Industrial policy in the economic literature
Recent theoretical developments and implications for EU policy

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Economic theory on "industrial policy" is not to be found in a single and coherent body of work. This can be partly explained by the difficulty of economists to agree on a definition of the concept of industrial policy. However, the last decade has seen a strong resurgence of literature in a series of areas closely linked to industry such as innovation, economic growth, technological progress, entrepreneurship or public policy.

At the risk of oversimplification, this paper attempts to provide a brief overview of the main ideas from this recent literature and its policy implications.

1. Industrial policy in economics theory

1.1 The traditional market failure justification

In mainstream economic theory the justification for public policy lies in the need to offset some pre-existing market failure. This approach is often associated with a sceptical posture towards government involvement in the economy. It is not only difficult for public authorities to recognise market failure but government intervention is also often linked to "government failure" which may more than offset the benefits of intervention.

Market failure can take the form of externalities, market power, information problems and public goods. In the specific field of industrial policy the most widely accepted rationale for public action are externalities in R&D and knowledge creation. Firms cannot appropriate all the benefits of their own investment in knowledge because some of these accrue to other firms or sectors. The social return on investment on R&D and knowledge creation is larger than the private return. Hence, the R&D effort will normally be below that which is socially optimal. As a consequence, <u>there is a role for the public sector to organise publicly funded R&D or to enhance the incentives of private firms to invest in knowledge creation.</u>

The appropriability issue of knowledge extends beyond the level of the firm. A national government may face similar incentive problems as many of the benefits of knowledge created in its country may in fact accrue to firms in other countries. In this context, there is a case for research policy to be conducted at a higher level so that international spillovers are fully internalised.

In contrast to the adherents of neo-classical thinking, who tend to downplay the role of public intervention, other authors have recently stressed the generalisation of market failure. De Bandt (1995) for instance, has underlined that the mushrooming of exceptions to the proper functioning of markets largely justifies industrial policy intervention.

1.2 Economic growth theories and technology policy

In the orthodox neo-classical growth theory (the Solow-Swan model) output is determined by the stock of capital and labour. In this model, the key determinant of economic growth is capital accumulation as productivity growth results from increases in the amount of capital per worker. However, as capital per worker increases the marginal productivity of capital declines. In the long-run equilibrium growth is left unexplained as it is fully determined by an exogenous term, labelled 'technological progress'. Technology is treated as a public good determined exogenously to the model.

New growth theory (NGT) was developed in the second half of the 1980s as an attempt to overcome the problems with the orthodox models and explain long-term economic growth endogenously. Romer and Lucas (1988) put forward the idea that technological change is linked to new accumulation of capital (physical and human). In their models, the beneficial external effects of capital accumulation, technological progress through learning-by-doing, outweigh the reduction in marginal returns of capital per worker and long-run productivity growth may occur.

In the 1990s, a second generation of papers in the NGT tradition has been developed. Following Romer (1990), in these models innovation is no longer conceptualised as a pure externality but is the product of a deliberate effort of firms. Profit maximising companies decide on the amount of investment to be allocated to the production of "ideas", that are used as an input in the production of final goods. New technologies are partially excludable and hence innovators enjoy temporary monopolies. In this world of increasing returns and imperfect competition, the main determinant of long-term growth is no longer capital accumulation but investments in R&D by the firms and the degree of appropriability of innovations. As a result, <u>public policy can raise growth permanently by increasing the size of investments on R&D or improving the appropriability conditions of knowledge</u>.

The Schumpeterian search of monopoly profit and the *intentional* production of ideas are now widely recognised as two important forces driving economic growth. Baumol (2002) has stressed that one of the keys of the "growth miracle of capitalism" is that in modern economies the production of technological progress has been routinised and innovation is now produced in an "assembly-line".

1.3 Strategic trade policy

Significant theoretical attention has also been placed on imperfect competition as a rationale for targeted industrial policy. Spencer and Brander (1983) were the first to develop the case for "strategic policy". The concept of strategic trade and industrial policy is linked to the market failure of imperfect competition, which in some *strategic* industries would lead oligopolistic firms to realise excess returns and pay higher wages. With a view to retaining the largest possible share of the excess profits within national borders, governments may have an incentive to foster an artificially dominant position of domestic firms, for instance through state aid of any form. In the Brander-Spencer analysis, subsidies can deter investment and production by foreign competitors, raising the profits of domestic firms by more than the amount of the aid. As underlined by Leahy and Neary (2001), such a theoretical approach would provide a robust case for sectoral industrial policy. This strategic policy rationale actually lies behind the more aggressive perceptions of industrial policy in oligopolistic markets.

Another closely related argument for governments to subsidise national producers is the infant-industry argument. In a setting with learning-by-doing effects, which translate into a downward sloping cost curve, government intervention at the early stages of the life of a firm would be justified. The aim would be to speed up the production externalities by subsidising or protecting national production. This would push national companies down the learning curve and allow them to compete more effectively in international markets. In this context, if the governments' commitment to a specific policy course is credible, industry support may lead to higher national welfare (Leahy and Neary, 1995).

However, with the exception of measures targeted at certain market failures affecting young companies - like difficult access to finance or information imperfections - the infant-industry case is actually subject to a number of well-founded criticisms. The same holds true for the strategic justification of interventionist industrial policies.

Besides the negative implications of protected markets for domestic consumers, insufficient information and the likely prospect of retaliation – be it by triggering a trade war or larger subsidies by competing countries - make it hardly advisable to implement such policies in practice. Indeed, policies based on strategic or infant-industry considerations seek to raise national income at the expense of other countries. Also, the interdependence of different industries, among which scarce resources need to be allocated, and the danger of making a bad judgement on which sectors to favour, further discredit such theories. Overall, numerous theoretical objections undermine the potential policy implications of the case for strategic or infant-industry policies.

1.4 Network externalities and standardisation

Markets with network externalities provide for a further rationale for industrial policy in the form of standard setting. Network externalities arise when the value of a given good or technology depends on the number of users that have the same good or compatible ones. Standardisation, be it by a public standardisation body or a private one, like an industry federation, may bring positive welfare effects. It reduces inefficiencies linked to inertia, by which potential users wait to adopt the new technology so as to minimise the risk of choosing the less diffused or less performing one. Standards also reduce consumers' search and co-ordination costs. On the supply side, by ensuring interoperability and compatibility in a large market, standards provide stronger incentives to invest in commercially viable innovations. Other benefits for producers range from reduced storage and production costs to increased trade.

But standardisation may also entail some potential inefficiencies. Rigid standards may prevent the emergence of innovative products or alternative technological paths. In individual cases, there may also be a trade-off between the positive network externalities and the costs linked to limited diversity and competition. Furthermore, the opposite extreme of the inertia effect – premature standard setting - is also inefficient, as it may entail locking-in effects for the subscribers and have very expensive repercussions if the choice turns out to be wrong.

In the EU context, standards came to play a predominant role since the implementation of the so-called “New Approach”, which has left manufacturers the choice of the technical means to meet the objectives set by directives. Regulators lay down only the essential requirements related to public health, consumer protection or environmental objectives. Standards are elaborated on a voluntary and market-determined basis.

Recently, the emphasis has been placed on the flexibility of standards, so that they can be adapted to rapid technological changes. Promoting international standardisation, in order to increase market access and technology diffusion, has emerged as another strong priority for standardisation bodies and policy makers.

2. Evolutionary economics

Pioneered by Nelson and Winter's book *Evolutionary Theory of Economic Change* (1982), evolutionary economics has built up as an alternative to the neo-classical mainstream thinking. The evolutionary theories on growth and innovation have been developed in a wide literature, mostly "appreciative" - as opposed to formal -, complemented by numerous case studies and empirical research.

2.1 Disruptive change as a dynamic process of evolution

The delineation between endogenous growth theory and "pure" evolutionary economics is not perfectly clear-cut. The latter moves the emphasis from the concept of equilibrium to the dynamic process of how things are being done. Schumpeter's evolutionary view of the economy is one of a system continuously being "disrupted" by technological change. Learning and evolution are conceptualised as a disequilibrium process. On the basis of initial diversity, dynamic selection and mutation show the way to superior responses. This model of growth based on disequilibrium led to the concept of "creative destruction". Structural change, and ultimately growth, are the result of the irruption of new technologies in the economic system that create new sectors and fresh investment opportunities.

Drawing on the "waves" of economic activity identified by Kondratiev (1925), Schumpeter studied economic cycles under the prism of disruptive innovations. He saw business cycles as driven by new sets of technologies that would replace old ones and foster capital accumulation in innovative sectors. Radical innovations would tend to cluster together in time, creating eras of economic expansion.

More recently C. Christiansen (1997) has focused on how disruptive technologies affect market dynamics at the microeconomic level. As opposed to *sustaining technologies*, which introduce improvements in existing markets, *disruptive technologies* open new markets undermining the value or totally replacing existing products. Christiansen's evidence points out that structural reasons lead incumbent market leaders to overlook the potential of new disruptive technologies, which tend to start as marginal, money-losing businesses. It is only gradually that new small niches linked to the disruptive technology expand, occupying old markets and displacing dominant incumbents.

In the evolutionary view, firms, which are seen as the key players, are characterised by their strategic behaviour and intrinsic capabilities. Emphasis is also placed on the institutional framework, which plays a crucial role in determining the performance of firms and the economy as a whole. The evolutionary process is also characterised by high ex-ante uncertainty and path-dependency. As a result, one of the main tasks of public authorities is to develop and strengthen institutions which are conducive to growth, but without directly intervening in the selection of market outcomes.

Evolutionary theory has provided the implicit base for the framework concepts of *innovation systems* and *clusters* around which today's paradigm on innovation and growth has developed. Before presenting the central elements of these approaches the next subsections briefly discuss two core concepts of evolutionary theory: knowledge and innovation.

2.2 Knowledge

A main contribution from evolutionary theory has been the differentiation between codified and tacit knowledge.

Codified knowledge is formalised and can be stored, copied and transmitted easily. New technologies allow the rapid transmission of codified knowledge across large distances and at low cost. On the contrary, tacit knowledge is accumulated through experience and learning-by-doing, is embodied in individuals and can only be transferred through social interaction. Unlike codified knowledge, tacit knowledge is non-formalised. A central idea of evolutionary economics is that large parts of the knowledge needed in innovation processes are tacit.

Nelson and Sampat (2001) have gone a step further and identified a third type of knowledge that they term “social technologies”. Even within an organisation, knowledge is divided and widely distributed among individuals and groups. Social technologies are the knowledge on how to co-ordinate and combine the elements needed in a process. This know-how is associated with the structure of the division of labour and the procedures for task co-ordination and management. Equally important is the concept of “social capital” which relates to the cultural and social context, the set of unwritten rules that frame the relationships between actors in the system. In this sense, “trust” is often highlighted as a key element for the development of non-market based knowledge flows.

The distinction between tacit and codified knowledge has strong geographical implications for the structure of industry. Tacit knowledge can only be transferred through face-to-face contact between individuals, so that they learn from each other’s experience. Innovative firms which are located close to competitors, suppliers and customers have further opportunities for interaction and hence higher access to know-how.

This explains one of the paradoxes of globalisation: location is crucial. Despite the expanded possibilities of communication provided by new technologies (e-mail, internet, fax, etc.) and corresponding lower costs of information transmission, knowledge diffusion is still intimately linked with face-to-face contact and proximity. Location is a source of competitive advantage. The increased complexity of knowledge, and the difference between information (codified knowledge) and tacit knowledge lie at the root of this paradox.

At the same time, ICT allow activities that draw mainly on codified knowledge (information) to be easily de-localised to low-cost locations. Standardised processes which can be easily reproduced tend to be moved away from the most developed economies. Conversely, the highest value added links in the value chain locate where the best possibilities for knowledge production exist.

Another implication of the high content in tacit knowledge of innovation is the critical importance of human capital. Highly skilled people are the most mobile. This creates an important role for policymakers to design policies to attract highly qualified and specialised people.

Finally, knowledge is not only created in specific sectors or activities, it is created in all firms throughout evolutionary learning processes. However, the growing complexity of modern industry has led to large shares of knowledge input being produced outside the firm as R&D and certain knowledge-intensive services are outsourced. In parallel, the providers of highly specialised services like consulting or ICT often pollinate knowledge throughout the economy as their personnel is temporarily detached to client firms.

Another example of the development of "knowledge markets" is the increasing licensing of patents, which is simply another way to commercialise knowledge. Baumol (2002) stresses the role of patents in diffusing knowledge, as innovators license their new techniques to those whom may use them more efficiently.

2.3 Innovation

Evolutionist theory sees innovation and technological progress as the key drivers of economic growth.

Innovation is conceptualised as the result of complex and interactive learning processes through which firms tap into complementary knowledge from other organisations and institutions. Tacit knowledge and learning-by-doing are important features of innovation. These characteristics reinforce the agglomeration of innovation activities in geographic clusters, which can either be country-specific or reach across national borders.

Since Schumpeter, innovation is viewed as a multidimensional concept. It does not only take the form of new products or processes. More efficient reorganisation of production, logistics or distribution, improved managerial techniques, access to new markets, substitution of cheaper inputs or materials in the production process, etc. are all examples of innovation. In any case, invention or discovery only become innovation when they are translated into economic or social benefit.

Academic and empirical research commissioned by the Enterprise DG of the European Commission in the "Innovation Policy Studies" series has come to a number of central findings on innovation which are strikingly consistent with the evolutionary view. The most salient features of innovation as underlined by these findings and the larger evolutionary literature are the following:

- <u>Innovation is not only driven by a small set of high-technology industries</u>. Lundvall talks of innovation as a "ubiquitous phenomenon" which happens in "practically all parts of the economy". Innovation surveys and data, particularly for the EU, clearly show that innovation is widely spread across European industrial sectors. Mature and low-tech industries often generate substantial amounts of sales from new products and frequently integrate process innovations in their production. The service sector is also highly innovative.

- <u>Non-technological innovation is important</u>. Innovation is not only the result of scientific and technological research. It relies also on organisational, marketing, social, economic and other types of knowledge. Organisational innovations and new managerial practices become critical to reap the full productivity-enhancing potential of ICT. Innovations in areas such as distribution, logistics or organisation need to accompany technological innovations before they provide economic value. Moreover, in the knowledge economy the importance in many sectors of *presentational innovation* (marketing, design, branding, etc.) is increasingly acknowledged.

- Technological co-operation and collaboration among firms is essential. Innovation is rarely created within a firm in isolation, it most often requires an interactive process among firms. Access to new sources of knowledge through collaborative networks is essential. Co-operation allows the internalisation of technological spillovers and stimulates the diffusion of information entailing reductions in information costs. It is worth noting that in parallel with the increasing importance of alliances the share of inter-regional alliances has also grown over time.

- Innovative firms draw largely on the science system and science base. Innovation in networks and individual firms may depend on the new technological opportunities opened by basic research. In many industries, e.g. pharmaceuticals or biotechnology, science provides the critical knowledge base. Research institutes and universities play a major role as collaborating partners of industry. Technology transfers between these institutions may be an ingredient in successful innovation processes.

- Innovation processes are uncertain and non-linear. New innovation theories move away from the "linear model". The translation of knowledge into new products and processes does not follow a linear path from basic R&D to applied research and further to new products and processes. The path of innovation is unpredictable and characterised by complex feedback mechanisms and interactive relations between numerous actors and institutions within a system.

- Innovation processes have a cumulative nature. The future path of innovation processes is dependent on the state-of-the-art technologies existing today: current innovators have a comparative advantage to become the innovators of tomorrow.

- Innovation takes place in firms of all sizes. It is very often smaller and informal organisations that are at the origin of the most innovative thinking. This seems to be confirmed by studies investigating the neo-schumpeterian hypothesis according to which the relationship between firm size and innovative output is non-linear. However, SMEs still tend to face a number of difficulties in realising their innovative potential. Lack of necessary skills, finance, management capabilities or limited access to external networks often hamper SME development and innovation.

The evolutionary literature on innovation also draws some important policy implications from these findings:

⇨ As innovation is widely spread across all sectors in the economy, industrial policy must consider the needs of a wide spectrum of sectors and industries and avoid concentrating exclusively on a subset of high-tech activities. Moreover, industrial policies based on picking winners are unlikely to succeed. In a highly uncertain environment, governments, like firms, are rarely able to foresee the outcomes of different research paths.

⇨ Networking and co-operation in R&D need to be encouraged. Reinforcing the incentives for firms to co-operate and bring together their knowledge increases the possibilities of coming up with successful innovations. By networking, firms have access to enhanced knowledge and information flows. Inter-firm collaborative alliances also allow undertakings to dissipate the risks associated with the uncertainty and complexity of the innovation process.

Clearly co-operation on research projects among competitors entails certain risks of facilitated collusion in final markets. There is therefore a case for close public monitoring of the competitive process in order to ensure that no collusive behaviour develops. Recent literature tends however to place stronger emphasis on the pro-competitive aspects of knowledge sharing. The concept of “alliance capitalism” used by Dunning (1997) relates to the co-existence of competition, strengthened by globalisation and liberalisation, with an increasing number of alliances and network relations between competitors.

⇨ Public authorities should foster the links between industrial R&D and the science system. Comparative studies point to the significance of the links state-industry-university. The management of intellectual property resulting from publicly funded research owned rights is an important element to determine the final diffusion of public research results. A fruitful strategy might consist in granting the intellectual property rights (IPR) to the research institution while ensuring that individual researchers get a good share of the resulting revenues (OECD 2002b). Moreover, reinforced co-operation between firms and the R&D infrastructure is also necessary if public authorities are to get the maximum possible social return from publicly funded research.

⇨ Evolutionary economics shares the basic conclusions from new growth theory and the externalities argument, which stress the importance of public support for R&D. However, the level of R&D alone explains very little of the economic and competitiveness performance of the economy. Even if R&D investment is an essential element, it is but one of the determinants of innovation output. Attention needs also to be placed on raising the productivity of R&D spending. Given the process of evolution which the economy is constantly undergoing, innovation is related to the overall capability of the “innovation system” to dynamically create knowledge and transform it into innovative products and processes. Finally, the cumulative nature of innovation can be exploited to leverage existing knowledge. Public policy should promote an institutional framework that consolidates and amplifies the existing knowledge stock of the economy.

The evolutionary view of innovation has been developed within the conceptual frameworks presented below: innovation systems and the clusters approach. In addition, closely linked to the concept of clusters, a branch of literature has developed in the 1990s that focuses on the links between the microeconomic environment and business performance.

3. The systemic approach: Systems of Innovation and Clusters

3.1 The Systems of Innovation approach

The Systems of Innovation (SI) approach has been developed as the conceptual framework of the evolutionary theory on innovation. A system of innovation has been defined as "all important economic, social, political, organisational, and other factors that influence the development, diffusion and use of innovations" (Edquist 1997). The SI approach stresses the role of institutions, the core elements of SI, as determinants of innovation and technological progress.

The literature on systems of innovation is very extensive. Since the pioneering books edited by Lundvall (*National systems of innovation: towards a theory of innovation and interactive learning* (1992)), and Nelson (*National systems of innovation: a comparative study* (1993)), publications on innovation systems have flourished. Substantial empirical and case-based research has also been undertaken under the auspices of the OECD.

The SI approach builds on the concept that innovation is not a sequential process but the result of the interactions amongst numerous actors within a *system*. Hence the SI framework places much emphasis on the systems in which firms are embedded, including the institutional and organisational framework, the cultural and social context, the regulatory systems and other infrastructures. In this view of the world, institutions shape the actions and incentives of firms through laws, technical standards, public funding, social rules, health regulations, etc.

A central dimension of the approach, recurrent in most innovation literature, is that innovations are based on knowledge creation and diffusion which are both context-related and interactive. The flows of knowledge within the system are a crucial element in the innovation process as most often access to complementary knowledge is a prerequisite for firms to innovate.

Another recurrent idea is the importance of institutional learning, or the capacity of institutions themselves to adapt to technological change and to promote technological diffusion. Research from the OECD (2001a) also relates a system's innovative capacity to the extensiveness and efficiency with which it diffuses and absorbs knowledge.

This idea has also been recently highlighted by Mowery and Nelson (1999), who see the notion of institutional "competencies" as a fundamental determinant of the capacity of an economic system to produce innovation. They conclude from a series of sectoral case studies that local competencies are vital for success at the firm level. They find that local access to highly-skilled labour, availability of venture capital or the national university system are all critical factors for industry competitiveness. They provide numerous examples of the importance of the nature and size of domestic markets as a determinant of industry development.

Although much of the initial emphasis of SIs was in a national context – from where the commonly used term "National Systems of Innovation" – numerous authors question the relevance of the national perspective. Lundvall (1998), for instance, has emphasised increasing internationalization as an argument against looking systematically at innovation systems as *national*. Recent evidence collected from the OECD (2002a) confirms the increasing importance of the international dimension of innovation systems.

3.2 The cluster approach

Clusters are increasingly seen as a key determinant of industry competitiveness and innovative performance. Roelandt and Hertog (1999) define economic clusters as "networks of production of strongly interdependent firms (including specialised suppliers) linked to each other in a value-adding production chain." In a sense clusters go beyond the sectoral approach as they are formed by disparate and complementary firms specialised in different links or segments in the value chain. Clusters are generally associated with better economic performance.

As in the SI approach clusters often also encompass links with universities, research institutes, suppliers of knowledge-intensive business services and customers. Actually, clusters can be conceptualised as reduced-scale systems of innovation.

Also as is the case for SI, evidence points to cross-border clusters becoming important as firms are increasingly involved in international production and knowledge networks. However, at the same time the competitive advantage of "cluster industries" relies on a high degree of specialisation and in the interaction with local or regional resources (SME Observatory 2002).

Interactions and interdependencies among different cluster participants are crucial for the development of learning processes. These relations are intense and many of them are not related to market transactions. These happen also through a wide range of non-market mechanisms.

Clustering is explained by the recurrent finding that innovation is facilitated by geographic proximity. The complex and sticky nature of knowledge tends to lead to a geographical clustering of activities based on innovation. Given that the transmission of (tacit) knowledge becomes more costly and difficult with increased geographical distance, it happens more efficiently between organisations located close to each other. Alternative interpretations of regional clustering include reduction of inter-firm transaction costs and the formation of pools of specialised human resources.

3.3 Porter's school: the microeconomic business environment

In parallel with the evolutionary framework of "innovation systems" and "clusters" a strand of management literature has also developed a cluster-based theory of industrial competitive advantage. In his seminal book *The competitive advantage of nations* (1990), Porter emphasised the role of the microeconomic environment in country-specific industrial clusters. Porter highlights how cluster innovative activity is shaped by four main factors: (i) the availability of high-quality and specialised innovation inputs (above all human capital and accumulated knowledge); (ii) the local competitive context, including intellectual property protection, local rivalry and openness to international competition; (iii) the nature of local demand conditions; and (iv) the density and interconnectedness of vertically and horizontally-related industries within the cluster. These four areas have been referred to as the *diamond*.

Porter (1990) emphasises that the geographic concentration of suppliers, customers and rivals fosters the competitiveness of the firms in the cluster. He also underlines how governments affect innovation performance and competitiveness through their influence in the business environment. Factor conditions are for instance affected by education and training policies. Government procurement or consumer protection regulations affect demand conditions. Similarly competition policy influences market rivalry, and so on.

More recently Stern, Porter and Furman (2000) have conducted empirical exploration to characterise the determinants of "national innovative capacity" (their term). They find that the production of international patents (patents by foreign countries) is highly correlated with R&D manpower and spending, intellectual property protection, openness to international trade and the share of research performed by the academic sector and funded by the private sector. They also find that patenting productivity is highly influenced by a country's accumulated knowledge, which is in line with the evolutionary view of innovation as a cumulative process.

3.4 Policy implications

In the field of innovation, theory and policy have recently progressed hand in hand, as some of the most relevant pieces of research have been conducted either by public bodies or commissioned by them. This is clearly the case for the markedly policy-oriented research conducted by the OECD, but also of the Innovation Policy Studies series commissioned by the Enterprise Directorate-General of the European Commission. Some of the most relevant policy implications are:

⇨ Government intervention should still be primarily focused on the proper functioning of markets, <u>creating the favourable framework conditions for enterprise development and innovation</u>. This is associated with putting into place the appropriate regulatory framework, implementing sound macroeconomic policies, ensuring availability of venture capital, promoting vigorous competition, etc. As a direct implication, the horizontal EU industrial policy approach is not put into question.

It is worth noting, however, that focusing on the framework conditions is not understood as an emphasis on broad horizontal measures. The main implication of the SI and cluster frameworks is that if industrial policy is to be effective it has to <u>focus on the specifics of every system</u>. Effective policy needs to take into account the way in which innovation processes are contextually specific. Policy has to be tailored to specific sectors and develop competencies that are specific to the local/regional context. Getting the horizontal policies right is essential, but a narrow focus on horizontal policies alone will have only mild effects.

In this context, a fundamental task for public authorities is to stimulate and facilitate the emergence of innovative clusters. However, clusters can't be created from scratch, they tend to emerge of their own sake, as a market-induced phenomenon. Possible ways of contributing to the development of emerging clusters include reinforcing the links between industry and the knowledge infrastructure or stimulating formal and informal inter-firm co-operation.

⇨ As a second step, the innovation system and cluster approaches shift the policy emphasis from the traditional concept of tackling market failure to the aim of removing "systemic imperfections". Policy makers should facilitate the efficient functioning of the systems by addressing any problems in their constituent elements and dynamics. Edquist (2001) identifies four main categories of system failures, depending on what element of the system is missing or malfunctioning: organisations, institutions, functions or interactions/links between the elements of the system.

The suggested available tool for governments to recognise "systemic problems" is benchmarking. In an evolutionary context there is no such thing as an optimal state in relation to which "failures" can be identified. Hence the necessity to compare systems and clusters against each other in a detailed manner so as to ascertain the determinants of success and potential sources of "systemic failure". Similarly, examples in terms of "best performance" are provided by other benchmark systems.

Deep cluster or system analysis is a necessary prerequisite for policy action. In the systemic approach policy action is based on a solid understanding of the functioning and interactions of all organisations and institutions in the system (firms, universities, public authorities and agencies, regulatory framework, etc.) It is the combination of thorough analysis and benchmarking that can provide insights on gaps in innovation networks, infrastructure needs, economic strengths and weaknesses, suitable targets for increased investment in research, lacking skills, etc.

⇨ State intervention to tackle 'systemic problems' can take several forms. The OECD (1999) finds that in those countries where innovation policies have started to integrate the innovation systems approach, governments "shift away from direct intervention towards indirect inducement". In this context the main task for public authorities is building the right institutions which facilitate the development of innovative clusters. These may include the links between enterprises and the knowledge infrastructure or the formal and informal channels of co-operation between firms.

At the same time governments can exploit their role as a key player in many markets, for instance health or defence. Demand pull strategies through technology procurement policies can stimulate innovation from the demand side. The state can play the role of a demanding customer that puts pressure on firms to develop innovative solutions.

In addition, the effectiveness of industrial policy is enhanced when it is implemented in co-operation with the firms: policies should follow a bottom-up approach. Policymakers have to be attentive to the needs and demands of the firms. The starting point for policy action lies at the firm level, enhancing and promoting market-induced initiatives instead of formulating priorities at the national or supranational level. At the same time, such an approach entails positive inducement effects on the firms and has a larger impact in their behaviour.

⇨ In many fields of relevance for innovation systems and clusters a number of institutions and policies act at the EU level. In this sense, the challenge for the EU is to ensure the maximum possible effectiveness of the European innovation systems as a means to raise the quality and efficiency of innovation activities and hence the competitiveness of EU industry. In addition, evidence points to a growing importance of cross-border clusters and the supra-national features of innovation systems. There is however still very little research on these issues.

Finally, the systemic approach stresses the need for integrating more systematically the different functionally organised public policies and develop a better understanding of how different policy areas shape the innovation performance. Many of the policies that affect the functioning of systems and clusters lie outside a narrow definition of industrial policy. The systemic approach requires reinforced coherence across different policy fields, particularly enterprise, competition, taxation, trade, regional development, public procurement, research and development, health and consumer protection and internal market.

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