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Striving Towards a Holistic Innovation Policy in European Countries - But Linearity Still Prevails!

Charles Edquist (charles.edquist@circle.lu.se)
CIRCLE, Lund University

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Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University
P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN
http://www.circle.lu.se/publications

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Keywords: Innovation, innovation policy, holistic innovation policy, research policy, the linear view, systems of innovation

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* Professor, Centre for Innovation Research and Competence in the Learning Economy (CIRCLE), Lund University, Lund, Sweden, charles.edquist@circle.lu.se, http://charlesedquist.com,

1. INNOVATION, GROWTH, JOBS, AND GLOBAL CHALLENGES

It is widely known and accepted that innovation is a major driver of long-term economic growth and employment, and that it can also help to meet global challenges. Hence innovations affect a variety of socioeconomic conditions. Just think back 150 years—to a society without cars, telephones, airplanes, antibiotics, electronics, or the Internet!

The relationship between innovation and employment is especially complicated. It is because certain types of innovations reduce the number of jobs, while other types increase it. In order to clarify this, I must first explain what I mean by different types of innovations.

Innovations are here defined as new creations of economic or societal importance, usually performed by firms.[1] Innovations can be new or improved products or processes. New products (*product innovations*) may be material goods or intangible services; it is a question of what is produced. New processes (*process innovations*) may be technological or organizational; it is a question of how the products are produced.[2]

It is the difference between process innovations and product innovations that explains innovation's "double character" in relation to employment. The introductions of process innovations are necessary, for reasons of competitiveness, and lead to productivity increases. But a smaller amount of labor is therefore needed to produce the same volume. If there is a problem of high unemployment (as in Europe in 2014), a partial solution is to compensate for the loss of jobs by producing new products. Product innovations actually lead to the creation of new jobs, and this compensates for the jobs lost through process innovations.[3]

If this compensation mechanism does not work spontaneously and automatically in the economic and innovation system, then public intervention is called for in the form of an innovation policy that stimulates the development, implementation, and diffusion of product innovations. This is essential to achieve low unemployment in the medium and long term.

2. WHAT IS INNOVATION POLICY AND WHEN IS IT CALLED FOR?

Industrial policy is often associated with support for old and dying sectors. Still, rather than provid-

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[1] However, the firms do not develop innovations in isolation from other organizations, but are parts of innovations systems; see section 4 below. Schumpeter talked about innovations as "new combinations," i.e. two existing knowledge elements can be integrated into an innovation. Hence, innovations do not need to be based on scientific breakthroughs.

[2] Process innovations have been product innovations in earlier incarnations. This means that product innovations play a more dynamic role in the renewal of an economy than process innovations. (Edquist, Hommen, & McKelvey, 2002)

[3] There are, of course, many other compensation mechanisms and dimensions involved in such development processes. They are analyzed in some detail in Edquist et al (2002). To increase the number of jobs, a supplement to product innovations could, in principle, be to distribute the number of hours worked in the economy among more individuals.

ing public support to old sectors and established firms as a matter of course, policy should focus on helping the new to emerge, i.e. (product) innovations.

Which are then the reasons for public intervention in the process of innovation? Two conditions must be fulfilled for public intervention to be motivated in a market economy:

(1) Private actors must fail to achieve the objectives formulated, i.e. a "*problem*" must exist.
(2) Public actors must have the *ability* to solve or mitigate the problem (Edquist, 2011).

Innovation policy is sometimes needed, but must not replace, duplicate, or crowd out what private actors can do. It shall supplement private action. This is often called *additionality* and is expressed by condition (1) above. Public action should only contribute to solving problems that the private actors cannot handle. Producing and developing old processes and products are the tasks of established firms, while helping to develop brand new products can be an important task for innovation policy. It will obviously be an advantage if these new products help to satisfy human needs, solve societal problems, and meet global challenges. *Innovation policy can be given such an orientation,* if the objectives of the policy are formulated in an appropriate way.[4]

Additionality arguments constitute a basis for providing policy support to new and emerging industries rather than to existing ones. Established industries should care for their own renewal, research, and innovation on the basis of accumulated profits. Emerging sectors, on the other hand, are characterized by uncertainties and large risks, which sometimes cannot be absorbed by private actors. Emerging and growing sectors are also often argued to contribute more to growth and employment than traditional ones. Meanwhile, lobbying forces tend to try to influence policy in the direction of securing public support for existing and traditional sectors.

We know that innovations in the early stages of their development are associated with uncertainty and with such great risks that private actors often shy away. In such cases, there is a *problem* that is not solved by private actors; this is where government action, such as risk financing in the early stages (public seed funding of innovations), is justified. So, instead of talking about industrial policy, let us talk about innovation policy aimed at enhancing new creations of economic or societal importance.

Innovation policy is defined here as *all* actions by public organizations that influence innovation processes. This includes actions that unintentionally influence innovations. Innovation policy embraces all the policies that affect innovation processes, such as parts of research policy, education

[4] This is the question of the content of growth (or of production as a whole), which is discussed and analyzed far too little. A product can be either a material good or an intangible service. The good can be a car, a pleasure craft, or weaponry. A service may be a flight, a train ride, a heart operation, or a violin concerto. The effects on society and the environment obviously vary with the content of production and consumption. I will discuss objectives of innovation policy at the end of section 4.

policy, regional policy, defense policy, and public innovation procurement. Hence, it is a question of a large number of actions carried out by, for example, many government ministries and agencies. Obviously innovation policy is here defined in a very comprehensive and wide way. As a matter of fact, this broad definition of innovation policy implies (almost automatically) that such policies should be designed and implemented in a holistic way; it contains the seeds of a holistic innovation policy, a perspective to be discussed in the next section.

3. A HOSTLIC INNOVATION POLICY: WHY, WHAT AND HOW?

Public action should be coordinated in order to influence innovation processes, i.e. a coherent innovation policy needs to be developed. It must take into account the variety of factors that together influence the development of new products and new processes. Innovation is not just about basic research as many seem to think. It is also about basic education, demand-side factors (such as innovation procurement and product quality requirements), creation of new organizations (such as the stimulation of entrepreneurship and the formation of policy organizations), interactive learning between organizations, the development of new regulations (e.g. for patents or public procurement), and incubators to support new companies and venture capital for innovation, to name a few of the most crucial elements.

It is important to note that the state (national, regional, local), in practice, is already investing heavily in all these areas, but the measures are not sufficiently oriented towards supporting innovation processes. It is therefore a matter of adjusting these activities so that they, to a larger degree, stimulate innovation. I will, in Section 5, present innovation-related public procurement as an example of this.

An innovation policy that integrates all the different factors that influence innovation processes into one context is needed to influence the mode of operation of the innovation system. I call this a holistic innovation policy. *A holistic innovation policy is defined as a policy that integrates all public actions that influence or may influence innovation processes, for example by addressing all the ten activities included in Annex 1 in a coordinated manner*.[5] To be worthy of the name, such a policy must be coordinated with other policy areas and in some cases has to be given higher priority than other areas.

The development and implementation of a holistic innovation policy demand certain things. For example, an understanding of the innovation process is required; in other words there are demands for innovation *research.* Knowledge and competence are also necessary to formulate a holistic innovation *policy.* It also requires political will and political courage to prioritize innovation policy over other policy areas, which may be necessary. There are, in addition, demands on governance and coordination of the policy. I will address these subjects in the rest of this article.

[5] I have previously dealt with holistic innovation policy in Edquist (2013), Edquist (2014a), Edquist (2014b) and Edquist (2014d).

4. FROM LINEAR THINKING TO INNOVATION SYSTEM: SOME THEORY

Let me briefly touch upon the development of some parts of innovation theory in recent decades.

In the early days of **research on innovation and innovation policy**, the so-called *linear model* dominated the views on how innovations developed (Bush, 1945). The model was based on the assumption that innovations are applied scientific knowledge. It was called "linear" because the process was seen as well-defined, consecutive stages that innovations were assumed to go through, e.g. basic research, applied research, and development work resulting in new products and processes that ultimately influence growth and employment. It was a supply-push view.[6]

However, research does not automatically lead to innovations, i.e. to new products and processes. Scientific knowledge is not sufficient; it has to be transformed into innovations in order to create growth and employment. Some research results are never transformed into innovations and research is only one of the many determinants of the innovation process. Research is not always necessary, and it is never sufficient to achieve innovation-based growth.

In **the realm of research on innovation**, the linear model has been completely replaced, in the last couple of decades, by the systems of innovation approach, which stresses interaction and interactive learning between organizations. This new approach, in its different versions, is defined in terms of determinants of innovation processes, although different determinants are emphasized in different versions (Asheim & Isaksen, 2002; Bergek, Jacobsson, Carlsson, & Lindmark, 2008; Braczyk, 1998; Breschi & Malerba, 1997; Carlsson, 1995; Cooke, 2001; Cooke, Gomez Uranga, & Etxebarria, 1997; Edquist 1997; Freeman, 1987; Lundvall, 1992b; Nelson, 1993).

The pioneers in the development of the innovation systems approach were Lundvall (1992b) and Nelson and Rosenberg (1993). Both define national innovation systems in terms of determinants, or factors affecting innovation processes. But they point out different determinants as important in their definitions. Lundvall writes that the "structure of production" and "the set of institutions" together define an innovation system (Lundvall, 1992b, p. 10). Nelson and Rosenberg emphasize the organizations that support R&D—that is, the organizations that support the creation and dissemination of knowledge—as the main source of innovation (Nelson & Rosenberg, 1993).

Interactive learning has been central to the concept of a national innovation system already from scratch (Lundvall, 1992a,1992b). The main components of an innovation system are often said to be *organizations and institutions*. Organizations are formal structures that are consciously created and have an explicit purpose. They are actors or "*players*." Examples include companies, universities and policy organizations. *Institutions* are laws, rules, regulations, routines and habits. It is a

[6] We are dealing with innovation policy for knowledge production and R&D in Borrás and Edquist (2014b).

matter of "*rules of the game*" or regulations. Key institutions in innovation systems are patent laws, laws and rules that govern the relations between companies and universities, the rules governing the approval of drugs, etc.[7]

Most of the attention in innovation research has long been paid to the components (organizations and institutions) of innovation systems. Less has been said about what happens in the systems and how they change.

One way to deal with what is happening in the system is as follows. On a general level, the main role of the innovation system is to drive or enhance innovation processes, i.e. to develop and disseminate innovations. What we might call the *activities* of innovation systems are those that *affect* the development and diffusion of innovations. An example of such an activity is research and development (R&D) as a means to develop socially relevant knowledge that can form the basis for innovations. Another is the financing of the commercialization of such knowledge, i.e. the transformation of research findings and other kinds of knowledge into innovations and their diffusion. As we will see, there are other activities.

I believe that an emphasis on activities or determinants within innovation systems will become crucial for the development of both innovation theory and innovation policies in the future. It is also by influencing these determinants that enterprises and public authorities can influence the innovation processes through their strategies and policies.

A more general definition of a system of innovation is that they include "all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations" (Edquist, 1997, p. 3, p. 11, p. 12, Edquist, 2005, p. 184). Such factors are discussed below, and a list of ten activities (determinants) is presented in Annex 1. This definition of an innovation system is much broader than other variants (e.g. Lundvall's and, especially, Nelson's). It includes *all* determinants of innovation processes (as well as the innovations themselves) in the definition of an innovation system. A holistic innovation policy requires a broad definition of innovation policy and a broad and systemic view of the determinants of innovation processes, which means that it also requires a broad definition of "systems of innovation," as proposed above.

If all the factors that influence innovation processes cannot be included in the definition, we have to choose the potential factors that should be excluded, and motivate why. This is difficult, because we do not know, systematically and in detail, all these determinants today. It seems hazardous to exclude certain potential determinants, as these may prove to be important when our knowledge

[7] These concepts are discussed in Edquist and Johnson (1997). For Nelson and Rosenberg (1993) "institutions" are the same as different kinds of "organizations" ("players"), while the term "institution" primarily means "the rules of the game" for (Lundvall, 1992b). Hence, the term "institution" is used in different senses in the literature.

has increased. Thirty-five years ago, for example, it was natural to exclude interaction between organizations as a determinant of innovation processes. Today, we know that these are very important (Edquist 1997, 2005). Therefore, a broad definition is useful.

Annex 1 presents a list of ten important activities in innovation systems. The activities, which are also the determinants of innovation processes, are not ranked according to importance, but are clustered as:

I. Provision of knowledge inputs to the innovation process (e.g. research),
II. Demand-side activities (e.g. public procurement for innovation),
III. Support to key elements in innovation systems (e.g. entrepreneurship), and
IV. Support services for innovating firms (e.g. public seed funding of innovations).

The list of activities in Annex 1 (also sometimes called functions) is preliminary, hypothetical and one among several. It will certainly be revised when our knowledge of the determinants of innovation processes has improved. Nonetheless, this list can still be used as a checklist or signpost to discuss the factors that probably affect innovation processes. This is important, as innovation processes are very complex and influenced by a variety of factors. Among other things, the list can serve as a tool to avoid monocausality, i.e. an overly strong emphasis on one single activity (be it research or seed funding), and a neglect of others, when causally explaining innovation processes and selecting innovation policy instruments.

Hence, the list may be useful in assigning causes to problems. If the main cause of a problem is lack of research, then R&D should be in focus. If the cause is lack of demand for certain kinds of product innovations, then a demand-side instrument such as public procurement for innovation can be used. All the ten activities in Annex 1 can be related to several innovation policy instruments (Borras & Edquist, 2013). In fact, several instruments might have to be used for each of the ten activities in the innovation system, i.e. it can be a matter of choosing among scores of instruments (Borras & Edquist, 2013).

It is important to point out that public innovation policy is not included as one of the ten activities. The reason is simply that public innovation policy is a part of *all* the ten activities. Part of each activity is performed by public organizations. The activities are carried out by organizations in innovation systems and these are normally both private and public when it comes to most activities. As an example, R&D is funded and performed by public organizations (universities, public research institutes) and by private organizations (enterprises) in all innovation systems. This also applies to education (although the balance between private and public here varies greatly between different (national) innovation systems. What is important is the division of labor between private and public organizations with regard to the carrying out of each of the activities. The parts of the various activities carried out by public organizations actually c*onstitute* innovation policy (see definition at the end of section 2).

In **the realm of innovation policy,** the linear model is still much more dominant than it is in academic work. However, recent years have seen an increasing interest in "broad-based innovation

policies," "systemic innovation policies," "a demand-pull view," and "demand-oriented policy instruments." This may constitute the beginning of a transformation towards a "*holistic innovation policy*." As mentioned, such a policy approach requires a broad and systemic view on the determinants of innovation processes. It must indeed take into account all the determinants of the whole innovation system.

Provision of R&D results (including research policy) is only *one* of the (ten) determinants of the innovation process and therefore also it is only one of the ten activities forming innovation policy (see Annex 1). It dominates the linear view. The other extreme in the continuum linear–holistic is a genuinely holistic innovation policy, which takes into account all the determinants of innovation processes.

A holistic innovation policy is about determinants (of innovations) and about innovation policy instruments. As such, it says nothing about the objectives of innovation policy. They have to be specified separately. Indeed, the *ultimate* objectives of innovation policy are determined in a political process. These objectives may be economic (growth, employment, competitiveness, etc.), environmental, social, related to health, defense and security, etc. How different ultimate objectives of innovation policy should be balanced is an important political issue. The determination of innovation policy objectives is typically done in a complex process, which in democratic societies involves executive government initiatives, parliamentary discussions, public agencies, the civil society, and so on. When we have specified the objectives of innovation policy, and when we have a general picture of the policy problems and their causes, we can design policies to mitigate the problems. The ultimate objectives of innovation policy are concerned with the important *consequences* that innovations have for socioeconomic and political matters such as economic growth and the environment (mentioned above). Politicians are actually not interested in innovations as such, but in their consequences (Borras & Edquist, 2013).

A useful way of addressing appropriate instruments, and analyzing their role in the innovation system, is to relate them to each of the ten activities. In the real world, however, the instruments of innovation policy are rarely used standing alone. Normally, innovation policy instruments are combined in specific mixes, using groups of different instruments in a complementary manner. Instrument mixes are created because the solution of specific problems requires complementary approaches to the multi-dimensional aspects of innovation-related problems (Borras & Edquist, 2013).

Of course, innovation policy instruments are not intended to (and cannot) influence the ultimate objectives (e.g. growth, the environment or the health system) in a direct and immediate sense, because these instruments can only influence innovation processes. Problems to be mitigated by innovation policy must be identified and specified in innovation terms. This implies that the ultimate socio-political objectives must be "translated" into concrete problems related to innovation intensities—problems that can be influenced directly by innovation policy instruments. For example, we need to know how the ultimate objectives of economic growth and environmental protection are related to (certain kinds of) innovations.

The objectives expressed in innovation terms may be called *direct* objectives, which are to solve innovation intensity "problems." Problems to be mitigated by innovation policy must be identified and specified in innovation terms. The ultimate objectives may (partly) be achieved by means of fulfilling the direct objectives, i.e. in a mediated way. Hence, innovation policy instruments are selected to achieve the direct objectives and thereby the ultimate objectives (Borras & Edquist, 2013). *A problem*, in our sense—from a policy point of view—is, for example, low *performance* of the innovation system, i.e. low innovation intensity (or a low propensity to innovate) of a certain category of innovations (product, process, etc). In other words, a "problem" exists if the objectives in terms of innovation intensities are not achieved by private or public organizations.[8] As low innovation intensities are problems to be solved or mitigated by innovation policy, we need to know (be able to measure) the innovation intensities for specific categories of innovations in the context of the innovation system(Borras & Edquist, 2013; Edquist, 2011).

5. INNOVATION POLICY IS BEHINDHAND: STILL LINEAR

The innovation systems approach has diffused extremely rapidly and is now widely used in academic contexts.[9] It has completely replaced the linear view in the field of innovation research.

The innovation systems approach is also used in policy contexts by regional organizations, national governments, public agencies, and international organizations such as the OECD, EU, UNCTAD, UNIDO, etc. In recent years, innovation policy has also increasingly been discussed in terms of "broad-based innovation policies" and "a demand-pull view." This rapid diffusion is due to the strengths and advantages associated with this approach (Edquist, 2005).

Also "demand-oriented policy instruments" are increasingly discussed and they must certainly be a part of a holistic innovation policy, although more is required for a policy to warrant the name "holistic." Examples of demand-side policy instruments are public procurement of innovation (PPI) and pre-commercial procurement (PCP) (Edquist & Zabala, 2012; Edquist, Vonortas, & Zabala, 2014). These instruments are being pushed by the European Commission but are still not widely used in the Member Countries. However, their use has enormous potential as innovation policy instruments (Edquist, 2014c).[10]

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[8] "Problems" and how they can be identified through empirical analyses comparing innovation systems are issues that are discussed in much more detail in Sections 3 and 4 in Edquist (2011).

[9] In September 2014, the number of hits at Google was:
- "System of Innovation": 1,130,000 hits
- "National Innovation system": 2,060,000 hits.

These figures are very high for a scientific approach. The acronym Vinnova is short for The Swedish Governmental Agency for Innovation Systems ("Verket för innovationssystem" in Swedish). Hence a public agency has taken its name from a scientific approach, which is unusual.

[10] Other demand-side innovation policy instruments are, for example, standard-setting, subsidies or tax incentives to support demand, and enhancing articulation of user needs. Such instruments have been addressed by Edler (2009).
The nineteen responding countries were: AT, BE, CY, CZ, DK, EE, FI, FR, HU, IE, LT, MT, NL, PRT, SE, SI,

The above are burgeoning changes towards what can become a "holistic innovation policy." But the use of the innovation systems approach for actual *policy* purposes is still often a matter of lip service; it is mainly used only by name. The content of innovation policies is still dominated by the linear model. Let me indicate that this is so by summarizing some results from a recent study in this field (Edquist, 2014a).

I was asked by the European Research and Innovation Area Committee (ERAC) of the European Commission to design and organize a mutual learning seminar during the spring of 2014. The topic was "Efficiency of Research and Innovation Systems for Economic Growth and Employment." ERAC is a strategic policy advisory committee whose principal mission is to provide strategic advice to the European Council, the European Commission, and EU Member States on research and innovation issues that are relevant for the development of the European Research Area (ERA). The process, the seminars and the result are reported in (Edquist, 2014a), upon which the following is based.

As part of that project I designed a questionnaire that was sent out to the twenty-three EU Member Countries that had indicated an interest in participating in the project. Nineteen of these countries (83%) responded and the empirics that follow are based on these responses.[11]

Above, I have argued that the linear model is much more dominant in the field of innovation policy than in innovation research. This is strongly confirmed by the responses from the participating countries.

When it comes to the design of innovation policy, some countries report that the policy is quite linearly oriented, for example Belgium (the regions of Flanders and Brussels). Ireland frankly says, "To date the linear model has not been replaced by a holistic innovation policy…" The Netherlands write, "Most governmental instruments are still based on the linear model." Malta states, "Malta's innovation policy instruments are largely focused on supply-side instruments."

There are also differences in the ambitions with regard to how comprehensive governments want innovation (and research) policy to be. Switzerland, for example, writes, "The government restrains itself to foster favorite framework conditions for research and innovation." It simply gives the state (national, regional, local) a limited role. At the same time, the response makes it clear that "Switzerland never had an innovation policy based on an exclusively linear approach." Cyprus responds, "A holistic business innovation policy, instead of the linear model, has started being used only in the last three years…" France writes, "The linear model is still present in France, regarding the support to innovation research, but it is progressively complemented by a more holistic approach…."

The last two quotes actually capture the position of most of the nineteen responding countries. The

[11] The nineteen responding countries were: AT, BE, CY, CZ, DK, EE, FI, FR, HU, IE, LT, MT, NL, PRT, SE, SI, UK, CH, and NO

responses indicate, in one way or the other, that the countries are pursuing, or are trying to develop, a "holistic" [12] innovation policy. In Norway, the white paper on research from 1993 criticized the linear model and introduced the "national innovation system" as a more appropriate perspective. Analytically, a systems perspective has been part of research and innovation policy in Norway since then. The Norwegian response adds, "To what extent innovation (or research) policy in its design and implementation is 'holistic' could of course be discussed."

In summary, the responses indicate that at least sixteen of the nineteen countries (84%), in one way or another, are striving in the direction of developing innovation policy into a more holistic one. This includes Ireland, Cyprus, Norway, Lithuania, Finland, Estonia, Sweden, Denmark, Austria, France, Hungary, certain regions in Belgium, the Netherlands, Portugal, Slovenia, and the United Kingdom. Exceptions may be Switzerland, Czech Republic and Malta.

However, when the countries respond to the questions about which demand-side policies are the most important, most of them reveal that they are not actually pursuing much innovation policy that can be considered demand-side oriented. This also applies to the responses to the question of whether Public Procurement for Innovation (PPI)[13] is used as an innovation policy instrument. Those countries that report PPI activities at all are just planning to start, have done it only for a few years, and do it on a small scale. Finland may be an exception here, as well as Estonia and Belgium, and also the United Kingdom when it comes to the demand-side research policy instrument of PCP (see footnote). Hence, at most four of the nineteen countries (21%) use demand-side innovation policy instruments to any considerable degree. However, not even these countries pursue a holistic innovation policy in the sense the term is used here.

At the same time, many of the responses indicate that "Provision of R&D results" (see Annex 1) is the most important activity in terms of resources spent for innovation policy purposes. Countries that clearly indicate this are: Sweden, Switzerland, Cyprus, Ireland, the Czech Republic, Estonia, Hungary, Belgium (regions of Flanders and Brussels), France and Slovenia, i.e. ten out of nineteen countries (53%).[14]

This points to the very important question of how to measure or estimate the importance of an innovation policy instrument. As just indicated, this is sometimes done by means of looking at how

[12] Alternative terms used are "systemic," "broad-based," "comprehensive," and "demand-oriented."

[13] Public Procurement for Innovation (PPI) occurs when a public organization places an order for the fulfillment of certain functions through a new product (Edquist & Zabala, 2012). Pre-Commercial Procurement (PCP) refers to the procurement of expected research results. Hence PCP is not a demand-side policy instrument in relation to innovation. However, it is a demand-side policy instrument in relation to research (Edquist & Zabala, 2014). What seems to be practiced on a large scale in the UK (the SBRI programme) is PCP, but not PPI. In Ireland, an SBIR programme is being tried; these SBIR kinds of activities are PCP and not PPI. However, PCP might, in today's world, have a large potential as a R&D policy instrument operating from the demand side. In addition, "innovation-friendly" regular public procurement has a much larger potential than both PPI and PCP (Edquist & Zabala, 2012; Edquist & Zabala, 2014; Edquist, 2014, 2014c).

[14] Some countries did not respond at all to this question.

much money is spent on an instrument such as publicly funded R&D.[15] There are several problems associated with this. Firstly, not all the resources spent on public R&D will have an effect on innovation. This may be because some kinds of research are irrelevant for innovation processes, or because the research effort is inefficient or simply failing, which reflects the fact that R&D expenditure is an input measure. A better measure (of R&D performance) would be an indicator of research results of the R&D, such as scientific citations or patents.[16]

The situation with resources spent on education is similar. All education is not intended to influence or enhance innovation processes and/or does not do so for other reasons. It is also hard to know exactly what kinds of education have (what kinds of) effects on (what kinds of) innovation and what kinds do not have any such effects. In addition, education systems vary substantially in terms of quality between countries.[17] As a consequence, not all public resources spent on research or on education can be called innovation policy.[18]

On the other hand, some actions might be important innovation policy instruments without costing a lot of money. Examples could be the creation of an effective patent law or a public procurement law that really enhances innovation. Such institutional initiatives do not need to be very costly in money terms and can still have important consequences for innovation performance. It may require a lot of knowledge, however. Thus, things other than economic expenditures are also very important, for example creating framework conditions that enhance innovation processes.

Hence, we cannot measure the importance of different innovation policy instruments by the economic resources spent on them.

A much better measure of the importance of innovation policy instruments would be to try to systematically measure the *consequences* of the instruments for the innovation processes as such. Ideally, we should be able to estimate the importance of each innovation policy instrument[19] by measuring its effects on (different kinds of) innovations. This would be preferable, but also more difficult. Nonetheless, it may be achieved by means of considerable efforts aimed at more widespread, profound, and independent evaluations. In the longer term, this is the only reasonable way. Evaluations are badly needed.

As a conclusion, we should stop talking so much about what instruments cost and concentrate more

[15] Tax credits are equalized with spending public money directly.

[16] Still, scientific knowledge and patents may, or may not, be transformed into innovations and innovations must not necessarily be based on patents.

[17] Again, it would be better to measure the results achieved by the students. As the PISA analyses have clearly shown, quality varies considerably between countries. For example, Sweden is a big spender on education, but shows very low results in terms of student performance. In addition, the competencies and abilities of graduates may or may not be useful for innovation processes.

[18] Education and innovation policy has been dealt with in Borrás and Edquist (2014a).

[19] It is also important to measure the effects of combinations of instruments, and even instrument packages, i.e. policies as a whole.

on instruments that have large effects on innovation processes.

Together, the responses to the questionnaire from the nineteen countries clearly indicate that many of the countries striving in the direction of pursuing a holistic innovation policy have a long way to go from the linear towards the holistic path. It is a "path," because it is not necessarily a matter of reaching an innovation policy that is 100% holistic. It is rather a matter of getting away from a mono-causal (linear) view towards a broader, systemic, and multi-causal one. A holistic policy is the vision.

There seem to be three main possibilities regarding the linear/holistic spectrum:

1. There are countries that mainly pursue a linear innovation policy and find no reason to change this.
2. Most of the countries indicate that they strive towards a "more" holistic (systemic, broad-based, comprehensive,) innovation policy, but they have not yet achieved very much.
3. The third possibility is that a country could pursue a genuinely holistic innovation policy in the sense defined above. None of the nineteen countries have yet achieved this.[20]

Clearly, it is relevant to analyze the pros and cons of these three possibilities, in the context of the arguments above and below. Obviously, the "linear" element should be seen as partly integrated or contained in the "holistic" approach, since (part of) research is obviously relevant for innovation processes. In addition, the discussion should include what to prioritize in an evolutionary paradigm change from a linear to a holistic perspective. At the same time, the design of a holistic policy must always be based on politically determined objectives as well as on the identification of problems and their causes, as emphasized elsewhere in this article.

Another comment in this context addresses the relations between research policy and innovation policy.

In some countries, these two policy areas are kept apart when it comes to which public organization (ministry) is the leading one. For example, this applies to the following countries: Norway[21], Lithuania, Finland, Estonia, Switzerland, Portugal, the Netherlands, and Slovenia (i.e. eight countries: 42%). In the following countries, the two policy areas are under the same Ministry: Ireland, Cyprus, United Kingdom, Denmark, Hungary, Sweden, and Malta (i.e. seven countries: 37%). The situation is unclear in the cases of Belgium, Austria, the Czech Republic, and France (i.e. four countries:

[20] Perhaps this is what the Norwegian response hints at when they write: "A comprehensive innovation policy includes nearly all policy areas, including competition, taxation, infrastructure, education and research policy, regional, labor market policy and public procurement policy." It can also be pointed out here that Norway, in the quote above, expressed some doubts about the extent to which the policy actually is holistic "in its design and implementation."

[21] In Norway two different ministries are responsible for research policy and innovation policy, but at the level of public agencies "The Research Council of Norway" plus "Innovation Norway" deal with much of both.

21%).[22]

According to the Irish response, research policies and innovation policies have traditionally been considered to be almost the same thing. In practice, however, research policy has taken preference over innovation policy. It might also be mentioned that, in some countries, there is a separation between research policy and innovation policy going on. In Malta, traditionally, the design of innovation policies has always been closely linked to the design of research policies. However, over time, innovation policy design has taken on a more distinct niche for itself.

The OECD thoroughly reviewed Sweden's innovation policy in 2012 (OECD, 2013) and revealed that innovation issues were not prioritized, even within the Ministry of Enterprise, Energy and Communications. For example, its website had no mention of "innovation" as one of its nine areas of responsibility (p. 28, p. 224). The OECD report also stressed that innovation issues should have higher priority on the agenda of the Ministry of Enterprise, Energy and Communications (p. 29, p. 234). Also notable is how the Ministry of Education and Research has the formal responsibility for coordination in the government on all matters relating to research *and* innovation (p. 233). "Innovation" does not constitute a separate policy area in the Ministry of Education, either (p. 224). It is also said that coordination seems weak between the two ministries (p. 28).

Why then is innovation policy still mainly linear and not holistic, although the linear view has been completely abandoned in innovation research? In principle, one answer could be that it is as it should be. But this is not consistent with the results of innovation research or with the fact that the absolute majority (84%) of the participating countries strive in the direction of pursuing a more holistic innovation policy.

Policymakers that attend research conferences on innovation are more often than not in favor of holistic (systemic, broad-based, comprehensive, etc) innovation policies. They too have abandoned the linear view, learning from innovation research. As a result, the division between "linear" and "holistic" is located *within* the community where innovation policies are designed and implemented. This community is composed of policymakers (administrators/bureaucrats) and elected politicians. Perhaps the dividing line is between these two groups in that politicians, who actually make the decisions, may be believers in the linear view in a reflexive way. There may also be disagreements between (the leaderships of) different ministries, e.g. between the Ministry of Finance and other ministries or between the Ministry of Research and Ministry of Industries.

The discussion above might also lead to reflections on whether it would be justified to separate innovation policy from research policy in the design and implementation of policies and in terms of the public organization that is responsible. After all, research policy and innovation policy are

[22] In policy implementation, research and innovation policies are more separated from each other than they are in their design. This is simply because different policy instruments are (and have to be) used for the two policies.

actually different things, and such a separation might be a way of facilitating the transformation of innovation policy from linear to holistic. This is because a continued integration of research and innovation policies might cement the linear character of the policy, partly because research policy is still considered to be so central. It would be better to deal with "research policy" and "innovation policy" separated from each other and coordinate them in a later stage (in the same way as many other policy areas have to be coordinated with each other).

In addition to this, it might also be noted that many countries use the label "science and technology policies." Recently, some countries, such as Japan, have added innovation, and hence talk about "science, technology, and innovation policies." This is, of course, tautological since all new technologies are normally included in the concept of innovation (see section 1 above).

Of course, if we use broad definitions of innovation policy and research policy (as I think we should), there must be overlaps between the two policy areas, actually "intruding" into each other's "territories." This can be generalized: they also intrude into the territories of additional policy areas, such as labor market policies, public procurement policies, defense equipment policies, energy policies, transport policies, health care policies, environmental policies, and regional policies. The effect of the resulting "intrusion" or "trespassing" makes it clear to everyone that policy areas do overlap and that they therefore have to be coordinated.

It is important to note that the state in practice allocates very large resources to all the policy areas mentioned above. If the government wants to emphasize and strengthen innovation policies, they can also exploit this overlapping of policy areas. Procurement policy can be an example (Edquist, 2014c).

Public procurement can be adapted so that it stimulates innovation to a much larger degree than is currently the case. Regular public procurement can, in this way, be transformed into public procurement that triggers innovation. It is important here to note that public procurement accounts for about 20% of GDP in Europe (2.3 trillion Euros).

Out of the 700 billion Swedish crowns—also 20% of GDP—that are used for public procurement in Sweden each year, at most 0.05% is used in a way that stimulates innovations (Edquist, 2014c). This is a significant neglect[23] but it also constitutes a significant possibility for enhancing innovation through public procurement. The extremely low percentage also supports the previous observation that demand-side innovation policy instruments are used to an extremely small degree and that innovation policies are therefore very far from being holistic.

[23] This is in spite of the fact that Sweden has a "great" history of public procurement for innovation compared to other countries. Let me mention some Swedish examples. One was when the Swedish Telecommunications Authority ordered the world's first electronic telephone switch (AXE). A second was when Vattenfall (the electricity agency) ordered a then non-existing system for the transmission of electricity at 400,000 volts. A third was when the State Railway Company (Statens Järnvägar) ordered a high-speed (X2000) train that leans into curves to be able to increase speed (Edquist & Zabala, 2012). See Edquist (2014c) for a review of the opportunities and obstacles when it comes to different types of innovation procurement.

If ten percent of the regular public procurement in Sweden can be converted into Public Procurement of Innovation, it means that at least 70 billion SEK per year will be used to promote innovation processes. As a comparison, it is noteworthy that the total Swedish public research budget is 35 billion SEK per year.[24]

To coordinate policy areas in this way does not need to increase the combined economic resources needed for the two coordinated policy areas, in this case public procurement and innovation. It may even decrease cost and improve efficiency of procurement in the medium and long term, thanks to innovation (Edquist, 2014c).

Innovation policy design is certainly lagging behind innovation research when it comes to being systemic, broad-based, or holistic. This is clearly an example of a disturbing failure when it comes to the communication between innovation researchers and politicians/policymakers in the field of innovation.[25] This may be a strong reason to involve innovation researchers in the design and implementation of innovation policy to a much higher degree. There is a lot that policymakers and, in particular, politicians can learn from innovation research, not only in principle or analytically, but also regarding policy practice.

Just like in the case of public procurement, regional policy, education policy, infrastructure policy, research policy, procurement policy, defense policy, and other policy areas could also be used or adjusted to support innovations to a greater extent. Such adjustments could have considerable effects on growth, employment, the environment, and health, without requiring additional public financial resources.

We have, above, tended to drift into discussions of how a holistic innovation policy should be governed and coordinated with other policy areas, as well as whether it should be given a higher priority than some other policy areas. This is also probably the reason that so many countries are creating "councils" for "science and technology" (and innovation) policies or "innovation" policies. These issues of governance and organization of innovation policy will have to be dealt with more systematically in another article.

[24] This is an example of what I mean by adapting or turning existing public expenditures into also supporting innovation processes to a larger extent.

[25] Such communication seems to work much better in the field of the environment and climate.

Appendix 1: Key activities in innovation systems

Box 1: Key Activities in Systems of Innovation

I. Provision of knowledge inputs to the innovation process

1. Provision of R&D results and, thus, creation of new knowledge, primarily in engineering, medicine and natural sciences.

2. Competence building, e.g. through individual learning (educating and training the labour force for innovation and R&D activities) and organisational learning. This includes formal learning as well as informal learning.

II. Demand-side activities

3. Formation of new product markets, for example through public procurement of innovation.

4. Articulation of new product quality requirements emanating from the demand side.

III. Provision of constituents for SI

5. Creating and changing organisations needed for developing new fields of innovation. Examples include enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms, and creating new research organisations, policy agencies, etc.

6. Networking through markets and other mechanisms, including interactive learning among different organisations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from the outside with elements already available in the innovating firms.

7. Creating and changing institutions—e.g., patent laws, tax laws, environment and safety regulations, R&D investment routines, cultural norms, etc.—that influence innovating organisations and innovation processes by providing incentives for and removing obstacles to innovation.

IV. Support services for innovating firms

8. Incubation activities such as providing access to facilities and administrative support for innovating efforts.

9. Financing of innovation processes and other activities that may facilitate commercialisation of knowledge and its adoption.

10. Provision of consultancy services relevant for innovation processes, e.g. technology transfer, commercial information, and legal advice.

Source: Adapted from (Edquist, 2005) and (Edquist, 2011).

References

Asheim, B. T., & Isaksen, A. (2002). Regional innovation systems: The integration of local 'sticky' and global 'ubiquitous' knowledge. *Journal of Technology Transfer, 27*(1), 77-86. doi:10.1023/A:1013100704794

Bergek, A., Jacobsson, S., Carlsson, B., & Lindmark, S. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy 37*(3), 407-429. doi:10.1016/j.respol.2007.12.003

Borrás, S., & Edquist, E. (2013). The choice of innovation policy instruments. *Technological forecasting and social change 80*(8), 1513-1522. doi:10.1016/j.techfore.2013.03.002.

Borrás, S., & Edquist, C. (2014a). Education, training and skills in innovation policy. *Science and public policy. doi:10.1093/scipol/scu043*

Borrrás, S., & Edquist, C. (2014b). Innovation policy for knowledge and R&D: The investment portfolio approach. In F. Crespi, & F. Quatraro (Eds.), *The economics of knowledge, innovation and systemic technology policy*. Routledge (forthcoming)

Braczyk, H. J. (1998). *Regional innovation systems: The role of governances in a globalized world*. London: UCL Press.

Breschi, S., & Malerba, F. (1997). Sectoral innovation systems: Technological regimes, schumpeterian dynamic, and spatial boundaries. In C. C. Edquist (Ed.), *Systems of innovation: Technologies, institution and organisations.* London, UK: Pinter Publishers.

Bush, V. (1945). *Science: The endless frontier*. Transactions of the Kansas Academy of Science (1903-)(3), 231. doi: 10.2307/3625196.

Carlsson, B. (Ed.). (1995). *Technological systems and economic performance:* The case of factory automation. Dordrecht: Kluwer.

Cooke, P. (2001). Regional innovation systems, clusters, and the knowledge economy. *Industrial and corporate change 10*(4), 945-974.

Cooke, P., Gomez Uranga, M., & Etxebarria, G. (1997). Regional innovation systems: Institutional and organisational dimensions. *Research policy 26*(4), 475-491.

Edler, J., (2009). *Demand policies for innovation in EU CEE countries* (Manchester Business School Working Paper No 579). The University of Manchester.

Edquist, C. (1997). Systems of innovation approaches - Their emergence and characteristics. In C. Edquist (Ed.), *Systems of innovation: Technologies, institution and organisations.* London, UK: Pinter Publishers.

Edquist, C. (2005). Systems of innovation: Perspectives and challenges. In J. Fagerberg, D. Mowery, & R. Nelson (Eds.), *Oxford handbook of innovation* (pp. 181-208). Oxford, UK: Oxford University Press.

Edquist, C. (2011). Design of innovation policy through diagnostic analysis: Identification of systemic problems (or failures). *Industrial and Corporate Change 20*(6), 1- 29. doi: 10.1093/icc/dtr060.

Edquist, C. (2013). Den svenska regeringen missar innovationspolitiken (The Swedish government misses innovation policy - in Swedish). *Dagens Nyheter, 6.* (Translation into English is available at http://charlesedquist.com.)

Edquist, C. (2014a). *Efficiency of research and innovation systems for economic growth and employment. Discussion paper for the 2014 ERAC (European Research and Innovation Area Committee) Mutual Learning Seminar on Research and Innovation Policies, March 20, 2014* (CIRCLE Electronic Working Paper no. 2014/08). Lund, Sweden: Centre for Innovation and Research in the Learning Economy, Lund University.

Edquist, C. (2014b). En helhetlig innovationspolitik – varför, vad och hur? (A hollistic innovation policy – Why, what and how? – In Swedish). In M. Ögren (Ed.), *Position Sverige.* Stockholm, Sweden: Ekerlids förlag. (Available at: http://charlesedquist.com).

Edquist, C. (2014c). *Offentlig upphandling och innovation (Public Procurement and innovation – in Swedish).* Stockholm, Sweden: Konkurrensverket (Swedish Competition Authority) Retrieved from http://charlesedquist.com/2014/09/12/report-innovation-procurement-obstacles-and-possibilities/

Edquist, C. (2014d). *Holistic innovation policy – Why, what and how? With examples from Sweden.* Paper presented at the Lundvall symposium "Innovation Policy – can it make a difference?", Aalborg, Denmark 13-14 March 2014.

Edquist, C., & Johnson, B. (1997). Institutions and Organizations in Systems of Innovation. In C. Edquist. (Ed.), *Systems of innovation:*

Technologies, institution and organisations. London, UK: Pinter Publishers.

Edquist, C., Hommen, L, & McKelvey, M. (Eds.). (2002). *Skapar innovationer jobb? Produktinnovationer och processinnovationer i den kunskapsbaserade ekonomin (Creating innovations job? Product innovations and process innovations in the knowledge economy – In Swedish).* Stockholm, Sweden: SNS Publishers.

Edquist, C., Vonortas, N., & Zabala, J. M. (2014). Introduction. In C. Edquist, N. Vonortas, J. M. Zabala, & J. Edler (Eds.), *Public procurement for innovation*. UK: Edward Elgar Publishing Ltd., (forthcoming).

Edquist, C., & Zabala-Iturriagagoitia, J. M. (2012). Public procurement for innovation (PPI) as mission-oriented innovation policy. *Research Policy 41*(10), 1757-1769. doi: 10.1016/j.respol.2012.04.022

Edquist, C., & Zabala-Iturriagagoitia, J. M. (2014). *Pre-commercial procurement: A demand or supply policy instrument in relation to innovation?, R&D Management.*

Freeman, C. (1987). *Technology policy and economic performance: Lessons from Japan.* London: Frances Pinter.

Lundvall, B.-Å. (1992a). User-producer relationships, national systems of innovation and internationalization. In Lundvall, B. A., (Ed.), *National Systems of Innovation*. London, UK: Pinter Publishing.

Lundvall, B. A., (1992b). *National Systems of Innovation.* London, UK: Pinter Publishing.

Nelson, R. R. (Ed.). (1993). *National systems of innovation: A comparative study.* Oxford, UK: Oxford University Press.

Nelson, R. R., and Rosenberg, N. (1993). Technical innovation and national systems. In R. R. Nelson (Ed.), *National Systems of Innovation: A Comparative Study.* Oxford, UK: Oxford University Press.

OECD (2013). *OECD Reviews of Innovation Policy: Sweden 2012,* OECD publishing.