Economic Systems, Vol. 18, No. 2, June 1994, pp. 87–116

STRATEGIC TECHNOLOGY POLICY FOR EASTERN EUROPE

Slavo Radosevic *

In this paper I apply the concept of strategic technology policy (STRTP), originally developed by Justman and Teubal, to the East European situation. I view strategic technology policy as an indispensable bridge between science policy, industrial policy and competition policy. Strategic technology policy means explicit targeting for the improvement of technological and related capabilities, based on co-ordination between groups of enterprises and government. The concept is discussed in the context of three different theoretical approaches to technology policy—neo-classical, transaction costs and evolutionary.

The analysis is then applied to the example of Croatia, on the basis of which I generalize and apply the STRTP concept, distinguishing between three groups of industries which differ regarding the loci of their technological capabilities—production know-how based, engineering based and R&D based. I conclude that STRTP must be based primarily in the evolutionary approach, but that in Eastern Europe it should incorporate some of the features of transaction costs and neo-classical approaches.

1. Introduction

The East European countries[1] are currently faced with the task of formulating technology policies which will be closely linked to their industrial capabilities and will improve their competitive positions. S&T policies based on the notion of compensating for market failure do not on the whole address the kind of problems that East European countries face. The concept of strategic technology policy (STRTP) offers a theoretical basis for a policy approach that tackles the structural blockages and strategic choices that dominate the agenda in Eastern Europe today. The STRTP concept is not a theoretical *inventum*, but a piece of *ex post* theorising derived from existing policy practice in OECD

* Science Policy Research Unit, University of Sussex, Falmer, Brighton BN1 9RF, United Kingdom. This paper is part of an ongoing project on: The Role of S&T Policy in the Economic Transformation of Eastern Europe and the former Soviet Union, supported by the Leverhulme Trust. I am grateful to Chris Freeman, Nick von Tunzelmann, Keith Pavitt, Margaret Sharp, David Dyker and Richard Nelson for very useful comments on earlier versions of this paper. I alone am responsible for any remaining errors and omissions.

[1] Eastern Europe denotes here the countries of Central and Eastern Europe, and excludes the countries of the former Soviet Union.

countries, which is in turn based on the new relationships that have emerged between government, industry and universities. The most notable examples are the EC programs ESPRIT, JESSI, OMI (Open microprocessor initiative), and the British ALVEY program, as well as the well-known Japanese VLSI project and Korean DRAM program.

Strategic technology policy is explicit targeting for the improvement of technological and related capabilities based on the co-ordination of groups of companies and government.[2] It is strategic in the sense that its formulation and implementation is based on interaction between firms, or between firms, universities and government.[3]

While the activist type of industrial policy focuses on selected industries, STRTP concentrates on targeting deficient capabilities.[4] In conditions of increasing marginalization of Eastern European S&T systems, STRTP is a conceptual attempt to give them more direct relevance, in the context of a predominantly *laisser faire* atmosphere.

In the next section I set up the theoretical framework for discussing technology policy. Three different theoretical approaches to technology policy are discussed—neo-classical, transaction cost and evolutionary. Then the STRTP idea is applied to the examples of a few Croatian industrial sectors. In the last part I elaborate on the main issues that the application of STRTP in Eastern Europe might raise. The concept is further developed by applying it to three groups of industries which we distinguish on the basis of locus of technological capabilities—R&D based, engineering based and production know-how based.

2. The problem of capability enhancement in the policy context of Eastern Europe

2.1. Incentives, institutions and capabilities

The problem of development policy formation in Eastern Europe has so far been confined to the dimension of macroeconomic policy. The dominant policy advice has been as follows: free prices, remove subsidies, open the economy to international trade, make the currency convertible, privatize public enterprises, and invite in foreign investors. This, it has been argued, will produce an

[2] The concept is developed theoretically by Justman and Teubal (1992).

[3] STRTP should not be confused with policy to support strategic technologies. The term "strategic" here refers to the interactions of various agents which jointly determine policy outcomes, as in "strategic" trade theory. It connotes primarily strategic *intentions*. Obviously the *effects* of the programs may be much less than originally intended. In other words, strategic intentions and interactions may end up as merely *tactical* improvements for the companies involved, for the most part confined to the R&D function.

[4] Justman and Teubal (1992, p. 1) define STRTP as a policy which targets technology *infrastructure*, rather than industries.

intensive marketization process. And it cannot be denied that in practice an irreversible process of economic change, much shaped by these principles, has indeed been launched.

However, the process of marketization is unfolding at a much slower pace than originally expected, particularly as regards privatization. This has led to widespread re-examination of the theoretical basis of standard policy advice to Eastern Europe. It has become clear that the *institutional* requirements for the market economy have been seriously underestimated. More concretely, the state of institutional vacuum has deepened a crisis that would in any case have been extremely profound.

This neglect of the institutional basis of the market economy originates from the perception of that construct as a 'pure market economy', where there is no explicit place for active social and political actors. In practice, markets are not abstract spaces, but rather the product of society, and of institutional development processes. Recognition of the role of institutions has led us beyond the old slogan of "getting the prices right", to a new one of "getting (at least some) institutions right" [Winiecki (1992)], and also to an explicit recognition of the need for policy to offset "institution failure" [Sharp and Pavitt (1993)]. The institution-creating issues are now increasingly seen as critically relevant to the business of building market economies in this region.

However, from a technology perspective, a policy framework which comprises only incentives and institutions is insufficient—for it neglects the third dimension—the role of *capabilities*.[5] Enterprises may have certain capabilities which enable them to react faster to given incentives within a given institutional setting. It is these capabilities that ultimately determine what can be achieved. It is clear that, in the long run, economic growth is the result of the interplay between incentives and capabilities, moulded through institutions [OECD (1987)]. Let us now look at these elements in greater detail.

1) *Incentives* are shaped primarily by macroeconomic policy and derive from prices.
2) *Capabilities* are shaped primarily by educational, industrial and technology policy, and represent economic competencies which enable the identification, expansion and exploitation of the opportunity set.

[5] Even the recent literature on strategic management does not pay particular attention to capabilities. The so-called "competitive forces approach" in strategic management [Porter (1990)], which is rooted in the "structure-conduct-performance" paradigm, presumes that capabilities *per se* do not pose a problem, since "the smart money will back the guys who are able to put pieces together" [Teece et al. (1990)]. Consequently, the argument continues, enterprises should worry only about how to get into good strategic position to defend themselves against competitive forces or to influence them in their favour. "The dynamic capabilities" approach developed by Teece, Pisano and Shuen (1990), in contrast, predicates that strategic change, which is value-augmenting, is difficult and costly to perform. The underlying argument is that capabilities must be built—they cannot be bought.

3) *Institutions* are the end-products of institutional transformation and adaptation and shape or are shaped by the above two components (see Figure 1).[6]

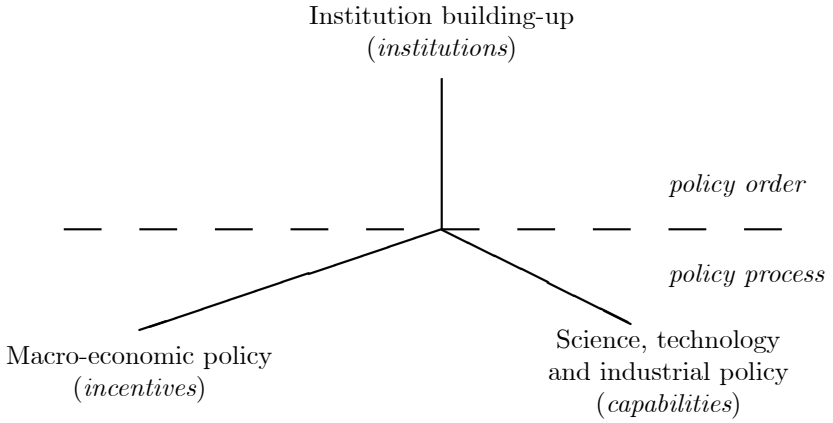

FIGURE 1
The elements of transition policy

It is clear that without strong incentives, i.e. a set of competitive prices, capabilities cannot be used and upgraded. It is equally true that without capabilities incentives cannot operate. Institutions, in turn, set the rules of the game and modify incentives and capabilities. In short, there is mutual dependence of institutional conditions (order policy) and macro economic policies and micro economic policies/reactions (process policy). All three components are essential ingredients of a "virtuous circle" in which processes of learning are reinforced by a stable macro economy and a congenial institutional setting.

Reviewing the current standard policy advice package to Eastern Europe in the context of this "incentives, capabilities, institutions" framework, we may conclude that in the sequence of policy options a stable macro economy and a corresponding institutional basis are necessary first steps. However, they do not, by themselves, rebuild the real economy. In practice, the process of marketization and institutional development will be constrained by the extent to which capabilities are upgraded. The effect of any set of market incentives on enterprises will remain limited, as long as the latter remain unable to respond

[6] These categories are primarily analytical. In practice it is very difficult to separate them. For example price systems, especially prices of labour and capital, are institutionally embedded, and cannot be readily changed without changing the institutions. Equally, it is difficult to separate institutions from technologies. See Sorge (1993).

to them in an efficient way. Policies that enforce processes of restructuring on a micro level, and which address problems of firms' capabilities, are as important as macro policy. This makes technology and industrial policy an indispensable input into the transition process.[7]

2.2. Science policy, industrial policy and (strategic) technology policy

In the last sub-section I defined technology policy as being focused on the dimension of capabilities. However, science policy and industrial policy also target this area.

Science policy deals with the science base, therefore not necessarily with production and technological capabilities. It is, however, crucial in its impact on the science system. The overmanned and inefficient science system in Eastern European countries badly needs a new science policy. The enforced downscaling of R&D systems in these countries exerts strong pressure for radical transformation. It is, nevertheless, primarily in firms and sectors that the problem of weak capabilities in the economies in transition is located. To the extent that the science base is decisive in upgrading production and technological capabilities, however, it plays an important role. The role of the science base varies greatly between sectors, and there are clear limits to the extent to which science policy can, by itself, be relied upon as a mechanism for the technological regeneration of Eastern Europe.[8]

Industrial policy is a very loose term, covering a wide set of activities oriented towards specific industries and firms. During the seventies, industrial policy was focused on alleviating the consequences of structural change by assisting the process of demise of sunset industries, primarily in Western Europe [Cowling and Thomas (1990)]. Its very specific, *activist* application in East Asian countries has certainly contributed to structural change in these countries. It is very unlikely, however, that it could be applied in Eastern Europe in this activist form. It could be applied as *neutral* industrial policy.[9]

Neutral industrial policy is relevant to Eastern Europe in that it tries to synthesise two approaches to growth—the *modified structuralist* (import substitution, massive protection, intervention on a micro level), and the *neo-classical* or liberal (export orientation, foreign trade liberalisation, "hands-off" approach). The neutral industrial policy approach admits that structural change is central to the growth process, and also that an export-oriented and liberal approach

[7] Technology and industrial policy are here understood, not as normative policies, but as sets of activities, under various institutional labels, which focus on improving firm-level capabilities.

[8] I am not talking about *innovation* policy here. I see that as a comprehensive notion that tries to capture the importance of "non-technology" policies (trade, education, competition, etc. policies) for technological development. This comprehensiveness is both the main strength and the main weakness of the concept of innovation policy. It seems difficult to operationalize, and I see its value primarily as a kind of "awareness raising" concept.

[9] The concept of 'neutral' industrial policy is elaborated in Justman and Teubal (1988).

necessarily limits the role of government in correcting the operation of market forces and promoting structural change. This implies correction, support and stimulation, rather than substitution of market forces. The neutral approach argues that government should support the improvement of quality of key inputs—education and training, telecommunications infrastructure, in addition to offering technical assistance, access to cheap capital, etc. However, these should not be differentiated by sectors—that is the force of the "neutral"—but only by activities (capabilities). Subsidies are offered for any project proposed by enterprises that satisfy minimal conditions. This ensures that relative profitabilities of enterprises are not changed. At this point, however, it becomes increasingly difficult to separate industrial from *technology policy*.

Strategic technology policy differs from the conventional notion of technology policy in its shift of emphasis from infrastructure and science to firms. The more conventional approach may be termed *general technology policy*.[10] It is general in the sense that it is not addressed to specific groups or sectors, and it offers or supports freely available information (e.g. general infrastructure). It usually encompasses the building-up of the general education and science infrastructure, and neutral instruments like R&D tax credits, grants for innovation, pre-competitive R&D and innovation infrastructure which are applied irrespective of sectors.[11] STRTP, by contrast, addresses the capabilities of enterprises explicitly, and supports the creation of knowledge that is very localized or semi-proprietary.

Whereas general technology policy is not very much concerned with enterprise behaviour, because it is "firm neutral", STRTP is based explicitly on the reactions of enterprises, and on strategic interactions of firms and governments. The firm is not seen as an isolated entity, but as an organism that feeds itself by interacting with its surrounding environment. STRTP assumes that the behaviour of an individual company is part of a pattern of collective behaviour that can be induced or co-ordinated, even though the company retains full independence. *Strategic response* on the part of companies is the very essence of the strategic technology policy concept.

The instruments of general technology policy provide a workable solution in a stable macroeconomic situation, where the dominant problems are of a purely tactical or evolutionary character. In Eastern Europe, by contrast, R&D tax credits, for example, will not re-orient companies strategically, however extensively they are applied. Financial incentives for R&D and innovation do not meet the need for co-ordination and strategic negotiation. In Eastern Europe today, uncertainties and risks are too big to be resolved by generalized, tactical policy instruments.

[10] A similar distinction is used by Dosi; see UNCTAD (1993).

[11] This neutrality is in practice very conditional. Usually such measures favour big firms which are able to bear the high governance (transaction) costs of participating in such programs.

The importance of STRTP stems from the observation, supported by the recent empirical work, that competitive advantages of countries arise not only from general factors (education, science), but also from specific factors (sector-specific, specialized knowledge) [Porter (1990)]. These cannot be addressed by activities focused on general infrastructure and general instruments.

2.3. Market failure, strategic uncertainty and interdependence as theoretical justifications for technology policy

The proposition that policies addressing problems of firms' capabilities be given the same weight as macro economic policy and institutional development for macro economic policy will meet with very little opposition. Where disagreement will appear is in regard to the type and the extent of such policies. I shall briefly present three theoretical perspectives that may serve as justification for very specific policy practice in Eastern Europe. These perspectives are based on the neo-classical, transaction cost and evolutionary frameworks.

2.3.1. The neo-classical justification for technology policy

Based as it is on the Pareto optimality criterion of welfare maximization, this framework recognises the inability of perfect markets efficiently to allocate resources with public goods components, i.e. where there are significant external economies.[12] In such cases "market failure" occurs because economic agents cannot appropriate all the benefits from investment in these "goods"—which leads to under-investment [Nelson (1959); Arrow (1962)]. In cases where the market mechanism is not the best allocator of resources, neo-classical theory accepts that intervention, in the form of subsidies and tax relief, is legitimate. As information is also a commodity with public good characteristics, this must apply to S&T as well.

Applying the "market failure" argument to Eastern Europe would limit the scope of policy to support for those activities that can be considered public goods, i.e. basic research, the S&T infrastructure, education etc.

[12] Bator's (1958) classic analysis of the problem shows that "market failure" is an endemic and pervasive phenomenon, not confined to the public goods component. He defines an externality in terms of "any situation where some Paretian costs and benefits remain external to decentralised cost revenue calculations in terms of prices." Using his analysis of market failure, we may argue that perfect markets may fail to recognise all the benefits and costs of technological change on account of three types of externalities. The first is caused by the character of information as a good with a public component (market failure by existence). Additional information consumption will not lead to a loss for other users, since marginal costs of use are zero. The second externality arises out of incomplete ownership over information on account of significant spillovers and the impossibility of full protection (failure by enforcement). The third cause of market failure stems from indivisibilities of technical information and knowledge (failure by structure). Since, however, these arguments pose more questions than they provide answers from the neo-classical perspective, we will confine ourselves to the "orthodox" understanding of the neo-classical perception of "market failure".

2.3.2. The transaction costs justification for technology policy

The transaction cost school perceived that a world in which the main problem is to satisfy Pareto welfare criteria is a world without transaction costs. Coase's theorem demonstrates that the argument for public intervention on grounds of market failure is logically inconsistent, in that it compares a world with zero transaction costs with a world with transaction costs [Demsetz (1969); Dahlman (1979)].[13]

Once we assume, realistically, a world with transaction costs, then the liability assignments and ownership rights start to have effects on the allocation of resources. In a transaction costs world the very idea that there is a norm against which potential intervention can be judged loses ground.

In that context, the privateness or publicness of a given activity ceases to be an inherent characteristic. Since appropriability of innovations is dependent on the system of property rights, the proper areas for technology policy will to a great extent depend on the way regulations that enforce appropriability are structured. For example, if patent legislation is rather weak, there is no point in just taking general measures to stimulate innovation. On the other hand, if patent law is too restrictive, diffusion might be seriously hampered.

The transaction cost view provides justification for government action that cuts down costs of interaction between firms. Any kind of strategic coordination that reduces uncertainty among agents, as well as any activity that reduces search and information costs, bargaining and decision costs and policing and enforcement costs, is legitimate.

Co-operative R&D programs, private provision of public programs like venture capital schemes, consultancies and so on, can be justified on the basis of potential transaction costs reductions. The transactions cost approach thus offers justification for a wide range of public/private mechanisms in technology policy, in areas where the neo-classical perception of clearly defined "public goods" tends to lose its meaning.

The transaction cost approach sees the main problem of allocative efficiency as an informational problem. As institutions are in essence uncertainty-reducing structures, we may claim that this approach is focused on only two dimensions—incentives and institutions. The power of the approach lies in its recognition of the mutual dependence of incentives and institutions, and in the abandonment of the idea of "optimal" behaviour, on the grounds that the world is transaction-cost constrained. However, the approach says less about dynamic problems and the role of policy in promoting structural change. In fact the transaction cost theory may be best seen as a static framework, useful for analysis of short-term problems. At a certain level, when all the possibilities of increasing allocative efficiency through reduction of transaction costs or estab-

[13] It is puzzling that the bulk of the literature on technology policy avoids any reference to transaction costs in analysis of the Arrow type of argument as a basis for policy.

lishment of appropriate organizational forms (markets, hierarchies, networks) are exhausted, this approach reaches its limits.[14]

2.3.3. The evolutionary framework for technology policy

The evolutionary approach recognises potential interdependencies and complementarities and their dynamic effects when coupled with the appropriate incentives and organizational forms. However, the most important novelty of evolutionary theory is the idea that these interactive mechanisms, of which prices are only one, occur in a world where capabilities cannot be reduced to the possession of information, since knowledge is to a great extent tacit and local, and as such inseparable from the organizations from which it derives [Foray (1993)]. The emphasis is on dynamic and diffusion effects generated by the coupling of interdependencies and incentives. The implicit policy recommendation goes beyond strategic co-ordination to reduce uncertainties, as in the transaction costs approach, to encompass activities that strengthen complementarities and connectivity within the S&T system, and between it and the economy. In short, any policy that improves the economy's dynamic efficiency is legitimate in the mirror of evolutionary theory.

2.3.4. Neo-classical, transaction cost and evolutionary approaches in comparative perspective

Coming back to our conceptual—"incentives, capabilities, institutions"—framework (Figure 1), we see that the neo-classical framework confines itself to incentives, that the transaction cost framework explicitly addresses both incentives and institutions, while the evolutionary framework encompasses feedbacks (positive and negative) between incentives, institutions and capabilities, as well as these categories in themselves. What do these differences mean in practical policy terms?

There are *a priori* cases which qualify for intervention from a market failure perspective, but not from a transaction cost point of view. These are the cases where the costs of intervention may exceed the potential welfare effects, even though from a market failure point of view the intervention is justified. By the same token, we may find cases where action is not justified from a market failure point of view, but where external and multiplicative effects are such that intervention is justified from a long-term, evolutionist, point of view.

Neo-classical and evolutionary views both recognise the role of externalities. However, for the former these are deviations from an attainable optimum (Pareto relevant externalities), while for the latter they are sources of potential

[14] Langlois (1992) offers a rare attempt to develop transaction costs theory as a dynamic concept. The dynamism comes from the notion of dynamic governance costs. These are the costs of transferring capability, or the costs of not having the capability you need when you need it. This approach clearly tends to fusion with the evolutionary approach.

dynamic growth. The transaction cost view, on the other hand, questions the very existence of externalities, in recognising only those externalities which cannot be internalized through alternative property arrangements, i.e. Pareto irrelevant externalities. A transaction costs approach would investigate whether those interested in the results of inventions could negotiate with inventors and compensate them for increased "production". The neo-classical view would take the current state of affairs as "normal", and seek to determine whether support for inventors could be justified on grounds of externalities. Support for S&T infrastructure would be evaluated from the neo-classical view on a cost/benefit basis, while the evolutionary view would seek to take into account the dynamic and multiplicative effects that such investment might have.

Whereas the "market failure" approach is only concerned with price distortions and with the financial interventions needed to correct these, the evolutionary is concerned with all aspects of structural blockage or strategic choice in industry. The focus of market failure based policy is on corrective taxes and subsidies, to the detriment of the potential co-ordinating role of the government or business associations. Co-ordination from the evolutionary viewpoint should be understood in a broader sense to encompass a wide range of informal mechanisms or associations which function as *mechanisms of economic articulation* [Robertson (1992)]. These mechanisms (consumer and producers' associations, enterprise-university associations, etc.) operate in some countries as developed networks, functioning in complementarity with the dynamics of market forces, negotiating over "market failures", and facilitating the working of complex economic mechanisms.[15] This co-ordinating role, i.e. the actual operation of mechanisms of economic articulation, can occur in very different institutional arrangements, and as "soft" or "hard" intervention. For that reason, the quality of policy is a constant concern of the transaction cost approach. While it is interested in these mechanisms from the allocation point of view, the evolutionary approach is interested in terms of their role in the process of knowledge accumulation.[16]

The policy practice of the OECD countries abounds in programs, grounded on different principles, but which may all be labelled as neo-Schumpeterian, and thus treated as applications of the evolutionary approach. Their implicit

[15] The fact that the Japanese aluminium industry was, within three years, able to reduce its capacities by 50% cannot be explained either by the high quality of market incentives in relation to other countries or by strong government intervention, but only in terms of highly developed "mechanisms of economic articulation". The example of the German Social Market Economy shows how rich the network of decentralized links between business and government can be. Great Britain, by contrast, is centralized but "economically non-articulated" because it has weak mechanisms of economic articulation [Robertson (1992)].

[16] The difference between these two views can be interpreted in the following way. The transaction cost view offers a negative explanation of the existence of institutions, claiming that activities have to be integrated because they cannot be separated on account of high transaction (governance) costs. The evolutionary view gives a positive explanation of the existence of institutions, claiming that activities have to be integrated because of synergies between them which lead to the improvement of competences [Foray (1993)].

basis is the perception that the complexities of competitive situations cannot be reduced to textbook situations where divergences between private and social profitabilities can be discerned easily, and appropriate levels of temporary intervention determined. This perception must be at least as appropriate for Eastern Europe. However strong the incentives are, if they do not address key deficiencies they will fail to effect changes. Remember that in a neo-classical world the problem of capabilities does not exist. Any price change instantly ensures the appropriate supply of capabilities. In conditions of actual transition, gradual adjustment of incentives to firms' capabilities, i.e. processes of adjustment on a micro level, are essential. The experience of East European countries, where some enterprises have been and are still exposed to "big bang" shocks (Poland) while others have undergone a more gradual process of marketization (Hungary), clearly confirms this. When the shock is too big, threatening the very survival of the firm in its existing form, it effectively hinders adjustment [see Estrin et al. (1993)].

2.4. Neo-classical, transactional and evolutionary approaches to technology policy in the context of Eastern Europe

In this part I will try to flesh out the practical policy implications of these different theoretical frameworks for East European technology policies:

2.4.1. The neo-classical view

The essence of this view lies in the principle that changes in relative prices should be *marginal*, so that they can perform their allocative function, and the belief that where the price system in general is heavily distorted, individual prices cannot allocate resources efficiently. Therefore a rational cost/benefit approach to estimating the (in)appropriateness of intervention in any given case is infeasible. In practice the various alternative policy instruments have to be ranked according to the criteria (subjective) of the intensity of distortions of relative prices that they produce (hierarchical approach) [Corden (1974)].

It is clearly of immense importance to establish allocative price efficiency in Eastern Europe. The region presents an extreme example of the misguided use of the price structure as a means of achieving national goals, such as is observed in many developing countries. [Cody et al. (1990)]. In that context the neo-classical view delivers a salutary warning on the welfare effects of excessive intervention.

However, in addition to their *allocative* function, prices also fulfil the function of *adaptation* mechanisms, i.e. conveyors of structural change. If countries and enterprises had always been constrained by the principles of static allocative efficiency, they would never have managed to exploit dynamic competitive advantages. So, a certain degree of distortion seems indispensable for promoting structural change. Certainly, empirical research suggests

that policy-induced distortions should be held at a minimal level [Dornbusch (1990)]. However, in the light of the degree of environmental degradation in Eastern Europe, for example, it is difficult to see how environmental concerns could be reconciled with the objective of minimal price distortions.

2.4.2. Transaction cost approach

The transaction cost perspective is very revealing in any East European policy-formation context today. In conditions of radical or "structural" uncertainties, transaction costs probably reach their extreme values. In that kind of situation, old style "co-ordination" and S&T policy, emanating only from the public authorities, does not work. Any successful new policy must rely for its implementation on private actors and on their entrepreneurial abilities. However, pure supply side programs that "deliver" needed services to users are too expensive in relation to current financial possibilities. Eastern Europe today needs very innovative, low-budget programs in technology policy, programs that will involve a large number of actors. The "private production of public goods" approach should be a high priority for policy-makers.[17]

The transaction cost theory argues that there are no areas that are predestined, *a priori*, for either public or private action. That proposition can be interpreted as positing that there is no public program which cannot be implemented by private agents.[18] Alternatively, schemes could be based on public/private co-operation. This is an extremely important point on account of the low administrative capability in Eastern Europe to implement public policy—in the S&T area or any other area. Here is a policy area, and a part of the world, where governance costs could be *extraordinarily* high.

2.4.3. The evolutionary view

This approach focuses on activities that increase dynamic externalities and interdependencies, complementarities and connectivity within the techno-economic system. The emphasis is much more on diffusion, and on increasing competencies in key sectors and technologies. The implication is that policy should be concerned not only with financial (neo-classical) and institutional (transactionist) efficiency, but equally with the quality of the relationships between different S&T activities, viewed as an integral process.

The evolutionary/neo-Schumpeterian approach to S&T policy assumes that changes in relative prices (either "natural" or policy-created) do not automatically lead to changes in enterprise behaviour.[19] While in a neo-classical world

[17] A very stimulating paper which develops this approach is Demsetz (1970).

[18] See Coase (1974) for a revealing account of this kind of problem.

[19] For a wider discussion of this approach and its application in the case of Brazil, see Schmitz and Cassiolato (1992).

every divergence between desired and actual is solved through prices, in a neo-Schumpeterian world such divergence is seen as a complex phenomenon whose essence lies in deficient capability. In the conditions of high uncertainty and mutually exclusive alternative paths of growth which prevail today in Eastern Europe, pure market solutions will fail because purely price-based incentives will be insufficient.[20]

Neo-classical theorising assumes the automatism of learning, whatever the problem. The neo-Schumpeterian view posits that learning is specific, whether in relation to organizational, technological, financial or marketing spheres. The essence of restructuring problems may lie less in the financial and production spheres as such, than in the weaknesses of the external environment (lack of complementary markets, negative externalities) or in deficiencies of information and knowledge, in a high degree of uncertainty, etc. To achieve the first-best solution, it is necessary to be completely familiar with the challenges and prospects of competitiveness of a given sector. These challenges and prospects are not standardized, and cannot be reduced to problems with specific inputs (factors) which can be solved by equilibrating prices through competition, or through temporary divergence of prices from equilibrium levels.

An important corollary of all this is that there is plenty of room for policy interventions that are not limited exclusively to financial incentives. Japan, for instance, reports the lowest level of financial transfers (subsidies, tax deductions) from the government to industry in the OECD, in the context of very sophisticated industrial policy [OECD (1987)]. The co-ordination and information functions of technology and industrial policy are often the most important. Again, the successful economies demonstrate the important role of informal mechanisms, and of very loose co-ordinating mechanisms, which function as policy instruments *par excellence*.

3. Sectoral restructuring and the need for strategic technology policy: The case of Croatia

Capabilities are located in firms, groups of firms (networks) and sectors. These are also the places where weaknesses in capabilities can be most easily identified

[20] This point is well argued by Justman and Teubal (1992, p. 3): "The distinction emerges most sharply when the economy is at a node of structural change and *must choose from among a set of discrete, mutually exclusive, alternative paths for growth.* In such circumstances market failure is endemic: not only is there no reason to assume that the market will choose the best path—or even identify the elements of infrastructure that are necessary for growth when they are needed ... but market failure analysis alone *cannot identify a 'preferred' path of growth.* ... Even when the appropriate path for growth has been determined, getting on this path may take more than just the price based incentives—subsidies, tax credits—on which technology policy has mostly relied in the past. It may require co-ordination and co-operation among potential users of the new technological infrastructure in determining which elements are necessary and should be supported. And in some cases, co-ordination of supply and demand will be needed."

and addressed. I will use material from three sectors of the Croatian economy to illustrate the kind of problems that require for their solution the application of strategic technology policy. I believe these case studies to be rather typical for Eastern Europe.

3.1. The textile and garments industry[21]

The textile and garments industry is the biggest Croatian exporter. It consists of 119 enterprises of very different sizes, which together account for 16% of all industrial employment. The 15 biggest enterprises contribute more than 50% of aggregate sales in the sector. The total annual value of exports is $743 mn (1992), representing 18.5% of total Croatian exports, of which straightforward export of goods is worth just $195 mn. The difference is exports through the so-called "loan", or "putting out" business, whereby the buyer supplies the producer with material inputs and specifications [Hobday (1993)]. The domestic producer thus sells its work services. In conditions of chronic foreign currency shortage and low quality of domestic inputs, this method of doing business has become widespread in the textile and garments sector.

Over the last 40 years, the garments industry has been unprotected in the domestic market. In addition to that, it has never enjoyed preferential access to cheap credits. This has created a special incentive to export, simply in order to survive. Firms have entered into OEM (original equipment manufacturer) arrangements with foreign, mainly German, partners, under which Croatian goods have been sold under German brand names. This has enabled them to develop, over the last 30 years, a pattern of competitiveness that emulates some characteristics of export-led growth, albeit at a relatively slower pace [Hobday (1993)].

Croatian textiles and garments firms have learned to produce quality products based on the seller's specifications. From the mastery of simple production requirements, they moved gradually to more complex specifications, and acquired the ability to meet tight deadlines. The best of them have developed design capabilities, and are developing marketing capabilities through search for an appropriate niche strategy.

The key factors of success here are:

- experience and good quality, developed through learning by exporting;
- a well-qualified technical work force with know-how acquired through learning by doing;
- long-term links with foreign buyers (trading houses).

[21] This and the following two sections are based on studies produced as part of the project: The Competitiveness of Croatia, led by the author. The study of the Croatian textile and garments industry is based on Knezevic (1993).

The enterprises display very heterogeneous degrees of vertical integration. Some are fully integrated with their own yarn production, while others purchase all inputs on the domestic market or through "loan" arrangements. The textile segment is made up of technically very varied elements: some plants are quite modern, while others have rather outdated equipment. The competitiveness of the textile segment is on average much below that of the garment segment, which represents a structural disadvantage weakening the overall export strength of the sector.

Further development of industry is dependent on:

- orientation to marketing and close relations with buyers;
- capacity to satisfy requirements of small buyers;
- ability to meet delivery schedules;
- scope for prompt purchase of all required components.

Further development of the industry is likely to evolve from production towards design and marketing capabilities. To do this, however, the firms will have to overcome the following weaknesses:

- poor utilization of materials;
- problems in the supply of tools;
- lack of specialized equipment;
- undeveloped marketing capabilities.

These weaknesses would be overcome more rapidly if there were a market for infrastructural services (marketing firms, quality services, technical information centres). The current reality is that enterprises operate in a poor environment as far as information and services are concerned, and cannot rely on external support. Their production capabilities have developed steadily over the years, and do not represent a major problem. However, the lack of complementary markets (quality control services, marketing companies, technical information services) hampers their further advance. Support for the development of complementary markets would strengthen what is still only a shallow textile and garment cluster [Porter (1990)]. Such support would enable them to move into higher-value-added segments, where non-price factors are dominant. This would further improve the state of the textile segment and deepen the cluster.

The process of evolution of the industry will continue, irrespective of policy actions. The fact remains that the enterprises involved have few mutual links, their industry association is weak, and they rely too much on individual efforts to improve marketing capabilities. There is already significant potential demand for the kind of infrastructural services that the Croatian textiles and garments sector needs, and for the co-ordination of production, financial and marketing activities. Here is an obvious case where support for development of a market for infrastructural services, and for improving enterprise co-ordination, is badly needed.

3.2. Petrochemicals[22]

The Croatian petrochemical industry is a legacy of the Yugoslav import substitution strategy of the 1970s. Unlike the textiles and garments industry, which grew up as a result of comparative advantage, and of the subsequent generation of dynamic competitive advantages, the petrochemicals industry was created through a series of strategic decisions at the top level. It was the result of a desire for structural change and independence from imports of petrochemicals. The biggest investments were made after the Oil Shock (1976–82), when world prices rendered such investments for a country dependent on oil imports very dubious. However, at the micro level the investments seemed rational because the structure of domestic relative prices was highly distorted by over-valued exchange rates, cheap foreign loans and the predominant import-substituting pattern of development. The debt crisis at the beginning of 1980s, followed as it was by a deep economic crisis which deprived the industry of the investments needed to complete the petrochemical chain, changed the situation dramatically. As exports were forced, in order to service Yugoslavia's foreign debt during the eighties, the full scale of the sector's problems began to emerge. Those problems were greatly exacerbated by significant structural changes in the world petrochemicals industry itself.

Up until the Oil Crisis, the development of the petrochemicals industry was based on cheap raw materials. The following trends have reshaped the structure of the industry since then:

a) increases in raw material prices have led to a change in the structure of fixed and variable costs. From a ratio of 70:30 at the beginning of the 1970s this had gone to 30:70 by the beginning of the 1980s. As a result, the price of petrochemicals became much more dependent on the price of crude oil. Lack of long-term supply arrangements puts the Croatian sector into a particularly unfavourable position, by making it highly vulnerable to price swings and temporal patterns of purchasing;

b) the development of new technologies have led to increasing efficiency in the use of raw materials, energy and equipment;

c) global recession has had a particularly injurious effect on an industry which is heavily dependent on trends in GDP;

d) the pressure for downstream integration coming from the oil-producing countries has posed a serious threat to the competitive prospects of countries like Croatia;

e) ecological pressures have produced demands for restructuring towards ecologically benign products.

These trends have led most countries to restructure away from conventional/bulk commodity segments into specialized, value-added chemicals.[23]

[22] This section is based on Cimesa, Sekulic, and Antunac (1993).

[23] Thus for Dow Chemicals 50% of production and 80% of profits were coming from spe-

The key factors of success in conventional petrochemicals are low production costs, low transport costs, efficient process technology and scale economies. In speciality chemicals the key factors of success are R&D, marketing and services. Current forecasts for conventional petrochemicals are rather gloomy, particularly for small players.

These trends have found the Croatian petrochemical industry weighed down by import substitution investment patterns, with the export structure 92.9% dominated by conventional petrochemical products like polyethylene, polystyrene and fertilisers. Current exports (1992) are mainly based on short-term contracts (69%), long-term co-operation (4.7%), re-export (23.1%) and "loan" export (2.1%). It should be emphasised that the price competitiveness of Croatian petrochemicals exports is at the level of other non-OECD countries.

On the domestic side, the sector's main problems are:

- imbalances between production capacities and absorptive capacities on the domestic market side caused by the loss of the former Yugoslav market;
- technological obsolescence of equipment;
- imbalances in the production chain, leading to re-export and re-import;
- at best partial security of supply;
- lack of finance for investment (modernization and restructuring).

The availability of a qualified labour force and the rapid rate of absorption of technical assistance during the build-up phase, led to dynamic efficiency gains in the early stages of development of conventional petrochemicals. Some confirmation of this can be found in the development of the export of technical services to some Arab countries. However, structural changes, sub-optimal capacities, reduction of the size of the domestic market, and lack of funds to completing the production chain, have all resulted in a subsequent loss of these dynamic efficiency gains. The only way that the problems of conventional petrochemicals can be resolved is through long-term supply arrangements, technical modernization and new investment to bring the production chain into balance. The amount of investment needed is around $500 mn, which is way beyond the resources of the industry. Even if investment funds could be found, it remains uncertain whether they would be paid off through exports.

The industry has two parallel strategic options:

- restructuring through a state-supported program, or through foreign privatization;
- reorientation towards specialized chemicals, i.e. moving into higher value-added segments.

It would be unreasonable to expect that the industry could make such a strategic choice by itself. The most market-friendly solution would be foreign privatization. However, it is very unlikely that a foreign partner would be

---

ciality chemicals by 1992.

willing to take over the whole sector. Domestic privatization can only have a marginal effect. A "hands off" policy on the part of government is also infeasible, as the sector is currently in public ownership and a monopolist, with a potentially high drainage effect on the budget.

On the other hand, bureaucratic involvement in strategic business decisions might increase costs, and lead to further failures. The final outcome will probably be the result of the interplay between the interests of potential foreign investors, government actions, and managers' ability to implement strategic changes.

The type of policy that might pay off in the context of such a high level of strategic uncertainty is *conditional assistance*. The government could provide funds for restructuring, or actively search for and negotiate foreign sources for the financing of restructuring. The conditional assistance would be temporary, and would be linked to the fulfilment of certain performance indicators (productivity, export, quality, etc.). The role of the government should be one of mild, rather than strong involvement. Final solutions of highly complex problems should be left to the industry's management. However, temporary and performance-conditioned financial assistance has a role to play in exerting pressure, and inducing 'stick and carrot' behaviour.

Assistance might also extend to facilitation of the shift towards speciality chemicals. But this would be a special kind of assistance. Its precise strategic direction could only be identified after a degree of progress in conventional petrochemicals restructuring had been made.

From the strategic technology policy perspective, it is important to bear in mind that the problems of Croatian petrochemicals sector are not solely problems of technological capability. The restructuring of low-value petrochemicals, the shift towards speciality chemicals, puts market considerations to the fore. Restructuring policy must link together technological and marketing and financial aspects of the problem.

3.3. Pharmaceuticals[24]

While the textile industry grew as a result of comparative advantage, and the petrochemicals industry as the outcome of an import-substitution strategy, the pharmaceutical industry has developed as a result of competitive advantage. It is one of the few R&D based sectors in Croatia. Its growth is the result of domestic demand and the available science base (university, independent research institutes), which were successfully coupled with the efforts of the biggest national pharmaceutical company. Relative technological isolation of the pharmaceutical sector from other sectors has facilitated successful interaction within this small cluster.

[24] This section is based on de Villa (1993).

On the basis of its developed "in house" R&D capability, the leading domestic pharmaceutical company, which makes 90% of Croatian output, succeeded in developing its first antibiotic, and licensing it to Pfizer. It also successfully produced a long chain of generics.

The annual sales of the Croatian pharmaceutical industry are $250 mn (1991), of which 33.2% is exported. Of total exports of $84 mn, bulk active elements make up $44 mn (93% of production) and final products $37.4 mn (19%). The domestic market is small, and is divided between two domestic (38% and 15%), two Slovenian (23% and 19%) and one German (5%) company.

The Croatian pharmaceutical industry produces around 40 pharmaceutical raw materials, azitromycin and vitamin C being the most important. It does not produce "over the counter drugs"(OTC) but rather generics. These are exported to less demanding markets, primarily East European. Bulk pharmaceuticals are exported to the West. The key factors for success in the industry are: knowledge, experience and tradition, and human resources.

The domestic production program of the Croatian pharmaceuticals industry has diversified as the result of import substitution demands from the national health authorities. Most of the products are made under licensing agreements, with corresponding restrictions on export sales. Following the opening up of the former Soviet markets, the industry has experienced great difficulties in exporting its licensed products.

The complete breakdown of the old market structure occurred during the on-going process of polarization of the world pharmaceutical industry, involving consolidation and mergers of big companies, accompanied by the growth of market niches filled by specialized small companies. With big firms diversifying, and small firms specializing, producing so-called "orphan drugs", medium-sized companies (like Croatia's leading company) are in danger of being squeezed by the high-profile companies.

The bargaining power of the industry in international markets is small. The entry barriers in OTC products are insurmountable, on account of high R&D and marketing costs. The current strategic thrusts—OEM export of raw materials to Western markets and export of generics to Eastern, on top of the increasing import substitution demands of the domestic market—have limited dynamic effects. The industry has the choice of either becoming a subsidiary of one of the big pharmaceutical companies, or transforming itself into a small niche producer. These strategic decisions should not in any way be influenced by policy-makers outside the industry. However, it is crucial that the industry receive indirect support in whatever strategic decision it takes. In the case of the pharmaceutical industry, the best support would be support for R&D. Technology policy would strengthen links between industry and universities. It would also give support to the internationalization of R&D efforts through fostering co-operation in international projects. The precise forms of R&D co-operation should be negotiated between companies, universities, independent institutes and the Ministry of S&T.

4. Strategic technology policy for Eastern Europe[25]

In the first part of this section I will try to generalize on the basis of the three Croatian sectors studied. Then, in the second part, I try to adduce the main principles for the application of STRTP in Eastern Europe.

4.1. Sector-specific types of strategic technology policy for Eastern Europe

Capabilities, which I have described as the main targets of strategic technology policy, are usually sector-specific. However, some capabilities are so widespread that they can be addressed as industry-wide, or even economy-wide, problems. Capabilities like quality control, information system-building and inventory management, for example, are generic techniques which are applicable in all sectors. However, even they are usually sector-specific in detailed implementation. For that reason, I shall concentrate on sector-specific STRTP though without prejudice to the importance of functional STRTP.[26]

The design of STRTP in different sectors is based on the specificities of sectoral technological capability, and their relation with the production and science system. The assumption is that the profile of technological capabilities determines the specific strategic technology policy approach. This assumption underlies the distinction between production know-how based sectors, engineering based and R&D based sectors (for a summary see Table 1).

Table 1

Sectoral strategic technology policies for Eastern Europe

Type of sector	*Type of strategic technology policy*
Production know-how based	Building markets for infrastructural services
Engineering based	Conditional assistance Network creation problem SMEs as subcontractors
R&D based	Academy-industry links - Co-operative projects - International co-operation - R&D management capability

[25] The analysis contained in this section is addressed particularly to the smaller East European states like Hungary, the Czech Republic, Slovakia, Bulgaria, Slovenia, Latvia, Estonia, and Lithuania.

[26] Justman and Teubal (1992) attach particular importance to the distinction between sectoral and functional STRTP.

The taxonomy that is suggested here tries to link STRTP activities with the dominant sources of technology accumulation. It is not primarily a taxonomy of innovations, as in Bell and Pavitt (1993) and Pavitt (1984), but rather of policies.

4.1.1. Know-how based sectors

By know-how based sectors I mean industries in which technological capability is nested in production, i.e. in the knowledge of workers and technicians. These are traditional industries (textiles, wood, classical machine tools) or services like tourism. Here the problem of capabilities does not, in principle, exist. Production capability has been mastered, and the main problem is to move into higher value-added segments. This move implies upgrading of production capabilities, which is a part of the natural trajectory of enterprises. Examples include industries like textiles in Poland, food and beverages in Bulgaria, the wood industry in Slovenia, etc.

The most common situation in the region is one where there is no developed domestic market for services for upgrading production capability in know-how based sectors. The process of building this market could develop without public action. However, a purely market-driven evolution will take too long, and will be less effective with respect to potential externalities that may develop through networking.

The process can be speeded up by co-ordination between producers. This problem is labelled by Justman and Teubal (1992) *network creation type N1*—producer-producer links to exploit external services and complementary markets. Through facilitation of "user need determination", i.e., explicit efforts to adapt to differentiated user needs, the fundamental uncertainty regarding the absence of a market for the services can be overcome. If there is any targeting, then it is "infrastructure targeting". The process itself is market-driven. Support for this market should ultimately bear fruit in fully commercial services purveyed by private enterprises. Those private enterprises may be created on the basis of the small number of existing domestic private consulting companies in Eastern Europe, which offer general services like accountancy and marketing, or by privatizing parts of technical institutes which can offer various technical or quality management services. These services may be subsidized on a decreasing basis until the demand reaches the critical level for commercial profitability.

4.1.2. Engineering based sectors

By engineering based industries I mean industries in which the technological capability is based on engineering activity.[27] The communities around which the

[27] This notion should not be confused with engineering as an industry. Here I use the term engineering as a generic technological term covering machine-based problem-solving, whether in the chemicals, mechanical engineering, software, or other industry.

enterprises in these sectors operate are "hybrid communities". The enterprises rely on R&D, the core of which comes from the "transfer sciences".[28] These are areas like mechanical engineering, automation, computer sciences, chemical engineering—disciplines that play an essential role in establishing productive relations between science and industry. The difficulty in forming hybrid communities is in straddling the conventional borders which separate "science" from "technology". These interfaces are rich and complex institutionally, so that it is a very complicated task to create corresponding networks. At the heart of hybrid communities there usually lies a big national complex. The problem in Eastern Europe is that that national complex is usually in a deteriorating competitive situation.

It is in the engineering based industries that conditions in the East European economies are now particularly unfavourable. These industries are usually the heritage of past policies of import substitution, and are burdened by serious competitiveness problems. Examples include the steel industry in Hungary and the petrochemicals industry in Romania. Prospects for the revival of sectors like these are especially gloomy in that the sectors are very "network intensive". They require a large network of co-operating companies as subcontractors, and also rely heavily on inputs from other industries. The general weaknesses of the economies in question are very much felt in these sectors. The competitiveness of the latter, such as it is, is very much of the "structural competitiveness" type [OECD (1986)].

If engineering based sectors could be restructured during the initial phases of transition, the effects would be widespread, and felt in a large number of linked sectors. However, these sectors are the most demanding to restructure in all respects (technical, financial), and it is in practice very unlikely that restructuring would start first in these sector. There is, nevertheless, scope here for a mixture of organizational and technological measures which could be implemented through conditional assistance.

The heart of the typical restructuring problem in engineering based industries in Eastern Europe is a national industrial giant, or a few big enterprises, where government cannot afford a hands-off policy. Direct governmental involvement is called for—a very problematic requirement in Eastern Europe today. But only through the restructuring of the core of a given network can scope be created for follow-on indirect policies calculated to rejuvenate such complex networks. So, an appropriate policy would have to combine very direct intervention with very indirect. The complexity of the network creation problem in these sectors is reflected in the fact that, in Justman/Teubal's terminology, the relevant networks here are of both types—N1 and N2—between similar producers, as well as between supplier and assembler or core company and subcontractor.

[28] Transfer sciences are fields that straddle the normal borders separating "science" from "technology". For a discussion of the role of transfer sciences see OECD (1992) and Blume (1990).

4.1.3. R&D based sectors

R&D based sectors are sectors in which core technical capabilities represent the result of an organized research process. Here production is the legacy of big R&D investments in the past, which have left pockets of competency in industry. In Eastern Europe these isolated islands of capability typically developed in areas where the need for market interaction was smaller, and where demand was high and exacting in spite of a generally undeveloped market. Typically, this was either in defence sectors, or in pharmaceuticals, where demand from health systems was the driving force.

Uncertainty with regard to potential demand is the dominant feature of this sector. While in the know-how based sector production capabilities exist, and the structure of demand is well known, in the R&D based sector the case is the opposite. The pattern of demand has to be researched, production and R&D capabilities improved, and links with academia strengthened.

Co-operation with potential users or buyers (user-producer links) is of essential importance here. It can best be developed through pre-competitive projects, or through any other form of industry-academy collaboration.

The network here is, in the Justman/Teubal terminology, of the N2 type (user-producer). The approach therefore needs to be project-oriented. The main policy problem is how to link project definition to the needs of industry. Project definition is very much under the influence of the scientific community, which is of course governed by its own objectives. One possible way of coupling industry and academia is through technology foresight exercises.[29]

4.2. General principles and issues in the implementation of strategic technology policy for Eastern Europe

I view strategic technology policy as an indispensable bridge between science and industrial policy, and between them and competition policy. Science policy, focused as it is on the knowledge base and institutional R&D, has limited leverage by itself on the technological weaknesses in enterprises. In similar fashion, general technology policy, which creates general conditions for S&T development, does not necessarily address crucial deficiencies in sectoral capabilities. For example, innovation centres as a generalized solution for all sectors do not make much sense. And if you want STRTP to have an impact, a developed competition policy which would prevent monopolies, and ensure liberal trade regimes and healthy competition is *de rigeur*.

However, East European countries also need structural change, and this cannot be effected fast enough, if at all, by market forces alone. The complexity of the situation is compounded by the fact that any kind of active industrial policy, which presumes huge transfers within or between industries, would be

[29] A strategic shift in S&T policy based on technology foresight is one of the key points of the new UK White Paper on S&T; see HMSO (1993).

untenable in Eastern Europe. Structural change must, therefore, be combined with openness and a liberal environment. Activities of the STRTP type are the only kinds of policy action that could be expected to resist the pressures of the sectoral lobbying and special pleading which currently so dominate the political life of the East European countries—and even then only under certain conditions.

4.2.1. Strategic technology policy design is context- (industry-)specific

In order to ensure the first-best solution it is necessary to know the key factors of success or failure of industry and industries in particular countries.[30] These are not standardized, and cannot be reduced to the equilibration of factor prices or temporary distortions in factor prices.

4.2.2. Strategic technology policy is seldom feasible as a separate, self-sufficient policy

As technological capabilities are intertwined with financial, marketing and other capabilities, strategic technology policy is in practice very often a component of a restructuring package.

4.2.3. Because STRTP is by definition strategic, its formulation is inseparable from its implementation

The parties concerned rarely have any clear idea in advance of the details of the policies they want to pursue.[31] It is precisely in the course of interaction that better understanding of key problems is acquired and a consensus reached.

4.2.4. STRTP is not solely supply-side or demand-side

Indeed its formulation and implementation could be summed up as a process of coupling demand and supply.

[30] The need to understand industry-specific key factors of success, as a basis for "bench marking" national industries is an explicit aim of the new UK industrial policy. Michael Heseltine, UK trade and industry secretary, puts it this way: "Information is critical. Because on the quality of the information we gather, the respect of industry depends. If we are known to understand, to be aware, to have views that are coherent, thought through, well-informed, then industry will take this department seriously .... We are constantly being asked for project launch aid and I would expect people here advising ministers to be experts in leading edge technology, knowing where it is going to be in 10 years time." See: "Heseltine's plan to help Britain win", *Financial Times*, April 26, 1993.

[31] The EC Open Microprocessor System Initiative (OMI) is a good example of how a diverse range of interests, involving even competing companies, can evolve into a coherent European program. This case is a good example of STRTP, and of the inseparability of formulation and implementation, with an initially completely misaligned set of players managing to regroup into the programmatic alignment of a capability-building initiative; see Molina (1993).

4.2.5. STRTP requires developed administrative capability and close co-operation between public administration and the business community

This is the biggest problem for STRTP in Eastern Europe and the condition most difficult to meet. The inherited inert and bureaucratic machine could misuse STRTP in order to demonstrate the need for its continued existence. By the same token, a STRTP program could be exploited by big enterprises as just another source of subsidies.

These problems could to a degree be overcome through policy transparency. The peculiar historical and cultural heritage of Eastern Europe presents a real danger of "government failure". Societies that were overburdened by excessive co-ordinative activities now tend to neglect them. This pattern, accompanied as it has been by the objective uncertainties of institutional change and instability, has led to confusion and extreme forms of "short-termism".

Such a situation clearly cries out for co-ordination activities. However, in the real policy arena of Eastern Europe it is difficult not to cross the "red line", beyond which the whole question of co-ordination becomes *déjà vu*. The whole is particularly problematic in sectors where the market is the superior learning engine because of its ability to generate rapid trial and error learning (know-how based sectors, R&D based sectors) [Langlois (1992)].

The main problem of STRTP in the given context is, then, feasibility and implementation rather than justification—or as Dosi puts it more generally, the argument against intervention is not an economic one, but an administrative and political one [UNCTAD (1993)].

4.2.6. The only way out of the impasse is strong competition policy and openness in foreign trade[32]

Otherwise the application of STRTP, in conditions of monopoly and high entry barriers, may simply be hi-jacked by rent-seekers and lobbyists.

Small Eastern European economies cannot apply a Japanese-type approach to the problem, namely combining temporary protection with fierce domestic competition. This is why an open trade regime is indispensable for creating incentive pressures in Eastern Europe. But by the same token, the more market pressure is introduced, the more these countries need mechanisms of the STRTP type which will strengthen firms' capabilities. What STRTP must not do is to produce distortions in macro prices which might then inhibit the forces of market selection. Such distortions can be tolerated only temporarily, in order to restructure engineering based industries for which financial requirements are very high. Note, however, that full trade openness should ensure the selective efficiency of markets even in these cases.

[32] STRTP implicitly assumes that the power of market resides, not in its allocative efficiency, but in its selective efficiency. The point is emphasised by Dosi in UNCTAD (1993).

4.2.7. The cost of applying STRTP in Eastern Europe would not be a major problem

Except in the case of the engineering based sectors, STRTP would be much cheaper than the currently widespread system of cheap loans for big enterprises, which continues to function as an implicit industrial policy and acts as a major financial drain on the domestic banking system. A second source of finance would be the restructuring of the existing mechanisms for financing basic, applied and strategic research.

4.2.8. Different competitive situations in different sectors require different approaches

STRTP offers no general policy solution which can be applied across all sectors. In other words, there is no blueprint for policy makers. For that reason, policy itself becomes a highly information- and knowledge-intensive activity, as well as an intensive social networking activity [Radosevic (1992)]. This underlines the very strong *information function* of STRTP, a function which requires intensive flows of tacit or semi-codified information.[33] These are easier to handle through informal arrangements, or through networks.

5. Conclusions

We have discussed and developed STRPT as a practical concept in the context of different theoretical approaches to technology policy. While Eastern Europe has been a particular focus of attention, our conclusions have general validity.

The main conclusion is that STRTP is "evolutionary-economic" in character, but that in its application in Eastern Europe it should incorporate some of the features of the transaction costs and neo-classical approaches.

Theoretical constructs cannot be applied directly in policy practice. Indeed, because of problems of consistency and applicability, the various theoretical approaches can function only as useful heuristic devices that capture different, but complementary, aspects of the technology policy problematic, such as seem to me to be relevant today in Eastern Europe. These aspects are summarized in Table 2.

[33] This problem is explicitly tackled by the UK Department of Trade and Industry's new competitiveness policy. "The intention is to use the DTI divisions as a conduit between DTI and industry and as a source of quality market intelligence to assist competitiveness at home and overseas .... The ambition, according to a senior official with responsibility for some of the industry divisions, is to make them so informed and knowledgeable that the private sector will value their contribution." See "Where the main thrust of the DTI's new competitive policy will be focused", *Financial Times*, April 26, 1993.

TABLE 2

Policy characteristics
of different theoretical approaches

	Focus	*Usefulness*	*Problems*
Neo-classical	financial intervention	high anti-distortionary bias	misleading state/market dichotomy
Transaction cost	costs of intervention	alternative mechanisms of implementation	static in character
Evolutionary	dynamic effects of intervention	potential for promoting struct. change	indeterminacy

In practice STRTP seems a "high risk operation". It requires the simultaneous presence of competitive markets, highly developed administrative capabilities and developed networks of collective mechanisms—"mechanisms of economic articulation". It also requires favourable internal (education level) and external conditions (access to world markets). The essence of the STRTP policy problem is to build a rich network of co-operation mechanisms in the context of fierce competition. This is not something that derives readily from the experience of the East European countries.

References

Arrow, Kenneth J., *Economic Welfare and the Inventive Activity*, Washington D.C., National Bureau of Economic Research, 1962.

Bator, M. Francis, "The anatomy of market failure", *Quarterly Journal of Economics, 72*, August 1958, pp. 351–379.

Bell, Martin, and Keith Pavitt, "Technological accumulation and industrial growth: Contrasts between developed and developing countries", *Industrial and Corporate Change, 2*, 2, 1994, pp. 157–210.

Blume, Stuart, "Transfer sciences: Their conceptualisation, functions and assessment", paper prepared for the TEP Indicators Conference, OECD, Paris, July 1990.

Cimesa, Miljenko, Gordana Sekulic, and Oskar Antunac, "Konkurentnost petrokemije Hrvatske", (The competitiveness of the Croatian petrochemicals industry), Ekonomski institut, Zagreb, 1993.

Coase, Ronald H., "The lighthouse in economics", *Journal of Law and Economics, 17*, October 1974, pp. 357–376.

Cody, John, Richard Kuitchen, and John Weiss, *Policy Design and Price Reform in Developing Countries. Guidelines With Special Reference to Industry*, New York and London, Harvester and Wheatsheaf, 1990.

Corden, Max, *Trade Policy and Economic Welfare*, Oxford, Clarendon Press, 1974.

Cowling, Thomas, and Harry Tomman (eds.), *Industrial Policy After 1992: An Anglo-German Perspective*, London, Anglo German Foundation, 1990.

Dahlman, Carl, "The problem of externality", *Journal of Law and Economics, 22*, April 1979, pp. 141–162.

Demsetz, Harold, "The exchange and enforcement of property rights", *Journal of Law and Economics, 7*, October 1964, pp. 11–26.

Demsetz, Harold, "Information and efficiency: Another viewpoint", *Journal of Law and Economics, 12*, 1969, pp. 1–23.

Demsetz, Harold, "The private production of public goods", *Journal of Law and Economics, 13*, October 1970, pp. 293–306.

Dornbusch, R"udiger, "Policies to move from stabilisation to growth", in: *Proceedings of the World Bank Annual Conference on Development Economics 1990*, Washington D.C., The World Bank, 1990, pp. 19–58.

Estrin, Saul, Alan Gelb, and Inderjit Singh, "Restructuring, viability and privatisation: A comparative study of enterprise adjustment in transition", London Business School, mimeo, 1993.

Foray, Dominique, and Christopher Freeman (eds.), *Technology and the Wealth of Nations: The Dynamics of Constructed Advantage*, London and New York, Pinter Publishers and OECD, 1993.

Freeman, Christopher, and Bengt A. Lundvall (eds.), *Small Countries Facing Technological Revolution*, London, Pinter Publishers, 1988.

HMSO, *Realising our Potential: A Strategy for Science, Engineering and Technology*, London, May 1993.

Hobday, Mike, "Export led technology development in the four dragons: The case of electronics", SPRU, mimeo, Brighton, 1993.

Justman, Moshe, and Morris Teubal, "A framework to an explicit industry and technology policy for Israel and some specific proposals", in: Freeman, Christopher, and Bengt A. Lundvall (eds.), *Small Countries Facing Technological Revolution*, London, Pinter Publishers, 1988.

Justman, Moshe, and Morris Teubal, "Strategic technology policy for new industrial infrastructure: Creating capabilities and building new markets", The Jerusalem Institute for Israel Studies, discussion paper, 25, Jerusalem, 1992.

Knezevic, Ana, "Konkurentnost tekstilne i odjevne industrije Hrvatske", (The competitiveness of the Croatian garment and textile industry), Ekonomski institut, Zagreb, 1993.

Krugman, Paul R. (ed.), *Strategic Trade Policy and the New International Economics*, Cambridge, Mass., MIT Press, 1988.

Lieberman, Ira, "The restructuring enterprise", in: OECD, *The Transition to a Market Economy. Part I*, Paris, 1991, pp. 82–91.

Molina, Alfonso, "Insights into the successful generation of a large-scale European initiative: From misalignment to programmatic alignment in the build up of sociotechnical constituencies", paper presented at UK PICT National Conference, Kenilworth, May 1993.

Nelson, Richard R., "The simple economics of basic scientific research", *Journal of Political Economy, 67*, 1959, pp. 269–290.

OECD, "The notion of international competitiveness: A discussion paper", DSTI/SPR/81/32, Paris, 1986.

OECD, *Structural Adjustment and Economic Performance*, Paris, 1987.

OECD, *Technology-Economy Program: Key Relationships*, Paris, 1992.

Pavitt, Keith, "Sectoral patterns of technical change: Towards a taxonomy and a theory", *Research Policy, 13*, 1984, pp. 343–373.

Porter, Michael, *The Competitive Advantage of Nations*, New York, The Free Press, 1990.

Radosevic, Slavo, "Techno-economic networks and social intelligence as useful concepts in technology policy making", in: Cronin, Bloise, and Nera Silovic (eds.), *From Information Management to Social Intelligence: The Key to Open Markets*, London, ASLIB, 1992, pp. 29–42.

Robertson, Neil, "Economic articulation: A neglected dimension of economic performance?", Institute of Social Studies, ISS working paper series, 122, The Hague, April 1992.

Schmitz, Hubert, and Jose Cassiolato (eds.), *Hi-Tech for Industrial Development: Lessons from the Brazilian Experience in Electronics and Automation*, London and New York, Routledge, 1992.

Sharp, Margaret, and Keith Pavitt, "Technology policy in the 1990s: Old trends and new realities", *Journal of Common Market Studies, 31*, 2, 1993, pp. 129–151.

Sorge, Arndt, "Introduction" to chapter IV (Institutional and technological change: The importance of diversity), in: Foray, Dominique, and Christopher Freeman (eds.), *Technology and the Wealth of Nations: The Dynamics of Constructed Advantage*, London and New York, Pinter Publishers and OECD, 1993.

Teece, David J., Gary Pisano, and Amy Shuen, "Firm capabilities, resources, and the concept of strategy: Four paradigms in strategic management", CCC working paper, December 1990.

UNCTAD, "Report of ad hoc expert group in technology policies in open developing countries economies", ITD/TEC/3, Geneva, 1993.

de Villa, Zeljka Kordej, "Konkurentnost farmaceutske industrije Hrvatske", (The competitiveness of the Croatian pharmaceutical industry), Ekonomski institut, Zagreb, 1993.

Winiecki, Jan, "Shaping the institutional structure", in: Siebert, Horst (ed.), *Privatization: Symposium in Honour of Herbert Giersch*, T"ubingen, J.C.B. Mohr, 1992.

Zusammenfassung

Dieser Beitrag analysiert das Konzept der Strategischen Technologiepolitik (STRTP), das urspr"unglich von Justman und Teubal entwickelt wurde, auf die Situation in Osteuropa. Strategische Technologiepolitik wird hier als unerl,,áliches Bindeglied zwischen Wissenschafts-, Industrie- und Wettbewerbspolitik angesehen. Strategische Technologiepolitik zielt explizit auf eine Verbesserung technologischer M"glichkeiten ab und basiert auf einer Koordination zwischen Gruppen von Unternehmen und der Regierung. Das Konzept wird im Rahmen dreier verschiedener theoretischer Ans,,tze an Technologiepolitik diskutiert, der Neoklassik, dem Transaktionskostenansatz, und der evolution,,ren 2122konomie.

Die Analyse wird anschlieáend auf das Fallbeispiel Kroatien angewandt, wobei zwischen drei Industriegruppen differenziert wird, die sich in bezug auf ihre technologische Basis unterscheiden: Produktions-Know-How, Herstellung, bzw. Forschung und Entwicklung. Die Schluáfolgerung des Papiers lautet, daá eine STRPT-Politik haupts,,chlich auf einem evolution,,ren Theorieverst,,ndnis beruhen muá, das unter den spezifischen osteurop,,ischen Bedingungen aber auch neoklassische Elemente und solche der Transaktions"konomie beinhalten sollte.