Paper no. 2006/04

Rationales for public policy intervention from a systems of innovation approach: the case of VINNOVA

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http://www.circle.lu.se/publications
ISSN 1654-3149

WP 2006/04

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Keywords: systems of innovation , innovation policy.

Rationales for public policy intervention from systems of innovation approach: the case of VINNOVA

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Abstract

This chapter discusses the implications of the adoption of the National Innovation Systems approach for innovation policy. It starts by positioning the 'systemic' approach against other theoretical approaches, such as neoclassical theories. The authors argue that the adoption of one or the other frameworks leads to different criteria for intervention. The main rationales for public intervention under each approach are then discussed. We make a distinction between classic *market failures* (grounded in neoclassical theory) and *systemic problems* - often called systemic failures - (grounded in the evolutionary/systemic approaches). On the basis of this, the authors will discuss other important issues to be considered when discussing public policy intervention under a system of innovation.
An outline of the paper follows:

1. Introduction

Innovation policy can be defined as "the public actions that influence innovation processes, i.e. the development and diffusion of (product and process) innovations". The objectives of innovation policy are often economic ones, such as economic growth, productivity growth, increased employment and competitiveness. However, they may also be of a non-economic kind, such as cultural, social, environmental, or military. The objectives are determined in a political process, and not by researchers. They must, however, be specific and unambiguously formulated in relation to the current situation in the country and/or in comparison to other countries.

In innovation processes, private as well as public organisations are operational. Large-scale and radical technological shifts rarely take place without public intervention, while incremental innovation is normally carried out by firms. An important question for innovation policy design is in which situations public organisations should intervene and when they should not. Hence, innovation policy design is very much a question of the division of labour between on the one hand the actions of private firms and the operations of markets and on the other the actions of public organisations - with regard to factors influencing innovation processes. To discuss this division of labour is the same as discussing the *rationales*, *reasons* or *criteria* for public policy intervention.

Although the issue of the rationale for public intervention under the systems of innovation perspective has recently received an increasing attention among scholars and practitioners (Koch, 2003, OECD, 2001, Smits and Kulhmann 2004, Woolthuis et al 2005), there has not been yet an attempt to profoundly discuss the implications of the adoption of the IS approach for the design and implementation of innovation policies. We will try to pursue such a discussion both from a theoretical perspective and a practical one, including giving some examples of innovation system based policies.

Since the emergence of the system of innovation concept in the 1990's in academic arenas (Freeman, 1987; Lundvall,1992, Nelson, 1993 and Edquist 1997) the concept seemed to attract rapidly the interest of policy makers, especially international policy think-tanks such as the OECD (Mytelka and Smith, 2002). As many studies have argued, the OECD played a significant role in the dissemination of the concept to national governments. Its many initiatives on systems of innovation and policy (OECD, 1994, 1995a, 1995b, 1996, 1997, 1999, 2001 and 2002) had a strong impact on the way that national governments started to design and implement innovation policies. Today, countries like Finland, Sweden or Japan have explicitly adopted the system of innovation approach in their innovation policies.

Despite the widespread use of the IS approach in policy-maker circles, it remains a fuzzy concept - very difficult to use in practice as we have argued before (Chaminade and Edquist 2006, forthcoming). We still know very little about the implications of the adoption of the SI approach for public policy (what to do, when and how to do it). One way to tackle this issue is to compare the basic assumptions of the IS approach to those of the neo-classical theory (Lipsey and Carlaw 1998; Smith 2000) and discuss the knowledge, learning and innovation in neoclassical and evolutionary theories and the implications for this discussion on public intervention. Another issue is to

critically address how countries that have explicitly adopted the SI approach are dealing with the questions of when and how to intervene. Particularly, in this paper ee will address the case of Sweden.

The paper will be structured as follows. In section 2, we will compare the basic assumptions of the neoclassical and evolutionary-systemic theories and the implications of the adoption of one or another for the rationales for public intervention (why to intervene). We will then introduce in section 3 some additional issues of relevance for intervention and some principles that emerge when the system of innovation approach is adopted for innovation policy. Finally, in section 4, we will critically look at the Swedish case, where a new agency VINNOVA was created in 2001 for the design and implementation of innovation system based policy in Sweden and we will conclude with some open questions and issues for further research.

2. Neoclassical vs. evolutionary theories: conceptual framework and rationales for public intervention

2.1. Concept of knowledge, learning and innovation in the neoclassical theory

There is no explicit definition of knowledge or learning in the neoclassical approach, although it is implicit in the analysis (Smith, 2000). One of the basic assumptions of the neoclassical theory is perfect information. It is assumed that all economic agents can maximize their profits because they have perfect information about the different options available to them. Knowledge is equal to information, i.e., it is codified, generic, and it is accessible and easily adaptable to the firm's specific conditions.

These tacit assumptions about the properties of knowledge are reflected in the discussion about the process of invention. For Nelson (Nelson 1959) and Arrow (Arrow 1962) the knowledge emanating from research has some specific properties: uncertainty, inappropriability and indivisibility (Lipsey and Carlaw, 1998).

- *Uncertainty* refers to the impossibility to fully know the outcomes of the research process and the risk associated to it[1].

- *Inappropriability*, means that firms cannot fully appropriate the benefits which derive from the invention. There will always be externalities emanating from the research process. As knowledge is considered to be information and this is assumed to be costlessly accessible to all economic agents, this means that the incentive for research activity by firms is limited , i.e. smaller than it would be if it was possible for firms to appropriate all the benefits.

- *Indivisibility* implies that there is a minimum investment in knowledge before any new knowledge can be created.

The neoclassical analysis provided governments with strong arguments to invest heavily in fields such as energy, large-scale science and technology projects, defence

[1] The problems of uncertainty in the design of innovation policy will be discussed with more detail in section 3.2.

research, etc. where the public rate of return was expected to be high, the barriers to entry were significant and the externalities were also assumed to be sizeable.

For the neoclassical scholars, the innovation process is narrowed down to research (and invention). How to transform the results of the research activity into products or processes that can be used in the economy is a black box (Rosenberg 1982, 1994). For the neoclassical theorists, the process of innovation is a fixed sequence of phases, where research efforts will automatically turn into new products.

The three characteristics of scientific knowledge (uncertainty, inappropriability and indivisibility) will lead to an under-investment in R&D activities by private actors. This constitutes the main rationale for public intervention in research activities. Policy makers have to intervene because of a *market failure*: economies will systematically under-invest in R&D not reaching the optimal allocation of resources for invention[2].

A critical concept in neoclassical theory is equilibrium. For the neoclassicals, markets will always tend to achieve equilibria under the conditions of perfect information, perfect competition and profit maximization. Governments should intervene to mitigate non-desired externalities and asymmetries in information, correct inefficient market structures or eliminate the barriers to entry so that the markets can reach the desired equilibrium.

The main strength of the neoclassical market failure argument is its simplicity. However, the policy implications that emerge from the market failure theory are actually not very helpful for policy-makers from a practical and specific point of view. They are too blunt to provide much guidance. They do not indicate how large the subsidies or other interventions should be (as it is not possible to determine the optimum level of investment) or within which specific area one should intervene. Standard economic theory is not of much help when it comes to formulating and implementing specific R&D and innovation policies. It only provides general policy implications; e.g., that basic research should sometimes be subsidised (Edquist, Malerba et al. 2004). As neoclassical theorists tend to ignore the economic structure or institutional frameworks in which the innovation activity takes place, their policies apply across the whole economy (Lipsey and Carlaw, 1998, OECD, 1998). The market failure approach is too abstract to be able to guide the design of specific innovation policies. An overall observation is that neoclassical theory does not address innovation processes broadly defined– but mainly research and invention.

[2] Indeed research conducted for the OECD countries (Mohnen, 1966 cf Norgren and Hauckes, 1999) has shown that the social rate of return of investments in R&D and Human Capital largely exceeds the private rate of return, therefore providing strong arguments for public intervention in the supply of R&D and the provision of human capital.

2.2. Concept of knowledge, learning and innovation in Evolutionary theory and the System of Innovation approach

The general policy implications of the Systems of Innovation approach are different from those of standard economic theory. This has to do with the fact that the characteristics of the two frameworks are very different. The Systems of Innovation (SI) approach shifts the focus away from actions at the level of individual and isolated units within the economy (firms, consumers) towards that of the collective underpinnings of innovation. It addresses the overall system that creates and distributes knowledge, rather than its individual components, and innovations are seen as outcomes of evolutionary processes within these systems.

The SI approach has its roots in the evolutionary theory (Nelson and Winter 1982). Firms are a bundle of different capabilities and resources (Eisenhardt and Martin 2000; Grant 1996; Spender 1996) which they use to maximize their profit. Knowledge is not only information, but also tacit knowledge; and can be both general and specific and is always costly. Knowledge can be specific to the firm or to the industry (Smith 2000). While in the neoclassical approach information asymmetries are considered to be a market failure, under the evolutionary theory and the SI approach asymmetric information is essential to provide novelty and variety.

The evolutionary theory puts the emphasis on the mechanisms of diversity creation and selection (e.g. competition) as the engines of innovation. It also stresses the path-dependency of innovation processes. The SI approach, takes the evolutionary theory as one of the points of departure, to focus on the interactive mechanisms that shape the emergence and diffusion of innovations.

The SI approach emphasises the fact that firms do not innovate in isolation but with continuous interactions with other organisations in the system (at regional, sectoral, national and supranational level) (Edquist, 1997, 200; Lundvall, 1992). The innovation process is interactive within the firms and among the different organisations in the innovation system. At the firm level (Kline and Rosenberg 1986) innovation can take place in any part of the firm and in interaction with external sources of knowledge.

Understanding innovation as a complex interactive process has important implications for the design and implementation of any kind of policy to support innovation. It affects the focus of the policy, the instruments and the rationale for public policy, among other issues (Chaminade and Edquist, forthcoming 2006). The systematic approach to systems of innovation (SIs) does not imply that these systems are or can be consciously designed or planned. On the contrary, just as innovation processes are evolutionary, SIs evolve over time in a largely unplanned manner. Even if we knew all the determinants of innovations processes in detail (which we certainly do not, and will never do), we would not be able to control them and design or ‘build’ SIs on the basis of this knowledge. Centralized control over SIs is impossible and innovation policy can only influence the spontaneous development of SIs to a limited extent.

A main focus of the SI approach is therefore the system and the complex interactions that take place among the different organisations (‘players’) and institutions (‘rules of

the game') in the system. Policy makers should intervene in those areas where the system is not operating well, that is, when there are **systemic problems**. But when do we talk about systemic problems or problems in the system?

One mode of approaching this question is the following (Chaminade and Edquist, forthcoming 2006, Edquist and Chaminade forthcoming 2006): In a modern society, it is assumed that capitalist firms and the market mechanism best fulfil many economic tasks. The market mechanism evaluates and co-ordinates the behaviour and resources of private and public actors – often in a smooth and flexible manner. This concerns the production of most goods, and a large proportion of service production. It is also true for the creation of many innovations, in particular incremental ones. Most of them occur through the actions of firms and in collaboration projects between firms. This is, however, less true for radical innovations, especially in the early stages of the development of new technology fields.

There are reasons to complement the market system through public intervention for two main reasons: a) Either there is no market mechanism operating at all and the activities are fulfilled through other mechanisms, e.g., regulation or b) the market mechanism does not lead to the fulfilment of the objectives established by the government and have, for decades, been complemented by public intervention in most industrial countries. This is true in the areas of law, education, environment, infrastructure, social security, income distribution, research or innovations, etc

What, then, are the reasons for public policy intervention in a market economy? As regards, for example, technical change and other kinds of innovations, two conditions must be fulfilled for there to be reasons for public intervention in a market economy (Edquist and Chaminade 2006):

(1) Firstly, capitalist firms and the market mechanism must fail to achieve the objectives formulated. A *problem* that is not spontaneously solved by private actors and market forces must exist We have called this a systemic problem. It can also be called a public policy opportunity.
(2) Secondly, the state (national, regional, local) and its public agencies must also have or be able to build the *ability* to solve or mitigate the problem. This can be called policy competences).

It is important to note that innovation policy – or other kinds of public intervention – should be a complement to the market, not replace or duplicate it. If there is no "additionality" the public actions are a *substitute* for the actions of private firms and the operation of markets. The two are overlapping or competing. It is of great importance that there actually is additionality associated with the public intervention. If not the public resources invested will not influence innovation processes, but lead to increased profits for the firms or to increased spending on other things than those targeted by the policy. In other words, there must be a *' systemic problem'* - which is not automatically solved by capitalist actors and market forces - for public intervention to be 'considered'. Such problems can be identified through analysis.

It is important to know that the notion of optimality is considered to be irrelevant by the SI approach. As mentioned earlier, "market failure" in mainstream economic theory implies a comparison between conditions in the real world and an ideal or

optimal economic system. However, innovation processes are path dependent over time and it is not clear which path that will be taken. They have evolutionary characteristics. We do not know whether the potentially 'best' or 'optimal' path is being exploited. The system never achieves equilibrium and the notion of optimality is irrelevant in an SI context. We cannot specify an ideal or optimal system of innovation. Hence, comparisons between an existing system and an ideal or optimal system are not possible. Thereby the notion of "failure" looses its meaning and applicability[3]. Instead we talk about systemic problems. Some of these systemic problems mentioned in the literature include (Norgren and Haucknes, 1999: Smith 2000; Woolthuis, Lankhuizen et al. 2005):

- *Infrastructure provision and investment problems*, including the physical infrastructure (transport, etc), the scientific infrastructure (high-quality universities and research labs, technical institutes, etc) and the network infrastructure (IT, telecom).
- *Transition problems*: They refer to the difficulties that might arise when firms and other actors encounter technological problems or face changes in the prevailing technological paradigms that exceed their current capabilities. Firms might not be capable to foresee the emergence of new paradigms, radically new pervasive technologies or significant changes in the markets that require new technological solutions. As we will argue later, the transition from one prevailing paradigm to the next involves a high degree of uncertainty which might prevent private actors to enter the new technological field or market.
- *Lock-in problems*, derived from the socio-technological inertia, which might hamper the emergence and dissemination of more efficient technologies[4]. Firms and other organizations might be locked into existing technologies (and technology systems). The strength of technology systems might hamper the development of new technologies alien to the prevailing technological system or technology regime. Lock-in problems might lead to transition problems to the extent that the excessive focus on existing technologies might prevent the firms to foresee the emergence of new technological opportunities.
- *Hard and soft institutional problems*: linked to formal rules (regulations, laws) as well as more informal and tacit ones (social and political culture for instance). The system of innovation approach pays special attention to the role of institutions in the systems. Institutions are *sets of common habits, norms, routines, established practices, rules or laws that regulate the relations and interactions between individuals, groups and organizations* (Edquist and Johnson 1997: 46). The institutional framework plays a very significant role in the production of innovations as well as in the adoption and dissemination of innovations. The government can play a significant role in the development of the formal rules whilst in most cases this role is marginal when the most tacit elements are to be influenced (culture, firm routines, social networks, etc).

[3] It is important to note that the absence of an optimum implies that there is no clear "gap" that policy makers need to target as in the neoclassical theory. That is, policies can not be objectively defined against a clear (and measurable) target.

[4] One clear example of lock-in is the fossil energy. The productive system is so dependent on the fosile energy that it is preventing the expansion of new forms of energy (such as solar, eolic, etc).

- *Network problems*: which include those derived from too weak linkages or too strong linkages (blindness to what happens outside the network) in the system of innovation. Although it is easy to understand that the system might suffer from network problems that may require some kind of government response, in practice it is very difficult to assess the adequate degree of strength of the linkages in the system. Both strong and weak linkages are reported to have advantages and disadvantages, in terms of openness and intensity of exchange (Nooteboom, 2004)
- *Capability and learning problems*: these systemic problems refer to the insufficient competences of firms (human, organizational, technological and so forth) which might limit their capacity to learn, adopt or produce new technologies over time. In other words, the system might have the right infrastructure and institutional framework, but the organizations of the system might have difficulties in accessing or creating new knowledge or in transforming knowledge into innovations.
- *Unbalanced exploration-exploitation mechanisms*: The system might be capable of generating diversity but not having the mechanisms to be able to make the adequate selections or it may have have very refined selection procedures but no capability to generate diversity.
- *Complementarity problems*: the competences of the system might not complement each other or they might not be connected so the positive effects that might emerge from the combination of complementary capabilities are not fully deployed.

Hence our discussion of rationales for policy intervention is based on **systemic problems**[5] rather than on market failure. The table below summarises some of the issues related to the neoclassical and systems of innovation approaches and the policy implications of these approaches.

	Neoclassical	Systems of Innovation
Underlying assumptions	Equilibrium Perfect information	Non-equilibrium Asymmetric information
Focus	Allocation of resources for invention Individuals	Interactions in innovation processes Networks and Framework conditions
Main policy	Science policy (research)	Innovation policy
Main rationale	Market failure	Systemic problems
Government intervenes to (examples)	Provide public goods Mitigate externalities Reduce barriers to entry Eliminate inefficient market structures	Solve problems in the system or to facilitate the <creation of new systems: Induce changes in the supporting structure for innovation: support the creation and development of institutions and organizations

[5] The notion of market failures is associated to the existence of an optimum. Since the evolutionary theory and the systemic approach does not support the idea of an optimum but rather a miryad of systems performing in different ways, we prefer to talk about systemic problems instead of market failures.

		& support networking Facilitate transition and avoid lock-in
Main strengths of innovation policies designed under each paradigm	Clarity and simplicity Long time series of science-based indicators	Context specific Involvement of all policies related to innovation Holistic conception of the innovation process
Main weaknesses of innovation policies designed under each paradigm	Linear model of innovation Framework conditions are not explicitly considered in the model (e.g. institutional framework) General policies	Difficult to implement in practice Lack of indicators for the analysis of the IS and evaluation of IS policies

3. Unsolved questions: Additional issues for consideration under the system of innovation perspective

3.1. Policy mistakes (and policy learning)

The role of the policy maker under the neoclassical theory was to help the market reach equilibrium again. In the words of Norgren and Hauknes (1999) we could talk about the optimising policy maker. However, the role of the policy maker under the SI perspective is one of adaptation. Policy makers need to adapt their policies to the identified systemic problems in systems of innovation – and these may change over time. We move from the optimising policy maker to the adaptive policy maker. This means the acceptance of mistakes in policy making but also points to the importance of evaluation of policies and policy learning. Under the SI approach, the formulation of policies is based on existing theory (limited), indicators (limited) and subjective judgement (common sense). It is difficult for the policy makers to know ex-ante how the system will react to the policy. Policy makers need to experiment and allow some room for mistakes. For this reason, evaluation of policies is very important.

In other words, it is not possible to know for sure – ex ante – if public intervention can solve the systemic problem or not.[6] The decision to intervene or not must thus be based upon whether it is likely or not that intervention mitigates the problem. Hence, the decision must be taken in a situation of uncertainty. Then one can afterwards – ex post – determine through evaluations whether the problem was solved or mitigated. If this was not the case, we are talking about a **policy mistake**. Policy mistakes can never be completely avoided because of the uncertainty mentioned. We must accept mistakes in public activity – as we do in private activities. Moreover, in order to be able to determine the success or failure of a given policy intervention through an

[6] This is especially the case with innovation. Here, by definition, it is highly unlikely that there will be any clear-cut precedents for the problem to be solved.

evaluation, it is necessary that the objectives of the policy are clearly formulated – ex ante.

There may be various reasons why public intervention cannot solve or mitigate a problem. One is that it is not at all possible to solve the problem from a political level. Then all types of intervention would be in vain and result in a policy mistake.[7] The other reason is that the state might first need to *develop its ability* to solve the problem. A detailed analysis of the problems and their causes may be a necessary means of acquiring this ability.[8] The creation of new organisations and institutions to carry out the intervention might also be necessary. A particular body of knowledge may not be represented in the national portfolio and require the establishment of a new research organisation or, a new policy instrument.

It is important to note that a 'problem' that motivates public intervention might concern the future. A 'problem' might be something that has not yet emerged. A '*problem-solving*' policy of this kind might alternatively be called an '*opportunity creating*' or anticipatory policy.[9] One of the problems to be solved might be that uncertainty prevents new technologies from emerging. One example of such a problem is the case where public funding of basic R&D might be necessary because capitalist actors do not have the incentive to fund it (e.g., because of inappropriability). Another example could be that training people in a certain field could create new opportunities that would not be realised without policy.

The discussion on policy intervention raises two important issues. First, policy intervention is specially needed when *uncertainty* and risk are very high and private actors do not find incentives to invest in those high risk products or new activities. Second, policy intervention needs to be *selective*, focusing on specific products, activities or technologies that better fulfil the (economic, social, environmental, etc) objectives of the government. The issues of uncertainty and selectivity will be discussed next.

3.2. Uncertainty

In the previous section we discussed the problems of the uncertainly related to the policy outcomes of an SI-based policy. In this section we discuss another type of uncertainty: the uncertainty linked to innovation processes, and the implications for the design of innovation policy. In other words, we argue that a high degree of uncertainty in the innovation process may be an important cause behind a systemic problem. This would then constitute a reason for public intervention.

One context in which firms and markets perform less efficiently is with regard to activities where uncertainty and risk are large. Sometimes they do not perform at all

[7] Hence, the problem is not solvable by private actors and the market mechanism *or* by public intervention.

[8] For example, it might be necessary to carry out a detailed comparative empirical analysis.

[9] There might be reasons to treat the solving of existing problems and the creation of future opportunities as two different kinds of situations calling for public intervention.

with regard to them. As mentioned earlier, one of the "problems" to be solved might be that uncertainty prevents new technologies from emerging. For example, public funding of basic *R&D* might be necessary because private actors do not have the incentive to fund it or they might under invest (Arrow, 1962) or they might even not invest in areas of great social return but low individual return (e.g. some drugs). Or if firms assume that *educating and training* shall be carried out by public organisations, the firms might not invest in human capital formation. In the very early stages of the development of new fields of innovation, there is uncertainty whether markets exists or not, and sometimes public organisations have been instrumental in *market creation* (directly, e.g. through public technology procurement, or indirectly). *Incubating activities* have been carried out in public or semi-public science parks to facilitate commercialization of knowledge in recent decades.

We have just mentioned four examples of "activities" where there are reasons for public intervention because of uncertainty and risk are large and, therefore, private organizations weak or unwilling to act. As a matter of fact, innovation as such is plagued by uncertainty. Such uncertainty is often largest with regard to innovation in *new* fields of production. Historically we have also seen that a minor public intervention in an early stage in an innovation process may have a very large impact.[10] A major effort in a mature stage may have only a small impact.[11]

The examples above indicate that risks and uncertainty is largest with regard to the emergence of *new* products. This indicates that "systemic problems" are more common. It also seems to be an empirical fact that large-scale and radical technological shifts rarely take place without public intervention (as opposed to incremental innovations in established sectors). This has been indicated in Carlsson and Jacobsson (1997), where they go through the cases of electronics, semiconductors and genetic engineering in the USA and Sweden. David Mowery has also clearly shown that publicly funded R&D in combination with public technology procurement has played a crucial role for the development of new high technology sectoral systems of innovation in the USA (and thereby in the world). Some examples are the early phases of the development of numerically controlled machine tools, commercial aircraft, semiconductors, computer hardware, computer software, and the Internet in the USA. Hence, the innovation policy support to new products and sectors has been very strong in the USA. The objectives of this public innovation polices have often been of a military character (Mowery 2005).

Smits and Kulhmann (2004) suggest two ways of coping with the uncertainty associated to any innovation process: by supplying the information that the different actors need to define their strategies and by providing the actors with the instruments, facilities and environments for experimenting and learning. This includes the provision of markets for new products (public procurement) or the provision of incentives for research in certain priority areas (R&D incentives) mentioned in the previous examples.

[10] The public support to the development of the NMT 450 mobile telecom standard in the Nordic countries is an example. The support amounted to a few hundred man-years.

[11] The massive public support to the Swedish shipyard industry in the 1970's and 1980's did not have any long term consequences, although it amounted to something like 0,5 % of GDP during ten years.

In sum, innovation involves a high degree of uncertainty and risk. The higher the uncertainty, the lower incentives private actors have to invest in certain new activities and public intervention will be motivated. This raises the important question, which is currently being debated among scholars and policy makers, about whether the government is in a better position than firms to forecast what are the critical new activities that should be funded. This raises the important issue of selectivity in innovation policy.

3.3. Selectivity

We have here argued that innovation policies should be focused upon solving or mitigating certain systemic "problems", and that these problems can be analytically identified To solve a problem, the policies have, of course, to target exactly this problem. This means that the policies cannot be neutral but are necessarily selective. When designing innovation policy, policy makers have to select the objectives of the policy (why and where to intervene) and the instruments (how to intervene).

The final policy is, however, the result not only of the analysis of the system, but often also of ideology, the influence of pressure groups (lobby) or simply the imitation of policy "models" (Edquist and Chaminade, forthcoming 2006).

Imitation is often practiced without proper adaptation to the circumstances in the new environment while the analysis and the lobbyism are more related to the specific circumstances of the country or the region. We will now discuss the interaction between these two and the possible negative outcomes of it.[12]

Lobbyists are special interests groups. They seldom find general subsidies or general support worth pressing for. Instead they often push for sector- and firm-specific public support, i.e. they pursue selective policies. Since lobbyists normally represent established interests and industries, they normally argue for policies supporting these established industries (currently for example, ship-yards, automotive and ICT) – and they are sometimes successful in achieving such public support.

One example indicating that innovation policy is selective is public investments in R&D. Analysis may reach the conclusion that x billion Euros shall be reallocated to research of relevance for the biomedical industry (from somewhere else). This is automatically a selective policy, since it favours the biomedical sectors of production and, more specifically the products and firms active in this industry – at the expense of others. The analysis of the system might also show that pharmaceutical companies are under investing in R&D related to some drugs that might have an extraordinary social impact (e.g. a drug to cure malaria) but that are rejected by private companies in favour of more profitable drugs (e.g. Viagra). The government might decide to allocate funds to research in those socially needed drugs.

In both the cases of innovation policy formed by lobbyism (which is common) and by analysis of the kind proposed by us (which is rare), the resulting policy is selective rather than neutral. There are reasons to limit the degree of selectivity – and maybe

[12] We hope to return to the issues of how innovation policy is formed in more detail in another paper fairly soon.

accept it only for sectors and products in *very* early stages of their development. However, this must be analyzed in more depth. Then a distinction could to be made between selectivity with regard to sectors, products, activities and firms respectively.

As Norgren and Hauknes (1999) argue one of the basic choices that policy makers need to make is between strengthening existing systems or facilitating the creation of new systems. In general, we argue that government support is most needed when uncertainty and risk are high and there is a risk that the private sector will not act - thus neglecting opportunities for change and renewal. Such support to new activities and products can encourage the emergence of brand new sectors a s well as support to the transformation of more traditional sectors.[13] The focus should be on supporting new activities (new products, new services, new technologies) and they can be in new or existing sectors. Furthermore, it should be noted that support might be needed for the emergence of a new product or technology but also for the dissemination of that new technology (for example) across sectors. This is especially relevant for generic technologies whose wider dissemination might increase the number of applications through complementary innovations.

It is important to note that the issue of selectivity need to be further discussed in relation to the different system levels. Although the rationales for public intervention continues to be to solve systemic problems, the specific purpose and target of the innovation policy (selection of objectives) is significantly different at the different levels.

Policies targeting *sectoral systems of innovation* tend to aim at promoting specific sectors that are considered crucial for growth (or some other policy objective). Whether policy makers should select new and emerging sectors or support new activities and products in existing sectors is still subject of a hot debate among academics and policy makers. In reality, what most governments have done is to chose a combination of emerging new sectors (Bio-tech, ICT, Nanotech) with others sectors deeply rooted in the country's economic structure (transport or materials).

Policies aiming at *regional innovation systems* are basically concerned with the growth of a specific region and its integration in international markets by means of mobilizing "all relevant players involved in the process of becoming internationally competitive within specific areas of growth" (Vinnova, 2001:5). Government intervene to 'create' or develop the regional system of innovation, by facilitating the interaction between the different actors and the development of a common growth strategy.

Finally, policies aiming at *national innovation systems* often aim at generating national competences for learning and growth (competence building) and are concerned, for example, with the development of a skilled workforce, a strong research capacity, etc.

[13] For example, supporting research in new engines using new forms of energy (bio-fuels, solar, etc) in the automotive industry.

3.4. Inertia or path dependency

Finally, it is important to note that a systemic innovation policy brings together a variety of policies that have traditionally been separated (education policy, industrial policy, etc). In this sense, innovation policy can be seen as a policy system itself, integrating traditionally individual and independent policies into a new systemic policy with new rationales, new instruments and new governance bodies. Adopting the SI approach implies the adoption of new rationales that might collide with former rationales. In other words, policy makers might adopt the system of innovation approach in their discourse while still using "market failure" arguments for allocating resources for innovation.

One way to overcome this path-dependency is to create new government structures or organizations responsible for the design, implementation and evaluation of innovation policies that explicitly adopt a system of innovation approach for policy-making. This is the case of VINNOVA, the Swedish Agency for Innovation Systems, which will be presented and discussed in the next section.

4. Systemic innovation policies: the case of VINNOVA[14]

The chapter will present and discuss a selected example of systemic innovation policy. One of the key governmental organisations, VINNOVA (The Swedish Agency for Innovation Systems), includes 'system of innovation' in its name. The rationales and instruments of VINNOVA's 'systemic innovation policy' will now be presented and discussed.

As compared with Finland who explicitly adopted the SI approach in the early nineties, Sweden can be considered a latecomer in the adoption of the SI approach in innovation policy. VINNOVA was inaugurated in January 2001. Its main task is to "promote sustainable growth and development for the business community, society and individuals by developing effective innovation systems …" (VINNOVA, 2001).

The general objective is translated into three main functions (Jacob, 2004):

- Advising the Government on innovation policy issues
- Commissioning and conducting in-house research on innovation related issues
- Design and implement (national, regional and sectoral) policy programmes to support and stimulate innovation

In their own words, VINNOVA "promotes effective innovation systems at a national, sectoral and regional level. The interaction between these different levels is a decisive factor in the development of strong, sustainable growth. For innovation systems to be effective, science, business and politics (the Triple helix) must work together to set

[14] This section is based on the analysis of official documents issued by VINNOVA, other relevant literature and our own experience collaborating with VINNOVA. The section will be further supplemented with additional material and analysis.

priorities and develop new initiatives within Sweden´s important growth areas" (VINNOVA, 2002:3)

VINNOVA has an annual budget of 1GSKK and employs around 150 people (www.vinnova.se), most of them formerly researchers who are very familiar with innovation theories in general and with the IS approach in particular.

4.1. Rationale for Government intervention in VINNOVA and the deployment of the SI policy at national, regional and sectoral levels

Although the rationales or reasons for intervention are not explicitly discussed in any official document, they can be inferred from the discourse and the objectives of the organization as well as the analysis of the Swedish innovative performance. Sweden is one of the countries investing a higher proportion of R&D/GDP as compared to Europe and other OECD countries. However, its performance in terms of product innovations – particularly those that are new to the world (Bitard et al 2005) are relatively poor. This apparent mismatch has been called the Swedish Paradox[15]. The apparent poor performance has been explained by the existence of problems in the system of innovation such as lack of demand, improper institutions, lack of financing or incubator support, or inappropriate organizations (such as lack of entrepreneurship, intrapreneurhip or policy organisations) as well as the embeddedness in specific historical paths, geographical areas or industry dynamics.

VINNOVA takes this paradox as its point of departure to design their strategic plan (VINNOVA, 2002). Policy actions deployed by VINNOVA aim at promoting problem solving research and develop *effective* innovation systems. VINNOVA defines *effective innovation systems* "as consisting of actors from science, business and politics, which interact to develop, exchange and apply new technologies and new knowledge in order to promote sustainable growth by means of new products, services and processes" (VINNOVA, 2002:3). VINNOVA aims to promote the effective interaction of these actors to facilitate the transformation of new knowledge into products, services and processes as well as ensuring the effective links with other innovation systems (national, regional and sectoral).

In order to develop these effective innovation systems at national, regional and sectoral levels, VINNOVA addresses the systemic problems adduced earlier in a variety of ways[16] (VINNOVA, 2002: 3-5:

- *Infrastructure provision and investment problems*: VINNOVA aims at strengthening the existing 23 competence centres[17] as well as creating new ones and investing in business incubators and a seed capital programme for new companies

[15] For a critique of the Swedish Paradox see Ejermo and Kander (2006)
[16] The following are just a selection of instruments used by VINNOVA to address the different systemic problems. They are by no means an exhaustive list of instruments used by VINNOVA.
[17] Competence centres are the result of the interaction between universities and companies in the field of problem-oriented research of high scientific quality (VINNOVA, 2002).

- *Transition and lock in problems*: One of the problems identified in the Swedish innovation system was the shortage of forums for pursuing a common discourse about the future (Teknisk Framsyn, 2004). To solve this problem the Swedish technology Foresight (Teknisk Framsyn) project was created. Foresight exercises are conducted with the participation of industry representatives as well as other actors of the system of innovation. The purpose is to engage all relevant actors in the discussion on emerging technologies and critical growth areas.
- *Hard and soft institutional problems*: Traditionally Swedish researchers were the only holders of the patents granted to their research results. Currently a new IPR system is being discussed, which places in the Universities the right to commercialize the patents generated by their researchers. The purpose of this measure is solving what was considered a "systemic problem": the low level of commercialization of the research results.
- *Network and complementarity problems*: The regional programme VINNVÄXT is the best example of how network problems are being addressed by VINNOVA. All initiatives funded at the regional level have to involve all relevant actors at that level, including policy-makers. To increase the cooperation between the organisations VINNOVA trains "innovation system developers", that is, facilitators that can "mobilise the level of commitment and resources needed to create efficient groups and processes which will produce concrete results" (VINNOVA, 2001:11)
- *Capability and learning problems*: Education and training of human resources seems to be a recurrent theme in all VINNOVA documents. Additionally, VINNOVA is also focusing on building capabilities in specific organizations (such as SMEs). For doing that, a special group has been created within the organization.
- *Unbalanced exploration-exploitation mechanisms*: As mentioned earlier, Sweden shows a very high performance in exploration activities (R&D, but also publications), but shows a relatively poor performance in product innovation. VINNOVA has increased the attention of research organizations and firms on the importance of "advanced-problem oriented research" as opposed to more basic research.

4.2. Selectivity and uncertainty

To deal with the issues of selectivity and uncertainty discussed earlier, VINNOVA bases its decisions on the results of foresight exercises and analysis methods, although there is a certain component of lobbyism and imitation, as we will discuss.

Foresight exercises: The design of innovation policy in Sweden relies strongly on the results of the Technology Foresight exercises. Since the creation of VINNOVA there have been two Technology Foresigh Projects, one in 2000 and another one in 2004. The purpose of those projects is to "identify Sweden´s preconditions for technological and economic growth in a ten –to twenty- year perspective" (Teknisk Framsyn, 2004). The results of the foresight projects lead, together with other analysis of the Swedish system of innovation to a selection of 18 growth areas which are shown in table 2.

Analysis: As a result of the foresight exercises and the analysis VINNOVA has identified 18 growth areas and activities in 6 main sectors (VINNOVA, 2002): information and communication technologies, services, biotechnology, manufacturing, materials and transports. Most of the selected 18 growth areas represent **new activities**, even in traditional industrial activities such as manufacturing, materials and transports, as table 2 shows:

Table 2. Priority growth areas

Growth areas	Sectors
Telecom systems Micro and nanoelectronics Software products	Information and communication technology
E-services in public administration IT in home healthcare The experience industry	Services
Pharmaceuticals and diagnosis Biotech supply Biomedical engineering Innovation in foods	Biotechnology
Complex and assembled products Wood manufacturing Intelligent and functional packaging	Manufacturing
Light materials and lightweight design Material design, including nanomaterials Green materials form renewal resources	Materials
Innovative vehicles and systems for different transport modes Innovative logistics and freight transport systems	Transports

Source: Vinnova, 2002.

Selectivity issues have thus been mainly dealt with through foresight and analysis.

Lobbyism: It can be argued that the design of policies is always influenced by key actors and interest groups, and Sweden is no exception on this.

Imitation: As indicated by Jacob (2004), traditionally Sweden has followed the OECD guidance for the design and implementation of innovation policy and, as we mentioned earlier in this paper, the OECD has been a very active carrier of the SI perspective among policy makers. In this sense, arguably, Sweden's innovation policy has been strongly influenced by the OECD. But not only. Nordic countries have a long tradition of collaboration and mutual learning which is extensive to policy circles.

4.3. Policy learning and evaluation

At the same time that VINNOVA was created, the Swedish parlament founded the Swedish Institute for Growth Policy Studies (ITPS). Its main task is to initiate, commission and evaluate industrial, innovation and regional policy measures (OECD, 2005 - check). The ITPS conducts and commissions analyses of economic development and growth. Since 2003 ITPS evaluates some of the R&D programs

initiated by VINNOVA. Additionally, VINNOVA has placed a greater emphasis on mid-term evaluations of all programs and impact assessments (OECD, 2003/$).

All projects funded by VINNOVA are evaluated periodically and the continuation of the funding support is contingent to the results of the evaluation. As an example, the projects funded by the regional program VINNVÄXT are assessed after 1, 3, 6 and 12 years respectively. The evaluations are used to assess the degree of fulfillment of the objectives settled in the project for that period as well as serve as a training tool for VINNOVA and the regional actors (www.vinnova.se).

However, not only the projects funded by each program are evaluated but also the program itself. As an example, the Competence Centre program has gone through three mid-term evaluations in its 8 years of activity that have resulted in significant changes in the program (www.vinnova.se).[18]

5. Conclusions (Under development)

In this paper we have tried to discuss rationales for public intervention under the neoclassical theory and the systems of innovation approach. We have argued that governments should intervene when a systemic problem that is not spontaneously solved by private actors and market forces exists, i.e. that firms and markets fail to achieve the objectives. Furthermore, the public agencies must have the ability to solve or mitigate the problem.

Some specific conclusions are the following:

- The notion of "market failure" looses its meaning and applicability. Instead we talk about "systemic problems".
- An optimal or ideal system of innovation cannot be specified and, therefore, the notion of optimality is irrelevant in the context of the systems of innovation approach.
- Comparisons can not be made between real systems and optimal ones, but only among different real systems (over time and space).
- Innovation policy is normally, and should be selective. Public policy intervention is seldom neutral, i.e. it is associated with a degree of selectivity.
- The selection should be made on the bases of a rigorous analysis of the system of innovation We have argued in favour of prioritizing those areas where there is a greater degree of uncertainty and risk or where the collective returns might be very high (for example in environmental or social terms).
- Adopting the SI approach for policy making implies accepting a potential degree of failure. In this sense, policy learning becomes a fundamental element in innovation policy.

[18] Of course, the Competence Centre Program was inherited by VINNOVA when it was created in 2001.

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