Innovation in Norway in a European Perspective

Fulvio Castellacci

Norwegian Institute of International Affairs (NUPI), Oslo.
Correspondence: fc@nupi.no

Abstract

This paper seeks to shed new light on sectoral patterns of innovation in Norway in a European perspective. It puts forward a theoretical framework based on a new sectoral taxonomy that combines manufacturing and services within the same framework. It then analyses innovative activities in Norway and compare them to other European countries by making use of data from the Fourth Community Innovation Survey (CIS4). Finally, it studies the recent evolution and current characteristics of the industrial structure in Norway and points out its peculiarities vis-a-vis other European economies.

The results of this work point to a contrasting pattern. On the one hand, Norwegian sectoral systems appear to be very innovative, often above the European average and, for some of the CIS4 indicators and some of the sectoral groups, they indeed emerge as the most innovative in Europe. This pattern is in fact more evident for those technologically advanced groups that the new sectoral taxonomy points out as the most progressive industries of the ICT-based age. On the other hand, these sectoral groups are relatively small in Norway, accounting for a much lower share of production than their European counterparts.

In a nutshell, by focusing on the sectoral characteristics of the Norwegian economy and by analysing them in a European perspective, the paper sheds new light on the so-called Norwegian paradox, according to which Norway is characterized by a peculiar combination of low innovation and high economic performance. The commonly made statement that innovation is low in Norway does in fact hide the contrasting pattern outlined above. The problem is not with innovative activities, as frequently asserted, but it has rather to do with the sectoral composition of the economy.
Introduction

A common argument maintains that the Norwegian innovation system is a paradox or a puzzle. The paradox argument highlights Norway’s peculiar combination of low innovation and high economic performance (e.g. Grønning et al., 2006; OECD, 2007). According to this view, the puzzling aspect is that innovation is commonly believed to be one major factor explaining the economic performance of industrialized economies, and it is therefore difficult to explain how Norway, a country with a relatively low level of investments in innovative activities, can achieve the high income levels and economic prosperity that it has experienced in recent years.

The crucial proposition upon which this argument is based is that innovation is low in Norway. But is this really the case? How low is the level of innovative activities in Norway compared to other industrialized countries? And how do the various industrial branches of the Norwegian economy differ in terms of their ability to create advanced products, processes and services? Motivated by these questions, the present paper intends to reassess the Norwegian paradox by carrying out an empirical analysis of sectoral patterns of innovation in Norway in a European perspective.

The paper has two distinctive features. The first is that it focuses on sectoral analysis, and argues that such an industry-level perspective can shed new light on the characteristics of manufacturing and service innovation in Norway and achieve a more thorough assessment of the Norwegian puzzle. The second is that the work analyses the Norwegian economy in a European perspective, in the hope that such an explicit comparative perspective may lead to a balanced reconsideration of this alleged paradox.
The work is empirical in nature, and its main intention is to provide some descriptive evidence and point out some major stylized facts on the recent evolution and current state of the Norwegian industrial system. However, the empirical analysis undertaken in this paper will not try to explore causal relationships among the relevant factors, nor is it able to provide a fully-fledged theoretical explanation of the various empirical facts, leaving this difficult task to some of the other papers in this project (see references).

The paper is organized as follows. The second section presents the theoretical framework that guides the empirical analysis, which is based on a neo-Schumpeterian taxonomic model of innovation, growth and competitiveness. This framework proposes a stylized ideal model by which the Norwegian industrial system is analysed. The third and the fourth sections analyse sectoral patterns of innovation in Norway in the 2002-2004 period by presenting fresh results from the Fourth Community Innovation Survey (CIS4), and compare sectoral innovation in Norway with the corresponding patterns in a large sample of European countries. The fifth section shifts the focus to the study of the industrial structure in Norway and the analysis of the main differences vis-a-vis other European economies. Finally, the last section summarizes the major empirical results obtained by the paper and discusses their policy implications.

**The theoretical framework: a new taxonomy of sectoral patterns of innovation**

The theoretical approach adopted in this paper is based on a new taxonomy of sectoral patterns of innovation that combines manufacturing and service industries in a single framework (for a more detailed and extensive presentation of this model, see Castellacci, 2007). Figure 1 presents a stylized representation of this taxonomic model. The typology
is constructed by dividing industrial sectors along two main dimensions. Drawing on the endogenous growth literature, the first dimension highlights the function that each industry takes in the economic system as provider and/or recipient of goods and services, i.e. its position in the vertical chain (Romer, 1990; Grossman and Helpman, 1991). Industries that provide final (intermediate) goods and services to other sectors are therefore positioned at a higher (lower) level on the Y-axis in the diagram in figure 1.

The second dimension represents, in analogy with previous taxonomic exercises in the innovation literature, the technological content of an industry, i.e. the overall level of technological capabilities of innovative firms in the sectoral system. This second dimension is thus defined by the technological regimes and trajectories that characterize sectoral systems, and the extent to which industrial sectors are able to create new technologies internally or rather rely on the external acquisition of machinery, equipment and knowledge from their suppliers. Technologically advanced sectors, which are able to develop new technologies internally are positioned on the right-hand side of the X-axis in figure 1, whereas industries that mostly acquire advanced knowledge from other sectors rather than creating them internally are positioned on the left-hand side of the X-axis.

The typology is built up by making use of these dimensions in a two-step conceptual exercise. First, sectors are divided according to the main function they take in the economic system (Y-axis). This leads to the identification of four major sectoral groups. Secondly, each of these four blocks is subsequently divided into two distinct sub-groups on the basis of the technological content that characterizes them (X-axis). By using these two layers of analysis, the taxonomy does not only point out the function of each sector as provider and/or recipient of goods, services and knowledge to other industries, but it also
acknowledges the presence of a great deal of heterogeneity within each industrial block, in line with previous related exercises in the innovation literature (Pavitt, 1984; Miozzo and Soete, 2001). On the whole, the manufacturing and business services branches of the economy are thus represented as a system of vertically integrated sectoral groups.

**Advanced knowledge providers (AKP)** are characterized by a great technological capability and a significant ability to manage and create complex technological knowledge. Two sub-groups of industries belong to this category: (1) within the manufacturing branch, specialised suppliers of machineries, equipments and precision instruments; (2) within services, providers of specialised knowledge and technical solutions such as software, R&D, engineering and consultancy, so-called knowledge intensive business services. What these industries have in common is that, in addition to being characterized by a high level of technological capability, they perform the same function in the innovation system as providers of advanced technological knowledge to other industrial sectors. They represent *the supporting knowledge base* upon which innovative activities in all other sectors are built, and they continuously upgrade and renew it. Firms in these industries are typically small, and tend to develop their technological activities in close cooperation with their clients and with the users of the new products and services they create. In the Fordist model, the typical example of this kind of user-producer interactions was Pavitt’s illustration of the close ties between specialised suppliers and car producers in the automotive industry. In more recent times, the greater technological specialization and deeper division of labour have increased the demand for complex innovative capabilities and, consequently, have led to the emergence and rapid growth of knowledge intensive business services, which now play the important role of
providers of specialised knowledge and technical solutions for the other advanced branches of the economic system.

Supporting infrastructural services (SIS) may be located, similarly to the previous category, at an early stage of the vertical chain, given that they mostly produce intermediate products and services rather than items for personal consumption. However, they differ from advanced knowledge providers in terms of their technological capability, and particularly in terms of their more limited ability to internally develop new knowledge. Their innovative trajectory is in fact typically based on the acquisition of machineries, equipments and other types of advanced technological knowledge created elsewhere in the economic system. To be more precise, two sub-groups of sectors can be distinguished here, each characterized by a different level of technological sophistication (Miozzo and Soete, 2001): (1) providers of distributive and physical infrastructure services (e.g. transport and wholesale trade); (2) providers of network infrastructure services (such as finance and telecommunications). Firms in the latter group typically make heavy use of ICTs developed by other advanced sectors in order to increase the efficiency of the productive process and the quality of their services, whereas the former group of industries has a significantly smaller capability in this respect. Regardless of these differences, what these sectoral groups have in common is the function they take in the economic system, namely they represent the supporting infrastructure upon which business and innovative activities carried out by firms in the whole economy are based. The more advanced this infrastructure is, the easier the process of intersectoral knowledge diffusion within the domestic economy, and the more efficient and productive the national system will be.
Sectors producing *mass production goods* (MPG) constitute a key part of the manufacturing branch. They may be located at an intermediate stage of the vertical chain, given that they produce both final goods and intermediate products that are used in other stages of the production process. In terms of their technological content, they are characterized by a great capability to internally develop new products and processes, although two distinct sub-groups may be distinguished (Pavitt, 1984): (1) scale-intensive industries (e.g. motor vehicles and other transport equipments) frequently have their own in-house R&D facilities, and their innovative activities also develop in close cooperation with the specialised suppliers of precision instruments and machineries; (2) science-based sectors (such as electronics) are characterized by a great ability to internally create new technological knowledge, and their innovation process is close to the scientific advances continuously achieved by Universities and other public research institutes. Different as they may be, these sectoral groups have a great deal of common characteristics. Firms are typically large, and their profitability depends to a great extent on the exploitation of scale economies that the mass production of standardized goods makes it possible to obtain. Further, they all assume a central position in the knowledge chain, given that they receive technological inputs from advanced knowledge providers and, in turn, they provide technological outputs (new products) that are used by infrastructural services as well as by producers of final goods. They are, in a nutshell, *the carrier industries* of a new technological paradigm (Freeman and Louça, 2001). By producing technologically advanced products on a large scale, by fostering the efficiency and quality of the production process of infrastructural and final goods and services, and by increasing the demand of specialised solutions from advanced knowledge providers, this group of industrial sectors thus plays a pivotal role in the economic system.
The fourth sectoral block is represented by the producers of personal goods and services (PGS). Located at the final stage of the vertical chain, these manufacturing and service industries are characterized by a lower technological content and a more limited ability to develop internally new products and processes. Their dominant innovation strategy is in fact typically based on the acquisition of machineries, equipments and other types of external knowledge produced by their suppliers, while they commonly lack the capability and resources to organize and maintain their own R&D labs. This explains the term supplier-dominated industries that is frequently adopted in the innovation literature – and that describes well both sub-groups of industries included in this category, namely (1) the producers of personal goods and (2) the providers of personal services (Pavitt, 1984; Miozzo and Soete, 2001). Firms in these manufacturing and service branches, typically small enterprises, are thus mostly recipients of advanced knowledge and, to the extent that they are able to implement new technologies created elsewhere in the economy, they may use them to increase the efficiency of the production process as well as to improve the quality of the final goods and services they commercialize. This type of strategy may lead to lengthen the industry-life cycle of these mature industrial sectors and recreate new technological opportunities (Von Tunzelmann and Acha, 2005).

In a nutshell, this sectoral typology presents a stylized view of some of the main vertical linkages between manufacturing and business services within a national system of innovation. One relevant aspect of this neo-Schumpeterian taxonomic model is the explanation it provides of the mechanisms driving growth and structural change in national systems of innovation. When a new technological paradigm emerges and diffuses
throughout the economy, industrial sectors greatly differ in terms of the technological opportunities, capabilities and constraints they face. High-opportunity technological regimes are those that are in a better position to exploit the advantages of the new general purpose technologies, and have a greater growth potential. Some of these industries belong to our mass production goods sectoral group and, by demanding new infrastructural services as well as advanced specialised knowledge and technical solutions to their suppliers, they transmit part of this growth potential to some of the other industrial groups.

To illustrate, during the Fordist paradigm the typical high-opportunity mass production sectors were, say, chemical, plastics and the car industries (Freeman et al., 1982). In order to follow their dynamic trajectories, these branches fostered the growth of specialised suppliers (e.g. producers of precision instruments) and of infrastructural services (in particular physical infrastructural services such as transport). It was the set of mutual interactions between these vertically integrated branches of the economy that sustained the dynamics of national systems in many advanced countries in the post-war era.

In a more recent period, due to the emergence and rapid diffusion of the ICT-based paradigm, greater technological opportunities can instead be found in other sectors. Electronics, hardware producers and pharmaceuticals may be considered as the high-opportunity mass production manufacturers of the present age. In their dynamic trajectory, these sectors have however also sustained the rise of advanced knowledge providers (such as software and technical consultancy) and of network infrastructure services (e.g. telecommunications). It is the exchange of advanced knowledge, goods and services among these high-opportunity manufacturing and service sectors that accounts for the bulk of the growth potential of the current era.
In short, the specific key industries differ in any given historical age, but the overall causation mechanism that drives the dynamics of the system is, by and large, the same. A new set of general purpose technologies need, at the same time, to be produced on a large scale, to be supported by an efficient infrastructure and to be sustained by the provision of an advanced knowledge base. Our four-group typology provides a comprehensive and general framework that accounts for the dynamics of a national system within each paradigmatic phase, as well as for the transformations occurring when a regime shift changes the locus of technological opportunities and of the related growth potential.

This theoretical view has one important implication for the competitiveness of national systems. Given the existence of a web of vertical linkages among industries, a specialization pattern in advanced manufacturing industries fosters the development of new services, and the latter does in turn enhance the growth of the former. The key mechanism of competitiveness of a national system is thus related to the ability of a country to undertake a process of structural change from traditional to GPT-related high-opportunity manufacturing and service industries. The policy implication of this perspective would thus be to emphasize the creation of new competitive advantages in the most progressive industries of each sectoral group, instead of relying on the existing set of comparative advantages, which will eventually turn out to be obsolete when a new set of general-purpose technologies will change the locus of the growth potential.

**Technological opportunities across countries in Europe**

The taxonomic model presented in the previous section provides a stylized representation of the process of growth and structural change, and argues that countries should make an active effort to invest in the new GPT-related industrial groups. Countries do however
significantly differ in their ability to adapt to the new technological paradigm. What is the extent of these differences in Europe, and how does Norway compare to other European countries? This section and the following consider this question, and present the results of the Fourth Community Innovation Survey (CIS4), which make it possible to analyse in greater details various relevant characteristics of the innovative activities carried out in Norwegian industrial sectors in the period 2002-2004, and to compare them with the corresponding trends in the rest of the European economy.

This section analyses the extent of cross-country differences in terms of technological opportunities, which is one crucial aspect of the process of innovation and paradigmatic change. Technological opportunities are measured by the variable OPPORT, defined as the total innovation expenditures of industrial sectors (expressed as a share of their total turnover). This indicator is more general than the commonly used variable of R&D intensity, given that it does not simply consider R&D expenditures but also other types of innovative investments (e.g. acquisition of machinery, equipments, software, etc.). It is therefore an appropriate indicator for measuring the innovative intensity of a large variety of industrial sectors, including also low-tech manufacturing and service industries, which typically do not spend much in R&D but frequently carry out other types of innovative activities.

Table 1 shows our CIS4 indicator of technological opportunities for the various sectoral groups of the taxonomy and for a sample of 17 European countries. The table suggests that, for each sectoral group, countries largely differ in terms of their innovative intensity. In particular, if we look at Norway and compare it to the EU average, we see that Norwegian high-tech sectoral groups appear as much more innovative than their European
counterparts, and indeed among the most innovative in Europe. This is particularly the case for the groups of advanced knowledge providers manufacturing (6.7% versus 5.4%), advanced knowledge providers services (30.4% against 19.2%), science-based manufacturing (7.8% vis-a-vis 5.3%) and network infrastructure services (3.2% versus 2.6%). On the other hand, the lower-opportunities sectoral blocks of the taxonomy (scale intensive manufacturing, physical infrastructure services, and personal goods and services) are on average less innovative than their European counterparts. Such a pattern contrasts sharply with the commonly made argument that Norway, because of its specialization in traditional and resource-based industries, is a good example of innovation in low-tech industries – the CIS4 evidence presented here does not support this common argument.6

[TABLE 1 ABOUT HERE]

The extent of these large cross-country differences in Europe is represented in figure 2, which reports a series of boxplot graphs that show the distribution of technological opportunities across countries in Europe for each sectoral category of the taxonomy. The boxplots indicate that, for each of the four sectoral blocks, the cross-country variability is larger for the higher-opportunity groups, i.e. those whose productive activities are closer to the production and use of the new GPTs – namely science-based manufacturing, advanced knowledge providers services, and network infrastructure services. The interpretation of this pattern is straightforward – countries differ, first and foremost, in their ability to innovate and invest in the new GPT-related sectors, whereas the cross-country variability of innovative efforts for sectors related to previous technological paradigms is much more limited.
Let us therefore focus on these high-opportunity sectoral groups, and investigate how European countries are adapting to the emergence and diffusion of the new GPTs and, in particular, how Norway compares to other EU economies. Figure 3 presents the kernel density estimates for these sectoral groups, which show the cross-country distributions of technological opportunities and plot them vis-a-vis a standard normal density. The kernel graphs indicate a similar pattern for the three groups of sectors. Most European countries in the sample are concentrated on the left-hand peak of the distribution, characterized by a below-average level of technological opportunities, while a restricted group of countries score well above the average, i.e. those around the right-hand peak of the distribution. In other words, figure 3 suggests that different groups of European countries do indeed differ in terms of their innovative intensity and their ability to invest in the high-opportunity sectors of the present age.

Where does Norway stand in comparison to other European countries? In order to analyse more thoroughly the grouped-structure of the data and point out the relative position of the Norwegian economy, we have carried out a cluster analysis, whose purpose is precisely to identify clusters of countries characterized by different levels of the technological opportunity variable. The cluster analysis has made use of a so-called hierarchical algorithm, which initially treats all cases (countries) as separate clusters and progressively aggregate them together on the basis of their similarity on the OPPORT indicator (which is the input variable in the cluster analysis).
Figure 4 shows the results of the hierarchical cluster analysis. The upper panel of the figure reports the dendogram, which shows all the steps of the iteration procedure, where similar countries are progressively grouped together to form different clusters. The lower panel of the figure presents a more simplified and more synthetic view of these empirical results by representing the various resulting clusters in a two-way graph. The X-axis of this diagram refers to the technological opportunity of countries in science-based manufacturing, whereas the Y-axis measures countries’ opportunities in advanced services (i.e. the advanced knowledge providers and network infrastructure services sectoral groups).

The top-right quadrant comprises countries that have high technological opportunities in both science-based manufacturing and advanced services. These clusters include Norway, Sweden, France, Italy and Greece. These economies, different as they may be, are indeed similar in that they seem to be adopting a balanced innovative strategy and combine technological activities in both high-opportunities manufacturing and service industries, instead of simply focusing on one of these industrial groups. The bottom-right quadrant refers instead to a smaller cluster, formed by Germany and the Netherlands, whose major characteristic is to have high innovation intensity in science-based manufacturing but a relatively low position in advanced services. The top-left quadrant comprises a set of catching up countries, from Southern and Eastern Europe, that have high innovation intensity in either knowledge intensive business services or network infrastructure services, but a comparatively low innovation performance in science-based manufacturing. Finally, the bottom-left quadrant refers to a set of countries whose level of technological opportunities is clearly below the EU average for all sectoral groups, and that therefore show no sign of technological catching up.
The taxonomic model presented in the previous section argues that it is the interaction between technologically advanced manufacturing and service industries that constitutes the crucial factor of growth and competitiveness of national systems. Countries positioned in the top-right quadrant of figure 4, according to this view, will have a competitive advantage in the new ICT-based era, given that they are currently devoting a significant amount of innovative resources to all the sectoral groups that constitute the bulk of the growth potential in the current era, instead of focusing on just one of them. Among these countries, Norway emerges as one of the economies with the highest level of innovative intensity in all the high-opportunity sectoral groups.

[FIGURE 4 ABOUT HERE]

**Sectoral patterns of innovation: Norway in a European perspective**

Technological opportunities certainly represent one crucial aspect of the technological activities of industrial sectors. However, innovation is a multifaceted phenomenon, and it is therefore important to broaden up the scope of our cross-country analysis by looking at a set of other dimensions of innovative activities. Tables 2 to 7 present other results of the CIS4 Survey, comparing Norway to the EU average for a large set of indicators that take into account different relevant aspects of the innovative process (for a definition of the indicators, see Appendix 2; for a more detailed presentation and discussion of the underlying theoretical dimensions, see Castellacci, 2007). Each indicator is reported for the various sectoral groups of the taxonomic model presented in the second section, so that it is possible to analyse the innovative patterns in different branches of the Norwegian economy in a European perspective.
Table 2 looks at the efforts and expenditures in innovative activities. It considers three indicators. One of them measures the cumulativeness conditions of different sectoral groups (CUMUL), i.e. the share of innovative firms that are continuously engaged in R&D activities. The other two represent synthetic measures of the dominant innovation strategy adopted by firms in different sectors. These are the R&D expenditures as a share of total innovation costs8 (so-called disembodied innovation strategy, DISEMB) and the percentage of innovative firms engaged in training activities directly linked to the introduction of technological change (TRAIN).

The first two indicators show that Norwegian sectors invest on average a greater amount of resources in innovative expenditures than their European counterparts. This is particularly the case for the sectoral groups that our neo-Schumpeterian taxonomy has pointed out as the most progressive industries of the ICT-based age, namely advanced knowledge providers (particularly knowledge intensive business services), science-based mass production manufacturers and network infrastructure services. The strong propensity to invest in R&D activities, instead of adopting other types of embodied technological change, is indicated by the variable DISEMB, according to which nearly all sectoral groups in Norway score much above the EU average, as well as significantly above other advanced countries such as Sweden and Denmark.

The third variable, TRAIN, suggests instead a different pattern, where Norwegian industries always perform well below the EU average. Considering that training activities directly linked to the introduction of technological change are more frequently undertaken by large firms than by SMEs, a possible explanation of this pattern may simply be that
Norway has on average a larger number of small and medium enterprises than other European countries.

Table 3 focuses on the sectoral patterns of interactions in the innovative process, i.e. the ability of firms to take advantage of external sources of opportunities by interacting and cooperating with other actors in the sectoral system of innovation. Three commonly used CIS indicators measure the interactions of innovative firms with their suppliers, the users and the public science system respectively. The variable SUPPLIERS show that most Norwegian industries are commonly characterized by a below-average intensity of producers-suppliers interactions, with the exception of infrastructural services, which score slightly above the European mean. The intensity of user-producer interactions is instead strong for all sectoral groups, much above the EU average and well above the other Nordic countries (particularly for the most technologically advanced groups). The variable SCIENCE indicates that the propensity of innovative firms to collaborate with the public science system is particularly strong (and much above other European countries) for knowledge intensive business services and for science-based manufacturing industries. In a nutshell, the main pattern emerging from table 3 is that the most technologically advanced groups, the key ICT-related industries in our taxonomic model, are those that are better connected to their users and to the University system, whereas more traditional and low-tech sectors appear to be more closely linked to their suppliers – which is precisely the ideal pattern that a Pavitt-like model would suggest.

Table 4 shifts the focus to the internationalization strategies, i.e. the ability of Norwegian firms to exploit the opportunities provided by the increasing globalisation of technological activities (Archibugi and Michie, 1995; Carlsson, 2006). This is a particularly relevant
aspect to consider, given that Norway is a small open economy and it is thus extremely important for Norwegian firms to exploit foreign markets and take advantage of international cooperations in order to overcome the lack of a large domestic market. CIS4 data provide some limited information on this aspect. The first variable (COOP-OTHER) measures the share of innovative firms that have cooperated with enterprises in countries outside of the EU, and it thus refers to an important channel for the globalisation of innovative activities (Archibugi and Iammarino, 2003). The second indicator (SELL-OTHER) refers to a more traditional form of internationalization, namely the ability of firms to sell their products and services in international markets (i.e. in countries outside of Europe).

CIS4 data suggest that Norwegian firms have a higher propensity to collaborate internationally than their European counterparts, and this pattern is particularly evident for the most technologically advanced sectoral groups. Regarding the export propensity, Norway scores well above the European average for advanced service industries, such as knowledge intensive business services and network infrastructure service providers – confirming the greater scope for internationalization that this type of activities has recently experienced (Hoeckman and Primo Braga, 1997; Miozzo and Soete, 2001).

Table 5 looks at the policy support to innovative activities, and makes use of three variables. The first (FUND) measures the share of innovative firms that have received public support for their technological activities in the period 2002-2004. The indicator shows a remarkable pattern: in nearly all sectoral groups (with the exception of infrastructural services), a large percentage of Norwegian firms (between 45 and 65%) have benefited from public support schemes. This share is strikingly higher than in the
corresponding sectoral groups in other EU countries, and if we rank European economies after this indicator, Norway is number 1 in the list.

The other two variables measure the origin of this public support, i.e. the extent to which it is part of national schemes of the Norwegian government (FUND-NAT) or related to the EU policy framework (FUND-EU). These variables show quite evidently that the bulk of the innovation policy support comes from the Norwegian central government, which appears to play a much more active role than what done by national authorities in other European countries (all Norwegian sectoral groups score in fact much above the EU mean, and most of them are ranked first in the country list). On the contrary, Norwegian firms have been supported much less by EU sources.

The pattern emerging from table 5 is on the whole quite strong, and points to the important role that public policies have played for the support of private innovative activities in recent years in Norway. However, this also raises the question of the effectiveness of this strong public support, which, according to some, may hamper the efficiency of private innovative activities (David et al., 2000; OECD, 2007). While this aspect is analysed in more details by Clausen (2007), some preliminary evidence on this aspect can also be obtained by simply looking at the performance of innovation in Norwegian sectoral systems – if the technological performance is positive and above the EU average, we would get at least a rough indication of the fact that innovation policies constitute one of the important ingredients in this successful story (it would indeed be difficult to argue otherwise). This is the aspect that tables 6 and 7 look at.
Table 6 focuses on the technological performance of Norwegian sectoral systems in terms of the *innovativeness* of different industrial sectors, which is measured by the number of firms that have introduced at least one technological innovation (INNOV), an organisational innovation (ORGAN) or a marketing innovation (MARKET) in the period. In terms of the first variable, only knowledge intensive business services and science-based manufacturing industries show an above-average performance. The innovativeness of Norwegian firms in a European perspective is more evident in relation to the indicator measuring marketing innovations, where the advanced knowledge providers and the science-based groups score much above the European average and are ranked as number 1 in this particular European contest.

On the contrary, organisational innovation does not seem to be an aspect where Norwegian firms do particularly well, and most of the sectoral groups actually perform worse than their European counterparts. One possible factor explaining this could be that, as mentioned above, the market structure in Norway is characterized by a relatively larger number of SMEs than in other countries, whereas organisational innovations are more frequently introduced by large firms given that these need to manage, organize and rationalise a greater amount of human resources. The lower average size of Norwegian firms could therefore be one possible factor explaining the low performance of the ORGAN variable.

Table 7 reports two different indicators of *technological performance*. One refers to the patenting activity of firms (PATENT), while the other measures the turnover from the commercialization of new products as a share of the total turnover of firms (TURNEW). Both variables indicate that the technological performance of Norwegian industrial sectors
is positive, and for nearly all sectoral groups above the European average. For instance, PATENT indicates that in science-based manufacturing and knowledge intensive business services the percentage of Norwegian firms that have applied for at least a patent in the period is around 10 points higher than in the rest of the EU. The variable TURNEW instead suggests that Norwegian enterprises belonging to the science-based and network infrastructural services groups have a share of turnover from the commercialization of new products that is twice as high as the corresponding sectors in Europe, and that Norway can be ranked as the European number 1 in terms of this indicator.

Summing up, the large set of CIS4 indicators presented in this section shows a clear and quite remarkable pattern. Norwegian sectoral systems are on the whole very innovative, often above the European average and, for some of the variables and some of the sectoral groups, they indeed emerge as the most innovative in Europe. This pattern is in fact more evident for those technologically advanced groups that the neo-Schumpeterian theory would point out as the most progressive industries of the ICT-based age, namely advanced knowledge providers (especially services), science-based manufacturing and network infrastructural services. In Norway, these industries are currently characterized by a high commitment to innovative activities, close ties with external sources of technological opportunities (including foreign sources), a very active public support and a positive technological performance.

[TABLE 2 TO 7 ABOUT HERE]
The industrial structure in Norway in a European perspective

The third and the fourth sections of this paper have depicted a rather positive picture of sectoral patterns of innovation in Norway, and shown that Norwegian industries are much more innovative than their European counterparts, and more clearly so for the set of industrial blocks that constitute the bulk of the growth potential in the current era. However, in order to get a thorough and more balanced assessment of the patterns and potential of innovation in Norway, one important aspect needs to be additionally considered, namely the characteristics of the industrial structure.

The composition of the economy, that is the share of resources that is employed in the different industrial sectors of the economic system, is important because it contributes to define the aggregate amount of resources that each country devotes to innovative activities. In fact, the overall innovation intensity of a national system may be thought of as the average of the innovation expenditures of the various industrial sectors weighted by the sectors’ size (e.g. their value added shares), as indicated by the following formula:

$$ II_i = \frac{\left[ \sum_j (II_{ij} \cdot S_{ij}) \right]}{\left[ \sum_j S_{ij} \right]} $$

where II is the innovation intensity, S is the sector’s size, and the indexes i and j denote the country and the sector respectively. While the third and the fourth sections have empirically analysed the first term of the product between parentheses ($II_{ij}$), the present section shifts the focus to the analysis of the second term ($S_{ij}$).

Table 5 presents the value added shares of the various sectoral groups of the taxonomy for a sample of 18 European countries (average of the period 2000-2003). The last row of the
table refers to the EU average, which indicates that the greatest shares of resources in the European economy are employed by the groups of supporting infrastructural services and personal goods and services (around 20% each), while advanced knowledge providers and mass production manufacturing account for a much smaller share of total production (around 9% and 8%, respectively).

However, the table also indicates the existence of significant cross-country differences in the industrial structure of European economies. Norway, in particular, is characterized by a peculiar composition of the economic system, given that a very high share of value added is produced in the energy sector (oil and gas), whereas all manufacturing and business services sectoral branches have a production share that is much below that of the EU average (with the only exception of physical infrastructure services, which score slightly above the mean).

[ TABLE 8 ABOUT HERE ]

It is interesting to compare the peculiar industrial structure of the Norwegian economy with its sectoral patterns of innovation, whose characteristics have been previously pointed out in the third and the fourth sections. Figure 5 presents an attempt to combine the two aspects together, and studies the relationships between technological opportunities and value added shares of the sectoral groups of our taxonomy. In order to be directly comparable to the cross-country analysis of technological opportunities undertaken in the third section, the figure focuses on the high-opportunity groups of the taxonomy, which are those that have been shown to have a larger cross-country variability.
The upper part of figure 5 represents a stylized typology of industrial sectors. In industries that have both a high innovation intensity and a large size, the impact of innovative activities is of course high (top-right quadrant of the figure). On the other hand, sectors in the top-left (bottom-right) quadrant of the diagram are characterized by low innovation intensity (small value added share), and should therefore make an active effort to increase their innovative activities (transform their industrial structure). Finally, in sectors that have both low innovation intensity and a small size, the impact of innovative activities is inevitably limited.

The empirical counterpart of this simple typology is considered in the lower part of figure 5, which plots the levels of technological opportunities and the corresponding value added shares for the sectoral groups of the taxonomy for a bunch of European countries. The scatterplot reveals an interesting pattern, and should be compared to the results of the cluster analysis previously presented (see figure 4, in the third section). The cluster analysis identified in fact a restricted set of countries that have high innovation intensity in both science-based manufacturing and advanced services, namely Norway, Sweden, France, Italy and Greece. In the light of figure 5, we now observe that, among these countries, Sweden, France and (to a less extent) Italy also appear to have a quite advanced industrial structure, with above-average value added shares in the ICT-related sectoral groups (see the top-right quadrant of the figure). On the contrary, Norway and Greece are characterized by a more traditional composition of the economy and a below-average size of the high-opportunity sectoral groups. Norwegian industries, in particular, can all be found in the bottom-right quadrant of figure 5, the one that combines high technological opportunities with a low size of the industry.
In a nutshell, this graphical analysis points to a contrasting pattern, which is indeed a crucial aspect of the Norwegian system. On the one hand, technological opportunities are high in Norway, and the bunch of new GPT-related sectoral groups has among the highest innovative intensity in Europe. This is the case, as pointed out above, for the industrial groups of advanced knowledge providers, science-based manufacturing and network infrastructure services. On the other hand, these sectoral groups are relatively small in Norway, accounting for a much lower share of production than their European counterparts. So, the commonly made statement that innovation intensity is low in Norway (e.g. Grønning et al., 2006; OECD, 2007) hides such a contrasting pattern. The problem is not with innovative activities and innovation policies, as frequently asserted, but it has rather to do with the sectoral composition of the economy. The specialization in resource-based and traditional industries has in fact constituted a stronghold of the Norwegian system for several decades. The industrial structure we observe today is thus the result of the continuous policy support to this type of Fordist trajectory, whereas new and more innovative industrial branches, that could potentially drive the growth of the system in the post-oil era, have progressively decreased their importance in the Norwegian economy.

This is particularly evident when we look at the employment shares of various branches of the economy and their evolution in the last three-decade period. The graphs in figure 6 show in fact that most of the sectoral groups have experienced a decline in their employment shares, while just a few branches have increased their importance in the economy. One of these expanding industries is, as well-known, the energy sector, which however has increased its value added shares much more rapidly than its employment
share (and this explains its spectacular productivity performance). Interestingly, the other expanding sectors are constituted by advanced knowledge providers services and, more strikingly, public services. The interesting fact is that these two expanding sectors have increased their employment more rapidly than they have been able to increase their production share – their labour productivity has for this reason decreased over time.

The interpretation of this pattern is that the explosion of the energy sector has had two consequences for these industrial groups. On the one hand, it has increased the demand for technical consultancy and specialised solutions that advanced knowledge providers have the function to provide, thus fostering the expansion of this type of industries. On the other, it has made available a large amount of public resources to the State. The international pressures to restructure the welfare system have consequently been mitigated by the healthy conditions of public finance in Norway, and the public sector has thus visibly enlarged by absorbing employment, in contrast to what has happened in many other industrialized countries in the same period.

As a consequence of this trend, the composition of the Norwegian economy is now more dependent on low productivity services. Public services currently employ more than 35% of the working population, and if we add low productivity services such as supplier-dominated and physical infrastructure services, the employment share gets to around 60%. Table 9 reports the level of labour productivity (average of the period 2000-2003) for the sectoral groups of our taxonomy, which corroborates this interpretation. In Norway, science-based manufacturing and network infrastructure services have much higher labour
productivity levels than the average European country, and are ranked as number one in Europe. On the other hand, advanced knowledge providers manufacturing and services are characterized by a labour productivity that is well-below the European average and among the lowest in Europe.

These figures cast some doubts on another common argument about the Norwegian innovation system, namely that the rise of the oil sector has had a positive effect for specialised suppliers manufacturing and service producers (i.e. our sectoral groups of advanced knowledge providers) because these had the possibility to follow a dynamic trajectory and experience a positive economic performance by specialising in the provision of technical solutions for the domestic energy sector (Grønning et al., 2006; see also Wicken, 2007, and Sogner, 2007). Such an interpretation contrasts with the labour productivity levels presented in table 9, which indicate that these industrial groups in Norway are among the least productive in the European economy. It may well be that the rise of the energy sector has provided these industries with opportunities for expanding their scale, but their productivity performance is however not as bright as it is frequently pointed out.

In summary, the analysis of the Norwegian industrial structure in a European perspective carried out in this section leads to the following interpretation. The explosion of the energy sector has attracted a substantial amount of investments towards this important branch of the economy and sustained the overall performance of the system for the last few decades. However, it has at the same time driven out productive resources from high-opportunity
manufacturing and business services, which are those that are potentially able to drive the growth of the economy in the post-oil era. These high-opportunity industries are indeed very innovative in Norway, but they still lack the amount of resources and minimum scale that would be necessary to have a visible effect on the aggregate performance of the Norwegian system. These sectoral blocks will become more and more crucial in the years to come, and a transformation of the industrial structure towards these advanced branches represents therefore a key challenge ahead for the Norwegian economy.

**Conclusions and policy implications**

The analysis carried out in this paper has tried to shed new light on sectoral patterns of innovation in Norway in a European perspective. The paper has first put forward a theoretical framework based on a new sectoral taxonomy that combines manufacturing and services within the same framework (second section). It has then analysed innovative activities in Norway and compared them to other European countries by making use of CIS4 data (third and fourth sections). Finally, it has studied the recent evolution and current characteristics of the industrial structure in Norway and pointed out its peculiarities vis-à-vis other European economies (fifth section).

The results of this work point to a contrasting pattern, which is indeed a characterizing feature of the Norwegian system. On the one hand, Norwegian sectoral systems appear to be very innovative, often above the European average and, for some of the CIS4 indicators and some of the sectoral groups, they indeed emerge as the most innovative in Europe. This pattern is in fact more evident for those technologically advanced groups that our sectoral taxonomy points out as the most progressive industries of the ICT-based age, namely advanced knowledge providers (especially services), science-based manufacturing
and network infrastructural services. In Norway, these industries are currently characterized by a high commitment to innovative activities, close ties with external sources of technological opportunities (including foreign sources), a very active public support and a positive technological performance.

On the other hand, these sectoral groups are relatively small in Norway, accounting for a much lower share of production than their European counterparts. The impressive growth of the energy sector has in fact attracted a substantial amount of investments towards this important branch of the economy and sustained the overall performance of the system for the last few decades. However, it has at the same time driven out productive resources from high-opportunity manufacturing and business services, which are those that are potentially able to drive the growth of the economy in the post-oil era. At present, these high-opportunity industries still lack the amount of resources and minimum scale that would be necessary to have a visible effect on the aggregate performance of the Norwegian system.

In conclusion, by focusing on the sectoral characteristics of the Norwegian economy and by analysing them in a European perspective, the paper sheds new light on the so-called Norwegian paradox, according to which Norway is characterized by a peculiar combination of low innovation and high economic performance (e.g. Grønning et al., 2006; OECD, 2007). The commonly made statement that innovation is low in Norway does in fact hide the contrasting pattern outlined above. The problem is not with innovative activities, as frequently asserted, but it has rather to do with the sectoral composition of the economy.
This interpretation leads to one major policy implication. The fact that the Norwegian economy is currently robust and that it has experienced a positive economic performance for the last decades should not lead to neglect the possible risks it faces for the future. The great availability of financial resources currently saved in the Oil Fund does not provide a strong enough insurance from these future risks. Quite on the contrary, these resources constitute a good opportunity to start undertaking a new direction already in the present, and to compensate for the costs and risks associated with the development of a new path.

If the diagnosis presented in this paper is correct, the natural policy implication would be to emphasize the building up of new competitive advantages in technologically progressive industries rather than the strengthening of the current specialization patterns based on the existing set of comparative advantages. The first and crucial step in this new direction would be the construction of a well-developed home market for the production of technologically advanced products, processes and services. When a critical mass of resources will be available in the high-tech branch of the industrial system, dynamic economies of scale and inter-sectoral knowledge spillovers will be able to activate and sustain a cumulative growth mechanism. At that point, the competition between the two technological paradigms might result in a different outcome, and the dynamics of the Norwegian system will possibly take a different direction than the one it is currently following.
Notes

1 Both Grønning et al. (2006) and OECD (2007) derive such a statement based on an empirical analysis of different data sources. The former work makes use of CIS3 data, whereas the latter analyses more traditional indicators such as R&D and patent statistics. The overall conclusion that innovation intensity is low in Norway, according to these papers, is based on the aggregate evidence for the whole industrial system, i.e. the average level of innovative activities in Norway as compared to other EU countries. The present paper differs from these previous studies in that it carries out a more disaggregated analysis that looks at sectoral patterns of innovation in different industrial branches rather than simply at the overall country averages.

2 It may be argued that, in addition to those considered here, there are other sectoral branches of the economy that may be important in terms of the linkages they develop with manufacturing and business services. For instance, the existence of a set of well-developed resource-intensive industries (e.g. oil and gas) or agricultural activities may have important effects for the set of linkages and knowledge flows in the industrial system. These branches are particularly important in the Norwegian case, but they are much less relevant for most other European countries. For this reason, given that this paper seeks to compare Norway to other EU economies, the sectoral taxonomy that has been adopted here only focuses on manufacturing and service industries, and neglects other sectoral branches. In other words, the taxonomy presented in this section provides a sort of general and stylised model that is assumed to be valid for all advanced countries, instead of presenting an accurate description of the Norwegian system only. A more precise description of the industrial system in Norway, without any explicit comparison to the characteristics of other EU countries, can be found in Wicken (2007).

3 According to Freeman et al. (1982), the Fordist paradigm is a period spanning from approximately the end of World War II up to the 1990s. For a description of different historical phases in the neo-Schumpeterian approach, see Freeman and Louça (2001).

4 What is the correspondence between the sectoral categories outlined in this taxonomy and the industrial blocks or layers described by Wicken’s (2007) historical analysis of the Norwegian system of innovation? Wicken’s small-scale decentralized path corresponds to our sectoral group of personal goods and services. The large-scale centralized path does instead refer to the branches that sustained the growth of advanced economies during the Fordist era, whereas the R&D intensive network based path more closely corresponds to the high-opportunity industries of the present age, namely those closer to the core of the ICT-based paradigm. There is however no direct one-to-one correspondence between the two classification schemes, given that Wicken’s layers focus on the long-run historical evolution of broad parts of the Norwegian economy and society, while the present paper focuses on the characteristics of industrial sectors in a more recent period.

5 It is important to emphasize that such a normative statement is based on the taxonomic model presented in the previous section and clearly rooted in a neo-Schumpeterian theoretical framework. This highlights the role of emerging technological paradigms and the related high-opportunity industries. Such a theoretical view provides a general and stylised representation of the process of growth and structural change, which may of course constitute a valid description for the process of industrial transformation for some advanced countries but not for others. This paper acknowledges this limitation of the adopted theoretical framework, but it still considers it as a useful model, given that the overall purpose of the work is to provide a comparative analysis of several European countries, rather than carrying out a precise description of one specific national case.

6 This evidence based on CIS4 data can also be expressed by using the terminology of Wicken’s layers (see Wicken, 2007). The CIS4 results indicate that Wicken’s R&D intensive network based path is the one characterized by one of the highest levels of innovative intensity in Europe, while his small-scale decentralized and the large-scale centralized paths are characterized by lower technological opportunities than their European counterparts.

7 The fact that Greece turns out to belong to this high-opportunity advanced cluster may at first sight look surprising. It is however important to recall that the opportunity variable (OPPORT) used in this cluster analysis is not output-weighted, i.e. it does not take into account the size of these advanced sectors. The fifth section of the paper will consider this aspect in further details, and will show that Greece, when taking into
account its low-tech specialization and traditional industrial composition, has in fact an innovation performance that looks far less bright than what figure 3 suggests.

8 Total innovation costs include, in addition to R&D expenditures, also investments for the acquisition of machineries and equipments, for the purchase of software and other types of external knowledge, and for training and marketing activities.

9 According to Archibugi and Iammarino (2003), evidence suggests that this channel of the globalisation of innovation is progressively becoming more important over time. In addition to the variable used here, the CIS4 dataset also contains an indicator that measures intra-EU technological collaborations. We have not used this variable in our analysis because it appears to be much less effective in identifying cross-country differences, in the sense that most European countries, including Norway, score close to the EU average in terms of this indicator.

10 It should be observed that innovation may, in a long-run perspective, be a major factor driving structural change and industrial transformations. The sectoral composition of the economy should therefore be considered as an endogenous variable, given that innovative activities and results determine changes in the industrial composition of a nation. However, such a problem of endogeneity may be neglected in the present context, given that our analysis simply focuses on the static pattern in the period 2002-2004 rather than considering longer-term transformations.
References


Clausen, T. (2007): “Do subsidies have positive impacts upon R&D and innovation activities at the firm level?”, TIK Working Papers in Innovation Studies, Centre for Technology, Innovation and Culture, Oslo.


Appendix 1: List of industries in each sectoral group

**Advanced knowledge providers – Specialised suppliers manufacturing (AKP-M):**
Machinery and equipment; medical, precision and optical instruments

**Advanced knowledge providers – Knowledge intensive business services (AKP-S):**
Computer and related activities; research and development; other business activities

**Mass production goods – Science-based manufacturing (MPG-SB):**
Chemicals; office machinery and computers; electrical machinery and apparatus; radio, TV and communication equipment

**Mass production goods – Scale-intensive manufacturing (MPG-SI):**
Rubber and plastic products; other non-metallic mineral products; basic metals; fabricated metal products; motor vehicles; other transport equipment

**Personal goods and services – Supplier-dominated goods (PGS-M):**
Food and beverages; textiles; wearing; leather; wood and related; pulp and paper; printing and publishing; furniture; recycling

**Personal goods and services – Supplier-dominated services (PGS-S):**
Sale, maintainance and repair of motor vehicles; retail trade and repair of personal and household goods; hotels and restaurants

**Supporting Infrastructure services – Network infrastructure (SIS-N):**
Post and telecommunications; financial intermediation; insurance and pension funding; activities auxiliary to financial intermediation

**Supporting Infrastructure services – Physical infrastructure (SIS-P):**
Wholesale trade and commission trade; land, water and air transport; supporting and auxiliary transport activities
Appendix 2: Definition of the indicators

**OPPORT**: total innovation expenditures, share of total turnover

**CUMUL**: firms engaged continuously in R&D, share of innovative firms

**DISEMB**: R&D expenditures, share of total innovation costs

**TRAIN**: firms engaged in training activities, share of innovative firms

**SUPPLIERS**: firms considering their suppliers as a very important source of information for their technological activities, share of innovative firms

**USERS**: firms considering their clients as a very important source of information for their technological activities, share of innovative firms

**SCIENCE**: firms considering the Universities as a very important source of information for their technological activities, share of innovative firms

**COOP-OTHER**: Enterprises engaged in innovative activities within United States and other countries, share of innovative firms

**SELL-OTHER**: Enterprises selling their products to any other country outside the EU, share of innovative firms

**FUND**: Enterprises that received any public funding, share of innovative firms

**FUND-NAT**: Enterprises that received public funding from the central government, share of innovative firms

**FUND-EU**: Enterprises that received public funding from the European Union, share of innovative firms

**INNOV**: innovative firms, share of total population of firms

**MARKET**: firms introducing marketing innovations, share of total population of firms

**ORGAN**: firms introducing organisational innovations, share of total population of firms

**PATENT**: firms that have applied for at least one patent, share of innovative firms

**TURNNEW**: turnover of new products, share of total turnover

**LP**: labour productivity in constant prices and expressed as indices, reference year 2000 (source: OECD-STAN indicators)
Table 1: Technological opportunities (OPPORT) for the various categories of the new sectoral taxonomy in European countries – Source: CIS4 data (2002-2004)

<table>
<thead>
<tr>
<th></th>
<th>Advanced knowledge providers - Manufacturing</th>
<th>Advanced knowledge providers - Services</th>
<th>Mass production goods - Science-based</th>
<th>Mass production goods - Scale intensive</th>
<th>Supporting infrastructure services – Network</th>
<th>Supporting infrastructure services – Physical</th>
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<td>2.61</td>
<td>4.56</td>
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<td>5.27</td>
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Table 2: Efforts and expenditures in innovative activities

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<td>SIS-P</td>
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Legend. All numbers are percentages. For a definition of the indicators, see Appendix 2.
AKP-M: advanced knowledge providers – specialised suppliers manufacturing
AKP-S: advanced knowledge providers – knowledge intensive business services
MPG-SB: mass production goods – science-based manufacturing
MPG-SI: mass production goods – scale intensive manufacturing
PGS-M: personal goods and services – supplier-dominated manufacturing
SIS-N: supporting infrastructure services – network infrastructure
SIS-P: supporting infrastructure services – physical infrastructure
Table 3: Interactions and external sources of opportunities

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Legend. As for table 2.

Table 4: Internationalization and global technological activities

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<td>12,9</td>
<td>61,8</td>
<td>61,9</td>
</tr>
<tr>
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<td>46,0</td>
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<tr>
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<tr>
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<tr>
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<td>5,9</td>
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<tr>
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</table>

Legend. As for table 2.

Table 5: Policy support to innovation

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<tr>
<th>Sectoral groups</th>
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<th></th>
<th>FUND-NAT</th>
<th></th>
<th>FUND-EU</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Norway</td>
<td>EU</td>
<td>Norway</td>
<td>EU</td>
<td>Norway</td>
<td>EU</td>
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<td>AKP-M</td>
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<td>28,2</td>
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<td>8,7</td>
</tr>
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Legend. As for table 2.
Table 6: Innovativeness

<table>
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<tr>
<th>Sectoral groups</th>
<th>INNOV Norway</th>
<th>EU</th>
<th>MARKET Norway</th>
<th>EU</th>
<th>ORGAN Norway</th>
<th>EU</th>
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<td>32,2</td>
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<tr>
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<td>41,2</td>
<td>39,1</td>
</tr>
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<td>29,9</td>
<td>32,5</td>
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<td>MPG-SI</td>
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<td>49,3</td>
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<td>11,7</td>
<td>18,0</td>
<td>25,9</td>
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<tr>
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<td>19,5</td>
<td>23,1</td>
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<td>17,9</td>
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<td>23,6</td>
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Legend. As for table 2.

Table 7: Performance of innovation

<table>
<thead>
<tr>
<th>Sectoral groups</th>
<th>PATENT Norway</th>
<th>EU</th>
<th>TURNEW Norway</th>
<th>EU</th>
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<td>22,1</td>
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<tr>
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<td>15,1</td>
<td>15,8</td>
<td>14,4</td>
</tr>
<tr>
<td>MPG-SB</td>
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<td>25,6</td>
<td>29,5</td>
<td>14,6</td>
</tr>
<tr>
<td>MPG-SI</td>
<td>22,8</td>
<td>19,2</td>
<td>16,1</td>
<td>10,9</td>
</tr>
<tr>
<td>PGS-M</td>
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<td>28,3</td>
<td>10,3</td>
<td>11,0</td>
</tr>
<tr>
<td>SIS-N</td>
<td>31,3</td>
<td>26,7</td>
<td>17,6</td>
<td>9,7</td>
</tr>
<tr>
<td>SIS-P</td>
<td>19,7</td>
<td>18,6</td>
<td>5,6</td>
<td>8,3</td>
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</tbody>
</table>

Legend. As for table 2.
Table 8: Value added shares for the various categories of the new sectoral taxonomy in European countries (average 2000-2003) – Source: OECD-STAN database

<table>
<thead>
<tr>
<th>Sectoral groups</th>
<th>Austria</th>
<th>Belgium</th>
<th>Czech Republic</th>
<th>Denmark</th>
<th>Finland</th>
<th>France</th>
<th>Germany</th>
<th>Greece</th>
<th>Hungary</th>
<th>Netherlands</th>
<th>Norway</th>
<th>Poland</th>
<th>Portugal</th>
<th>Slovakia</th>
<th>Spain</th>
<th>Sweden</th>
<th>UK</th>
<th>EU average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced knowledge providers - Manufacturing -</td>
<td>2.85</td>
<td>1.40</td>
<td>2.55</td>
<td>2.90</td>
<td>3.15</td>
<td>1.90</td>
<td>4.20</td>
<td>0.45</td>
<td>2.00</td>
<td>1.50</td>
<td>1.10</td>
<td>1.90</td>
<td>0.55</td>
<td>1.50</td>
<td>1.40</td>
<td>3.30</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>Advanced knowledge providers - Services -</td>
<td>5.75</td>
<td>9.70</td>
<td>-</td>
<td>5.60</td>
<td>4.15</td>
<td>9.20</td>
<td>9.30</td>
<td>2.65</td>
<td>6.30</td>
<td>7.75</td>
<td>4.30</td>
<td>-</td>
<td>1.80</td>
<td>-</td>
<td>4.70</td>
<td>7.54</td>
<td>6.74</td>
<td>3.05</td>
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<tr>
<td>Mass production goods - Science-based -</td>
<td>3.30</td>
<td>5.10</td>
<td>1.75</td>
<td>3.10</td>
<td>6.85</td>
<td>3.60</td>
<td>4.60</td>
<td>1.00</td>
<td>6.20</td>
<td>3.15</td>
<td>0.60</td>
<td>2.50</td>
<td>1.80</td>
<td>1.80</td>
<td>2.60</td>
<td>3.24</td>
<td>6.20</td>
<td>3.24</td>
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<tr>
<td>Mass production goods - Scale intensive -</td>
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<td>6.15</td>
<td>3.30</td>
<td>3.65</td>
<td>5.00</td>
<td>6.20</td>
<td>7.90</td>
<td>3.00</td>
<td>7.10</td>
<td>6.05</td>
<td>3.30</td>
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<td>2.50</td>
<td>6.70</td>
<td>5.20</td>
<td>5.20</td>
<td>5.20</td>
</tr>
<tr>
<td>Supporting infrastructure services - Network</td>
<td>15.60</td>
<td>18.70</td>
<td>2.95</td>
<td>18.30</td>
<td>17.65</td>
<td>19.20</td>
<td>18.70</td>
<td>20.80</td>
<td>16.45</td>
<td>19.30</td>
<td>12.95</td>
<td>2.30</td>
<td>15.40</td>
<td>4.60</td>
<td>15.70</td>
<td>15.08</td>
<td>15.08</td>
<td>15.08</td>
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<tr>
<td>Supporting infrastructure services - Physical</td>
<td>5.20</td>
<td>4.20</td>
<td>-</td>
<td>5.80</td>
<td>7.25</td>
<td>4.15</td>
<td>3.60</td>
<td>-</td>
<td>4.80</td>
<td>5.05</td>
<td>6.75</td>
<td>-</td>
<td>3.80</td>
<td>-</td>
<td>5.60</td>
<td>5.12</td>
<td>5.12</td>
<td>5.12</td>
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<tr>
<td>Personal goods</td>
<td>5.75</td>
<td>5.00</td>
<td>7.20</td>
<td>5.10</td>
<td>8.25</td>
<td>4.90</td>
<td>4.70</td>
<td>5.70</td>
<td>6.70</td>
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<td>9.35</td>
<td>5.70</td>
<td>17.50</td>
<td>13.50</td>
<td>14.60</td>
</tr>
<tr>
<td>Personal services</td>
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<td>13.50</td>
<td>12.60</td>
<td>11.65</td>
<td>11.55</td>
<td>12.60</td>
<td>11.75</td>
<td>20.60</td>
<td>12.80</td>
<td>16.45</td>
<td>14.70</td>
<td>10.35</td>
<td>21.60</td>
<td>17.10</td>
<td>15.55</td>
<td>15.03</td>
<td>15.03</td>
<td>15.03</td>
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</table>

Table 9: Labour productivity (LP), comparing Norway to the EU average (average 2000-2003; source: OECD STAN Indicators)

<table>
<thead>
<tr>
<th>Sectoral groups</th>
<th>LP</th>
<th>Norway</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>AKP-M</td>
<td>87.4</td>
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</tr>
<tr>
<td>AKP-S</td>
<td>90.5</td>
<td>95.4</td>
<td></td>
</tr>
<tr>
<td>MPG-SB</td>
<td>310.1</td>
<td>133.7</td>
<td></td>
</tr>
<tr>
<td>MPG-SI</td>
<td>107.6</td>
<td>109.9</td>
<td></td>
</tr>
<tr>
<td>PGS-M</td>
<td>110.9</td>
<td>108.6</td>
<td></td>
</tr>
<tr>
<td>SIS-N</td>
<td>142.2</td>
<td>119.6</td>
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<tr>
<td>SIS-P</td>
<td>107.6</td>
<td>112.3</td>
<td></td>
</tr>
</tbody>
</table>

Legend. As for table 2.
Figure 1: A new taxonomy of sectoral patterns of innovation in manufacturing and service industries (source: Castellacci, 2007)
Figure 2: The cross-country distribution of technological opportunities – Boxplots for the various sectoral groups of the taxonomy.
Figure 3: The cross-country distribution of technological opportunities – Kernel density estimates for the high-opportunity sectoral groups of the taxonomy

- Mass production manufacturing - Science based
- Advanced knowledge providers - Services
- Supporting infrastructure services - Network
Figure 4: Results of cluster analysis – Dendogram from hierarchical cluster analysis (upper panel), and a stylised representation of the resulting clusters (lower panel).

Average linkage method - Absolute value distance

Dissimilarity measure

0 1 2 3 4

BG PT EE LT HU CZ RO SK FR NO IT GR SE DE NL PL ES

Cluster 1: FR, NO, IT
Cluster 2: GR, SE
Cluster 3: DE, NL
Cluster 4: PL, ES
Cluster 5: CZ, RO, SK
Cluster 6: BG, PT, EE, LT, HU

Advanced services
Science-based manufacturing

Service-based catching up
Cluster 4: PL, ES
Cluster 5: CZ, RO, SK

High opportunities in manufacturing and services
Cluster 1: FR, NO, IT
Cluster 2: GR, SE

No technological catching up
Cluster 6: BG, PT, EE, LT, HU

Science-based opportunities
Cluster 3: DE, NL
Figure 5: Technological opportunities and industrial structure in European high-tech industries

**Value added share**

- **Technological opportunities**
  - **High impact**: high opportunities in large industries
  - **Missing scale**: high opportunities in small sectors
- **Low impact**: low opportunities in small sectors

**Value added shares (standardized)**

**Technological opportunities (standardized)**

- **Missing innovation**: low opportunities in large industries
- **Low impact**: low opportunities in small sectors

- **High impact**: high opportunities in large industries
- **Missing scale**: high opportunities in small sectors

Key:
- MPG-SB
- AKP-S
- SIS-N
Figure 6: Expanding and contracting branches in the Norwegian economy – Dynamics of employment shares of GDP, 1970-2002

Manufacturing and business services

Other Branches

[Graph showing employment trends in different sectors from 1970 to 2002]