

Elaboration Analysis of the Relationship between Delivery Model and Educational Attainment

by
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Abstract

As the programme to renew secondary school buildings gathers pace, questions are being asked if the investment is producing results in improved educational attainment. This research sought to verify finding from earlier research that educational attainment improved faster in PFI rebuilt schools compared to conventionally-procured rebuilt schools. Quantitative analysis, incorporating the latest data, was performed and the finding was confirmed, though statistical significance was not universally established due to large variance within the dataset and small sample size. The finding was deemed note-worthy still because the sample included all the rebuilt schools with complete longitudinal data.

Further quantitative analysis was performed to elaborate on this finding. Unauthorised absence was used as a proxy to students' motivation. Analysis results provided some, evidence of statistical significance for the hypothesis that PFI rebuilt schools improve students' motivation more than conventionally-procured rebuilt schools. In addition, a significant correlation was found to exist between improved students' motivation and improved educational attainment. Therefore, students' motivation elaborated the original finding thus: PFI rebuilt schools improved students' motivation more which showed up in faster improvement in educational attainment.

As an extension to the elaboration analysis, a conceptual framework was developed to build a comprehensive understanding of the mechanism through which the original relationship works. Path analysis, together with its path diagram and associated structural equations, was proposed. This paved the way to an in-depth quantitative analysis to unpick the complex nature of the relationship between procurement choice and educational attainment in the next stage of research.

Keywords

school facilities, educational attainment, intervening variable, path analysis, Private Finance Initiative (PFI)

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List of Abbreviations

4ps	Public Private Partnerships Programme
BSF	Building Schools for the Future
CABE	Commission for Architecture & the Built Environment
CIC	Construction Industry Council
CVA	Contextual Value Added
D&B	Design & Build
DBB	Design Bid Build
DCSF	Department for Children, Schools and Families
DfES	Department for Education and Skills (now DCSF)
DQI	Design Quality Indicator
FM	Facilities Management
G7	Group of Seven Industrialized Nations: Canada, France, Germany, Italy, Japan, United Kingdom, and United States of America
GCSE	General Certificate of Secondary Education
GDP	Gross Domestic Product
ICT	Information and Communication Technology
LEP	Local Education Partnership
NAO	National Audit Office
OECD	Organisation for Economic Co-operation and Development
OfSTED	Office for Standards in Education, Children's Services and Skills
PFI	Private Finance Initiative
PfS	Partnerships for Schools
PP	Percentage Point
PPP	Public Private Partnership
PUK	Partnerships UK
SPV	Special Purpose Vehicle
UK	United Kingdom
USA	United States of America
VA	Value Added
VfM	Value for Money

1 Introduction

1.1 Delivery Model and Educational Attainment

Verriopoulos (2007) and KPMG (2008), in their study of investment in school facilities and educational attainment, showed that schools procured through PFI delivered better educational outcomes faster than those procured conventionally¹. In particular, when comparing only fully rebuilt school facilities, the rate of improvement in PFI schools was 92 percent higher than in conventionally-procured school.

Verriopoulos (2007) acknowledged that there was an indirect nexus between the delivery model and educational attainment. It is the purpose of the current research to clarify the link between delivery model and educational attainment.

1.2 Intervening Factors

Delivery Model and Quality of School Accommodation Service

The choice of delivery model is expected to impact the quality of school accommodation service in several aspects. This is because each delivery model has a set of incentives and could therefore lead to different outcomes (KPMG 2008).

Quality of School Accommodation Service and Educational Attainment

Studies have established evidence of a relationship between physical school environment and pupil performance. However, the relationship is not universally positive or significant. It is suggested that the presence of complex interacting factors such as school leadership, pedagogical and psychological factors make it difficult to come to firm conclusions about the impact of school buildings on pupil performance (PWC 2007a).

Some research has sought to elaborate on this relationship. For example, PWC (2001), in a qualitative analysis with head teachers in five local education authorities found that capital investment had a strong influence on teacher and pupil motivation. These in turn had a major impact on pupil performance.

¹ Conventional procurement refers to DBB and D&B types of contracts.

1.3 Research Objectives

The objectives of the present research are:

- 1) to confirm findings from earlier research about the relationship between delivery model and educational attainment;
- 2) to elaborate on the relationship; and
- 3) to develop a framework for studying the mechanism through which the relationship operates.

1.4 Scope

The investigation is limited to secondary schools in England. The particular focus is on fully rebuilt schools because it was for this group that previous research has established statistically significant findings.

1.5 Methodology

The first objective involves a re-run of the analysis performed by Verriopoulos (2007) with one year of additional data. The purpose is to confirm his research findings, in particular, the statistically significant relationship between delivery model and educational attainment. Additional performance data (GCSE results) will be obtained from the Department for Children, Schools and Families (DCSF) and analysed.

To achieve the second objective, absence data as a proxy to students' motivation will be obtained from DCSF to determine quantitatively whether student's motivation intervenes between the original relationship.

For the third objective, a conceptual framework will be developed through a review of existing literature. Path analysis, with its path diagram and the associated structural equations will be formulated.

1.6 Contribution to Knowledge

The present research serves to elaborate quantitatively the statistically significant relationship between delivery model and educational attainment established in earlier research. The conceptual framework helps to create a deeper understanding of the dynamics behind the relationship and the proposed path analysis paves the way to an in-depth testing of intervening variables between delivery model and educational attainment.

2. Background

1.7 Outline of Report

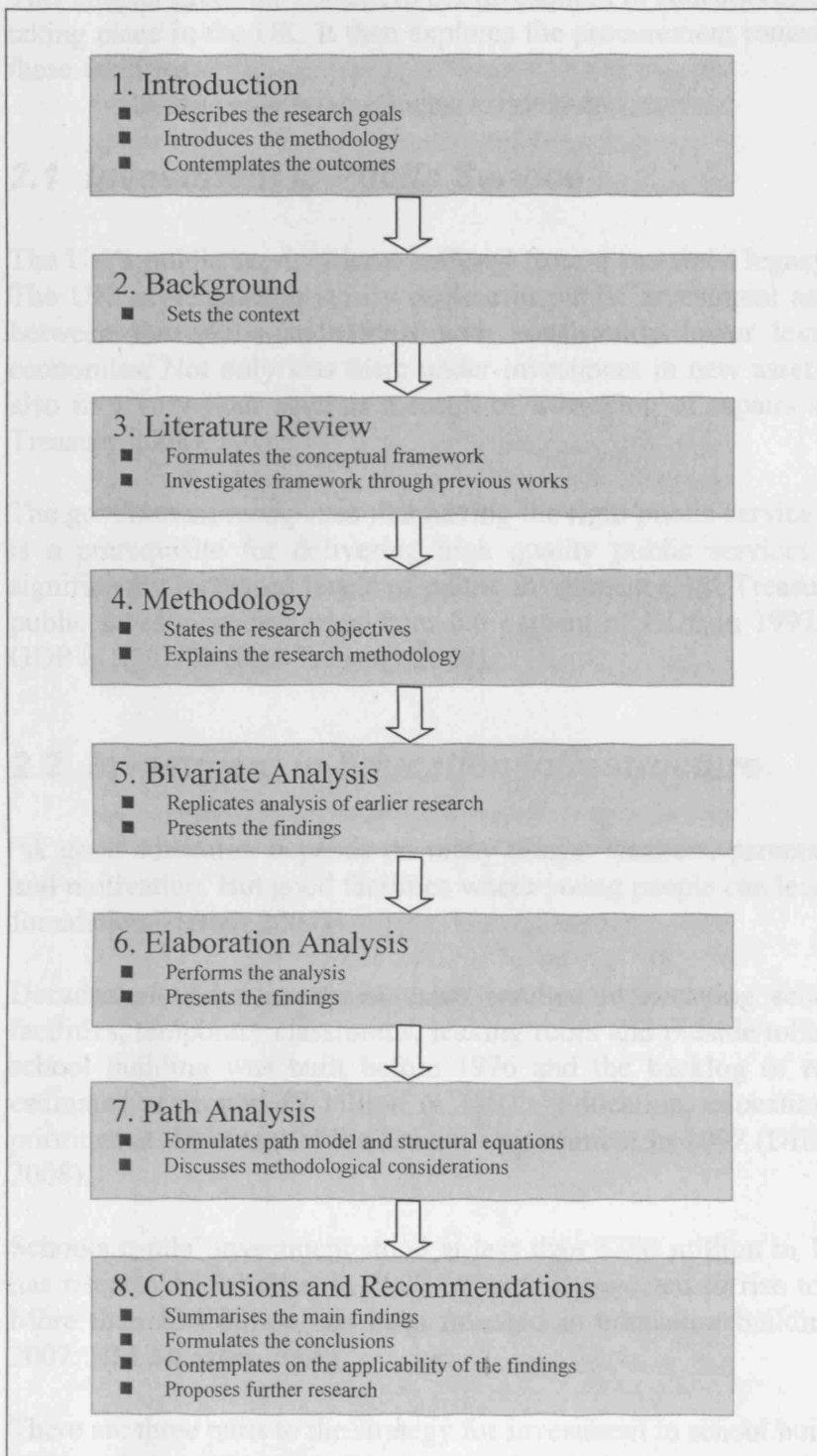


Figure 1 Report outline

2 Background

This chapter gives the context to the investment in educational infrastructure currently taking place in the UK. It then explores the procurement routes adopted to delivering these facilities.

2.1 Investment in Public Service

The UK's public services have suffered from a sustained legacy of under-investment. The UK experienced a steady decline in public investment as a proportion of GDP between the 1970s and 1990s with consistently lower levels than in other G7 economies. Not only was there under-investment in new assets, existing assets were also in a very poor state as a result of a backlog of repairs and maintenance (HM Treasury 2008).

The government recognised that having the right public service infrastructure in place is a prerequisite for delivering high quality public services and is committed to significantly increased levels of public investment (HM Treasury 2003). The level of public investment has risen from 0.6 percent of GDP in 1997/98 to 2.25 percent of GDP in 2007/08 (HM Treasury 2008).

2.2 Investment in Education Infrastructure

“A good education depends on many things: teachers, parents, standards, discipline and motivation. But good facilities where young people can learn and grow are a vital foundation.” (Blair 2007)

Decades of under-investment have resulted in decaying school buildings, shabby facilities, temporary classrooms, leaking roofs and outside toilets. Seventy percent of school building was built before 1976 and the backlog of repairs in schools was estimated at around £7 billion in 1997. “Education, education, education” was the priorities at the outset of the Labour Government in 1997 (DfES 2007; HM Treasury 2008).

Schools capital investment stood at less than £700 million in 1997-98. Since then, it has risen to £5.9 billion in 2007-08 and is projected to rise to £8.2 billion in 2010. More than £34 billion has been invested in education buildings since 1997 (DfES 2007; HM Treasury 2008).

There are three parts to the strategy for investment in school buildings (DfES 2007):

- Money for every school to spend at their discretion, and money for every local authority and diocese to spend on local priorities;
- Money invested for greatest impact through strategic school building programmes; and
- Money targeted for key projects with national priority.

2.3 Strategic School Building Programmes

For a more co-ordinated approach to support the Government's vision of educational transformation, strategic programmes were launched to effect the greatest impact.

The Building Schools for the Future (BSF) programme was launched by the DCSF in February 2004 and intends to rebuild or remodel every state secondary school in England (around 3,500 in total) by 2020. It will transform education for some 3.3 million students aged 11-19. Investment will be rolled out over 15 waves, subject to future public spending decisions (PFS 2008).

The Academies programme was introduced in March 2000, with a target of 400 Academies open or in the pipeline by 2010. Academies are publicly-funded, independently managed, schools that provide a first-class free education to local pupils of all abilities. In 2006, the Academies programme was integrated into the wider BSF programme (PFS 2008).

Primary Capital Programme was the latest initiative announced in 2007. The Government is committed to renewing at least half of all primary school buildings by 2022/23 (DCSF 2008a).

2.4 Delivery Models

Traditionally, school buildings were procured through conventional means. Conventional procurement is defined here as a process where the client obtains Design, Build and Operate services sequentially and independently. Often, Design and Build (D&B) services are bundled together in a single contract.

The Government introduced PFI procurement method in 1992 for the delivery of new public buildings. In a PFI procurement, a private sector partner is awarded a long-term contract to design and build the school and to provide the subsequent maintenance and operational services, usually for 25 years or more. Often that one partner comprises a consortium of organisations, working together and co-ordinated under one umbrella, called a Special Purpose Vehicle (SPV). The SPV is also responsible for raising the necessary private finance for the project.

However, given the scale of BSF, a more efficient means of procurement is introduced. For most local authorities, the standard approach will be to set up a Local Education Partnership (LEP). The LEP is a business which will provide long-term partnering services for the local authority. It is a joint venture company comprising the local authority, Partnerships for Schools (PFS) and a private sector partner. Where a LEP is to be formed for the delivery of BSF locally, it will set up or bring in an SPV for the PFI contracts. LEP can also place D&B contracts.

In March 2006, PFS takes over responsibility of delivering the Academies Programme which precedes the BSF Programme. It is now intended that PFS will integrate the Academy buildings within the BSF process where LEP has been formed in the local authorities concerned. Likewise, Primary Capital Programme will ride on the LEP

arrangement. Where there is no LEP, National Framework, which was launched in January 2007, can be used to procure schools on D&B basis (DfES 2006; DCSF 2008a; PFS 2008).

At a national level, roughly half the school projects will be procured through PFI contracts (PFS & 4ps 2008; DCSF 2008a; PFS 2008).

3 Literature Review

This chapter seeks to develop a conceptual framework to elaborate on the relationship between delivery model and educational attainment. The main purpose is to identify the intervening variables and their inter-relationships.

3.1 Conceptual Framework

Investment in educational infrastructure is a subset of the investment made in education, which in turn is a subset of the investment in human capital.

The provision of school accommodation service comprises design, construction and operation of the school infrastructure. These services are procured differently under the PFI and the conventional procurement. It is hypothesised that the performance of these services differs under the two procurement regimes.

The quality of school accommodation service has a direct impact on its users: the students and teachers. This is because quality of teaching (on the teachers' part) and quality of learning (on the students' part) will be affected by the school environment. The quality of teaching and learning will ultimately be reflected in the educational attainment of the students.

The framework below is reviewed on the basis of existing literature.

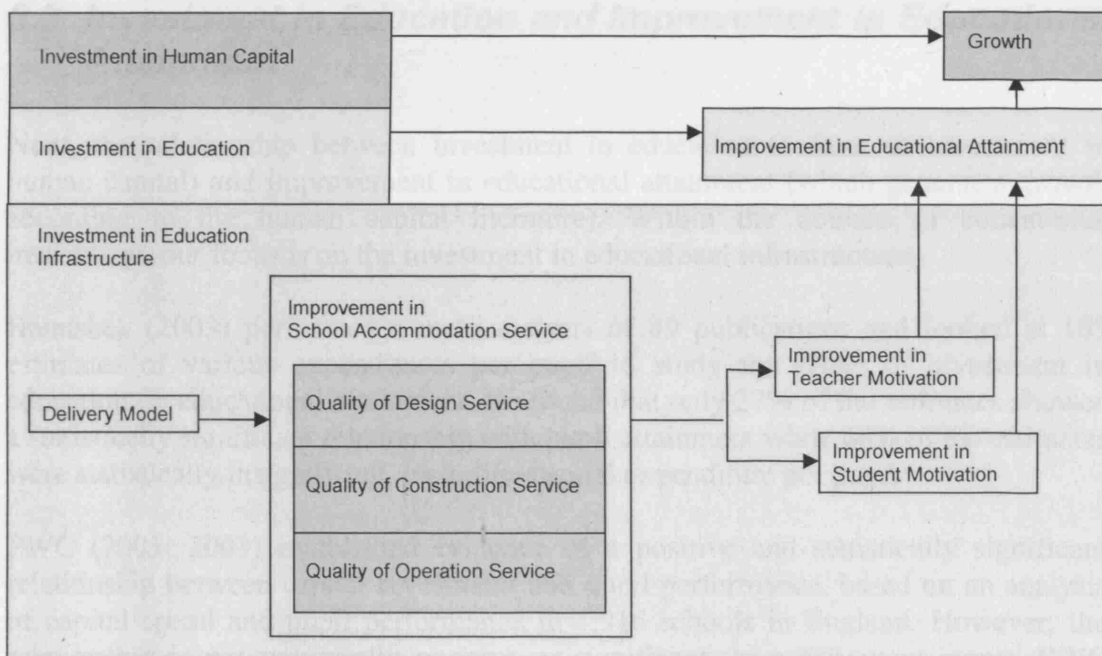


Figure 2 Conceptual framework

3.2 Investment in Human Capital and Growth

First, the overarching relationship of investment in human capital and growth is explored.

Human capital is defined by the OECD as the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being (Keeley 2007).

The concept of human capital can be traced to Adam Smith, who believed that economic activity was fuelled by the acquired and useful abilities of all the members of the society (Smith 1991). However, it was not until the 1960s that economists started looking at it in earnest. Schultz (1961) and Becker (1993) observed that a substantial growth in national income remained after accounting for the growth in physical capital and labour. They argued that investment in human capital accounted for most of the rise in the real earnings per worker and that education and training are the most important forms of investments in human capital.

OECD showed that if the average time spent in education by a population rises by one year, then economic output per head of population should grow by between 4% and 6% in the long run (Keeley 2007). However, Barro (2001) showed that the effect of quality of schooling is much more important than quantity. Beside growth, non-economic returns to learning, in the form of enhanced personal well-being and greater social cohesion, have also been observed (OECD 2001).

3.3 Investment in Education and Improvement in Educational Attainment

Next, the relationship between investment in education (a form of investment in human capital) and improvement in educational attainment (which generates growth according to the human capital literature). Within the domain of educational investment, our focus is on the investment in educational infrastructure.

Hanushek (2003) performed a meta-analysis of 89 publications and looked at 163 estimates of various expenditures per pupil to study the effect of investment in education on educational attainment. He found that only 27% of the estimates showed a statistically significant relationship with pupil attainment while 66% of the estimates were statistically insignificant, including capital expenditure per pupil.

PWC (2001; 2003) established evidence of a positive and statistically significant relationship between capital investment and pupil performance, based on an analysis of capital spend and pupil performance in 1,916 schools in England. However, the relationship is not universally positive or significant. In a follow-up report, PWC (2003) examined different types of capital investment and found that spending on suitability-related investment (i.e. investment that ensures the buildings are as appropriate as possible for the teaching of the curriculum) had a greater impact on performance than condition-related investment (i.e. ensuring that the buildings are in a good enough condition to enable the pupils to be educated).

3.4 Delivery Model and School Accommodation Service

Next, the relationship between investment in educational infrastructure and improvement in educational attainment is examined. The first link to explore is the effect of procurement model on school accommodation service.

3.4.1 Conventional Procurement and PFI

Delivery models are distinguished by how they apportion and manage risk. Appropriate risk allocation and associated contractual incentives are essential for cost-effective and efficient project delivery for the public sector (HM Treasury 2008).

The Government has repeatedly stressed that the choice of procurement route rested solely on VfM assessment (HM Treasury 2003; HM Treasury 2006a; HM Treasury 2008). Economic analysis demonstrated the mechanisms through which PFI procurement are better able to drive VfM compared to conventional procurement. The way these mechanisms, including risk transfer and incentive contract, interact to drive VfM has been detailed by Bettignies & Ross (2004) and Rintala (2004). Conventional procurement refers to both Design and Build (D&B) contract and where design and build services are procured separately (Design Bid Build or DBB contract).

There is also a difference in the process leading up to the confirmation of the investment decision. PFI needs to undertake a much more thorough assessment of the readiness of the project before proceeding to the market. Outline business cases, which have not been developed to an appropriate standard, will not be approved, irrespective of need. PFI also benefits from the disciplined approach senior debt providers take in analysing and apportioning risk before they are willing to lend (HM Treasury 2006a). These steps help to mitigate foreseeable risks by weeding out unfeasible and unaffordable proposals, hence contributing to the overall quality of the output accommodation service.

The following section examines how PFI procurement may influence specific aspects of the school accommodation service compared to conventional procurement.

3.4.2 Quality of Design Service

Theory

Scoping the discussion, quality for design service refers here only to functionality and fit-for-purpose over the asset's useful life. SPV is incentivised to minimise risk of designing a facility that is not fit for purpose, as it has to face the consequence of payment deduction if the design is not functional during operation. In addition, it has the incentive to design for lasting quality as it stands to maximise profit if it can keep operating costs down under the long-term incentive contract.

In conventional procurement, the designer is paid before the operational performance of the building is established, hence he has no economic incentive to manage design

risk even though he has the opportunity and is in the best position to do so. As the contract is short term, the designer has no incentive to design for whole life since he does not get rewarded for doing so. However, we have restricted our discussion to one-off game context. Indeed, the designer may still be incentivised to produce quality design in conventional procurement if he considers his options under a repeated reputation game context (Milgrom & Roberts 1992; Himmelweit et al. 2001).

Evidence

CABE (2006) carried out an audit on 52 of the 124 schools completed between January 2000 and September 2005. The assessment was conducted by design experts using a tailored form of the design quality indicators for schools (DQI for schools). It comprises indicators covering three categories: the way the building is designed to be useful as a school; its build quality; and its ability to create a sense of place and have an uplifting effect on the local community and environment. This categorisation aligns closely with the Vitruvian Triangle of commodity, firmness and delight (Spencer & Winch 2002).

Half of 52 schools audited were reviewed to be poor or mediocre, i.e. the overall scores were less than 50%. It also concluded that any procurement route can produce a good result, although schools using the PFI performed less well than other forms of contract. On the key areas that would improve the design quality, CABE's experts rated process issues such as time, cost and procurement highly. In particular, it argued that time constraints as a significant barrier to quality school design. It cited that the design timeframe for PFI school to be approximately 12-16 weeks while that for conventional procurement to be significantly longer at 12-18 months. The implication was that the poor design quality for PFI schools could be explained, at least in part, by the insufficient design timeframe.

Conclusion

Theory suggests that PFI is likely to produce higher quality design. However, the evidence suggests that design service standard is higher if the school is procured via conventional means. Even though the SPV has the incentive to provide quality design, it lacks the opportunity in terms of time to do so. One reason may be that the design timeframe gets squeezed because so much time is spent on structuring the PFI deal. This should be a temporary issue as the government and private sector becomes more familiar with the PFI process, the time taken for structuring the deal should significantly reduce (HM Treasury 2006a).

3.4.3 Construction Service

Theory

Quality for construction service refers to time certainty and high build quality here. The SPV has the incentive to deliver early or on time as it only starts receiving payment when the school buildings become available for operation. As the term of the contract is fixed, the earlier the buildings become available, the longer the period for which it is eligible for unitary payment. It has the incentive to achieve high build quality as it stands to maximise profit if it can keep maintenance costs down.

In conventional procurement, the constructor has little incentive to deliver early or on time, unless there is an early completion reward. Post contract, reversal of bargaining power in favour of the constructor occurs. Even when protective measures such as liquidated damages are in place, the client may still be vulnerable to constructors' threat of delay due to incomplete contract and ungovernable events (Chang & Ive 2007a; 2007b). Furthermore, the constructor has no incentive to achieve high build quality as it does not benefit from any operational efficiency. Indeed, the short-term contract and asymmetric information provides perverse incentive for the constructor to cut corners to boost profit (Bettignies & Ross 2004).

Evidence

NAO (2003) examined the construction performance achieved in PFI projects. The report cited strong evidence that the PFI approach brought significant benefits to the government in terms of delivering built assets on time and for the price expected by the public sector.

Their review showed that most PFI projects were delivering price certainty; only 22 percent of the projects surveyed had overrun their budget. This compared very favourably to some 73 percent of public sector construction projects that had run over budget historically (NAO 2001).

On timing of delivery, the survey found that only 9 out of the 37 PFI projects (24%) surveyed were delivered late. This compared to some 70 percent of central government's construction projects that were delivered late as reported in NAO (2001).

Conclusion

Both theory and evidence suggest that PFI is superior in the performance of construction service compared to conventional procurement.

3.4.4 Operation Service

Theory

Quality of operation service includes the availability of the asset and the support services provided along with it (HM Treasury 2003). In the school context, operation service comprises mainly hard facilities management (FM) service. PFI provides the incentive for the operator to perform as payment is directly linked to the compliance of service standard specified in the output specifications. Failure to comply will result in payment deduction. The expectation is that the incentive contract should create a robust monitoring regime such that less resource will be required from the school to resolve operational issues. Schools can therefore release their staff to concentrate upon teaching and learning.

In conventional procurement, the local authority and governing body are responsible for maintaining the building (PfS & 4ps 2008). They can provide it in-house or more commonly, procure it through a separate FM contract. A separate FM contract provides less incentive to perform as the quantum of payment and deduction are smaller than a PFI contract, i.e. less stakes are involved. With a less effective

incentive contract, more effort is expected from the schools in monitoring for performance.

Evidence

Partnerships UK's (2006) review on the operational performance of PFI projects covered a wide population of projects across sectors. It found 96 percent of projects are performing at least satisfactorily, with 66 percent performing to a very good or good standard, as reported by public sector contract managers. Surveys also showed that users believed service standards were delivered always or almost always in 79 percent of projects. 78% of public sector contract managers agreed that the payment mechanism supported effective management of their project.

Only 25% of the schools interviewed by Partnerships UK (2005) reported a reduction in resource requirements with others reporting a very significant increase in activity, with an additional bursar or senior administrator being recruited in three cases. In 4ps's (2006) review, schools also gave feedback that FM had remained unchanged from pre-PFI schemes in the sense that school staff continued to worry about the services and spend time resolving issues rather than the provider taking full responsibility for them on behalf of the school.

Conclusion

The evidence showed that even though the incentive contract appeared to be working, the expectation that PFI would release school management resources had not been realised.

3.5 School Accommodation Service and Educational Attainment

The second link to explore is between school accommodation service and educational attainment. There are two main streams of research in this subject. One studied the impact of individual design attributes on educational attainment. The other studied the relationship between the overall building condition and pupil performance.

Woolner et al. (2007) reviewed over 200 studies on the links between different aspects of building design and their impact on staff and pupils. He concluded that poor quality in air quality, noise and lighting led to poor outcome for learners. However, there was equivocal evidence of the impact of contextual factors such as room arrangements and furniture on pupil outcomes.

PWC (2007a) reviewed literature on the link between the overall building condition and attainment. Citing the works of Schneider (2002), Earthman (2004) and Clark (2002), it concluded that on balance, evidence pointed to a clear link between school building condition and pupil attainment.

However, some of these studies were vulnerable to criticism of difficult-to-measure variables, such as socio-economic factors. One approach was to control certain background variables in the multivariate analysis (PWC 2001; 2003).

Others have used a longitudinal data approach. By focussing on assessing the difference in performance in the same data set before and after renewal, this approach eliminated the impact of random external variables. In addition, this approach allowed for the lagged effect of capital investment to kick in. This is the approach used by Verriopoulos (2007) and KPMG (2008) in the study of the impact of investment in school facilities on educational attainment for secondary schools in the UK.

Woolner et al. (2007) noted that “the relationship between people and their environment is complex and therefore any outcomes from a change in setting are likely to be produced through an involved chain of events.” Higgins et al. (2005) suggested that the nature of improvements made in school might have less to do with specific environment element chosen for change than with the process of change itself. It argued that user engagement in defining and solving design problems was of great importance and that the most successful designs were those which offered flexibility and adaptability for new cohorts of users, new curriculum demands and new challenges. The holistic view taken by this review is particularly insightful. It broadened the discussion beyond architectural design and building condition to include the impact of the design process and the operation of the school environment on students’ behaviour and attainment. Our conceptual framework is consistent with this observation.

3.6 Intermediate Outcomes

Research has identified students’ and teachers’ attitude as a possible link to elaborate on the relationship between school accommodation service and educational attainment. PWC (2001) carried out a qualitative analysis, covering five local education authorities, to identify the key factors which headteachers judged to have an important influence on pupil attainment, and discussed the inter-relationships which existed between them. The research found that capital investment had a strong influence on teacher and pupil motivation. These in turn had a major impact on pupil performance.

Research participants in the first annual review of BSF indicated that improved buildings had the potential to raise aspirations and improve the morale and motivation of staff and pupils (PWC 2007b). Rudd et al. (2008) survey around 200 students at Bristol Brunel Academy before and after the opening of the new building. It found significant increase in the proportion of pupils who said they enjoyed going to school. The majority of teachers also said they enjoyed teaching more and felt more motivated and proud to be a teacher at the school.

3.7 Conclusion

The focus of the present research is on the relationship between investment in educational facilities and improvement in educational attainment. We have placed this relationship within the larger context of investment in human capital and growth.

While the existing literature identified a relationship between school buildings and pupil outcomes, they were unable to establish any causal relationships. As Lewis

(2000) noted, “with the complexity of the learning process and the number of factors that can influence it, it may not be possible to produce a definitive estimate of the effect of facility conditions on student achievement”. PWC (2007a) suggested that, rather than solely focus on establishing a direct causal relationship, “further research is needed to try and un-pick the nature of the relationship between school buildings and teaching and learning, taking account of the context within which schools are working, but also to take a more holistic view of the factors responsible for creating an effective school environment.”

Such is the motivation of the current research. A conceptual framework has been developed through a review of the literature. In brief, the proposed framework hypothesized that the choice of procurement model would have an impact on the quality of school accommodation service, which in turn influenced student and teacher motivation. The effect ultimately showed up in the improvement of educational attainment.

4 Methodology

This chapter explains the objectives of the research and the methodology adopted to achieve them.

4.1 Prior Research

Verriopoulos (2007) and KPMG (2008) found a statistically significant difference in the annual rate of improvement in educational attainment between rebuilt schools procured via PFI and conventional means. The annual rate of improvement for PFI rebuilt schools was found to be 92 percent higher than conventionally-procured rebuilt schools. This finding was significant at 0.1 level. Educational attainment was defined as the percentage of students obtaining five or more A* to C Grade GCSE results.

The same works also found that educational attainment improved at a rate 20 percent faster in renewed PFI schools than in renewed conventionally-procured schools. However, this difference was not statistically significant. A renewed school was one in which more than 50 percent was new as a result of rebuilding, refurbishment and/or extension.

Statistically speaking, the first finding concerning rebuilt schools could be used as a predictor of future performance. However, the sample size was a concern, even though the variance of the GCSE results in this particular sample of 31 PFI schools and 24 conventionally-procured schools was relatively small.

Another point to note was that in this particular sample of conventionally-procured schools, educational attainment actually worsened after the schools were rebuilt. The annual rate of improvement was -0.3 percent. The authors noted that educational attainment data appeared volatile year on year. As the methodology involved sorting the attainment data for the rebuilt schools in relation to the date of reopening, the period under which the school's performance was studied might be different from school to school, bringing with it the volatility of attainment data into the analysis.

The authors acknowledged that there was an indirect nexus between delivery model and educational attainment. In their conceptual model, building design and condition, building performance, learner attitude, teaching performance were identified as possible intervening variables which could elaborate the apparent finding.

4.2 Research Objectives

The current research aims to improve the analysis with an additional year of data to increase the sample size. It also aims to un-pick some of the intervening variables that work through the relationship between delivery systems and educational attainment.

The specific research objectives are:

- 1) to confirm findings from earlier research about the relationship between delivery model and educational attainment;
- 2) to elaborate on the relationship; and
- 3) to develop a framework for studying the mechanism through which the relationship operates.

4.3 Research Method

The present research builds on the quantitative analysis carried out by Verriopoulos (2007) and KPMG (2008). Quantitative research explains phenomena “by collecting numerical data that are analysed using mathematically based methods (in particular statistics)” (Aliaga & Gunderson 2005).

Muijs (2004) traced the foundation of quantitative research to the realist and positivist worldviews. Realists take the view that “the truth is out there” and it is the job of the researcher to use objective research methods to uncover that truth. Taking up the criticisms presented by subjectivists, post-positivists accept that we cannot observe the world we are part of as totally objective outsiders, but they believe nonetheless that objective reality exists. Therefore, rather than focusing on absolute truth, the post-positivist focuses on confidence and try to represent reality as best he can

According to Muijs (2004), there are four main types of research question that quantitative research is particularly suited:

- Q1 When we need a quantitative answer, e.g. “how many”, “what proportion”
- Q2 When we want to study numerical change, e.g. trends
- Q3 When we want to explain phenomena and make prediction
- Q4 When we want to test hypothesis

The present research objectives seek to confirm the hypothesis of a relationship (Q4) and study the factors that may predict educational attainment (Q3). Hence, quantitative research is appropriate.

4.4 Research Design

There are two main types of quantitative research design: experimental and non-experimental. An experiment is a test under controlled conditions to examine the validity of a hypothesis. In contrast, non-experimental research does not set up an artificial situation and only uses variables as they appear in real-world setting. Two common strategies of non-experimental research are survey and analysis of existing data sets. Survey involves the collection of data using questionnaire forms administered by various means such as phone, face to face or web-based forms. Alternatively, existing datasets, where available, can be analysed.

The present research adopts a non-experimental design as the variables cannot be controlled by the researcher. The strategy is to analyse existing datasets from DCSF.

5 Bivariate Analysis

This chapter reports the analysis on the relationship between Delivery Model and Educational Attainment.

5.1 Data Preparation

Data from DCSF were processed and matched for the purpose of this research. The sources of data used were:

- GCSE Performance Tables which contained the aggregate GCSE results and absence data for all schools in England;
- Capital investment impact audit conducted in March 2007 which contained information for the period 1993 to 2011 about the categories of capital investment works and the date of reopening; and
- PFI database which contained information about schools procured via PFI.

5.1.1 Dataset of Schools' GCSE Results

The starting point was the GCSE database compiled by Verriopoulos (2007) which contained 4132 schools. This included all secondary schools in England that were operational in 2006, excluding 884 special schools.

The GCSE performance results for 2007 were obtained from DCSF (2008b) and matched against the existing database. 4007 schools were successfully matched with 2007 results. The remaining 125 schools were included in the database without 2007 results. Therefore, the total number of schools in the database remained 4132.

5.1.2 Renewed and Non-renewed

The 4132 schools were split into two groups: "Renewed" and "Non-renewed". "Renewed" group included all schools which had undergone capital investment works (50% -80% refurbishing, >80% refurbishing, or rebuilding) between 1993 and 2006. The remaining schools were classified as "non-renewed".

After removing independent schools, private schools and schools with insufficient data from the dataset, the non-renewed group contained 2614 schools, consistent with Verriopoulos's dataset. The time-series GCSE results for these schools were de-trended with the England average. De-trending was necessary to account for factors that influence GCSE results from year to year, e.g. the level of difficulty of the examinations.

The data for the renewed group is similarly de-trended. Then, the de-trended average for the non-renewed group is deducted from the de-trended GCSE results for the renewed schools to show their relative performance over the non-renewed group.

To prevent other factors influencing performance from entering the analysis, the difference in performance before and after the renewal of a school was studied. To perform the longitudinal analysis, the schools' attainment data were sorted according to the year of opening. Only schools with data from year four before opening to year three after opening were retained in the final dataset of the renewed group. The study period of seven years is a balance between data availability and allowing sufficient time for any lagged effects to show through.

For the "before" value, the performance level of the school between four and two years before renewal was averaged. The performance level one year before renewal is excluded to eliminate possible distortions due to negative 'construction period disruption' effect and positive 'psychological' effect caused by the announcement of a forthcoming opening of the school in a renewed building (also known as the Hawthorn effect).

The "after" value was the average of the performance level between one and three years after renewal. The averaging was done to smooth the data as school performance data had very high variance. The improvement in educational attainment was then the difference between the "before" and "after" value.

The final dataset of renewed schools contained 167 schools. There was an increase of 10 schools in this group with the inclusion of 2007 GCSE results compared to Verriopoulos's study.

5.1.3 Conventional Procurement and PFI

The renewed schools were further categorised by their delivery model and types of capital works.

		Delivery Model		Total
		Conventional	PFI	
Type of works	Rebuild	22	39	61
	Refurbishment	73	33	106
All renewed		95	72	167

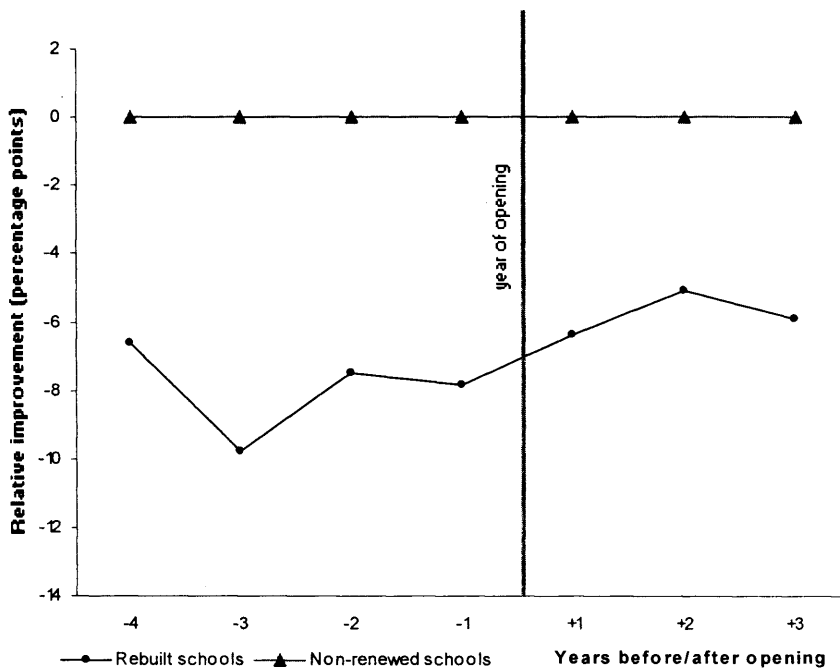
Table 1 Distribution of schools in sample

The sample of interest to the present research is the "Rebuild" group because the statistically significant relationship was found in this group by Verriopoulos (2007). Some unavailability of data was tolerated in Verriopoulos's (2007) study. In the present study, only schools with full set of data were included in the sample. As a result, 3 schools were removed from Verriopoulos's (2007) sample of "Rebuild" schools. The addition of 2007 data allowed 9 more schools into the sample, hence the "Rebuild" group increased by a net of 6 schools in the present sample.

5.2 Rebuilding and Educational Attainment

Year	Before renewal				After renewal		
	-4	-3	-2	-1	+1	+2	+3
Rebuilt schools	-6.63	-9.76	-7.51	-7.85	-6.38	-5.09	-5.93
Non-renewed schools	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-year average	7.97 (excluded)				-5.80		
Relative improvement	2.16						
Annual rate of improvement	0.54						

Table 2 Performance (percentage points) in rebuilt schools relative to non-renewed schools



Graph 1 Educational attainment in rebuilt schools relative to non-renewed schools

The study showed that the annual rate of performance of rebuilt schools relative to non-renewed schools was 0.54 percentage points (pp). A t-test was performed to determine if this annual rate is significantly greater than zero. The results showed that the annual rate of improvement for rebuilt schools was indeed significantly greater than zero at 0.05 level, indicating that there was a 95% probability that a rebuilt school improved performance at a faster rate than a non-renewed school.

Annual rate of improvement (pp)		1-tailed t-test		
Rebuilt Schools	Non-renewed Schools	t	df	Sig.
0.54	0	2.002	60	0.025

Table 3 t-test results of annual rate of improvement for rebuilt schools against that of non-renewed schools

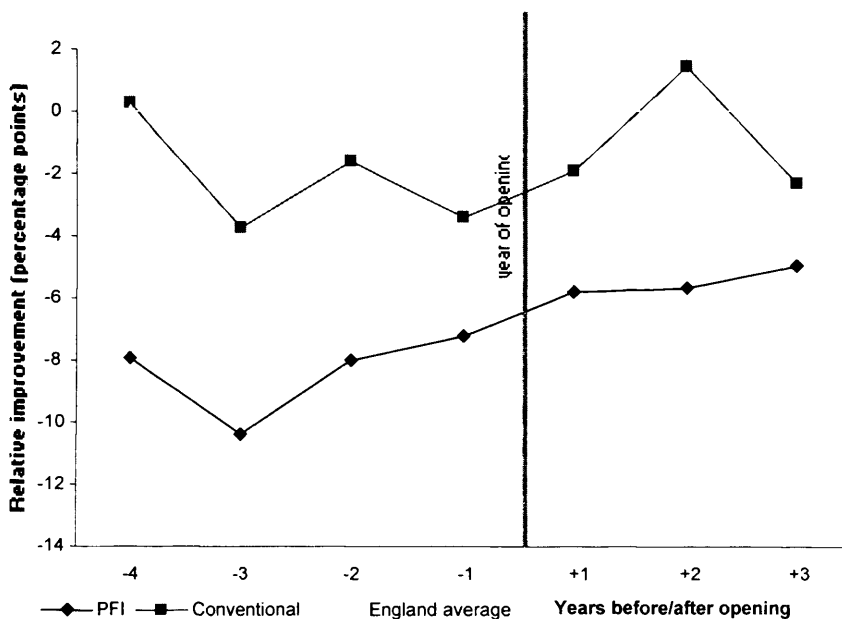
5.3 Delivery Model and Educational Attainment

Year	Before renewal				After renewal		
	-4	-3	-2	-1	+1	+2	+3
Renewed schools	0.24	-3.75	-1.63	-3.44	-1.91	1.45	-2.33
3-year average	-1.72			(excluded)	-0.93		
Relative improvement	0.78						
Annual rate of improvement	0.20						
Annual rate of absolute improvement	1.74						

Table 4 Performance (percentage points) relative to England average – conventionally-procured rebuilt schools (3-year average)

Year	Before renewal				After renewal		
	-4	-3	-2	-1	+1	+2	+3
Renewed schools	-7.91	-10.39	-8.02	-7.26	-5.82	-5.70	-4.94
3-year average	-8.77			(excluded)	-5.49		
Relative improvement	3.29						
Annual rate of improvement	0.82						
Annual rate of absolute improvement	2.36						

Table 5 Performance (percentage points) relative to England average – PFI-procured rebuilt schools (3-year average)



Graph 2 Educational attainment in fully rebuilt PFI and conventionally-procured schools relative to the England average (3-year average)

The relative improvement over the four-year period gave the annual rate of improvement. This rate for PFI schools (0.82pp) was over three times higher than that of conventionally-procured schools (0.20pp). Over the 12-year study period (1995 to 2007), the England average improved from 43.5% to 62%. This translated to an England trend rate of 1.54pp per annum. As the data series for the renewed schools were previously de-trended, this England trend rate could be added to the annual rate of improvement for the renewed schools to arrive at the annual rate of absolute improvement. The annual rate of absolute improvement for PFI schools (2.36pp) was

36% higher than that for conventionally-procured schools (1.74pp). This improvement rate at 36% was significantly lower than that reported by Verriopoulos (2007) at 74% and KPMG (2008) at 92%.

Paired-sample t-tests were run to determine if the “before” and “after” values of the sample were significantly different. The results showed that while performance before and after rebuilding was significant at 0.05 level for the whole sample and the PFI rebuilt schools subset, conventionally-procured schools did not show significant difference.

Sample	Sample size	Mean of “before” value (pp)	Mean of “after” value (pp)	t	df	Sig. (2-tailed)
Whole sample	61	-6.23	-3.85	-2.22	60	0.031
Only “PFI” schools	39	-8.77	-5.49	-2.37	38	0.023
Only “conventional” schools	22	-1.72	-0.93	-0.47	21	0.644

Table 6 t-test results of “before” and “after” performance for rebuilt schools (3-year average)

Next, a t-test was performed to determine if the improvement of educational attainment in PFI schools was greater than that in conventionally-procured schools statistically.

	Levene’s test for equality of variances		t-test for equality of means		
	F	Sig.	t	df	Sig. (1-tailed)
Relative improvement					
Equal variances assumed	0.49	0.49	1.12	59	0.13

Table 7 t-test results of performance for PFI and conventionally-procured rebuilt schools (3-year average)

The t-test results showed that the difference of the improvement in educational attainment between delivery models was not statistically significant. This contradicted the findings by Verriopoulos (2007) and KPMG (2008). It was found that two schools in this year’s “conventional” group had very high rates of improvement (19pp and 17pp) relative to the group average (0.78pp) and introduced large variance into the group, rendering the result statistically insignificant.

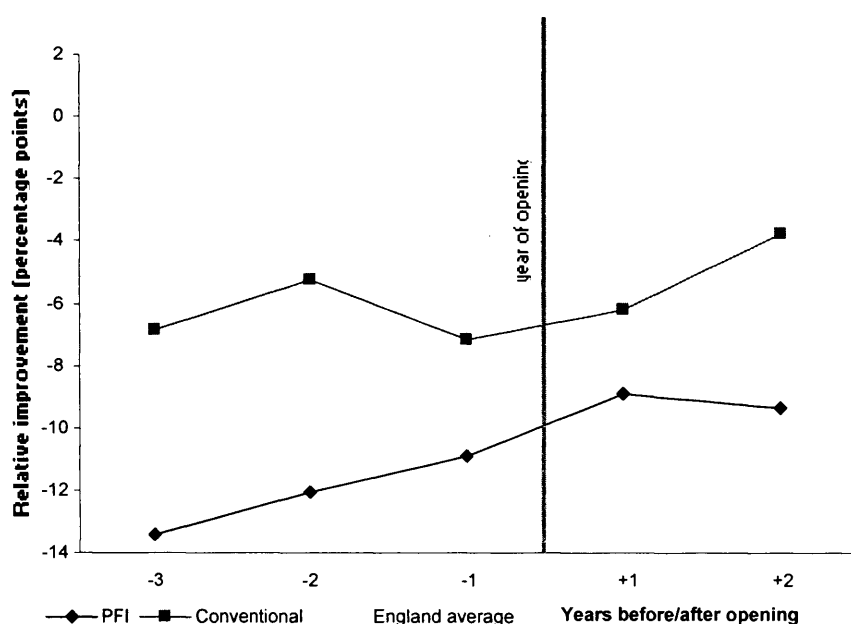
The test was repeated for schools with valid data for only 2 years before reopening and 2 years after reopening to increase the sample size. The number of PFI and conventionally-procured rebuilt schools increased to 57 and 32 respectively.

Year	Before renewal			After renewal	
	-3	-2	-1	+1	+2
Renewed schools	-6.89	-5.27	-7.17	-6.20	-3.76
2-year average	-6.08		(excluded)	-4.98	
Relative improvement	1.10				
Annual rate of improvement	0.37				
Annual rate of absolute improvement	1.91				

Table 8 Performance (percentage points) relative to England average – conventionally-procured rebuilt schools (2-year average)

Year	Before renewal			After renewal	
	-3	-2	-1	+1	+2
Renewed schools	-13.44	-12.08	-10.91	-8.93	-9.36
2-year average	-12.76		(excluded)	-9.14	
Relative improvement	3.62				
Annual rate of improvement	1.21				
Annual rate of absolute improvement	2.75				

Table 9 Performance (percentage points) relative to England average – PFI-procured rebuilt schools (2-year average)



Graph 3 Educational attainment in fully rebuilt PFI and conventionally-procured schools relative to the England average (2-year average)

Results from the paired-sample t-tests agreed with that for the 3-year average sample. It showed that performance before and after rebuilding was significant at 0.01 level for the whole sample and the PFI rebuilt schools subset while conventionally-procured schools did not show significant difference in performance.

Sample	Sample size	Mean of "before" value (pp)	Mean of "after" value (pp)	t	df	Sig. (2-tailed)
Whole sample	89	-10.36	-7.65	-3.34	88	0.001
Only "PFI" schools	57	-12.76	-9.14	-3.40	56	0.001
Only "conventional" schools	32	-6.08	-4.98	-0.92	31	0.363

Table 10 t-test results of "before" and "after" performance for rebuilt schools (2-year average)

Using only 2-year average, the annual rate of absolute improvement for PFI schools (2.75pp) was 44% higher than that for conventionally-procured schools (1.91pp). In addition, for this set of data, the 1-tailed test revealed that the difference was statistically significant at 0.1 level. This demonstrated that the analysis was highly sensitive to changes in the sample size, implying that the sample size was still too small. The trend for the "conventional" group also showed large variance in year-on-

year school performance data. The consequence was evident in the second t-test where the exclusion of 2 years of data yielded very different results compared to the first test.

Relative improvement	Levene's test for equality of variances		t-test for equality of means		
	F	Sig.	t	df	Sig. (1-tailed)
Equal variances assumed	1.63	0.21	1.50	87	0.07

Table 11 t-test results of performance for PFI and conventionally-procured rebuilt schools (2-year average)

As a measure of the representativeness of the “2-year average” sample, one-sample t-tests were carried out to compare the sample mean of the 2007 attainment against the mean of all 141 rebuilt schools (including those without sufficient data), the mean of all 331 renewed schools (including those without sufficient data) and the England average.

GCSE 5 A*-Cs in 2007 (pp)		2-tailed t-test		
Sample Mean	Average of all Rebuilt Schools	t	df	Sig.
56.84	57.46	-0.35	87	0.73
	Average of all Renewed Schools	t	df	Sig.
	57.52	-0.38	87	0.70
	England Average	t	df	Sig.
	62.00	-2.91	87	0.01

Table 12 t-test of sample performance mean against all rebuilt average, all renewed average and England average

The results showed that the sample mean was significantly different at 0.05 level from the England average. Therefore, the current sample was not representative of the population of state secondary schools in England. This was expected because schools were not randomly chosen for redevelopment. It was known that poorer performing schools were prioritised for redevelopment. Importantly, the result also showed that the sample mean was not significantly different from the average of all rebuilt and renewed schools. This meant that our sample was representative of the population of schools that were rebuilt and renewed.

5.4 Conclusion

The analysis replicated the earlier research findings that PFI rebuilt schools improved faster than conventionally-procured ones. However, statistical significance could not be established using the 3-year average sample. The analysis was repeated with a larger 2-year average sample and for this sample, statistical significance was established. This suggested that the analysis was sensitive to the rather small sample size. The mean 2007 performance of 2-year average sample was not significantly different from the mean of all the rebuilt/renewed schools, indicating that the sample was representative of schools that were rebuilt and renewed.

6 Elaboration Analysis

This chapter elaborates on the relationship between Delivery Model and Educational Attainment analysed in the previous chapter.

6.1 Students' Motivation

As noted in the literature review, students' attitude was identified as a possible link between renewed school accommodation and improved educational attainment. Absence data was sometimes used as a proxy for students' motivation. If students are motivated, they are less likely to play truant and this should be reflected in lower absence rates.

Absence data is available from DCSF in two forms: authorised and unauthorised absence as a percentage of half days missed (DCSF 2008b). Authorised absence is absence with permission from a teacher or other authorised representative of the school and for which a satisfactory explanation has been provided (e.g. illness). Unauthorised absence is absence without permission from a teacher or other authorised representative of the school and includes all unexplained or unjustified absences. Between the two forms, it appeared more reasonable to relate decreased unauthorised absence to improved motivation.

6.2 Hypotheses

The original relationship is broken down into two separate hypotheses:

- H1. PFI rebuilt schools improve students' motivation more than conventionally-procured rebuilt schools; and
- H2. A significant correlation exists between improved students' motivation and improved educational attainment.

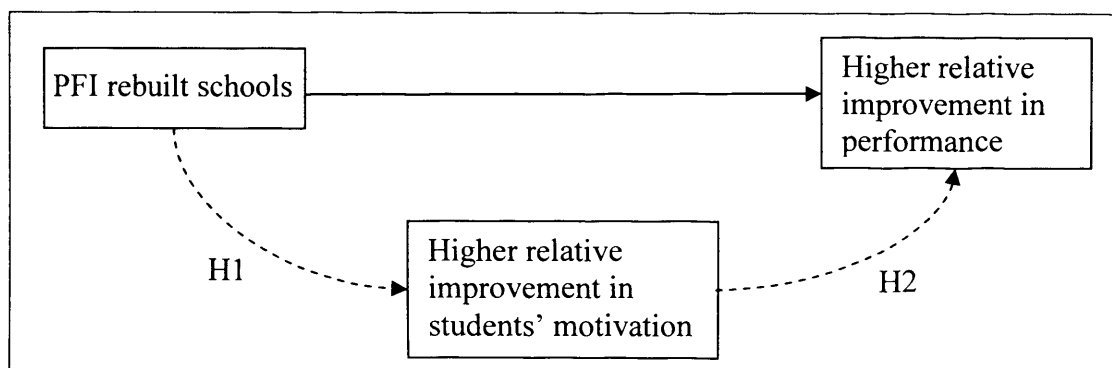


Figure 3 Original relationship broken down into two new hypotheses

6.3 Data Preparation

Unauthorised absence data was gathered and similarly treated as the GCSE data. Data was first de-trended with the England average and then sorted according to the year of opening. The “before” value was the 3-year average of the data between year four and two before opening. The data one year before opening is discarded. The 3-year average of the data between year one and three after opening constituted the “after” value. The difference between “before” and “after” values then became the improvement in motivation, expressed by a decrease in unauthorised absence.

The sample size was slightly smaller than the earlier test for rebuilt schools because absence data was on the whole less complete than GCSE results. There were 22 conventionally-procured rebuilt schools and 35 PFI rebuilt schools with complete absence data in the 3-year average sample.

Similar to the GCSE tests, a larger sample of 2-year average was prepared. There were 29 conventionally-procured rebuilt schools and 52 PFI rebuilt schools with complete absence data in the 2-year average sample.

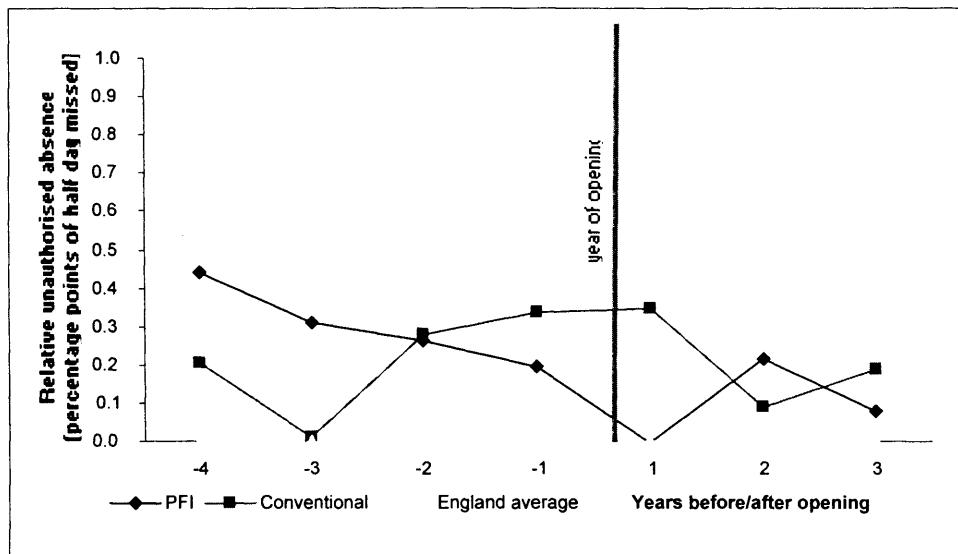
6.4 Delivery Model and Students’ Motivation

Year	Before renewal				After renewal		
	-4	-3	-2	-1	+1	+2	+3
Renewed schools	0.20	0.01	0.28	0.33	0.35	0.09	0.19
3-year average	0.16			(excluded)	0.21		
Relative increase in unauthorised absence	0.04						
Annual rate of increase in unauthorised absence	0.01						
Annual rate of absolute increase in unauthorised absence	0.04						

Table 13 Unauthorised absence (percentage points) relative to England average – conventionally-procured rebuilt schools (3-year average)

Year	Before renewal				After renewal		
	-4	-3	-2	-1	+1	+2	+3
Renewed schools	0.44	0.31	0.26	0.19	0.00	0.22	0.08
3-year average	0.34			(excluded)	0.10		
Relative increase in unauthorised absence	-0.24						
Annual rate of increase in unauthorised absence	-0.06						
Annual rate of absolute increase in unauthorised absence	-0.03						

Table 14 Unauthorised absence (percentage points) relative to England average – PFI-procured rebuilt schools (3-year average)



Graph 4 Unauthorised absence in fully rebuilt PFI and conventionally-procured schools relative to the England average (3-year average)

Absence data for the two groups exhibited large variation across years and did not show clear longitudinal trends. Both groups had positive relative unauthorised absence, meaning they had higher absence rates compared to the England average. It was shown in the previous chapter that these two groups had poorer GCSE performance compared to the England average. This supported our hypothesis that higher unauthorised absence is related to poorer educational attainment.

On the whole, the PFI group exhibited decreased unauthorised absence relative to England average after renewal. This is consistent with our expectation that a better school building may improve students' motivation, leading to less truancy. However, the relative absence for the conventional group increased slightly after the renewal.

Over the 12-year study period (1995 to 2007), the England average of unauthorised absence increased from 1.0% to 1.4%. This translated to an England trend rate of 0.03pp per annum. As the data series for the renewed schools were previously detrended, this England trend rate could be added to the relative rate to arrive at the annual rate of absolute increase in unauthorised absence. This rate for PFI schools (-0.03pp) was 0.07pp less than that for conventionally-procured schools (0.04pp).

Paired-sample t-tests were run to determine if the "before" and "after" values were significantly different. No significant results were found, but the difference in unauthorised absence before and after rebuilding for the "PFI" subset was comparatively more pronounced than that for the whole sample and "conventional" subset.

Sample	Sample size	Mean of "before" value (pp)	Mean of "after" value (pp)	t	df	Sig. (2-tailed)
Whole sample	57	0.27	0.14	1.03	56	0.309
Only "PFI" schools	35	0.34	0.10	1.49	34	0.145
Only "conventional" schools	22	0.16	0.21	-0.22	21	0.832

Table 15 t-test results of "before" and "after" absence for rebuilt schools (3-year average)

A t-test was carried out to test the hypothesis that PFI schools improve students' motivation (decrease in unauthorised absence) more than conventionally-procured rebuilt schools. However, statistical significance cannot be established for the 3-year sample.

Relative increase in unauthorised absence	Levene's test for equality of variances		t-test for equality of means		
	F	Sig.	t	df	Sig. (1-tailed)
Equal variances assumed	0.06	0.81	1.09	55	0.14

Table 16 t-test results of unauthorised absence for PFI and conventionally-procured rebuilt schools (3-year average)

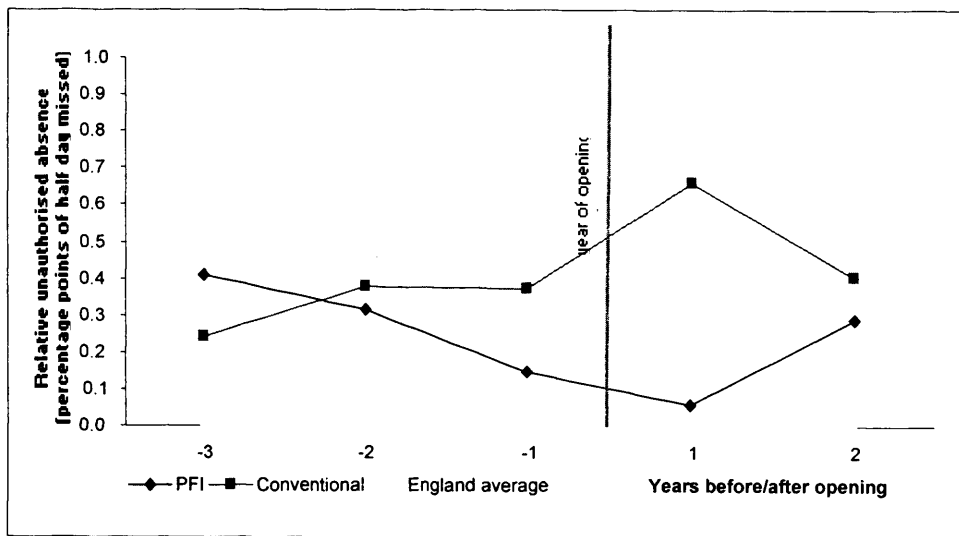
The analysis was repeated with the larger 2-year average sample. The results generally agreed with that from the 3-year average sample. On the whole, the PFI group exhibited decreased unauthorised absence relative to England average after renewal while the conventional group, the relative absence increased after the renewal. Absence for the conventional group increased by an annual rate of 0.07pp. This rate was much higher than the annual rate of 0.01pp from the 3-year average sample. It was found that two schools in this sample had very high increases in unauthorised absence after renewal. For one school, the value was more than four standard deviations away from the group's mean. When these two schools were removed from the sample, the relative absence decreased from 0.22pp to -0.06pp. This reinforced the conclusion reached earlier that the present sample might still be too small and too sensitive to small number of outliers in the sample.

Year	Before renewal			After renewal	
	-3	-2	-1	+1	+2
Renewed schools	0.24	0.38	0.37	0.66	0.40
2-year average	0.31		(excluded)	0.53	
Relative increase in unauthorised absence	0.22				
Annual rate of increase in unauthorised absence	0.07				
Annual rate of absolute increase in unauthorised absence	0.10				

Table 17 Unauthorised absence (percentage points) relative to England average – conventionally-procured rebuilt schools (2-year average)

Year	Before renewal			After renewal	
	-3	-2	-1	+1	+2
Renewed schools	0.41	0.31	0.15	0.06	0.29
2-year average	0.36		(excluded)	0.17	
Relative increase in unauthorised absence	-0.19				
Annual rate of increase in unauthorised absence	-0.06				
Annual rate of absolute increase in unauthorised absence	-0.03				

Table 18 Unauthorised absence (percentage points) relative to England average – PFI-procured rebuilt schools (2-year average)



Graph 5 Unauthorised absence in fully rebuilt PFI and conventionally-procured schools relative to the England average (2-year average)

Adding the England trend rate of 0.03pp per annum to these relative rates, the annual rate of absolute increase in unauthorised absence for PFI schools (-0.03pp) was 0.13pp less than that for conventionally-procured schools (0.10pp). It therefore appeared that PFI schools improved students' motivation more than conventionally-procured schools.

Paired-sample t-tests were run to test the difference in absence before and after renewal. The results generally agreed with that for the 3-year average sample. None of the results were significant, but the difference in unauthorised absence before and after rebuilding for the "PFI" subset was comparatively more pronounced than that for the whole sample and "conventional" subset.

Sample	Sample size	Mean of "before" value (pp)	Mean of "after" value (pp)	t	df	Sig. (2-tailed)
Whole sample	81	0.34	0.30	0.36	80	0.721
Only "PFI" schools	52	0.36	0.17	1.56	51	0.126
Only "conventional" schools	29	0.31	0.53	-0.98	28	0.338

Table 19 t-test results of "before" and "after" absence for rebuilt schools (2-year average)

A t-test was carried out to test the hypothesis that PFI schools improved students' motivation more than conventionally-procured schools. It was established statistically at 0.05 level that unauthorised absence decreased more in PFI schools than in conventionally-procured schools. This was contrary to the results found for the 3-year average sample where no significance was established.

Relative increase in unauthorised absence	Levene's test for equality of variances		t-test for equality of means		
	F	Sig.	t	df	Sig. (1-tailed)
Equal variances assumed	0.53	0.47	1.75	79	0.04

Table 20 t-test results of unauthorised absence for PFI and conventionally-procured rebuilt schools (2-year average)

6.5 Students' Motivation and Educational Attainment

A Pearson correlation test was carried out between improved students' motivation and improved educational attainment for both 2-year and 3-year average samples of rebuilt schools.

Results showed that the correlation was significant at 0.05 level for the 3-year average sample and at 0.01 level for the 2-year average sample. The correlation coefficients were negative, indicating that decreased unauthorised absence was related to increased GCSE performance. The coefficient of determination is the square of the Pearson correlation (Bryman & Cramer 2001). In this case, they were 8.4% and 9.2% respectively, meaning that about 10% of the variation in relative improvement in performance could be accounted for by the improvement (decrease) in unauthorised absence.

3-year sample (N=57)		Relative Improvement in Unauthorised Absence
Relative Improvement in Performance	Pearson Correlation	-0.289
	Coefficient of Determination	0.084
	Sig. (2-tailed)	0.029

Table 21 Correlation test between relative improvement in unauthorised absence and performance (3-year sample)

2-year sample (N=81)		Relative Improvement in Unauthorised Absence
Relative Improvement in Performance	Pearson Correlation	-0.303
	Coefficient of Determination	0.092
	Sig. (2-tailed)	0.006

Table 22 Correlation test between relative improvement in unauthorised absence and performance (2-year sample)

6.6 Representativeness of Sample

As a measure of the representativeness of the "2-year average" sample, one-sample t-tests were carried out to compare the sample mean of the 2007 unauthorised absence data against the mean of all 141 rebuilt schools (including those without sufficient data), the mean of all 331 renewed schools (including those without sufficient data) and the England average.

Unauthorised absence in 2007 (pp)		2-tailed t-test		
Sample Mean	Average of all Rebuilt Schools	t	df	Sig.
1.68	1.68	-0.01	79	1.00
	Average of all Renewed Schools	t	df	Sig.
	1.70	-0.13	79	0.90
	England Average	t	df	Sig.
	1.40	2.15	79	0.04

Table 23 t-test of sample absence mean against all rebuilt average, all renewed average and England average

The results showed that the sample mean was significantly different at 0.05 level from the England average. Therefore, the current sample was not representative of the whole population of state secondary schools in England. This was expected because poorer performing (correlated to higher absence) schools were prioritised for redevelopment. Importantly, the result also showed that the sample mean was not significantly different from the average of all rebuilt and renewed schools. This meant that our sample was representative of the population of schools that were rebuilt or renewed.

6.7 Conclusion

Improved students' motivation, expressed as a decrease in unauthorised absence, was shown to elaborate on the relationship between delivery model and improvement in educational attainment as an intervening variable. Analysis results provided some, though not conclusive, evidence of statistical significance for the hypothesis that PFI rebuilt schools improve students' motivation more than conventionally-procured rebuilt schools. In addition, a significant correlation was found to exist between improved students' motivation and improved educational attainment. It is therefore concluded that PFI rebuilt schools led to greater improvement in students' motivation which then showed up in faster improvement in educational attainment compared to conventionally-procured schools.

7 Path Analysis

A path diagram is developed in this chapter, together with a discussion on the regression modelling and methodological considerations for the proposed path analysis.

7.1 Path Diagram

In the elaboration analysis, one intervening variable was analysed. However, our conceptual framework based on existing literature revealed that the mechanism through which enhanced school buildings impacts on educational attainment is likely to involve many variables. A single multiple-regression model is insufficient, since it can handle only a single response variable. Instead, path analysis is more appropriate as it utilizes a number of regression models to include all proposed relationships in the theoretical explanation (Agresti & Finlay 2008).

The aim of path analysis is to provide quantitative estimates of the causal connections among variables. It entails the use of structural equations which stipulate the structure of hypothesised relationships in a model. These equations are then analysed using regression (Bryman & Cramer 2001).

Path diagram is a graphic summary of the theorized network of relationships. In the diagram, a relationship is represented by a straight arrow pointing from the explanatory variable to the response variable. Path coefficients, written over the arrow, are standardized regression coefficients for the regression equation of the response variable to which the arrows point. They show the direction and relative sizes of effects of explanatory variables, controlling for other variables in the sequence. Every response variable has a residual variable path attached to it in the path diagram. This represents the variation unexplained by its explanatory variables and its coefficient is computed by taking the square root of $(1 - R^2)$ where R^2 denotes the R-squared value of the regression equation for the response variable (Agresti & Finlay 2008).

An explanatory variable may operate on the response variable indirectly through intervening variables. The indirect effect can be computed by multiplying the path coefficients along the indirect path (Bryman & Cramer 2001). The total effect (also called effect coefficient) of an explanatory variable on the response variable is the sum of its direct effect (the associated path coefficient) and its indirect effects.

Box 1 Overview of path analysis

A path diagram (Figure 4) is developed from the conceptual framework to illustrate the mechanism through which variables work through the relationship between delivery model and educational attainment. In order to measure their contribution to the relationship, it is necessary to quantify the variables in meaningful terms. Some of the variables are very broad in scope (e.g. design service) while others are abstract in nature (e.g. teachers' motivation). These variables must be represented through measurable manifest proxies. The variables identified and their suggested measures

are listed in Table 24. Description of the suggested measures is attached at Appendix A.

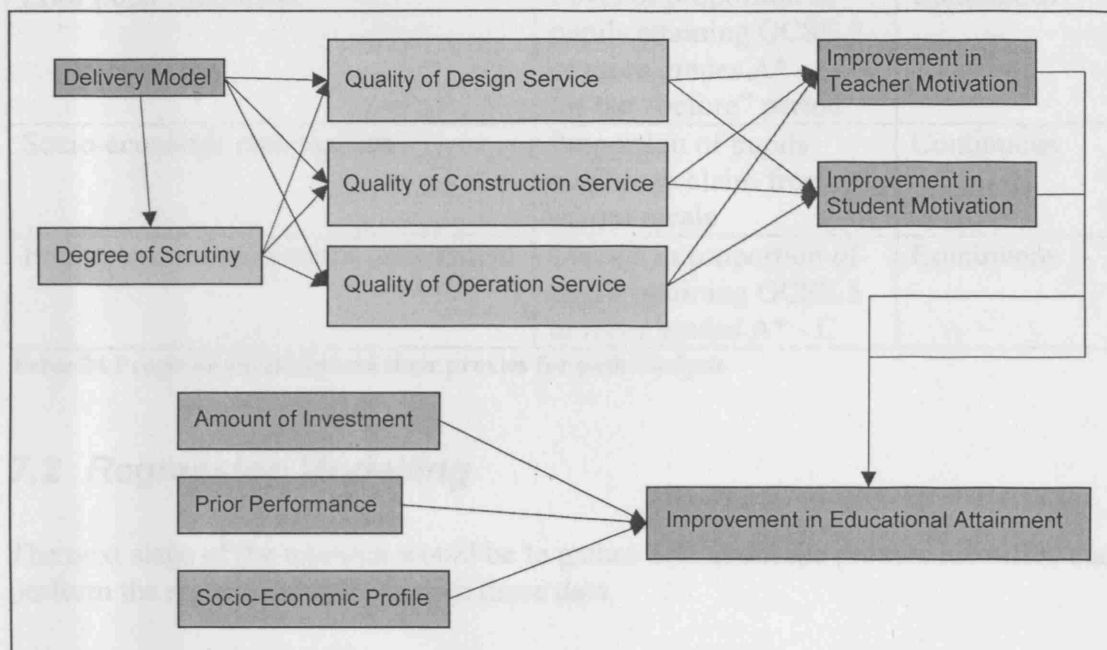


Figure 4 Path diagram

Variable		Measure/Proxy	Level of Measurement
Delivery Model	Procurement Route	PFI or conventional	Nominal
	Degree of Scrutiny	Number of parties providing scrutiny	Ordinal
School Accommodation Service	Design Service	Aggregate score based on survey	Continuous
		Construction Service	Length of the construction period
	Operation Service	Amount of budget overrun	Continuous
		Length of time taken to effect variation	Continuous
Intermediate Outcomes	Improvement in Teachers' Motivation	Change in absenteeism or attendance statistics; Change in staff turnover statistics	Continuous
		Change in amount spent on supply agency on teaching staff	Continuous
	Improvement in Students' Motivation	Change in absenteeism or attendance statistics	Continuous
		Change in exclusion statistics	Continuous

Level of Investment	Amount of capital investment	Continuous
Prior pupil attainment	Level of proportion of pupils attaining GCSE 5 or more grades A* - C for the “before” period	Continuous
Socio-economic composition	Proportion of pupils eligible to claim free school meals	Continuous
Improvement in Education Attainment	Change in proportion of pupils attaining GCSE 5 or more grades A* - C	Continuous

Table 24 Proposed variables and their proxies for path analysis

7.2 Regression Modelling

The next stage of the research would be to gather data about the proxies identified and perform the regression analysis with those data.

Based on the path diagram, seven structural equations (Box 2) are set up for the regression analysis, one for each response variable (variable with at least one arrow pointing into it) in the path diagram.

Denoting the variables as follows:

D = Delivery Model

S = Degree of Scrutiny

Q_d = Design Service Quality

Q_c = Construction Service Quality

Q_o = Operation Service Quality

M_t = Improvement in Teachers' Motivation

M_s = Improvement in Students' Motivation

I = Level of Investment

P = Prior pupil attainment

C = Socio-economic composition

A = Improvement in Education Attainment

The structural equations are:

$$S = a_1 + b_1 D;$$

$$Q_d = a_2 + b_2 D + b_3 S;$$

$$Q_c = a_3 + b_4 D + b_5 S;$$

$$Q_o = a_4 + b_6 D + b_7 S;$$

$$M_t = a_5 + b_8 Q_d + b_9 Q_c + b_{10} Q_o;$$

$$M_s = a_6 + b_{11} Q_d + b_{12} Q_c + b_{13} Q_o; \text{ and}$$

$$A = a_7 + b_{14} I + b_{15} P + b_{16} C + b_{17} M_t + b_{18} M_s$$

In the equations above, a represents the constant term and b represents the respective unstandardised coefficient.

Box 2 Structural equations

Having performed the path regression analysis, the total effect of delivery model on improvement of educational attainment can be determined (Figure 5). This total effect coefficient would represent the size of the effect of delivery model on the improvement of educational attainment in comparison to the effects due to the level of capital investment, prior pupil performance and socio-economic profile of the students.

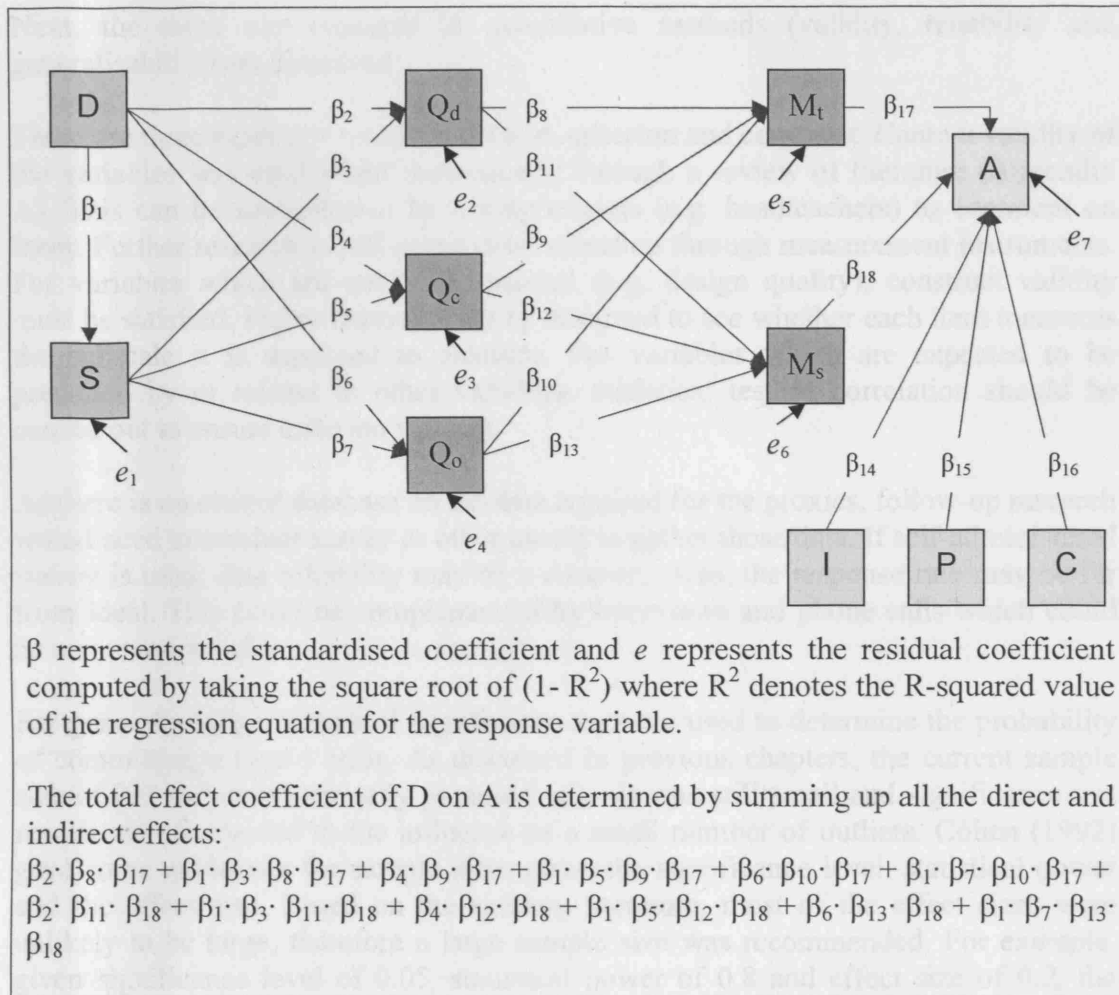


Figure 5 Determination of total effect coefficient

The model can be evaluated and checked against sample data by comparing the predicted correlation with actual sample correlation. If the difference cannot be explained by sampling error, then the causal hypothesis represented by the path diagram is refuted and needs to be amended. Also, if the analysis reveals that certain paths are insignificant, i.e. the β size is close to 0, these paths can be erased. The revised path model may then form the basis for further research (Agresti & Finlay 2008).

7.3 Methodological Considerations

Path analysis, as a form of multivariate regression analysis, cannot establish causality. Causality required three criteria to be satisfied: association, time order and elimination of alternative explanations. Path analysis requires that the researcher specify explicitly

the presumed causal relationship among the variables; this should clarify the time order among variables upfront. The path analysis would also establish if there exists association among variables. However, the path diagram, theorised by the research, must necessarily be a simplification of the real world and would not include all possible variables. It is likely that different results would occur if additional variables are included in the model.

Next, the three key concepts in quantitative methods (validity, reliability and generalisability) are discussed.

There are three aspects to validity: content, criterion and construct. Content validity of the variables was established theoretically through a review of literature (Appendix A). This can be strengthened by asking experts (e.g. headteachers) to comment on them. Further research would entail data collection through measurement instruments. For variables which are multi-dimensional (e.g. design quality), construct validity must be satisfied. Factor analysis may be designed to see whether each item measures the subscale it is supposed to measure. For variables which are expected to be predicted by or related to other variables, statistical test of correlation should be carried out to ensure criterion validity.

As there is no central database on the data required for the proxies, follow-up research would need to conduct survey or other means to gather those data. If self-administered survey is used, data reliability may be a concern. Also, the response rate may be far from ideal. This could be complemented by interviews and phone calls which could be resource-intensive.

For generalisability, statistical significance tests are used to determine the probability of committing a type I error. As discussed in previous chapters, the current sample size of PFI and conventionally-procured schools was still small and significance test results were subjected to the influence of a small number of outliers. Cohen (1992) gave some guidelines for sample sizes given the significance level, statistical power and the effect size. Based on the existing literature, most of the effect sizes were unlikely to be large, therefore a large sample size was recommended. For example, given significance level of 0.05, statistical power of 0.8 and effect size of 0.2, the required sample size was about 150.

8 Conclusions and Recommendations

8.1 Research Overview

The present research built on Verriopoulos's (2007) work about the impact of delivery model on educational attainment. The specific research objectives were:

- 1) to confirm relationship between delivery model and educational attainment;
- 2) to elaborate on the relationship; and
- 3) to develop a framework for studying the mechanism through which the relationship operates.

8.2 Findings from Quantitative Analysis

Bivariate Analysis: Delivery Model and Educational Attainment

The statistical analysis in Verriopoulos (2007) was replicated by incorporating the 2007 GCSE performance results.

The annual rate of improvement for PFI schools (0.82pp) was over three times higher than that of conventionally-procured schools (0.20pp). When the England improvement trend rate of 1.54pp per annum was added, the annual rate of absolute improvement for PFI schools (2.36pp) was about 36% higher than that for conventionally-procured schools (1.74pp). This improvement rate at 36% was significantly lower than that reported by Verriopoulos (2007) at 74% and KPMG (2008) at 92%.

However, the hypothesis that PFI schools improved more than conventionally-procured schools cannot be established statistically, contrary to Verriopoulos's (2007) finding. This was attributed to the large variance introduced into the data with the additional schools.

The bivariate analysis was repeated using only 2-year average with a larger sample of 89 schools. The annual rate of absolute improvement for PFI schools (2.75pp) was 44% higher than that for conventionally-procured schools (1.91pp). Moreover, this difference was established statistically at 0.1 level. This demonstrated that the analysis was highly sensitive to changes in the sample size, implying that the sample size was still too small.

The mean 2007 performance of the 2-year average sample was not significantly different from the mean of all the rebuilt/renewed schools, indicating that the sample was representative of the population of schools that were rebuilt/renewed.

Elaboration Analysis

Analysing the 3-year average sample, the annual rate of absolute increase in unauthorised absence for PFI schools (-0.03pp) was 0.07pp less than that for conventionally-procured schools (0.04pp). However, the hypothesis that PFI schools improved students' motivation more than conventionally-procured schools could not be established statistically.

The analysis, repeated with the larger 2-year average sample, showed different results. The annual rate of absolute increase in unauthorised absence for PFI schools (-0.03pp) was 0.13pp less than that for conventionally-procured schools (0.10pp). It was established statistically at 0.05 level that unauthorised absence decreased more in PFI schools than in conventionally-procured schools.

A significant correlation was found to exist between improved students' motivation (expressed as a decrease in unauthorised absence) and improved educational attainment. The correlation coefficients were negative, confirming the hypothesis that improved students' motivation was related to increased GCSE performance. The coefficients of determination were 9.2% and 8.4% for the 3-year and 2-year average sample respectively, meaning that about 10% of the variation in relative improvement in performance could be accounted for by the improvement (decrease) in unauthorised absence.

The mean 2007 unauthorised absence of the 2-year average sample was not significantly different from the mean of all the rebuilt/renewed schools, indicating that the sample was representative of the population of schools that were rebuilt/renewed.

8.3 Discussion of Quantitative Methodology

Three key concepts in quantitative methods are validity, reliability and generalisability (Muijs 2004).

In the present research, the proportion of pupils attaining GCSE 5 or more grades A* - C was used as the indicator of educational attainment for the following reasons:

- It is a national standard taken by all students completing secondary education in the UK;
- It is calculated on a consistent basis for the longest period compared to other performance indicators e.g. Value Added indices; and
- 5 or more A* - G was not used because for the better performing schools, this value stays consistently at a high level, therefore does not capture improvement of students' performance.

However, it was recognised that student profile for each school differs and with it, external influences such as levels of deprivation and prior attainment differ. Therefore, a measure of the progress made by students, such as value-added (VA), could be more meaningful than the absolute level of attainment. However, there was a lack of consistent value-added data. VA data was first published in 2002 and was replaced by contextual value-added (CVA) in 2006.

Furthermore, educational attainment should be a multi-dimensional construct that comprises more than just academic attainment measured by GCSE results. However, data on non-academic performance of schools was not readily available. In view of the above considerations, GCSE results were determined as a valid measure.

Absence data was selected as indicator of students' motivation as it was available on a consistent basis from DCSF for the entire period under study (1995 to 2007).

Authorised absence was not used because that is absence for which valid reasons were provided. Unauthorised absence, on the other hand, is absence without valid reasons. Therefore, it is indicative of the extent of truancy and the level of students' motivation in that school.

Reliability of the data used for the quantitative analysis was assured by obtaining the data directly from DCSF. Although the data was not error-proof (as evident by some inconsistency between databases), DCSF represented the best possible source of data available.

For generalisability, statistical significance tests are used to determine the probability of committing a type I error. It was shown that the current sample size of PFI and conventionally-procured schools was still rather small and significance test results were subjected to the influence of a small number of outliers. This would continue to be the issue in the near future but would resolve itself as more and more renewed schools become operational under the various waves of BSF.

8.4 Conclusions

The present study, incorporating an additional year of GCSE results, had confirmed the findings that educational attainment improved more in PFI rebuilt schools than conventionally-procured rebuilt schools. However, statistical significance was not consistently established, largely due to the high variance in performance data and the small sample size. These concerns will diminish as more schools re-open after renewal under the massive BSF programme in the next few years. The lack of statistical significance, however, should not overshadow the fact that the average improvement in educational attainment for PFI rebuilt schools was considerably higher than conventionally-procured ones. This finding deserved attention because the sample included all the rebuilt schools with complete longitudinal data.

The elaboration analysis had established students' motivation as an intervening variable between delivery model and improved performance. PFI rebuilt schools was found to improve students' motivation more than conventionally-procured ones, though statistical significance was again not consistently achieved. A significant correlation was found to exist between improved students' motivation and improved educational attainment. It is therefore concluded that PFI rebuilt schools led to greater improvement in students' motivation which then showed up in faster improvement in educational attainment compared to conventionally-procured rebuilt schools.

However, based on the review of existing literature, the mechanism through which enhanced school buildings impact on educational attainment is likely to involve many other variables. Path analysis is necessary to develop an insight into this theorized network of relationships. A path diagram, with its associated structural equations, was developed together with a discussion on regression modelling and methodological considerations. This laid the foundation for a comprehensive path analysis in the next stage of research.

Given that BSF is now being rolled out at full tilt, there is an urgent need to develop a greater understanding of the relationship between delivery model and improved

educational attainment as this could entail policy implications. Rather than delaying the analysis till a large enough sample is available, it is argued that preliminary analysis based on the present sample is still a worthwhile pursuit because tentative results could be useful in guiding procurement decisions in the interim.

8.5 Recommendations

PfS stated that for planning purpose, the working assumption is that where 70% or more floor space of a school is to be rebuilt, PFI procurement is likely to maximise VfM. For schools with a smaller proportion of new build, conventional procurement is likely to achieve better value (House of Commons 2007). However, in the same report, 4ps said that in reality many of the schools that were expected to be procured under PFI will be procured via Design and Build contracts. Local circumstances were cited as playing a part in the decision regarding choice of procurement method. Elsewhere, HM Treasury (HM Treasury 2003; 2006a; 2008) has repeatedly stressed that VfM assessment is the key to deciding the most appropriate delivery model.

The Green Book (HM Treasury 2003) requires public bodies to identify both the costs and the benefits that arise from public investment. It also encourages public bodies to monetise as many benefits as possible, including hard-to-value, intangible benefits. These monetised benefits should be factored into the VfM assessments concerning the choice of procurement route (HM Treasury 2006b). The finding that PFI schools improved performance faster than conventionally-procured schools, constituted such a benefit that should be quantified.

One way to quantify this benefit is shown in Box 3. The proposed path analysis should clarify the extent to which relative improvement is attributable to the choice of procurement method. This, together with the monetised value of the relative improvement in educational attainment and the finding from the bivariate analysis in this research, would allow this intangible benefit to be quantified, leading to a more comprehensive VfM assessment of different procurement routes.

<p>The annual monetised benefit of improved educational attainment of PFI over conventional procurement:</p> <p style="text-align: center;">$\text{£}X \text{ times } Y\% \text{ times } Z\%$</p> <p>where</p> <p>$\text{£}X$ = The monetised value of improvement in educational attainment (e.g. 1% rise in GCSE 5 A*-C leads to $\text{£}X$ increase in GDP)</p> <p>$Y\%$ = The contribution to the improvement due to the choice of procurement route (e.g. $Y\%$ from path analysis)</p> <p>$Z\%$ = The extent to which PFI schools improved more than conventionally-procured schools (e.g. $Z\%$ from bivariate analysis: the annual rate of improvement for PFI schools over that of conventionally-procured schools)</p>
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Box 3 Monetised benefit of improved educational attainment of PFI over conventional procurement

8.6 Further Research

The present study has laid the foundation for a research framework to evaluate the extent to which procurement methods play a part in educational attainment. The first task flowing from this agenda is to collate data on the various variables identified in the path diagram and then perform the quantitative analysis to establish the effect size of the choice of procurement route on the improvement of educational attainment.

A separate research agenda would be to monetise the benefit of improved educational attainment. For example, similar to the OECD's (2001) approach of correlating GDP growth with years of education (quantity of education), it is possible to correlate quality of education (e.g. measured by improvement in GCSE results) with GDP growth.

The timeframe for the present longitudinal study (up to 3 years before and after renewal) meant that only short-term effects of the renewal were measured. It is argued that PFI schools should outperform conventionally-procured schools in the long term because PFI was designed and structured for efficient whole-life operation (Rintala 2004). On the other hand, critics of PFI pointed to its inflexibility to accommodate changes in requirements and demand over the long term. Longitudinal study of longer periods should be conducted as PFI projects mature to clarify these issues with evidence-based research, in the same vein that the current research sought to assess the relationship between procurement route and educational attainment with empirical evidence.

8.7 Contribution to Knowledge

The starting point of the present research was Verriopoulos (2007) and KPMG (2008)'s finding that PFI schools improved faster than conventionally-procured schools. This research incorporated additional data that became available this year. Also, the research procedures have been tightened for a more rigorous assessment.

The main contribution of the research was the elaboration of this relationship by establishing students' motivation as an intervening variable. Further, the development of the conceptual framework and the path model helped to create a deeper understanding of the dynamics behind the relationship and pave the way to an in-depth analysis of the mechanism behind this relationship.

While a full quantitative assessment may not yet be available, the findings and theoretical framework in this report should assist decision-makers in their qualitative VfM assessment concerning procurement choice. This has immediate relevance to the UK government as the BSF programme continues apace.

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Suggested Measures for Path Analysis

A. Delivery Models

Delivery models are separated into 2 groups. PFI and Conventional. Conventional procurement refers to both D&B and DBB contracts.

PFI schools procured via LEP benefit from the oversight by both public and private partners in the LEP as well as the due process taken by private finance lenders. The latter was judged to be most significant as private finance providers had the greatest incentives to ensure the success of the project as repayment to their loans would suffer if the project failed. Private finance providers also had the best expertise and resources to conduct this scrutiny since scrutinising deals was their core business. PFI schools procured outside the LEP framework still benefit from the scrutiny taken by private finance lenders, but not from the private strategic partner.

Conventionally-procured schools via LEP were subjected to less scrutiny due to the absence of private finance providers but were still given oversight by the public and private sector partners which were experienced in the provision of accommodation service. Conventionally-procured schools outside LEP received the least scrutiny because private sector expertise was unavailable for evaluating the deal.

Suggested Measure:

An ordinal measure, determined by the number of parties providing scrutiny, as follows:

<i>1 (least scrutiny)</i>	<i>Conventionally-procured, non-LEP</i>
<i>2</i>	<i>Conventionally-procured, LEP</i>
<i>3</i>	<i>PFI, non-LEP</i>
<i>4 (most scrutiny)</i>	<i>PFI, LEP</i>

B. Design Service

The scope of this variable is very wide. It comprises both the quality of the design output (e.g. a high-performance building) and the process of producing the design (e.g. how the relevant stakeholders are being engaged and consulted). DQI for schools (CIC & DCSF 2008) is a process for evaluating the design quality of school buildings from the inception of the project through the design stages to completion of the building (CIC & DCSF 2008). It has been used by Audit Commission (2003) in assessing school design quality. It encompassed the three dimensions of functionality, build quality and impact. In addition, it put in place an engagement process to ensure design quality at every key stage of the development.

As DQI was launched only in July 2002 and was not a mandatory requirement for public projects, a good number of schools projects would not have undergone the process. To use DQI score as the proxy for design quality therefore requires the researcher to undertake a huge exercise to carry out DQI assessment for all operational schools which had not previously undertaken the assessment.

Alternatively, the researcher could design a survey, e.g. a shortened version of the DQI questionnaire such as that in CABE (2006), to measure the effectiveness of the design process plus the design quality along the three key headings of functionality,

build quality and impact. These could then be summed up in an aggregate score for further analysis.

Suggested Measure:

Aggregate score based on survey on the effectiveness of the design process plus the design quality along the three key headings of functionality, build quality and impact

C. Construction Service

Literature revealed that PFI offered better time and cost efficiency in construction performance. Most public sector managers were also satisfied with the build quality (NAO 2003). Build quality has been considered under design quality, hence this variable should focus on construction time and cost.

Of the two, time efficiency or the length of the construction period will have a more direct impact on school users. The longer the construction period, the longer they will have to make do with existing facilities. This will have an impact on the morale of teachers and students. Therefore, the length of construction period could be a proxy for the construction quality. It is acknowledged that the length may be affected by other project-specific issues such as ground condition.

Even though cost efficiency may not be an immediate concern to end users, on a more macro level, cost efficiency in construction could translate to more funds available to other areas of educational needs. Price certainty is an important aspect of cost efficiency. NAO (2003) reported that 73% of conventionally-procured projects suffered budget overrun compared to only 22% of PFI projects. Amount of budget overrun can also be used as a proxy to construction quality.

Suggested Measures:

The length of construction period; Amount of budget overrun

D. Operation Service

There are two aspects to operation service which may impact on school users. First, the efficiency and effectiveness of the service. This could be reflected in the length of time taken to effect variation, length of downtime of essential facilities, flexibility to accommodate changes, etc. Second, the amount of school management time spent on infrastructure related matters. Management time is a scarce resource, the less time school users need to worry about infrastructure matters, the more time they can focus on educational attainment. As cited in PWC (2003), one LEA put it succinctly: good operation service allowed teachers to concentrate on “brains, not drains”.

Suggested Measures:

Length of time taken to effect variation; Amount of school management time spent on infrastructure related matters

E. Improvement in Teachers' and Students' Motivation

PWC (2001) found that general attitudes, behaviour amongst students and teachers were more conducive to learning in schools which had significant capital investments. The analysis was carried out using data from OfSTED.

The proposed study differs from the studies conducted by PWC in the sense that it is longitudinal, i.e. of interest is the difference before and after the renewal. We therefore require data series which persist over time. The data from OfSTED is found to be unhelpful as the judgement criteria changed over the years, e.g. teachers' attitude is no longer inspected separately in the newer reports.

Data, other than those available from OfSTED, is therefore required for these two variables. As noted in the literature review, Green & Turrell (2005) suggested proxies such as attendance, turnover and behaviour patterns. Indeed, Buckley et al. (2004) and Schneider (2003) found that facility quality was an important predictor of the decision of teachers to leave their current positions. For student behaviour, Cash (1993) measured student behaviour by the per-student ratio of disciplinary incidents reported, number of suspensions and expulsions. In our elaboration analysis, unauthorised absence was used as the proxy for students' motivation.

Suggested Measures:

<i>Teachers' Motivation</i>	<i>Students' Motivation</i>
<i>Staff turnover statistics (Retention & recruitment)</i>	<i>Absenteeism or attendance statistics</i>
<i>Amount spent on supply agency on teaching staff</i>	<i>Exclusion statistics</i>

As we are interested in the "improvement" in these proxies as a result of the renewal, a similar process of "before" and "after" operations should be applied to these statistics as that performed for unauthorised absence and GCSE data in this research.

F. Improvement in Educational Attainment

In the present research, the proportion of pupils attaining GCSE 5 or more grades A* - C was used as the indicator of educational attainment for the following reasons:

- It is a national standard taken by all students completing secondary education in the UK;
- It is calculated on a consistent basis for the longest period compared to other performance indicators e.g. Value Added indices; and
- 5 or more A* - G was not used because for the better performing schools, this value stays consistently at a high level, therefore does not capture improvement of students' performance.

However, it was recognised that student profile for each school differs and with it, external influences such as levels of deprivation and prior attainment differ. Therefore, a measure of the progress made by students, such as value-added (VA), could be more meaningful than the absolute level of attainment. However, there was a lack of consistent value-added data. VA data was first published in 2002 and was replaced by contextual value-added (CVA) in 2006. Instead, it is proposed that those external influences be addressed by introducing appropriate control variables into the path model.

Furthermore, educational attainment should be a multi-dimensional construct that comprises more than just academic attainment measured by GCSE results. However, data on non-academic performance of schools was not readily available. In view of the above considerations, GCSE results were determined as a valid measure.

Suggested Measures:

Proportion of pupils attaining GCSE 5 or more grades A - C*

G. Control Variables

The amount of capital spend is controlled to eliminate its effect on the analysis since our interest is on the effect of the different delivery model on educational attainment, not whether a greater capital spend produces greater educational attainment (a relationship which has been generally established in the literature).

PWC (2001) found that schools whose performance levels at the beginning of the period being studied were relatively high, tended to improve their performance by less than schools which were starting out from a lower base. This is consistent with the economic theory of diminishing returns. Also, it found that schools in which a large proportion of pupils were eligible to claim free school meals (a proxy used for the socio-economic composition of the pupils in the school) generally improved their performance by less than those schools in which only a small proportion of pupils were eligible.

To eliminate these potential factors from distorting the analysis results, these variables should be controlled in the regression for the improvement on educational attainment.

Suggested Measures:

<i>Level of Investment</i>	<i>Prior Pupil Attainment</i>	<i>Socio-economic Composition</i>
<i>Amount of capital investment</i>	<i>The level of GCSE 5 or more grades A* - C of the "before" period</i>	<i>Proportion of pupils eligible for free school meals for the period studied</i>