey undertaken by the Institute of Grocery Distribution in 1979 found that of the firms in the grocery trade with a computer only 30% used it for vehicle scheduling (Robson, 1982). At the time of the survey, therefore, the vast majority of delivery routes were planned manually.

In recent years, however, numerous refinements have
been made to the main computerised routeing packages and there has been a general re-evaluation of the role of these packages in planning delivery routes. It has been admitted by agencies promoting this use of the computer, that many of the early packages were over-simplified and impractical, and that consequently "the results were disastrous and resulted in immense resistance to computerised vehicle scheduling for many years" (Jones, 1976). The shortcomings of these early packages have been thoroughly documented (Jones, 1976; Menzies, 1976; Mercer et al., 1978); some related to the generalized distance and travel time matrices upon which the calculations were based; others to the structure of the routes proposed. By being peripheral rather than radial and frequently intersecting, these routes conflicted with traditional routeing practices and were criticised for being more sensitive to delays and apparently wasteful. They also resulted in work loads becoming less evenly divided between drivers. The most serious complaint, however, concerned their inability to make allowance for special circumstances.

Many of these defects have been corrected in the new generation of computer routeing packages (Mercer et al., 1978), several of which can now be run on micro-computers. Being faster, easier and cheaper to use, these packages have become more suited to the planning of delivery routes on a day-to-day basis. It has also been recognised that these models should not replace, but complement, the route planner's judgment. As Robson (1982) points out, "it would be a somewhat dangerous, and rather naive, approach to simply program the mathematical equations into the computer and expect optimised answers to be produced". It has been suggested too that firms preferring not to use a computer package to redesign delivery routes daily can still profit from using computerised scheduling methods at longer intervals to draw up a general network of routes, around which actual routes can be planned manually to accommodate day to day variations in the pattern of demand (Mercer et al., 1978; Jones, 1976). As this scheme only optimises the general route structure at intervals of, say, several months, the extent to which actual routes diverge from the optimum will depend on the degree of variation in the
pattern of demand from day to day. The larger these variations, the greater will be the emphasis placed each day on manual route planning. If firms, therefore, are to take full advantage of the ability of the computer packages to optimise route schedules, it is desirable for them to minimize variations in the spatial pattern of demand.

The most effective way of minimizing these variations is by delivering to individual customers only on "specified days". A customer might then be informed that he could receive delivery only on a particular day of the week and that orders would have to be submitted a certain period (say, 4-5 working days) in advance of this delivery day. At present, it is common practice throughout the grocery trade for retailers' orders to be submitted at irregular intervals. As manufacturers then promise to deliver the goods within a certain number of days of the order being received (in accordance with their "service level"), the timing of the order will largely determine on which day of the week the delivery is made. Much of the day-to-day variation in the spatial distribution of delivery points therefore stems from customers submitting orders in an irregular and uncontrolled manner. In many cases, the irregularity of the inward flow of orders results from retailers postponing the replenishment of their stocks until supplies are almost exhausted, thereby minimizing the amount of stock they need to hold (Harvey, 1982). This, therefore, has the effect of transmitting fluctuations in the level of consumer demand back along the distribution channel and impairing the efficiency with which deliveries to shops can be organized. Furthermore, by holding small buffer stocks, the retailer increases the risk of running out of stock before the next delivery arrives, and thus losing sales.

By imposing more discipline on retailers' ordering habits and making service level guarantees conditional on orders being submitted a certain period in advance of the specified delivery day, manufacturers can exert much greater control over the distribution of points requiring delivery on any given day (Freight Transport Association, 1974). This produces a more stable framework within which vehicle
routes can be planned (Bowersox, 1978), and makes it possible for actual routes on particular days to adhere more closely to the network of optimal routes planned on a longer term basis by computer algorithm. By implementing a system of specified day deliveries, Cadbury-Schweppes were able to reduce the number of vehicle-kilometres per case by 9.3% (Mercer et al., 1978). In the case of a brewing firm, the adoption of a specified day delivery system coupled with computerised route scheduling yielded a reduction in vehicle-kilometres of 10% (Mercer et al., 1978). It is claimed that the vehicle scheduling packages currently available can reduce transport costs by between 10 and 50% (Robson, 1982), though the actual level of savings depends on the accuracy of the existing manual methods and the variability of the pattern of demand.

Despite these benefits, there is considerable resistance in the grocery trade to the use of computerised route scheduling and the implementation of a specified day delivery system. Much of the aversion to computerised route scheduling can be traced back to the failure of the early packages to live up to expectation. Some of it, however, reflects an unwillingness to rationalise the delivery operation in a way that would allow these packages to be applied more effectively, in particular by moving to a system of specified day delivery. Opposition to such a system comes mainly from marketing and sales staff who often argue that, by forcing customers to accept rigid timetabling of ordering and delivery, it weakens their company's competitive position and jeopardises sales. In many firms where marketing considerations dominate distribution planning, the fear of losing sales usually outweighs the desire to improve the efficiency of the delivery system. Research has shown, however, that retailers attach twice as much importance to the reliability of deliveries as to their speed (Christopher and Wills, 1974). By enhancing this reliability, the specified day system can improve the service the retail customer receives. Also, by lowering unit delivery costs, it can help firms to support a more extensive network of shop delivery than would otherwise be economically feasible. The fears of the sales staff can
also be partly allayed by the fact that firms, such as Cadbury-Schweppes, which have adopted such a system have been able to maintain or improve their position in highly competitive markets.

It seems likely, therefore, that the number of vehicle kilometres generated by the distribution of groceries to shops in multiple drop rounds could be significantly reduced by the wider adoption of the specified day system of delivery and more widespread application of computerised route scheduling. Further reductions in vehicle kilometres might be made possible at stage three of the routeing process by giving lorry drivers more guidance on their choice of roads. Studies have shown that a large proportion of the routes delivery drivers follow across the road network are unnecessarily circuitous (Hasell and Christie, 1978; Urquhart, 1976). As the number of drops per delivery declines and delivery patterns become more stable, it will become easier for firms to plan precise routes across the road network. This practice is also likely to be encouraged by the increasing availability of detailed computer models of the road network, such as Roadnet (Jones, 1976), and by the spread of lorry routeing restrictions. As much of the decision-making on the choice of route is currently devolved to the lorry driver, the actual pattern of vehicle movement on the road network would require more detailed investigation at the local scale than was possible during the course of this research.

**Implications for the Compilation and Analysis of Freight Statistics.**

Changes in the logistics of shop delivery also have important implications for the way in which freight statistics are compiled and the spatial pattern of freight flow is modelled. The compilation of these statistics and their subsequent analysis has always been complicated by multiple-drop rounds. Freight journeys of this type, known by the DTp as "intermediate journeys", constituted roughly 26% of all lorry movements in 1967/8. In the case of these journeys, it is difficult to decide which point on the delivery route to regard as the "destination", and
consequently how to calculate the average length of haul. In the 1962 Road Goods Survey the destination of "intermediate journeys" was taken to be the delivery (or collection) point most distant from the point of origin. It was then assumed that the entire load was unloaded (or picked up) at that point. This would have had the effect of increasing the average length of haul and distorted the observed pattern of freight flow. In analysing this pattern of flow, Heyman (1971) "hoped" that most of the intermediate journeys would be accommodated within individual traffic zones, thereby minimizing the effects of this distortion. Despite this arbitrary and unrealistic treatment of multiple drop rounds, Chisholm and O'Sullivan (1973) were able to obtain levels of explanation of 62% and 82% when they simulated the 1962 pattern of food movement using, respectively, gravity and linear programming models. These values were among the highest for all the commodity types examined and this Chisholm and O'Sullivan attributed to the fact that the movement of food is "characterised by short hauls and widespread sources and destinations". By comparison with other products, food has fairly dispersed patterns of production and stockholding and is sold through a large number of outlets. Since 1962, however, the spatial concentration of food production, stockholding and retail sales has considerably lengthened hauls and, as will be described in greater detail in chapter 11, reduced the number of "sources and destinations". This is likely to have significantly reduced the explanatory power of these models and if so, would raise more general questions about the practical value of freight traffic models whose accuracy is partly dependent on the spatial structure of the systems of production and distribution.

Since the 1962 survey, the DTp has refined its method of calculating the average length of haul for intermediate journeys. The DTp now uses one of nine formulae to calculate the ton-mileage of these journeys depending on the permutation of collections and deliveries en route. This calculation of ton-mileage, from which the average length of haul statistic is derived, takes account of the length of each section of the delivery round. Where the vehicle
makes fewer than five stops, a record is made of the distance between these stops. Where larger numbers of intermediate collections and deliveries are made, the lengths of the journey segments are simply averaged. While these methods of calculating average length of haul are superior to the former method, one of the most commonly used formulae, that relating to a conventional delivery round where loads are dropped off at several points en route, can be criticised on the grounds that the value it calculates for the average length of haul varies with the number of drops. This is illustrated by the simple example of a lorry making a round trip of 60 miles and delivering a total of 10 tons of supplies at varying numbers of points en route. As table 10.4 shows, when one applies the formula in question, the average length of haul increases as the number of drops diminishes. This formula will, therefore, have to some extent translated the reduction in the average number of drops per grocery delivery into an increase in average length of haul as calculated for the purposes of statistical accounting and traffic flow analysis.

It may be concluded, therefore, that neither the compilation of freight statistics nor the standard methods of freight flow analysis are sufficiently sensitive to changes in the logistics of shop delivery. This is particularly disturbing as this is an area of freight operations that has been undergoing major organizational changes and which is particularly intrusive in the life of the community.

Chapter 11 will try to relate the changes in the grocery distribution system outlined in this and previous chapters to some of the general trends apparent in official statistics on the movement of food.

Notes:
1. No data was collected on the logistics of wholesale deliveries.
2. This gives manufacturers similar control over the scheduling of retailers' orders to that which the central offices of supermarket chains exercise over their branch stores.
3. The statistics Chisholm and O'Sullivan employed included all types of food, not simply groceries.
Table 10.4: Average Length of Haul and Number of Drops per Delivery.

Formula applied where the vehicle leaves the base fully loaded, makes a series of deliveries and then returns empty to the starting point:

\[
TM = \frac{TD \times LM}{2 \left(1 + \frac{1}{ND + 1}\right)}
\]

where \(TM\) = ton mileage of the complete journey

\(TD\) = total weight delivered

\(LM\) = Loaded mileage

\(ND\) = No. of drops

Let \(TD = 10\) and \(LM = 60\), while varying ND:

<table>
<thead>
<tr>
<th>No. of Drops (ND)</th>
<th>Ton-Mileage (TM)</th>
<th>Average Length of Haul (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>314</td>
<td>31.4</td>
</tr>
<tr>
<td>15</td>
<td>319</td>
<td>31.9</td>
</tr>
<tr>
<td>10</td>
<td>327</td>
<td>32.7</td>
</tr>
<tr>
<td>5</td>
<td>350</td>
<td>35.0</td>
</tr>
</tbody>
</table>

Source: Dept. of Transport manual (unpublished).
Chapter 11

Recent Trends in the Movement of Food Products.

An attempt will be made in this chapter to relate some of the processes observed in previous chapters to recent trends in the main freight transport indices of tonnes lifted and tonne-kilometres moved. Unfortunately the commodity classification employed by the DTP does not allow one to isolate the group of grocery products that have been the subject of this study. As these products account for only 40% of total household expenditure on food (Notley, 1983), and as consideration has been given only to the movement of these products in finished state, it will not be possible to account for recent trends in the movement of all food products solely on the basis of the foregoing analysis. Nevertheless, there is some evidence to suggest that other sectors of the food trade have been experiencing changes similar to those occurring in the grocery distribution system. This, therefore, permits some generalization on the basis of earlier findings.

As only around 2% of the traffic of food, drink and tobacco products (measured in tonne-kms) is carried by modes other than road transport, the following discussion of trends in the movement of these products relates almost entirely to road transport.

The Weight Lifted:

Between 1962 and 1980, the weight of food transported fluctuated within a margin of 10%, but showed no obvious secular trend upwards or downwards (fig. 11.1). This variation may be explained with respect to three factors:

1. The total tonnage of food produced (or imported) and consumed (or exported) over this period.
2. The number of intermediate "lifting points" in the food supply system.
Figure 11.1: The Movement of Food, Drink and Tobacco Products (1962=100).


Average length of haul
Tonnes lifted
Tonnes-kms moved
Least can be said about the last of these since the Department of Transport does not qualify its statistical estimates with information on standard errors. It is thought, though, that the sample size (of 20,000 vehicles/annum making over 250,000 journeys/annum) is large enough to keep these errors within 2-3% in the case of the total volume of freight (DTp, private communication). Inevitably, the margin of error will be greater when this total is disaggregated by commodity type, but such inaccuracies are likely to be small relative to the variations in food tonnage carried. Attention therefore focuses on factors 1. and 2.

1. Food production and consumption.

Although the total expenditure on food (in real terms) has remained fairly stable since 1968 (IGD, 1982), there has been a gradual replacement of bulky staples by lighter processed and prepared foodstuffs (Halliday Assocs. Ltd.). This has produced a net reduction in the total weight of food consumed (table 11.1). These food consumption figures cannot be compared directly with the transported weight of food because in its calculation of "weight lifted" the Department of Transport includes the following: drink and tobacco, exports, packaging and containers and compound animal feedstuffs. In compiling figure 11.2, allowance has been made for these additional products. This graph relates the weight lifted to the weight of these products consumed. There is little evidence of a stable relationship between these variables. Clearly, therefore, variations in the weight of food, drink and tobacco lifted do not simply reflect variations in the actual weight of commodities consumed. The relationship between these two variables is likely to be strongly influenced by the spatial structure of the food supply system.

2. The Structure of the Food Supply System:

The above comparison revealed that the tonnes lifted figures far exceed the weights consumed. The ratio of the weight of goods lifted to the weight of goods consumed (or produced) was identified in chap. 2 as the "handling
Table 11.1: Total Weight of Food and Drink Consumed in Britain, 1968-80 (million tonnes):

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35.1</td>
<td>35.7</td>
<td>35.4</td>
<td>35.1</td>
<td>34.4</td>
<td>34.2</td>
<td>33.9</td>
<td>34.3</td>
<td>34.0</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture, Fisheries and Food "National Food Surveys".
Figure 11.2: Weight of Food, Drink and Tobacco Products Consumed and Weight Lifted onto Vehicles. (1962=100)
factor". A set of handling factors was calculated on the basis of the weight of food and drink products consumed in Britain or exported. Appendix 4 outlines how these handling factor values have been calculated. As shown on figure 11.3, the handling factor declined by about 11% between 1968 and 1974, but in 1975 it rose sharply. Since 1975, the handling factor has fluctuated around 5.2. This fluctuation casts some doubt on the existence of a secular trend, particularly over such a short time series. The Department of Transport's own calculations, however, suggest that handling factors have generally been declining, and it bases its freight traffic forecasts on an extrapolation of this downward trend (DTp, private communication). It is also possible that a decline in the handling factor is being masked by an increase in the weight of food and drink containers and packaging. The handling factor calculations done for this study make no allowance for changes in the weight of containers, such as churns, bottles and kegs, nor for the packaging of individual products. As there has been an increase in the amount of packaging (Corcoran et al., 1980; PIRA, 1980), this would add to the "weight consumed". For a given number of tonnes-lifted, an increase in the weight of packaging would reduce the value of the handling factor. In the absence of accurate estimates of increases in the weight of packaging, it is not possible to quantify this reduction.

If one accepts that the handling factor is declining, then the most probable explanation of this trend is that the number of nodes in the supply line has been decreasing. Broadly speaking, these nodes fall into two categories:

(i) nodes at which the physical form of the product is changed as a result of processing, preparation or packaging.
(ii) nodes at which the product is stored or transhipped between vehicles, but not physically altered.
Figure 11.3: Handling Factor for Food and Drink Products, 1962-80. (see Appendix 4 for method of calculation)
(i) **Production Points:** Food manufacturing has undergone a process of spatial concentration in recent years. In the present context, it is important to distinguish between two types of spatial concentration. The first involves the concentration of a single process (or set of related processes) in fewer factories. This might be called "horizontal concentration" as it centralizes one stage in the productive process (fig. 11.4). In contrast, the second type of concentration, which might be described as "vertical", assembles in a single location different stages in the productive process. Only "vertical concentration" would reduce the number of production points in the supply line and thereby affect the handling factor. A pre-requisite for concentration of this type would be the vertical integration of firms closely associated in the production of particular goods. Under common ownership, the various productive processes previously performed by different firms in different locations, might be brought together in large complexes. It appears, however, that only a small minority of mergers in the food industry have been of the "vertical" type (Parker, 1975). In this industry, high levels of vertical integration have been achieved by companies such as Ranks Hovis McDougall, Associated British Foods and Spillers French (Maunder, 1980). These companies are engaged both in primary processing and in the manufacture of consumer products. There is little evidence of "vertical concentration", however, in the recent experience of these firms. Although it was beyond the scope of this research to measure the degree of "vertical concentration" in the food industry, one may tentatively conclude, on the basis of available evidence, that the spatial concentration of food manufacturing has made little contribution to the decline in the handling factor.

(ii) **Stockholding and Transhipment Points:** Attention, therefore, focuses on the reduction in the number of intermediate stockholding and transhipment points. This reduction may be caused both by organizational changes in the "marketing channels" and by structural changes within the distribution systems of individual firms.
Figure 11.4: Horizontal and Vertical Concentration of Production.

Figure 11.5: Marketing Channels in the Fresh Fruit and Vegetable Trade (after Price Commission, 1974).

- Morrow Intervention in minority of cases.
- Channel increasing in importance.
- Channel declining in importance.
1. **Organizational changes**: These are changes that affect the number and nature of agencies engaged in the distribution of a product and the relationship between them. New marketing channels may develop that bypass one or more of these agencies, or, alternatively, the volume of business may be redistributed among existing channels. Often these organizational changes are manifest in a reshaping of the physical pattern of flow. There is clear evidence of this having happened in some sectors of the food industry, most notably that dealing with fresh fruit and vegetables (Price Commission, 1974).

The flow chart (fig. 11.5) illustrates the main marketing channels in the fresh fruit and vegetable trade. All these channels were in existence at the time when the Runciman Committee was investigating horticultural marketing in 1956. Since then, however, there has been a substantial shift of trade away from the secondary wholesaler and the independent retailer to the multiple green-grocer and, in particular, the supermarket chains (Duft, 1967; Barker, 1981). Flows along the more direct channels have grown at the expense of the less direct channels. In the 1970s, many large supermarket chains have become heavily involved in fruit and vegetable retailing. They generally buy produce in large amounts and deal direct with the grower. Supplies are delivered in bulk loads direct from the farm to the retailers' central warehouse, thus bypassing both the wholesaler's warehouse and the market (Wood Committee, 1983). Fresh fruit and vegetable markets have, therefore, suffered a serious loss of business. For instance, since opening in 1974, the New Covent Garden market at Nine Elms has been working well below capacity and is unlikely ever to recover more than a small part of its capital costs. As a result of organizational changes in the distribution of fresh fruit and vegetables, more of this produce in now channelled through fewer intervening nodes. This will have had the effect of reducing the handling factor.

The meat distribution system has been experiencing similar changes in recent years, but to a lesser extent (Webb, 1972; Price Commission, 1975a). So too has the
distribution of compound animal feedstuffs, with an increasing proportion of feed being delivered in bulk loads direct from the manufacturer and less being distributed in bags through the merchant (Price Commission, 1978d).

As explained in Chapter 4, the most significant organizational change in the grocery trade has been the growth of multiple retailing, principally at the expense of independent retailers and the wholesalers that supply them. This has not, however, resulted directly in a reduction in the number of nodes in the supply line, because the displacement of trade from independents to multiples has often merely diverted flows from wholesale warehouses to multiples' central warehouses. Nevertheless, in dealing direct with the manufacturer, the multiple creates conditions that are conducive to an increase in the amount of direct delivery. As this involves change within manufacturers' and retailers' logistical channels, it will be considered below under the heading of "structural changes".

2. Structural changes: These occur within the logistical system of a single firm and affect its use of intermediate depots. It is possible here only to comment on the distribution systems of the manufacturers and distributors of packaged groceries. The dominant changes within this sector in recent years have been as follows:

   a) Manufacturers distributing an increasing proportion of their output in bulk loads direct from factories to retail and wholesale customers, thus bypassing their own system of depots.

   b) Multiple retailers receiving an increasing proportion of the supplies for small and medium sized branch stores through their own warehouses.

   c) Multiple retailers developing large superstores that can receive supplies in bulk deliveries direct from the manufacturer. These supplies bypass the retailer's central warehouse.
These trends have resulted in a diversion of flows from channels 1, and 2 in figure 11.6 to channels 3, 4 and 5, and a general growth in the importance of channel 6. There are occasionally short-term shifts between channels 3 and 4, but these tend to balance out and, anyway, to not alter the total number of nodes in the supply line. On balance, this redistribution of flow between the various channels will have reduced the handling factor for groceries.

It would seem, therefore, that the reduction in the handling factor has been caused mainly by the decline in the use of intermediate nodes in the distribution system. It should be recognised, however, that these generalizations about the reduction in handling factors and the processes causing it may conceal important differences between the various sectors of the food industry. Reference to an average factor for food and drink overlooks the wide variation in the handling factors of different types of product. For example, the handling factors for some fruit and vegetable products is little more than one, as they tend to be transported direct from farm to shop. On the other hand, some cereals are subject to so many different stages of processing and distribution that they may have handling factors of over eight. The scale of the reduction in handling factors is also likely to have varied between product classes. It is also possible that some of the reduction in the average handling factor is the result of a change in the pattern of consumption away from products with large handling factors (e.g. canned vegetables) to products with lower ones (e.g. fresh vegetables). One is prevented, however, from analysing differences in the handling factors of particular product types by the system of freight classification employed by the Department of Transport. It offers no disaggregation, for example, of the large residual category, "other food, drink and tobacco", into which most grocery products fall. The calculation of disaggregated handling factors is further constrained by the incompatibility of the Department of Transport's scheme of food classification and that employed by the Ministry of Agriculture, Fisheries and Food in its surveys of food.
Manufacturers Distribution Depot.

Wholesale Warehouse.

Retail Central Warehouse.

Figure 11.6: Channels of Distribution.
production and consumption. These official statistics offer little insight, therefore, into the structure of the distribution systems of particular product classes and the way in which these systems are evolving.

The Amount of Freight Movement:

Unlike the weight of food "lifted", the volume of food movement (measured in tonne-kilometres) has increased steadily since 1962 (fig. 11.1). As the latter measure is the product of the weight lifted and the distance moved, the divergence of the two trends must have resulted from a lengthening of hauls. Between 1968 and 1981, the average distance travelled by food, drink and tobacco products increased by 69% from 54.1 kms to 91.6 kms (DTp, 1982). Several possible explanations may be offered for this lengthening of hauls (fig. 11.7):

1. Expansion of the market area: (fig. 11.7a) If the location of the production remains fixed but the area supplied expands, the average distance goods travel to customers will increase. In penetrating new areas a firm may either generate new sales there or displace sales from existing local suppliers. Consumers may substitute goods transported over long distances from large producers for locally produced items.

While there has been a great deal of geographical research on the trade areas of retail outlets, very little work has been done on producers' market areas (Watts, 1975). Most producers are understandably reluctant to reveal information about their pattern of sales.

Most of the large food manufacturers in the UK were marketing their products nationally by 1939. It is unlikely, therefore, that much of the increase in the average length of haul can be attributed to the expansion of the market areas of the main producers of packaged groceries. There have, nevertheless, been some instances of food and drink manufacturers extending their market areas over the period in question:
Figure 11.7:
SPATIAL PROCESSES CONTRIBUTING TO AN AVERAGE LENGTHENING OF HAULS

- a. Expansion of market area
- b. Redistribution of sales within market area
- c. Relocation of production away from main concentration of demand
- d. Concentration of production stockholding and sales
- e. Relocation of intermediate nodes away from direct route
- f. Elimination of intermediate nodes

- Market area boundary
- Declining sales density

- Factory
- Intermediate node (for processing, storage and/or break-of-bulk)
- Retail outlet
(i) The larger brewers (Corcoran et al., 1980) and a major manufacturer of crisps and snacks (Walkers) have considerably widened the areas to which they distribute their products.

(ii) The rapid growth of multiple retailing and the increased involvement of the multiples in the distribution of goods to their shops has made it easier for small producers to gain access to a wider market. It is no longer necessary for a producer to establish a costly system of shop delivery to ensure wide market coverage. Goods trunked to a multiple's central warehouse(s) can be distributed by the retailer to branch stores throughout the country. Indeed, some multiples partly justify operating central warehouses on the grounds that this enables them to expand their ranges by acquiring the products of suppliers, often on an own-label basis, that are too small to provide direct delivery to branch stores. This also helps them reduce their dependence on larger suppliers and thereby strengthen their bargaining position vis-à-vis these firms. The opportunity of delivering bulk loads direct to retail central warehouses has been a particularly important factor in the growth of many producers of frozen foods.

2. Redistribution of sales within the market area: (fig. 11.7b) Within a market area of given extent, sales of a firm's products may be redistributed away from the point of supply, perhaps as a result of changes in tastes or income levels in different parts of the country or spatial variations in the demand for new product lines or in the strength of competition. This would tend to increase the average length of haul within a given market area. It is virtually impossible, given the confidentiality of sales data, to examine changes in the pattern of firms' sales. It seems unlikely, however, that there will have been any significant net redistribution of sales away from the main concentrations of population and production.
3. Relocation of production away from the main concentrations of demand: (fig. 11.7c) The relocation of a factory to a point more distant from the weighted centre of its market area will also increase the average distance travelled by each unit of output. Such relocation has been encouraged by Government regional policy (DTp, 1979). Since 1972, the food, drink and tobacco industries have received roughly 10% (by value) of regional development grants (Dept. of Industry, 1982), a proportion in line with their share of total manufacturing employment (Annual Abstract of Statistics, 1983). In its evidence to the Armitage Inquiry, the Freight Transport Association (1979) identified regional development as an important factor in the lengthening of lorry journeys and it suggested that the costs associated with this additional lorry movement should be set against the benefits of regional development. The Association cites the example of Carrington-Viyella, which closed a shirt factory in London and, in response to regional policy incentives, transferred production to a new factory in Londonderry. No similar examples were encountered of firms in the food industry relocating their production in this way. There were instances, however, of firms setting up branch plants in assisted areas which complemented rather than replaced existing factories (Watts, 1982). The Kellogg factory in Wrexham and Kraft factory at Haverford West are examples of branch plants attracted to assisted areas by regional policy measures. The effect of the establishment of a branch plant on average length of haul depends on the nature of its production. If it produces similar goods to those of the parent factory, then it can distribute these goods to the surrounding area at closer range than the parent factory. The resulting division of the market area between the factories would have the effect of reducing the average length of haul. Where different products are manufactured at the branch plant and from there distributed nationally, the peripheral location of this plant relative to the main concentration of demand will cause delivery distances to be greater than they would have been had the firm merely expanded on its original, more centrally located site. The opening of the branch plant in a peripheral area
can also lengthen the firm's supply linkages. As little information was collected during the course of this research on the spatial organization of food processing, it is not possible here to assess the extent to which a redistribution of manufacturing capacity in the food industry has contributed to a lengthening of freight hauls.

4. Spatial concentration of production, storage and retail sales: (fig. 11.7d) Where a firm reduces the number of points from which it serves its market area, the average distance between supply points and customers will increase. This is usually considered to be the main reason for the lengthening of hauls. The 1976 Consultative Document on Transport Policy identified the "growing concentration of industry" as "probably the chief contributor" to the increase in the average length of haul (DTp, 1976, p16). It observed that "there has been a trend away from local factories supplying the local markets towards fewer, larger factories supplying the whole country." Corcoran et al (1980) and the Armitage Report acknowledge that the spatial concentration of stockholding has also played an important part in this process. Also, as outlined in chapter 10, the concentration of grocery sales in larger retail outlets has been accompanied by changes in the logistics of shop delivery that have resulted in an average lengthening of hauls. Overall, it has become conventional wisdom to attribute the lengthening of freight journeys to the spatial concentration of economic activity, often to the exclusion of other possible factors.

Concentration of production.

Census of Production figures show that between 1958 and 1978, the number of food manufacturing establishments fell by 26% (from 9390 to 6937). Using the number of employees as a measure of establishment size, it appears that the overall reduction in the number of plants is the result of a redistribution of production from small units to large (fig. 11.8). The degree to which production has been concentrated has varied widely amongst different sections of the food, drink and tobacco industry. A high degree of
Figure II.8: Changing Size Distribution of Food Manufacturing Establishments, 1958-78.
(Source: Census of Production, 1958 and 1978)
concentration has occurred in the brewing industry. Although beer production increased by roughly 50% between 1958 and 1973, the number of breweries decreased over this period by 67%. It has been estimated that this centralization in the brewing industry increased the distance travelled by the average unit of beer by a factor of between two and three (GLC, 1978).

The correlation between the concentration of production and the average length of haul cannot be tested statistically for disaggregated product groups as the Census of Production and Department of Transport employ different systems of commodity classification.

The concentration of production most likely to increase the length of haul would be that of the "horizontal" type, where similar processes are assembled in fewer locations and undertaken on a larger scale. This type of concentration has been promoted in the 1960s and 1970s by the numerous mergers of food manufacturers (Maunder, 1980). Between 1969 and 1973, for example there were approximately 100 such mergers (Development Analysts Ltd., 1975) It was a common occurrence for mergers to be followed by a rationalization of production in fewer, larger plants. This merger activity and subsequent restructuring has helped to concentrate a high proportion of the total production of some types of food in a few firms and a relatively small number of factories. Using Census of Production figures, it is possible to measure the extent to which production has become concentrated in the plants of the five largest manufacturers in the various sectors of the food, drink and tobacco industry. This can be expressed as a concentration index:

\[
\text{Concentration Index} = \frac{\text{Proportion of establishments operated by the five largest producers}}{\text{Proportion of net output produced by the five largest producers}}
\]

Table 11.2 presents concentration indices for the main classes of food product in 1970 and 1978. A reduction in this index indicates an increase in the proportion of net
Table 11.2: Concentration Indices for the Manufacture of Food, Drink and Tobacco Products.

<table>
<thead>
<tr>
<th>Product</th>
<th>1970</th>
<th>1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain Milling</td>
<td>0.187</td>
<td>0.192</td>
</tr>
<tr>
<td>Bread and Flour</td>
<td>0.339</td>
<td>0.165</td>
</tr>
<tr>
<td>Confectionery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biscuits</td>
<td>0.270</td>
<td>0.221</td>
</tr>
<tr>
<td>Bacon-curing etc.</td>
<td>0.121</td>
<td>0.080</td>
</tr>
<tr>
<td>Milk and Milk Products</td>
<td>0.372</td>
<td>0.194</td>
</tr>
<tr>
<td>Sugar</td>
<td>0.704</td>
<td>0.643</td>
</tr>
<tr>
<td>Cocoa, Chocolate and Sugar Confectionery</td>
<td>0.095</td>
<td>0.037</td>
</tr>
<tr>
<td>Fruit and Vegetable Products</td>
<td>0.148</td>
<td>0.094</td>
</tr>
<tr>
<td>Animal and Poultry Products</td>
<td>0.155</td>
<td>0.189</td>
</tr>
<tr>
<td>Vegetable and Animal Oil</td>
<td>0.200</td>
<td>0.343</td>
</tr>
<tr>
<td>Margarine</td>
<td>0.351</td>
<td>0.316</td>
</tr>
<tr>
<td>Starch and Misc. Foodstuffs</td>
<td>0.165</td>
<td>0.130</td>
</tr>
<tr>
<td>Brewing and Malting</td>
<td>0.225</td>
<td>0.307</td>
</tr>
<tr>
<td>Soft Drinks</td>
<td>0.176</td>
<td>0.129</td>
</tr>
<tr>
<td>Spirits and Distilling</td>
<td>0.350</td>
<td>0.409</td>
</tr>
<tr>
<td>British Wine and Perry</td>
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<td>0.253</td>
</tr>
<tr>
<td>Tobacco</td>
<td>0.517</td>
<td>0.587</td>
</tr>
</tbody>
</table>

Sources: Censuses of Production 1970 and 1978.
output concentrated in the factories of the five largest producers. Although the share held by these companies may have become more concentrated in fewer factories, these firms' share of total net output could have declined, in which case production need not have become more concentrated for the industry as a whole. In only six of the seventeen sectors, however, did the top five firms' share diminish. Eleven out of the seventeen sectors recorded a decline in the concentration index. The decline was most marked in the case of the processing of foods for final consumption.

It is generally agreed that the principal reason for this concentration of production has been the desire by food manufacturers to obtain greater economies of scale. Little empirical work has been done, however, on the nature and extent of these scale economies (Maunder, 1980).

Concentration of Stockholding.

Although official statistics exist on the distribution of warehouse space and stock levels within the economy, these do not allow one to monitor the spatial concentration of stockholding. Data compiled in the course of this research, however, has shown that within the grocery sector, stockholding has become much more concentrated (table 7.2), partly as a result of trade shifting towards distributive agencies that typically operate more centralized storage systems and partly because there has been a strong tendency for producers and distributors to concentrate stockholding within their individual storage systems. Several factors have promoted this process of spatial concentration.

1) **Desire to reduce the total amount of stock held, thereby releasing working capital:** This has been greatly strengthened in the 1970s by the high level of interest rates coupled with frequent liquidity crises. In the 1970s interest rates have become increasingly volatile (fig. 11.9) and on several occasions have soared to levels more than double the prevailing levels of the 1960s. As the financial cost of stockholding is closely related to interest rates, this has exerted a strong pressure on firms to minimise their stockholding. Much short-term destocking
Figure 11.9: Variations in Interest Rates, 1966-81.
(source: Central Statistical Office "Abstract of Statistics".)
in times of economic crises, such as the sharp reduction in the stock of food, drink and tobacco products in 1975, involves the depletion of stocks within existing premises. High and fluctuating interest rates also encourage a long-term reduction in stock levels, such as can be achieved by concentrating stock in fewer locations.

ii) Economies of scale in storage: As explained in Chap. 7, the unit costs of storage diminish as warehouse size increases (Powell, 1976; Williams, 1975). Advances in the methods of warehouse construction and the development of improved handling and stock control systems have been augmenting these scale economies (Thorne, 1977; Rudd, 1979).

These changes have produced a realignment of the stockholding/storage curve shown on figure 7.2, tilting it upwards and to the left. Had the transport cost curve remained unchanged, this realignment of the stockholding/storage curve alone would have increased the optimum degree of stock concentration. Improvements in the transport system (to roads, vehicles and handling methods) have, however, reinforced this tendency. By increasing the distance that can be travelled in the "driving day", they have relaxed the logistical constraint that limits the size of area a depot can efficiently serve and hence the degree of stock concentration. In economic terms, they have reduced the unit cost of transport and thereby lessened the transport cost penalty resulting from the concentration of stock. These transport improvements have had the effect of displacing the transport cost curve downward and reducing its slope. This has also affected the trade-off between the two cost elements, further reducing the optimum number of depots.

It is likely that the optimum number of production facilities has also been reduced by a similar set of forces. The optimum patterns of production and stockholding have therefore become more spatially concentrated. Although these more concentrated patterns generate a greater volume of freight movement, the real cost of transport per unit has
fallen to a level at which the cost of this additional movement is more than offset by scale economies in the two activities. The savings accruing from transport improvements have not been directly deducted from the total transport bill. They have instead been largely internalised in more efficient patterns of production and stockholding. As the Freight Transport Association (1979) has stated, "more freight movement, and greater expenditure on freight has been the price of achieving greater overall economies in the total industrial process, with the objective of meeting consumer demand at minimum overall cost" (p9). Between 1963 and 1968, for example, food manufacturers' transport costs per tonne-kilometre fell (in real terms) by about 12% (Censuses of Production, 1963 and 1968). This cost reduction more than offset the 9% increase in the average length of haul over this period. Transport costs, nevertheless, rose as a proportion of net output over this period in ten of the seventeen classes of food, drink and tobacco products (fig. 11.10). Only in the case of fruit and vegetable products did it fall by a significant margin.

It is also important to examine the structure of these freight transport costs. The costs have a "terminal" component, which is fixed for each journey and a "movement" component which varies with distance. As only the latter increases with distance, total transport costs taper as journey length increases (Chisholm, 1971). Table 11.3 expresses terminal costs as a % of total road transport costs for six classes of food product over the average distances they are moved. In every case terminal costs constitute more than half the total transport costs, and for the residual category of "other foods including fats and oils", which contains most processed foods, they represent over 70%. Table 11.4 shows how the costs of transporting the six classes of food over distances 25% greater than their average length of haul would increase by much less than 25%; in fact, by only 7.4% in the case of the "other foods" category. It is possible too that transport improvements may have reduced movement costs more than terminal costs and produced an even greater tapering of the
Figure 11.10: Transport Cost: Net Output Ratio for Food, Drink and Tobacco Products, 1963 and 1968.
(source: Census of Production.)

Transport Cost as a % of Net Output in 1968

Transport Cost as a % of Net Output in 1963

1. British Wines and Ciders
2. Bread and Flour Confectionery
3. Fruit and Vegetable Products
Table 11.3: Relative Size of Terminal Costs for Six Classes of Food Product (1966-8):

<table>
<thead>
<tr>
<th>Product Class</th>
<th>Average Length of Haul (ALH) (kms)</th>
<th>Terminal Costs as a % of Total Transport Costs (at ALH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>64.8</td>
<td>53%</td>
</tr>
<tr>
<td>Animal Feeding Stuffs</td>
<td>60.3</td>
<td>61%</td>
</tr>
<tr>
<td>Beverages</td>
<td>55.7</td>
<td>62%</td>
</tr>
<tr>
<td>Flour</td>
<td>81.8</td>
<td>69%</td>
</tr>
<tr>
<td>Fresh Fruit and Vegetables</td>
<td>48.5</td>
<td>69%</td>
</tr>
<tr>
<td>Other Foods (*)</td>
<td>55.2</td>
<td>71%</td>
</tr>
</tbody>
</table>

(*) incl. oils, fats and tabacco, excl. meat, fish, poultry, dairy produce and eggs.


Table 11.4: Effect on Transport Costs of a 25% Increase in Average Length of Haul.

<table>
<thead>
<tr>
<th>Product Class</th>
<th>% Change in Total Transport Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>+11.2</td>
</tr>
<tr>
<td>Fresh Fruit and Vegetables</td>
<td>+7.8</td>
</tr>
<tr>
<td>Beverages</td>
<td>+9.6</td>
</tr>
<tr>
<td>Flour</td>
<td>+7.9</td>
</tr>
<tr>
<td>Animal Feeding Stuffs</td>
<td>+9.7</td>
</tr>
<tr>
<td>Other Foods (*)</td>
<td>+7.4</td>
</tr>
</tbody>
</table>

(*) see corresponding note for Table 11.3
total transport cost curve. Distance has, therefore, had a comparatively small and diminishing part to play in determining total transport costs. This may further help to explain the apparent willingness of manufacturers and distributors to rearrange their production and stockholding into spatial patterns that require freight movements over longer distances.

Furthermore, as terminal costs represent a large proportion of the total cost of transporting food products, this gives their producers and distributors a strong incentive to minimise the number of nodes through which they pass and thereby exerts a downward pressure on their handling factor. Savings in terminal costs are also a valuable supplement to the other benefits accruing from the concentration of production and stockholding in fewer, larger premises.

Concentration of Retail Sales

The relationship between the spatial concentration of grocery retailing and the lengthening of freight journeys is less direct, but still worth noting. Between 1971 and 1981, the total number of grocery stores declined by 41%, while the volume of grocery sales increased slightly (Institute of Grocery Distribution, 1982). The closure of large numbers of smaller shops has been accompanied by the opening of numerous large supermarkets and superstores. It has been estimated that, as a result of these changes, the average size of supermarket increased by 50% between 1977 and 1981 (Harvey, 1982). The main effect of this spatial concentration has been to increase the average distance the consumer must transport the groceries he/she purchases, thereby generating additional "freight movement" by vehicles used principally for personal travel, which is not reflected in official transport statistics. As it is estimated that the average family of four takes home roughly 50 kg of food per week (Dawson, 1983), even marginal increases in the length of shopping trips can generate considerable amounts of this "latent" freight movement by personal modes of transport.

The spatial concentration of retail grocery sales has
promoted an increase in the average length of haul in three ways. First, as the turnover of retail outlets has risen, it has been possible to deliver supplies in larger loads, especially where these loads are consolidated at the warehouses of multiple retailers, wholesalers or distribution contractors. These larger loads can be distributed more economically over longer distances, permitting a greater concentration of stockholding higher up the logistical channel. Second, since larger stores can receive supplies in greater bulk, it has been possible to supply them more directly, thereby reducing the need for products to be channelled through intermediate nodes. As will be discussed in more detail in 6. below, the elimination of an intermediate node in a logistical channel can lengthen the freight journey. Third, as was explained in Chapter 10, the DTp's main formula for calculating the average length of haul for multiple drop rounds translates the reduction in the number of drops per delivery, that has accompanied the spatial concentration of grocery retailing, into an increase in average journey length. This increase is the result of a statistical anomaly. It does, however, highlight the arbitrary nature of the method of calculating the average length of haul, and hence tonne-kilometres, of multiple-drop journeys and the failure of the current method to reflect accurately the shift to more direct journeys with fewer drops.

5. Relocation of intermediate storage points: (fig. 11.7e)
Where goods are transported via intermediate nodes more distant from the direct route, this will have the effect of increasing average journey lengths. This can be the result of shifts between marketing and logistical channels. The redirection of flow from manufacturers' depots to retail central warehouses is likely to have increased the average distance from stockholding point to shop (as demonstrated earlier (p.316)). The displacement of trade from local wholesale depots to more centralized retail warehouses can have a similar effect. This relocation of the intermediate stockholding point is often closely associated with the spatial concentration of stockholding, discussed more fully under 6.
6. Elimination of intermediate nodes in the supply line: (fig. 11.7f)

This has resulted primarily from the redirection of flows away from channels containing two intermediate nodes (1 and 2 on fig. 11.6) towards more direct channels, and the growing importance of channel 6 in the bulk distribution of supplies to superstores and hypermarkets.

The extent to which average length of haul is increased by the elimination of an intervening node (B) depends on its location relative to the direct through-route from factory (A) to shop (C) (fig. 11.7f). The closer this node (B) lies to the direct route the greater will be the increase in average journey length. This leads to the rather odd situation where, if the node actually lies on the direct route from factory to shop, its elimination results in a doubling of average journey length, despite the fact that the total distance travelled remains the same. This highlights the danger of considering average journey lengths independently of the number of separate journeys a consignment makes in the course of its movement from factory to shop. Both these variables influence the relationship between the total amount of freight movement measured in tonne-kilometres and the total volume of goods consumed (or produced). This relationship may be defined as follows:

\[
\text{Total Freight Movement} = \frac{\text{volume of goods produced or consumed}}{\text{handling factor} \times \text{length of haul}}
\]

It was established earlier that the total weight of food and drink consumed changed little during the 1970s. Between 1968 and 1980 this weight increased by roughly 7% whereas the total amount of freight movement by these commodity classes rose by 31% (table 11.5). The net decline in the handling factor of about 16% between 1968 and 1980 would, on its own, have had the effect of reducing the total volume of freight movement. This reduction in the number of journeys per consignment has been far exceeded by the increase of 40% in their average length. The rapid
Table 11.5: Estimated Changes in Critical Variables, 1968-80.
(Food and Drink Products)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Movement (tonne-kms)</td>
<td>+31%</td>
</tr>
<tr>
<td>Total Amount Consumed and Exported (tonnes)</td>
<td>+7%</td>
</tr>
<tr>
<td>Handling Factor</td>
<td>-16%</td>
</tr>
<tr>
<td>Average Length of Haul (kms)</td>
<td>+40%</td>
</tr>
</tbody>
</table>

Sources: DTP "Transport Statistics: Great Britain."
Min. of Agric. Fish. and Food. "National Food Surveys."
increase in the total volume of freight movement by food and drink products suggests, therefore, that the increase in the average length of haul is not simply a result of goods bypassing intermediate nodes and travelling more directly from points of production to points of sale. The other factors listed above are clearly responsible for much of this increase.

**Summary**

It was argued in the introduction to this thesis that variations in general freight statistics can only be explained by examining the spatial structure of the production and distribution systems. This chapter has used information about the system of grocery supply to try to account for recent trends in the movement of food products. It has focused attention on two parameters that have a critical role in determining the relationship between the volume of consumption and the volume of freight movement, and which are key variables in the DTp's new freight forecasting model. These are the handling factor and the average length of haul.

Although fluctuating quite widely, the handling factor appears to have followed a downward trend, while the average length of haul has increased sharply. As the increase in the average length of haul has considerably exceeded the decline in the handling factor, the total number of tonne-kilometres has risen substantially, despite the fact that the volume of food consumed has remained fairly stable. Both the handling factor and the average length of haul are affected by changes in the spatial organization of production and distribution. The dominant spatial change in recent years has been the concentration of production, storage and retail sales. This has been caused by individual firms concentrating their activities, by mergers between firms at all levels of the distributive system and by the displacement of grocery flows towards logistical channels characterised by a high degree of spatial concentration in production, stockholding and retailing. Contrary to popular belief, however, concentration is not the only spatial process to have produced an average
lengthening of hauls. The extension of market areas, relocation of premises and redirection of flows are also likely to have increased average journey length.

To assess the overall impact of these spatial processes on the ratio of tonne-kilometres to the tonnes produced/consumed one must examine their effects on the complete route from point of production to point of sale. When one takes this broader view, it appears that as deliveries have become more direct, successive nodes in the distributive channel have become more widely separated, giving rise to a net increase in the volume of freight movement.

Notes:

1. Statistics refer to weight lifted onto vehicles.

2. This transport cost data was only made available in the 1963 and 1968 Censuses of Production.

3. Mohring and Williamson (1969) have called the savings in transport costs that result from a transport improvement "direct benefits" and those translated into more efficient patterns of production and distribution "re-organization benefits". They have undertaken a graphical analysis of the way in which a transport improvement yields these two types of benefit. They have also devised a model to estimate the size of these benefits and employed it to measure what the effect of a 25% reduction in unit transport costs would have been on American industry in 1947. It was estimated that 11.3% of the total cost saving would have taken the form of re-organization benefits, the remainder (88.7%) being expressed as direct benefits. No similar analysis has been undertaken of the effect of transport improvements on the British space economy. Such an analysis would require much more data on transport costs and the spatial organization of production and distribution than is currently available.
Chapter 12

Conclusion

Geographical studies of the pattern of freight movement have made little headway in recent years. An impasse has been reached in the development of models to simulate and forecast the spatial distribution of freight traffic (Hay, 1979). Forecasts of the aggregate volume of freight movement have been criticised on the grounds that they merely extrapolate past trends and are not based upon an understanding of the economic processes that generate this movement. It has also been recognised that the official transport statistics used in freight modelling exercises are "an inadequate measure of changes in the structure of a commodity movement system" (Lee and Lalwani, 1978). In an effort to shed more light on the system of grocery movement, this research has adopted a new approach to the study of freight flows. This has involved a detailed examination of the framework of marketing and physical distribution within which freight transport is organized, and concentrated attention on the routeing of consignments through the distributive system. This chapter will discuss the advantages and limitations of this approach, summarise the main research findings and consider the implications of this work for the way in which freight traffic is forecast and regulated.

Assessment of the Approach

The main benefits of this approach are clearly that it enables one to explore in much greater depth the reasons for a consignment following a particular route from factory to shop, and to see the transport operation in a much wider perspective. The distinction must be made, however, between the pursuit of explanation and the construction of operational models that may be used for forecasting and optimising. To date, the bulk of the research undertaken on the spatial distribution of freight flows has been dedicated to the development of accurate "black box" models based on inter-zonal flow data. As discussed in chapter 2, the
results of this work have been disappointing, largely, it would seem, because of its failure to take account of the complexity of the distributive system. An alternative approach might, therefore, be to model the pattern of flow quite explicitly with respect to the distributive system. This would entail "decomposing" this system into its various elements, such as the allocation of flows between marketing channels, the location of depots, the logistics of bulk movements and the routeing of delivery vehicles (Stasch, 1968). Once each of these elements had been modelled satisfactorily, they might be integrated into a composite spatial model of product flow through a distribution system. Though in theory quite an attractive proposition, an exercise of this type would encounter serious practical problems:

i) Most of the component models currently available are optimising models, that take no account of sub-optimal behaviour. It might be possible to incorporate a random element into these models to permit deviation from the optima, as has been done in the case of the linear programming version of conventional freight flow analysis (Pitfield, 1978b). This, however, would be a poor substitute for an understanding of the reasons for actual practices diverging from the optimum. It should also be noted that most of the optimising models currently used in distribution planning define optimality narrowly in terms of simple, commercial criteria.

ii) Attempts to develop models that were both positive and generalised would prove very difficult, given the great variety of distribution methods revealed by this research. Even within a single trade, such as that of packaged groceries, there can be marked differences in the way firms organise their distribution, as indicated by wide variations in such criteria as a) the proportion of a manufacturer's output delivered direct from the factory, b) the number of distribution depots a manufacturer operates, c) the extent to which it mixes bulk stocks, d) the nature of the supply arrangement between manufacturer and multiple retailer,
iii) Even if it were possible to develop models capable of simulating the various aspects of the distribution system, integrating these models would prove a formidable task. At present the links between marketing models and models of physical distribution are very poorly developed (Bartels, 1976). Schary (1970) has devised a comprehensive model of a physical distribution system, but this has not been operationalized, nor does it give adequate consideration to the spatial dimension.

iv) Such an integrated model of the distributive system would not relate directly to the pattern of freight flow. Rather, it would define a framework within which inferences could be made about the pattern of flow. It would be difficult, however, to estimate the volumes of flow passing along particular linkages in the system, especially in its lower reaches. Most firms are very unwilling to provide information on the internal flow of their products between their own premises and even more so in the case of external flows to customers. Attempts to estimate flow volumes on the basis of population data would be frustrated partly by spatial variations in consumption levels, but mainly by the complex pattern of overlapping service and trade areas which makes it possible for a consumer to receive supplies along several different routes.

Given these problems, it would be extremely difficult to construct an operational model of a distribution system, such as that of grocery products, that could accurately simulate the spatial pattern of freight flow. It would be easier in monopolistic or oligopolistic industries, in which there would be less variation in distribution method and more control exerted over the distribution system by the manufacturer. The experience of the Commodity Flow Study teams in attempting to model the flows of industries of this type is not encouraging, however (Pike and Gandham, 1981).

The failure of this approach to yield operational flow
models comparable to those of the traditional method of flow analysis does not invalidate its use. It can still offer a valuable insight into the workings of the freight transport system and thereby complement more superficial, statistical modelling. Although providing no direct quantitative input into freight forecasting models, research of this kind can allow forecasters to move away from blind extrapolation towards more reasoned speculation based on a detailed understanding of the dominant trends in the distribution system. This is particularly important in an industrial sector such as that of food, where total volume produced and consumed is fairly static and the growth in freight traffic attributable mainly to logistical changes. Only by examining the logistics of freight distribution can one establish the link between industrial output (or GDP) and tonne-kilometres. The freight forecasting model currently used by the DTP defines this link by means of two parameters, the handling factor and the average length of haul, both of which are largely determined by the spatial structure of the distributive system. If, as a result of a closer examination of the geography of the distribution process, these parameters could be predicted more accurately, the reliability and credibility of freight forecasting could be enhanced.

It has also been suggested that the link between industrial output and the volume of freight movement should be investigated with a view to finding ways of severing it (Civic Trust, 1979). This suggestion is based on the view that "it should be an object of policy to stabilise or reduce the movement of freight by road and that the forecast increases should be regarded as a warning of something to be avoided rather than something to be fulfilled" (Haigh and Hand, 1982). One major way of containing the growth of road freight is to alter the relationship between the volume of material consumption (or production) and that of traffic flow. Environmentalists have recently seized upon the fact that the relationship between these two variables is "elastic" (Quinet et al., 1982). This enables them to counter the argument frequently advanced in defence of present levels of lorry traffic, that these levels could
only be significantly reduced by scaling down the level of industrial activity (Pettit, 1973; Sharp, 1973). It would be possible to reduce the amount of freight traffic, while maintaining present levels of production and consumption by reorganizing the marketing and distribution of goods (Freight Management, 1975). While some of the ways in which this could be achieved, such as dividing market areas between competing manufacturers, would infringe trading laws and prove impractical (Sharp and Jennings, 1976), others, such as the rationalization of product ranges, improved coordination of the sales effort with distribution and increased consolidation of deliveries, are much more acceptable and have, in fact, been shown to yield significant economic benefits. The problem lies in deciding how best to promote rationalizations of this sort.

In the 1970s, various methods of controlling the movements of heavy vehicles were proposed, at central and local government levels, and some of these, such as lorry routeing and access restrictions, were widely implemented. In most cases, these proposals met with fierce opposition from firms using these vehicles, and local planners were frequently criticised for formulating policies on heavy lorries on the basis of a very limited knowledge of distribution methods (Smith, 1976). In the case of planning at central government level, the Armitage Report (1980) concluded that "the instruments available to the state are too blunt adequately to control the total quantity of freight transport, and, in economic terms, it is unlikely to do better in determining the "right" amount and kind of freight transport than the market does" (p49). In the absence of such controls, the most promising methods of arresting or reversing the growth of freight traffic are those which yield economic as well as environmental benefits, and thereby can command wide support from lorry users. As outlined in chapter 10, there has been a large increase in the consolidation of shop deliveries, which, ceteris paribus can reduce the amount of vehicle and freight movement per unit delivered and carry a host of other operational benefits. Consolidation is only one of several methods that might be used to reduce the internal and
external costs of freight movement. Surveys have revealed that the efficiency of firms' distribution systems can vary widely; so too can their environment impact. Some systems are clearly more transport-intensive than others, generating more vehicle movement per unit produced (or sold) than others. Plowden (1981) has devised a simple measure of vehicle utilization which could be used as an index of the transport-intensity of a distribution system:

\[
\text{Index} = \frac{\text{vehicle kilometres performed}}{\text{irreducible tonne-kms required}}
\]

While it might be possible to calculate this index for a single firm's distribution operation, using various optimising models to estimate the denominator, it would be very difficult to apply in practice to the complete through-movement of products from factory to shop. It could not, therefore, allow for the possibility that separately optimised systems, each minimising tonne-kilometres, might not, when linked together, yield a minimum number of tonne-kms in toto. The idea behind this proposed measurement is, nevertheless, a good one, for it recognises the need to standardise the comparison of distribution systems. Several comparisons have already been made of the costs of firms' distribution operations (Williams, 1975; McKibbin, 1982a). The present research has attempted to compare the spatial structure of distribution systems. By comparing systems in this way it may be possible to identify those that are most cost-effective and/or least damaging to the environment. As it is unlikely that the internal and external costs of a distribution system can be minimised simultaneously, some optimum trade-off between these cost elements will have to be established. This will involve making difficult environmental and economic choices, such as that between few, large lorries and numerous, smaller ones.

Improved methods of organizing marketing and distribution might then be more widely publicised, citing the experience of firms that already successfully employ them. It would be hoped then that other firms would follow
their example. A precedent for such convergence on an optimum practice has been set in the case of depot location, where a consensus has developed, certainly among food manufacturers, on the ideal locations from which to distribute one's products. Furthermore, the present diversity of distribution methods, even within highly competitive sectors of the grocery market, suggests that firms might be able to alter their distribution systems quite radically without jeopardising their market share.

It would seem preferable to encourage the rationalization of whole distribution systems, either of individual firms or of "chains" of firms linked in a marketing channel. Suggestions that distribution systems be reorganized at the urban scale (Plowden, 1981) may be challenged on the grounds that changes introduced in one area may have detrimental knock-on effects in neighbouring areas (Hasell and Christie, 1978) and that these may hinder more fundamental restructuring. Recognising the disadvantages of localised and piece-meal attempts to modify the distributive system, mainly by means of negative controls, Drury (1981) has proposed that a national policy on distribution be devised. This could promote a widespread application of more desirable distribution practices, such as consolidation, the rescheduling of deliveries and the use of improved routeing methods.

Before such a policy can be formulated, a great deal of information has to be accumulated on current distribution practices. This thesis has presented a framework for the collection and analysis of this data and identified the routeing of flows through a distribution system as the central issue. Product routeing is affected by decision-making at many different levels, ranging from the choice of marketing channel, through the planning of the physical structure of manufacturers', wholesalers' and retailers' distribution systems to the daily scheduling of delivery vehicles. At each of these levels, considerable diversity makes generalization difficult. Chapter summaries have discussed the extent to which one can make general statements about particular aspects of the grocery distribution system. By taking an overview of these
discussions, one can draw several major conclusions:

1. Variations in many of the distribution variables, such as the proportion of factory output distributed direct, the number of outlets supplied, depot numbers and the proportion of multiple retailers' turnover channelled through central warehouse are so great as to render averages fairly meaningless.

2. The route a consignment follows is not simply related to the nature of the product. The flow of almost all the grocery products considered was divided between different types of marketing and logistical channels. Manufacturers and distributors of the same product group often vary considerably in the way they organize their physical distribution. Many other factors, such as marketing policy, product mix, the geography of production and various historical circumstances, need to be taken into account. In attempting to explain the wide variation in many of the features of the distribution system that strongly influence the spatial pattern of flow, one cannot focus attention on any single independent variable. The analysis must, therefore, be sufficiently broad to incorporate a range of variables, most of which are inter-related and few of which can be easily quantified.

3. Many of the relationships between different aspects of the grocery distribution system are fairly weak. Little relationship was found, for example, between the following pairs of variables:

   a) the proportion of output a manufacturer distributes in bulk loads and the total number of outlets supplied.

   b) a manufacturer's relative dependence on the echelon channel and the number of distribution depots it operates.

   c) the nature of the supply link between a manufacturer and multiple retailer and the combination of the manufacturer's relative emphasis on direct delivery and the multiple's relative use of a central warehouse.

   d) a multiple's relative dependence on central warehouse deliveries and the spatial distribution of its branch stores.

Stronger correlations were found between the numbers of
depots manufacturers operate and the locations of these depots, and between the size of depot service areas and the nature of the outward delivery operation.

Overall, however, there are tight limits on the extent to which one can make inferences about a whole distribution system on the basis of a narrow investigation of one or two of its component parts. It is important, therefore, that whole systems be monitored and that comparisons made between different firms distribution operations be wide-ranging.

As Darker (1978) has noted, the diversity of distribution methods also makes "trend-spotting" difficult. Nevertheless, in the case of the grocery distribution system, several major developments have been occurring in recent years.

i) Distribution has become more direct both in marketing and logistical terms. In the case of marketing channels, this has been achieved mainly by the diversion of trade from wholesalers and the independent retailers they supply to multiple retailers, which deal direct with the manufacturer. In the case of logistical channels, increases in the size of depots, shops and the consignments they receive has permitted a reduction in the number of intermediate stockholding points.

ii) Production, stockholding and sales have become more spatially concentrated in a smaller number of larger premises. This has been made possible by transport improvements (including an increase in personal mobility) and the adoption of new materials handling methods in each of these spheres of economic activity.

iii) Responsibility for transport and storage has shifted down the distributive channel from manufacturer to distributor, from wholesaler to retailer and from retailer to consumer.

iv) There has been a large increase in the consolidation of deliveries as a result mainly of a) an increase in the proportion of groceries handled by multiple retailers, b) an increase in the use of distribution contractors and c) mergers and take-overs in the food processing industry.
These developments have all promoted several important changes in the way in which groceries are transported. They have broken down the traditional pattern of grocery movement, comprising a long distance trunk haul to a local storage/break-bulk point and, from there, local multiple drop deliveries by small vehicles. This pattern has been increasingly replaced by one in which the intermediate node serves a much wider area, consolidates rather than disaggregates loads and dispatches goods direct to shops in large, mixed consignments. The development of this new pattern of distribution has involved an increase in the use of heavier vehicles in a shop delivery role. By comparison with multiple drop rounds by small vehicles, the use of heavier vehicles for the delivery of consolidated loads has reduced the ratio of vehicle- and tonne-kilometres to the volume sold. The associated changes in the spatial structure of the distribution system have, however, generated additional vehicle- and tonne-kilometres. Foremost among these changes has been the spatial concentration of production and stockholding. The concentration of production has increased the average distance between factory and consumer, while the concentration of intermediate stockholding has made the actual route between the two, on average, more circuitous. Ironically, as the journey from stockholding depot to shop has become more direct, the overall route from factory to consumer has deviated further from the direct, straight line between them. The benefits accruing from the rationalization of local deliveries through increased consolidation must, therefore, by set against the additional costs of transporting goods within more concentrated patterns of production and stockholding.

In addition to making generalization and "trend-spotting" difficult, the diversity of distribution operations also complicates the forecasting of future developments. By adopting a "distributional" approach to the study of freight flows, however, one can apply forecasting techniques not available to those forecasting
these flows in isolation. Walters (1976) and Gattorna (1977), for example, have used the Delphi forecasting method to canvass the opinions of a panel of business executives on future developments in food distribution. Although it is not possible to translate the results of these exercises into quantitative estimates of future changes in the spatial distribution of grocery flows, forecasting work of this type could be addressed more specifically to the various aspects of distribution systems that most strongly influence this pattern of flow.

This is only one of several ways in which the research reported in this thesis might be extended. Similar studies might also be done on the distribution of other products. Although Sussams (1968) has argued that the grocery distribution system can serve as a useful model for the distribution of other products, surveys of distribution in other trades, such as footwear (Smith, 1977b), records (Smith, 1979b) and textiles (Lancaster, 1977) have revealed considerable differences in the way these products are marketed and physically distributed. In addition to extending this research horizontally into other industrial sectors, one might explore the spatial organization of distribution systems in greater depth. In the course of this research, it has been necessary on numerous occasions to make deductions about firms' motives for arranging their distribution in a particular way on the basis of available facts and figures. It would be preferable if decision-making in this field could be examined more directly by means of an explicitly behavioural study. Work of this kind would require a high degree of cooperation from the staff consulted and possibly access to information often regarded as confidential. The recent renaissance in distribution planning, however, has inspired new interest and enthusiasm among management staff for this long neglected function, creating favourable conditions for further, in-depth, investigations in this field.
Glossary

**Backhaul**: return journey to point of origin from point at which load is delivered.

**Break-of-Bulk**: disaggregation of large, bulk load into smaller consignments for dispersed delivery.

**Cross-Haulage**: where similar products travel in opposite directions between the same two locations, e.g. goods produced in town A travelling to customers in town B, while similar goods produced in town B are distributed to customers in town A.

**Cross-shipment**: movement of stocks between factories producing different products to permit mixing of bulk orders for direct distribution.

**Consolidation**: grouping of consignments for delivery to the same destination.

**Direct Channel**: direct routeing of products from factory to retail or wholesale customer.

**Drop Density**: number of deliveries per unit distance.

**Drop Shipment**: where goods are purchased centrally by multiple retailer or voluntary group, but delivered direct by manufacturer to the retail outlet.

**Dual System**: system of distribution comprising both direct and echelon channels.

**Echelon Channel**: indirect routeing of products from factory to retail or wholesale customer via one or more intervening stockholing points.

**Embulk with Order System**: see Throughput Carrier System.

**Handling Factor**: ratio of the weight of goods lifted onto vehicles to the total weight of these goods produced or consumed.

**Hinterland**: area to which goods are distributed from a factory, warehouse, port etc. (also referred to as "service area" in case of warehouse/depot).

**Intermediate Journey**: section of a multiple drop journey between two consecutive deliveries.

**Inter-haul**: movement of goods between factories or warehouses at the same level of the distributive channel.

**Logistical Channel**: channel along which products pass in their physical distribution from factory to shop, consisting of nodes, such as factories, depots and shops, and vehicle movements (also known as "Logistics Channel").
Marketing Channel: organizational channel, composed of various productive and distributive agencies, along which the ownership of goods is transferred.

Minimum Drop (or Order) Size: minimum size of order a manufacturer or wholesaler is prepared to deliver.

Modal Split: division of traffic between different transport modes.

Multiple Drop Round: lorry journey, beginning and ending at the same point, during which consignments are delivered to more than one customer.

Order Throughput System: see Throughput Carrier System.

Own Label Products: products sold under the distributor's trade name.

Physical Distribution: collective term for the series of inter-related functions (principally transport, warehousing, stockholding and handling) involved in the physical movement of goods from producer to consumer.

Service Area: see Hinterland.

Service Level: time taken for ordered goods to be delivered (measured either in average number of days for all orders, or proportion of orders delivered within a given time period).

Specified (or Nominated) Day Delivery: where a supplier delivers to a certain area or customer only on a particular day of the week, requiring the customer to submit his order a fixed number of days in advance of this delivery day.

Stockout: exhaustion of the stock of a particular product.

Stockturn: see Turnover Rate.

Throughput Carrier System: system of distribution in which a manufacturer distributes bulk loads to hauliers and distribution contractors which provide a local break-of-bulk and delivery service (also known as "Embulk with Order" and "Order Throughput" system).

Tonnes Lifted: unit of freight traffic comprising the weight of consignments lifted onto vehicles at the start of a journey.

Tonne-kilometres Moved: unit of freight movement calculated by multiplying the weight of consignments lifted onto vehicles by average journey length.
Trade Area: area from which a distributive facility (eg. shop or cash and carry warehouse) draws its customers.

Transhipment: transfer of goods between vehicles, usually of different sizes.

Turnover Rate: ratio of total annual sales to the value of stock held at the end of the financial year (also known as Rate of Stockturn).

Value Density: ratio of the monetary value of a product to its weight.

Value of Service Pricing: transport pricing scheme in which the level of charges is related to what a consignment "can bear" rather than the cost of providing the service.
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Appendix 1

Firms co-operating in the survey.

Food Manufacturers:

Associated Biscuit Manufacturers
Australian Canned Fruits

* Batchelors
  Beecham
  Brooke-Bond Oxo
  Cadbury-Schweppes
  Cavenham
  Crosse and Blackwell (Nestle)
  Del Monte
  * Farley Health
  * General Foods
    Hienz
    Imperial Foods
    Kellogg
    Kraft
    Lovell and Christmas
    Lyons-Tetley
    Nabisco
  * Pasta Foods
    Quaker
    Ranks Hovis McDougall
  * Robertsons
    Smiths Foods
    Spillers Foods
    Tate and Lyle
    United Biscuits
  * Van den Berghs

* Firms providing information only by post.
Multiple Retailers:
Allied Suppliers
Bishops
Budgen
Cater Bros.
Express Dairies
Fine Fare
Foodrite
Gateway
* Hintons
International
Jacksons
Laws
Lennons
Lows
Keymarket
MacMarket
Oakeshotts
Safeway
Tesco
Willsons

Voluntary Groups:
Spar
Mace
Harvey Bradfield Toyer (VG)
Wavy Line
* Londis

Distribution Contractors:
SPD
Cory
Lowfield
Associated Deliveries (ADL)
National Carriers
Co-operative Organizations:
* Co-operative Union
Co-operative Wholesale Society
Royal Arsenal Co-operative Society

* Firms/organizations providing information only by post.

Data on the following firms from published sources (Annual Reports, Price Commission reports, Hemingway (1979) and trade press):

Mars, CPC (UK), Weetabix, J.Sainsbury, Waitrose, ASDA, Kwiksave.
Appendix 2

Copies of Questionnaires and Introductory Letters Used in the Survey.

1. Introductory letter sent to multiple retailers
2. Questionnaire for multiple retailers
3. Introductory letter sent to food manufacturers
4. Questionnaire for food manufacturers
Dear

As part of a programme of doctoral research, I am currently compiling information on the storage and distribution of food products. I am principally concerned with the patterns of warehouse and shop location, how these have evolved and how they relate to other aspects of the distribution system, particularly the way in which food products are transported. A great deal of research has gone into finding ways of optimising various components of the distribution system. Few attempts have been made, however, to compile information about actual distribution practices. It is hoped that it may be possible to build up a general picture of the distribution systems of multiple retailers in the grocery trade which might assist companies in the formulation of future distribution policy and strengthen planners' understanding of retail supply methods.

I would like to know, therefore, if it would be possible to arrange a meeting with you or a member of your staff during which I might enquire about the way in which your firm organizes the delivery of supplies to branch stores. This meeting, I expect, would last about an hour. Any information which you gave me would be recorded and analysed in the strictest confidence, and your company's name would not appear in any subsequent documentation. Should you desire a summary of the survey results, this I would gladly provide.

I would be most grateful if you would complete and return the enclosed slip to let me know if and when I might meet you.

Yours sincerely,
Name of the Company:

1. Opening date and location of the first store:

2. How many stores did the Company operate in the following size categories in 1970, and how many does it operate today?

<table>
<thead>
<tr>
<th>Net Sales Area (sq. ft.)</th>
<th>1970</th>
<th>1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 2,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,000-4,999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5,000-9,999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,000-19,999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20,000-49,999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 50,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Roughly what proportion of the stores currently operated by the Company were taken over from other grocery multiples?

4. Please list the retail chains of more than 5 stores that have been acquired since 1960.

<table>
<thead>
<tr>
<th>Name of Company</th>
<th>Area Served</th>
<th>Date of Acquisition</th>
</tr>
</thead>
</table>

5. How many branch stores were a) opened and b) closed in 1976 and 1977?

a) Stores opened:

<table>
<thead>
<tr>
<th>Number</th>
<th>Average Size (sq. ft.)</th>
<th>1976</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Average Size (sq. ft.)</th>
<th>1977</th>
</tr>
</thead>
</table>

b) Stores Closed:

<table>
<thead>
<tr>
<th>Number</th>
<th>Average Size (sq. ft.)</th>
<th>1976</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Average Size (sq. ft.)</th>
<th>1977</th>
</tr>
</thead>
</table>

6. Under what names does the Company trade in groceries?

7. Overall, what proportion of the goods sold in the branch stores pass through a Company warehouse?

8. Is the long term trend in the proportion of goods passing through a Company warehouse

   a) upward
   b) downward
   c) stable

   if c), at what date did the proportion stabilise?
   if a), to what target is the proportion being raised?
9. Please tick those commodities in the following list which are channelled through a Company warehouse. Mark with a ‘V’ those commodities which are delivered to the warehouse by some companies and direct to the stores by others.

- Canned Meats
- Canned Fruit
- Canned Vegetables
- Biscuits
- Cake
- Cereals
- Coffee
- Tea
- Sugar
- Meat
- Butter
- Cheese
- Sausages
- Frozen Food
- Wines/Spirits
- Soap Powder
- Household Ware

10. Do some suppliers deliver direct only to the larger stores in the chain, leaving the smaller stores to be supplied from Company warehouse? If so, how many suppliers have entered such an arrangement and which products does this affect?

11. Please insert information in the following table on warehouses currently operated by the Company:

<table>
<thead>
<tr>
<th>Location</th>
<th>Opening Date</th>
<th>Storage Area</th>
<th>Extent of Area Served</th>
<th>Number of Product Lines</th>
<th>Number of Vehicles</th>
<th>Number of Staff (incl. drivers)</th>
</tr>
</thead>
</table>

12. Please insert information in the following table on any warehouses closed by the Company since 1960:

<table>
<thead>
<tr>
<th>Location</th>
<th>Opening Date</th>
<th>Closing Date</th>
<th>Storage Area</th>
<th>Reasons for Closure</th>
</tr>
</thead>
</table>

13. Please insert information in the following table on any further warehouses planned by the Company:

<table>
<thead>
<tr>
<th>Location</th>
<th>Proposed Opening Date</th>
<th>Storage Area to be Served</th>
</tr>
</thead>
</table>

14. What factors determine which goods pass through a Company warehouse?
15. How long, overall, would stocks last at an average rate of consumption:
   a) in the warehouse(s)?
   b) in the branch stores?
16. Is packaging or other pre-sale processing carried out in the warehouse(s)?
   If so, which products are packed/processed?
   If done at one time but no longer, when did packing/processing in the warehousing cease?
17. What factors dominated the decision on where to locate the warehouse(s)?

18. How many vehicles are operated by the Company and what are their gross weights?

19. How many of these vehicles are a) articulated?
   b) leased?
20. Does the Company employ the services of a) a road haulier?
   b) a distribution contractor (offering storage as well as a transport service)?
   c) other transport operator (please specify)?
   If so, are they employed i) on a permanent basis?
      ii) temporarily?
   If they are only employed occasionally, under what circumstances are they used?

   Are they employed for particular routes or products? If so, for which?

21. What handling methods are employed for deliveries from Company warehouse(s) to branch stores? (e.g. use of Coabitainers/Unitainers or wooden pallets)

22. How frequently are deliveries made to branch stores from the Company warehouse(s)?

23. If this frequency of delivery varies with the size of the branch store or its location, please describe, in general terms, the nature of the relationship.

24. On average how long does it take for a branch store order to be supplied from a Company warehouse?
25. What proportion of delivery vehicle trips from the Company warehouse(s) would drop supplies at: a) 1 store?  
   b) 2-3 stores?  
   c) 4-5 stores?  
   d) 6 or more stores?  

26. On the average day, what proportion of delivery vehicles would have a) 1 reload?  
   b) more than 1 reload?  

27. What is the average load factor on delivery vehicles leaving the warehouse(s)?  
   (i.e. actual load as a % of the full capacity load)  
   By weight:  
   By volume:  

28. Are any products collected from suppliers a) in Company vehicles?  
   b) by a haulage/distribution contractor?  
   If so, which products are involved?  

29. Is "backdoor congestion" regarded as a problem at: a) any  
   b) many  
   c) most  
   d) all stores in the chain?  

30. How many branch stores, if any, are considered to have a) difficult access?  
   b) inadequate unloading facilities?  

31. How frequently are vehicle schedules revised?  

32. Are routes planned a) manually?  
   b) by computer program?  

33. How many product lines would be stocked in an average sized branch store?  

34. How many of these would be "own label" lines?  
   Is the number of "own label" lines increasing, decreasing or remaining stable?  

35. Do you foresee any significant changes in the way products are delivered to branch stores over the next five years?  
   If so, what changes do you anticipate and what factors do you consider will exert the greatest pressure for change?  

Thank you for your cooperation.
Dear

As part of a programme of doctoral research, I am currently compiling information on the storage and distribution of food products. No previous study has attempted to map the major nodes in the food supply system nor to compare different distribution strategies within an explicitly geographical framework. I have already collected information on the distribution systems of over twenty large supermarket chains and am now extending my survey to cover the main food suppliers. The Institute of Grocery Distribution has expressed an interest in this part of the survey, and it is hoped that it may be possible to make some general statements about the grocery distribution system which will assist companies in the formulation of future distribution policy. The study is particularly concerned with recent changes in the location and size of food warehouses, with minimum drop sizes and the general relationship between the distribution operations of producers, wholesalers, and retailers.

I would like to know, therefore, if it would be possible to meet you sometime soon to ask you some questions about the form of your company's distribution system. This meeting, I expect, would last about an hour. Any information that you gave me would be recorded and analysed in the strictest confidence, and your company's name would not appear in any subsequent documentation. Should you desire a summary of the survey results this I would gladly provide.

I would be most grateful if you would complete and return the enclosed slip to let me know if and when I might meet you.

Yours faithfully,
Study of the Grocery Distribution System

Name of Company:

1. Information on the company's factories in the UK:

<table>
<thead>
<tr>
<th>Location</th>
<th>Products</th>
<th>Storage Space (in sq.ft.)</th>
</tr>
</thead>
</table>

2. If different products are made at different factories, is there a central mixing point for distribution purposes? If so, where is it, how much storage space does it have and when did it open?

3. Information on warehouses/distribution depots:

   a) Operated by the company:

<table>
<thead>
<tr>
<th>Location</th>
<th>Size (sq.ft.)</th>
<th>Opening Date</th>
<th>Number of Employees:</th>
<th>warehouse drivers others</th>
</tr>
</thead>
</table>

   b) Contracted:

<table>
<thead>
<tr>
<th>Location</th>
<th>Space Allocation (sq.ft.)</th>
<th>Date First Used</th>
<th>Is the delivery service provided by a warehouse contractor or by separate carrier?</th>
</tr>
</thead>
</table>

Please mark with an 'E' those warehouses of which the company has exclusive use.
### j. b) Contracted: (continued)

<table>
<thead>
<tr>
<th>Location</th>
<th>Space Allocation</th>
<th>Date Then First Used</th>
<th>Is the delivery service provided by a warehouse contractor or separate carrier?</th>
</tr>
</thead>
</table>

### c) Transshipment Points:

<table>
<thead>
<tr>
<th>Location</th>
<th>Parent Depot</th>
<th>Ownership (own/haulier's/distrib. contractor)</th>
</tr>
</thead>
</table>
4. Would it be possible to obtain a copy of a map showing the division of the country into depot service areas? If not, could the boundaries possibly be sketched onto the blank map appended to this questionnaire?

5. How large does a load have to be before it is delivered direct from a factory (or central mixing point) to a customer?

What proportion of company output (by weight and/or value) is distributed bulk in this way, thus bypassing the depot system?

Roughly what tonnage would this represent per annum?

Is the proportion of output being delivered direct a) increasing b) decreasing c) remaining stable?

6. To how many outlets are the company’s products delivered:

   a) overall
   b) through the depots
   c) direct from factory (or mixing point)

What was the total number of outlets serviced in 1960 and 1970? (or any other year since 1960, if statistics are not available for the years in question.)

7. Which of the following list of supermarket chains receive a) direct store delivery only b) warehouse delivery only c) mixture of store and warehouse deliveries? (Please tick in the appropriate column).

<table>
<thead>
<tr>
<th>Company</th>
<th>All to Warehouse</th>
<th>All to Stores</th>
<th>Mainly to Stores</th>
<th>Mainly to Warehouse</th>
<th>Mixed Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>TESCO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FINE FARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAINSBURY</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>ALLIED SUPPLIERS</td>
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<td></td>
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<tr>
<td>SAFETYWAY</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>INTERNATIONAL</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>WALLIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WAITROSE</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>MACHARCTES</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>KEYMARKETS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUDGEN</td>
<td></td>
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</tr>
<tr>
<td>CATER BROS.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KULIKAVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BISHOPS (London)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAREKNOTTS (London)</td>
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<tr>
<td>EXPRESS DAIRY (London)</td>
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</tr>
<tr>
<td>FOODRITE (Shoreham)</td>
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<tr>
<td>GATEWAY (Bristol)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>LEMONS (St. Helena)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HINTONS (Stockton)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(continued on page 3.)
<table>
<thead>
<tr>
<th>Company</th>
<th>All to Warehouse</th>
<th>All to Stores</th>
<th>Mixed Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>JACKSONS (Hull)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAWNS (Gateshead)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WILLSONS (Gateshead)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOWS (Dundee)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LONDON CO-OP</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Are there any geographical patterns in the way the more extensive chains are served (e.g. in one region the company's products might go to the warehouse, whereas in another they might go direct to the stores)?

8. What are the present a) minimum and b) average drop sizes?

What were they in 1960, 1970 and 1975?

9. To what extent do the terms charged to customers reflect differences in distribution costs (e.g. bulk load to a central warehouse as opposed to a small consignment to a shop)?
   a) closely  
   b) fairly closely  
   c) little  
   d) not at all

10. What proportion of total output is trunked out of the factory(ies):
    a) by the company's own vehicles?
    b) by outside hauliers?
    c) by rail?

   Are there some routes typically served only by one particular mode (a), (b) or (c)?
   If so, which routes and by which mode?

11. What proportion of outward trunk movements from the factory(ies) would comprise complete loads for a single destination?

12. What proportion of trunk movements by the company's vehicles obtain a backhaul load?

13. Do company vehicles carry any third party traffic (either on outward journey or backhaul)?
   If so, what types of product are carried and how much roughly per annum:
   trunk vehicles  
   delivery vehicles
14. Information on vehicles operated by the company:
   a) Trunk Fleet:  No. of Vehicles  Gross Weights
   b) Delivery Fleet:  No. of Vehicles  Gross Weights

15. What is the average load factor (by weight) on company vehicles:
   a) Delivery Vehicles:
   b) Trunk Vehicles

16. Please estimate peak throughput for the company's distribution system as a %
    of the average throughput.
    When are the main periods of peak demand for the company's products?

17. How long would company stocks last at an average rate of consumption?

18. How long, on average, does it take for a delivery to be made after an order has been
    received from a customer?

HISTORICAL BACKGROUND:
19. When was the company set up in the UK?
   Where was the first factory?

20. If the company has taken over or amalgamated with any other food manufacturers,
    please state at what date this occurred?

   Have the respective distribution systems been integrated?
   If so, when did this occur?

21. Has the company reduced significantly its number of depots?
    If so, when was the main phase of reduction?
    Please list the locations and closure dates of depots closed since 1960.

Thank you for your cooperation.
Appendix 3

The Co-operative System of Grocery Distribution

Although the Co-operative movement's share of total grocery sales has fallen from around 21% in 1960 to 14% in 1981, this share is still substantial and roughly equivalent to that of the largest food multiple. The unique organization of the Co-op, vertically integrating production, wholesaling and retailing, enables it to control the movement of some products along the entire length of the distribution channel from factory to shop (Guirdham, 1972).

Information for this examination of the Co-operative system of food distribution was provided by the Co-operative Wholesale Society (CWS), the Co-operative Union and a large Co-operative retail society in the South East of England. A similar framework of study will be used to that employed earlier for manufacturers and multiple retailers. First, however, it is necessary to provide background information on the organizational structure of the Co-op and the way in which it has evolved.

Organizational Background.

Retail Societies: There was a great proliferation of Co-operative retail societies in the latter half of the 19th century. By the end of the century, their food retailing operation had secured complete national coverage. Many societies had overlapping trade areas and actively competed for business. A series of boundary agreements made around the turn of the century, however, greatly reduced this competition (Co-operative Union, 1968). The total number of societies reached a peak of 1455 in 1903 (Jefferys, 1954), then gradually declined as a result of take-overs and amalgamations. There were still around 1000 societies in 1958. In that year the Report of an Independent Commission recommended that these societies be grouped into larger units to pool scarce capital and benefit from economies of scale. In 1958, roughly three quarters of the societies operated fewer than fifteen grocery stores, falling below
what was regarded as the minimum viable size of a multiple food retailing operation (Co-operative Union, 1958). The rapid growth of the grocery multiples at this time made these smaller societies particularly vulnerable. The Independent Commission advocated an extensive programme of amalgamation to reduce the number of societies to between 200 and 300. In the following years the decline in the number of societies "came about through force of economic circumstances and not through any foresight or deliberate planning." (Co-operative Union, 1968) By the time of the next major report on the state of the organization, the Regional Plan of 1968, the number of societies had dropped to 600. Estimates of the optimum number of societies had fallen by a much greater proportion, however, from 200 - 300 to 50. Improvements in road transport had increased the mobility of shoppers, making it necessary to coordinate retail efforts on a larger spatial scale; they also facilitated centralized distribution over wider areas. The increase in the recommended size of amalgamated societies was also a response to the dramatic growth in the size and buying power of the multiples during the 1960s. The 1968 Plan was not implemented, however.

In 1971, a new organization, called Co-operative Retail Services (CRS), was set up to act as a "rescue" agency to take-over and rehabilitate societies suffering financial crises. The absorption of insolvent societies by the CRS constituted a negative form of rationalization.

A revision of the 1968 Regional Plan (Co-operative Union, 1974) recommended the integration of the 240 societies still in existence at the time into 26 regional groupings. Once again these proposals were not put into practice. The main obstacle to large scale re-organization lies in the unwillingness of many retail societies to surrender their autonomy. Since 1979 the number of retail societies has begun to fall more sharply (to c.160 in 1982), though a thorough rationalization of the system of retail societies still appears some way off.
Co-operative Wholesale Society: The CWS was founded in 1863 (and its Scottish equivalent in 1867) initially to act as a wholesaler to the retail societies, but later it developed its own production facilities. Until the late 1960s, its role as intermediary in the Co-operative system of grocery distribution was limited to the bulk storage and distribution of imported foodstuffs and products manufactured in the CWS's own factories. Responsibility for localised storage and delivery of the general range of grocery products was left to individual retail societies. Since the late 1960s, the CWS has begun to expand its role in grocery distribution by handling products from sources other than its own factories and overseas, and by providing, on a regional basis, centralized systems of storage and shop delivery to replace the numerous separate systems operated by individual retail societies (Bamf ield, 1978). This new initiative was launched in the North East of England with the opening in 1969 of a large regional distribution centre at Birtley (NEDO, 1972). Although the retail societies in the area retained their independence, they relinquished control over the distribution of groceries to their shops. Most Co-op food shops in the area thereafter received consolidated deliveries from the Birtley distribution centre rather than from their local society warehouse. This new system offered three major advantages:

1. By centralizing the ordering of supplies, it increased the organization's buying power and hence ability to secure larger discounts from manufacturers.

2. By centralizing stock, it permitted a reduction in stock levels and the total amount of storage space required. Furthermore, in design and location the new warehouse was considered much superior to many of those it replaced. Many were older, multi-storey premises in congested inner urban locations.

3. By centralizing buying and storage, it promoted a more efficient management of stock in the retail outlets.

Since 1969, similar developments have occurred in other parts of England and Wales (table A3.1). By 1979, 62

<table>
<thead>
<tr>
<th>Location</th>
<th>Date of Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urmston</td>
<td>1967</td>
</tr>
<tr>
<td>Birtley</td>
<td>March 1969</td>
</tr>
<tr>
<td>Newport Pagnell</td>
<td>July 1971</td>
</tr>
<tr>
<td>Longridge</td>
<td>August 1971</td>
</tr>
<tr>
<td>Swindon</td>
<td>January 1972</td>
</tr>
<tr>
<td>Port Talbot</td>
<td>March 1973</td>
</tr>
<tr>
<td>Alfreton</td>
<td>January 1979</td>
</tr>
<tr>
<td>Barnsley</td>
<td>January 1979</td>
</tr>
<tr>
<td>Halesowen</td>
<td>July 1979</td>
</tr>
</tbody>
</table>

Source: Co-operative Wholesale Society.
retail societies were participating in the scheme accounting for 47% of the total number of Co-op food outlets and 40% of the organization's share of grocery turnover (in England and Wales).

The upper management of the CWS has increasingly come to regard this programme of rationalization as a means of demonstrating to retail societies the benefits of centralized distribution and of encouraging them to integrate other aspects of their operations on a regional basis, as the reports of 1958, 1968 and 1974 recommended.

**Logistical Channels.**

In examining logistical channels under the control of the Co-operative wholesale and retail societies, it is important to draw a distinction between products manufactured in CWS factories and those produced elsewhere.

**CWS Food Production:** By far the greater proportion of food produced in CWS factories is sold in Co-op shops; the remainder consists of a series of "own label" products manufactured under contract for some large retail chains. Most of the output sold in Co-op shops passes along one of three echelon channels:

i) via a retail society warehouse

ii) via a CWS regional distribution centre

iii) via a specialist CWS depot specialising in those products, such as soft drinks, biscuits and provisions, that the CWS has traditionally delivered direct to the shops.

It would be very unusual for products to pass through more than one of these depots. There are some instances, however, of bulk consignments of CWS products bypassing all three types of depot and travelling direct from factory to shop.

**General Range of non-CWS Products:** The Co-operative system of distribution links into the general system of grocery distribution at three levels:
a) CWS regional distribution centres - like multiple retailers' central warehouses, these receive direct bulk deliveries from manufacturers. Over 90% of these centres' turnover is of non-CWS products.

b) Retail society warehouses - like the societies to which they belong, these warehouses vary greatly in size, though most have large enough turnover and storage capacity to accept direct bulk deliveries from the majority of manufacturers.

c) Shops - like other chain stores, Co-op food stores receive some of their supplies direct from the manufacturer.

When these two classes of product are combined, the allocation of grocery supplies between the major logistical channels are as follows: for stores served by CWS regional distribution centres, the proportion of supplies delivered in consolidated loads from these centres varies between 47% and 58%; for stores served by retail society warehouses, this proportion varies more widely between 40% and 70%, and averages around 50%. Stores in the latter category generally also receive a larger proportion of supplies from the older CWS depots specialising in imported foods and the output of CWS factories.

The Co-operative movement is, therefore, currently operating two systems of grocery distribution. In some regions distribution is centralized; in others, responsibility for distribution is divided among numerous retail societies. In terms of the proportions of consolidated delivery the shops receive, the two systems are broadly similar. The mean proportions of supplies channelled through the two main types of Co-operative warehouse closely resembles the average for the sample of multiple retailers considered earlier. Variation about the mean is much greater, however, in the case of the multiples.

The Number of Stockholding Depots.

Each of the Co-operative systems of distribution has a separate set of depots. The ten CWS regional distribution centres handle around 20% of Co-op grocery supplies, while
the 140 or so warehouses operated by retail societies handle around 30%. Although there are no up-to-date statistics available on retail society warehouses, it is believed that almost all the retail societies that do not belong to a CWS regional distribution scheme operate at least one grocery depot. Some of the larger societies operate more than one. Where two or more local societies have merged, it has been common practice to concentrate grocery operations on the larger of the existing depots. Some of the wealthier societies, such as the South Suburban, have centralized their operations in a new warehouse. The numbers of warehouses operated by the retail societies has also fallen sharply as a result of the expansion of the CWS system of regional distribution. The ten regional distribution centres in existence in 1979 had replaced around 70 retail society depots.

Regional distribution centres have been set up in areas where several retail societies have expressed a willingness to participate in the CWS scheme. Some have been built in the expectation of other societies in the area being subsequently attracted into the system. In planning the capacity of each of its regional centres, the CWS has had to forecast:

(i) changes in the grocery turnover of societies committed from the outset to using the warehouse.

(ii) the subsequent entry of other local societies into the scheme.

(iii) changes in the grocery turnover of these other societies.

(iv) changes in the proportion of shop supplies to be channelled through the warehouse.

The regional distribution centres so far established have varied widely in size, reflecting differences in their initial base load and forecasts of the future growth of business within a radius of 50 - 60 miles. Despite the high degree of speculation in the planning of these centres, the CWS has managed to operate them at a turnover rate per square foot slightly above the average for multiple
retailers' central warehouses ( £430 / sq.ft as opposed to £400 /sq.ft.). It has been estimated that if all the retail societies joined the scheme, a total of about 25 distribution centres would be required. As discussed below, however, the actual number required would depend on the way in which the system evolved geographically.

Depot Locations

Many of the retail society depots are old, multi-storey premises located in the inner areas of the towns where the societies were originally founded. In many cases, these depot locations have been retained despite the fact that mergers with other societies have enlarged their service areas and reduced their centrality. The main Royal Arsenal Society depot at Woolwich, for example, is poorly situated relative to the combined area of the eleven societies with which it has merged (fig. A3.1). As mentioned earlier, however, there are some examples of wealthier retail societies closing older, inner-city depots and replacing them with new, more centralized facilities on greenfield sites (e.g. the South Suburban warehouse outside Croydon).

The locations of the CWS regional distribution centres have been determined by the spatial distribution of retail societies willing to participate in the CWS scheme. When enough retail societies within an area of 50-60 mile radius have agreed to join the scheme, the CWS has set up a distribution depot fairly centrally with respect to these societies' branch stores. In most cases, the choice of location has also been influenced by the possibility of other societies in the area entering the scheme at a later date. There has been no obvious pattern in the way the system of regional distribution centres has developed. This has depended upon the process of negotiation between the CWS and retail societies in different parts of the country.

There are clear disadvantages in this mode of development. It is doubtful if such piece-meal growth of the system will in the long term optimise the overall spatial distribution of the CWS regional depots. If planned in its entirety from scratch to serve all the
existing Co-op food shops, the system would probably comprise fewer depots and would possibly have depots in different locations from those currently occupied. At present, all but two of the depots have separate catchment areas of 50 mile radius. At later stages in the development of the system, however, it may prove difficult to serve the interstitial areas efficiently. They may not generate sufficient demand to justify the addition of new depots and, therefore, have to be served inefficiently over long distances from existing depots. Already one of the earlier distribution centres has had its location rendered suboptimal by the subsequent entry of other local societies into the scheme and by the development of another depot in an adjoining area.

The CWS recognises the possible long term disadvantages of setting up distribution centres in this way, however, it claims that all these centres have been built in accessible locations - six of the seven centres open in 1978 were within 5 miles of a motorway - to a standard that would make them easily saleable should relocation become necessary. Relocation, however, would only be justified where the costs involved were less than the resultant savings in distribution costs (Ballou, 1968). Were this not the case, it would be preferable to continue operating the depot in a suboptimal location, to the long term detriment of the system as a whole.

Areas Served by Co-operative Depots.

The hinterlands of the retail society grocery depots is generally conterminous with the societies' territories. The CWS regional centres serve the combined territories of the local retail societies participating in its distribution scheme.

These societies territories can be of a very irregular shape, largely as a result of the pattern of mergers. This is clearly illustrated by figure A3.1 which shows the division of the South of England into retail society areas. This pattern is very inefficient in terms of distribution. Two very small areas, around Crawley and Maidstone, are controlled separately by Co-operative Retail Services (CRS),
despite the fact that it would be more economical to integrate them into the larger, adjoining societies. Several of the territories, such as those of the Royal Arsenal Society and the CRS along the Kent coast, are very elongated and hence inefficient to service. The Royal Arsenal's territory is also in two separate parts as a result of a past merger with a non-contiguous society.

The present pattern of society boundaries bears little relation to the economics and logistics of distribution. Many of the boundaries date back to the agreements on society territories made around the turn of the century. Very few changes have been made to society boundaries in response to transport improvements or the redistribution of population. From a distribution standpoint, the spatial organization of the Co-operative retail societies is much less efficient than that of the grocery multiples.

Routeing.

Strategic Level: Only in the case of biscuits does the CWS manufacture the same products at different locations. Its biscuit factories produce a similar range of products and each serves a separate part of the country. There is very little cross-shipment of bulk supplies between CWS factories. Almost all the product mixing is done at separate CWS warehouses or at retail society depots. The CWS mixes stocks at two levels. It does so at large centralized warehouses, such as that at Shieldhall (in Glasgow), from which mixed, bulk consignments are distributed to retail society depots. It also mixes products at its new generation of regional distribution centres to assemble consolidated loads for delivery to shops. It was not possible to obtain estimates of the proportions of CWS-manufactured products passing along the four main logistical channels (fig. 6.1), though, from consultation with Co-op officials it appears that channels 1 and 2 are by far the most important.

Tactical Level: The limited amounts of information obtained on the logistics of deliveries to Co-op grocery stores suggest that deliveries made by the CWS from its regional distribution centres tend to achieve higher levels
of consolidation than those organized by retail societies. The average number of drops per delivery for one of the regional distribution centres was 2.2, whereas it was estimated that the corresponding figure for a delivery from a retail society warehouse was at least twice as large. This partly reflects the fact that Co-op stores belonging to the CWS system generally receive a larger proportion of their supplies from central warehouse than do those outside this system. It also results from the CWS's policy of reducing the frequency of store delivery and imposing tighter stock control on the shops it serves. The gradual absorption of Co-op grocery stores into the CWS regional distribution system has, therefore, had the effect of consolidating supplies in fewer, more direct deliveries.

Summary.
Although the organizational structure of the Co-operative system of grocery distribution is unique and currently undergoing radical change, this system has been subject to the same processes of stock concentration and delivery consolidation that have been observed in other sectors of the grocery trade. The concentration of stockholding has been achieved by:

i) retail societies centralizing their grocery stocks
ii) adjoining retail societies merging and combining their stocks
iii) (most important) the CWS establishing a series of large, regional distribution centres which can concentrate the grocery stocks of many retail societies in their hinterlands.

The increased use of the CWS distribution centres, coupled with the concentration of grocery sales into fewer, larger branch stores, has promoted the consolidation of deliveries, reducing the average number of drops per delivery and increasing average drop size.

The part of total grocery movement controlled by Co-operative agencies is subject to wide spatial variation. In the first place, the Co-operative's share of the grocery market varies significantly between different regions (Nielsen Researcher, 1974) (fig. 8.8). There are also
variations from area to area in the way branch stores are supplied. In some areas, the shops are served by CWS regional distribution centres; in others by local retail society depots. In the latter case, the retail societies can differ in the proportion of supplies they channel through their depots. In addition to being very complicated, the geography of the Co-op's system of grocery distribution is currently in a state of flux as a result of mergers between retail societies and the absorption of retail societies into the CWS regional distribution scheme. It is likely, however, that these changes will ultimately simplify the structure of this system and make it resemble more closely that of a large multiple such as Fine Fare, though on a much larger scale.
### Appendix 4: Calculation of Handling Factors.

**Weight of Food and Drink Products Consumed and Exported 1962-80.**

(millions of tonnes)

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Food Consumed (incl. Milk)</td>
<td>33.3</td>
<td>35.1</td>
<td>35.7</td>
<td>35.4</td>
<td>35.1</td>
<td>34.4</td>
<td>34.2</td>
<td>33.9</td>
<td>34.3</td>
<td>34.0</td>
</tr>
<tr>
<td>Alcoholic Drink</td>
<td>5.2</td>
<td>5.4</td>
<td>6.5</td>
<td>6.7</td>
<td>6.8</td>
<td>7.0</td>
<td>7.1</td>
<td>7.3</td>
<td>7.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Soft Drink</td>
<td>1.0</td>
<td>1.2</td>
<td>1.6</td>
<td>1.7</td>
<td>1.9</td>
<td>2.1</td>
<td>2.1</td>
<td>2.4</td>
<td>2.7</td>
<td>2.6</td>
</tr>
<tr>
<td>Food Exports</td>
<td>0.7</td>
<td>0.6</td>
<td>1.4</td>
<td>1.4</td>
<td>1.5</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>1.9</td>
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</tr>
<tr>
<td>Animal Feed</td>
<td>9.4</td>
<td>10.7</td>
<td>11.2</td>
<td>10.4</td>
<td>10.2</td>
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<td>10.8</td>
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<td>11.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49.5</strong></td>
<td><strong>53.0</strong></td>
<td><strong>56.4</strong></td>
<td><strong>55.6</strong></td>
<td><strong>55.5</strong></td>
<td><strong>56.6</strong></td>
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<td><strong>56.5</strong></td>
<td><strong>57.9</strong></td>
<td><strong>56.9</strong></td>
</tr>
</tbody>
</table>

**Total Tonnes Lifted (m)***

- 273
- 300
- 292
- 280
- 301
- 294
- 279
- 303
- 301
- 278

**Handling Factor**

- 5.52
- 5.66
- 5.18
- 5.04
- 5.42
- 5.19
- 4.98
- 5.36
- 5.20
- 4.88
Appendix 4: (cont.)

Notes:

1. The calculation of handling factors excludes
   a) containers
   b) packaging
   c) live animals
   d) tobacco products
   (c 100,000 tonnes of tobacco were "consumed" in 1977
    i.e. only 0.17% of the total weight of food and drink
    consumed/exported in that year.)

2. Handling factors only calculated for years in which
   surveys of road goods traffic were undertaken.

3. Figures for domestic food consumption were calculated by
   multiplying consumption/head by population.

4. The weight of food exported was calculated in relation
   to the monetary value of exported food, assuming that the
   value:weight ratio for exported food is the same as that
   for food consumed in Britain.

Sources: Central Statistical Office "Annual Abstracts of
Statistics."
Dept. of Transport "Transport Statistics: Great
Britain."