European Foundation for the Improvement of Living and Working Conditions

Knowledge society barometer

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Introduction

In recent years, new evidence and conclusions on the characteristics of innovation across the economy as a whole have given rise to new theories and new approaches to policy. The theoretical background for these studies is diverse; it includes literature, starting from traditional microeconomic theory, extending all the way to modern systemic theory of innovation.

These studies use differing units of analysis. Work undertaken in the field of sociology has analysed the impact of new technologies on social behaviours and the problems associated with social control of technology. A large number of historians of technology and researchers into technological change have put forward striking explanations for the causes determining intensification of the process of innovation in a given society. In these studies, the unit of analysis has been human society as a whole. Economic theory has concentrated on the effects of the process of innovation on growth and the economic nature of stimuli to innovate. The unit of analysis here is an economic system. Industrial economics has modelled relationships between the process of innovation and market structures, the unit of analysis being an entire industry.

This introduction briefly reviews three relevant approaches to innovation and innovation society. First, it discusses the role of innovation in traditional micro- and macroeconomic theories.

It then discusses the innovation studies approach. This perspective draws on the Schumpeterian concept of how competition takes place. Competition is preeminently a differentiating process, in which firms attempt to establish control over markets by developing new products and new processes. Firms seek competitive advantage, on the one hand, by continuous development of technologically differentiated products and, on the other, by changing processes in order to generate these products with competitive cost structures. This is in contradiction to the conditions of perfect competition in traditional micro- and macroeconomic theories and to firm behaviours which are conventionally presumed to follow from those conditions.

Lastly, the introduction presents some views on innovation and the innovative society from political and social science perspectives. It must be noted, however, that most of the academics in these fields have considered the information society literature to be a collection of intellectually rather loose popular writings without any real theoretical significance. These attitudes have gradually started to change, however. One of the most important turning points has been the publication of Manuel Castells's *Information Age* trilogy in 1996-1998, and the reception this work has received within the social scientific community.

Traditional micro- and macroeconomic theory

The basis of mainstream neo-classical economics is constituted by the production function approach. The firm is seen as a functional relationship between inputs and outputs of production. The questions posed are based on optimising the allocation of resources and the respective incentives of firm behaviour. Microeconomic theory has established the conditions under which an efficient allocation can be achieved. These conditions are to a great extent the same as those which underlie what economists call 'perfect competition' or 'competitive markets'. Macroeconomic growth models aim at explaining the constituents of economic growth and why the growth rates differ from one country to another.

With respect to innovation policy, the central concept in traditional microeconomic theory is that of market failure. A market failure is said to occur if markets fail to achieve the most efficient allocation of resources. In neo-classical models, the innovation is presented as an exogenous element. The flow of innovations has weighty economic consequences, as it determines the results obtained from production processes, but it is not seen as affected by them (Teece, 1988). In these models, technologies arising from the innovative activities are considered information-intensive goods (Arrow, 1962).

In accordance with these assumptions, firms cannot go beyond the technological limits established by their productive function, as these are determined exogenously, nor can they modify the attributes of the products they make, other than in respect of prices and quantities. Faced with technological changes, firms react instantly, since they are assumed to have perfect information about all existing technologies which can be acquired on the open market and assimilated, without need for a prior learning process.

The macroeconomic growth is historically determined by such factors as physical capital, labour and technical progress. In a neo-classical growth model by Solow (1956), technical progress is the most critical factor for the sustainable economic growth of a country. However, traditional neo-classical growth models cannot explain why the growth rates differ from one country to another, and why rich and poor countries may coexist in a world economy.

In recent years, a large literature on 'endogenous growth' models (e.g. Romer, 1986; Lucas, 1988; Rebelo, 1991) has explored the idea that investment in knowledge and learning can affect long-term growth rates. These endogenous growth models have tried to clarify the fundamental factors of the growth rate divergence. They describe the internal mechanism through which the technical progress is determined as an engine of economic growth. For example, it has been pointed out that the productivity of human resources in future periods depends on current assignments (Lucas, 1988, p.17). In this literature, investments in research and development (R&D) are always central to growth. However, the results are still ambiguous as to the effects that R&D subsidies have on growth.

Innovation studies

Since the early 1980s, the field of new industrial economics has moved away from the idea of perfect competition, invoking rather the structure-conduct-performance approach. This approach argues that, besides prices, other means of competition, e.g. marketing, R&D etc, play a role in determining firm behaviour. This is consistent with Schumpeter's concept of economic development in which the process of innovation occupies a central position.

As was outlined above, Schumpeter's concept sees competition as preeminently a differentiating process, in which firms attempt to establish control over markets by developing new products and new processes. Firms seek competitive advantage, on the one hand, by continuous development of technologically differentiated products and, on the other, by changing processes in order to generate these products with competitive cost structures. In their seminal study, Nelson and Winter (1982) show that this competitive innovation process generates a plausible explanation for economic growth.

Four particularly important and related developments can be selected with respect to innovation and technological development: 1) the idea that technological change is localised; 2) the notion that innovation at the level of the firm is the outcome of a cumulative process; 3) the different incidence of factors determining the appropriation of new technologies; and 4) a dramatic increase in value with each additional node or user, i.e. network externality.

The idea that technological change may be localised was put forward in a theoretical article by Atkinson and Stiglitz (1969). They contended that a localised 'bulge' in the neo-classical industrial production function may represent technological change better than simply a uniform shift of the whole frontier. The location of the bulge depends essentially on the point at which firms were producing initially, that is upon their prior technological choices.

A prominent feature of R&D is that it generates cumulative knowledge, so knowledge capabilities in the present may depend on past knowledge creation activities. This knowledge may be codified or tacit but, in either case, it raises a barrier against new activity. In a recent stream of research on the knowledge-based view of the firm, Cohen and Levinthal (1990) argue that the absorptive capacity – that is the ability of a firm to recognise the value of new, external information, and to assimilate and apply it – is critical to its innovative capabilities.

The third characteristic of innovation is that the knowledge incorporated in new technologies can, to varying degrees, be appropriated by the innovating enterprise. Appropriation of technological knowledge is essential to the innovative process, since it allows a temporary preemption of imitation and hence quasi-monopolistic rents.

In high-technology, the level of interdependence between technologies is increasing. When a technology is adopted by firms and end-users, the value of complementary technologies increases also, influencing the adoption decision of other users (Katz and Shapiro, 1994; Arthur, 1996). This results in the competition of different technological options and standards, and their diffusion through the population is affected by the installed base and the rate of adoption (Baptista, 2001). In the aforementioned case, the good is said to exhibit network externalities, that is, the larger the number of people using a similar good, the higher the value of the good is to an individual.

The main proposition put forward by the systemic innovation theory is that the environment in which economic agents act has a major influence on the agents. Such systemic effects rise when it is realised that individual agents do not merely respond and adapt to the environment individually, but interact in complex ways and create an environment in which they are immersed.

The chain-linked model of Kline and Rosenberg (1986) accounts for the origin of innovations as the coupling between science, technology and demand in the marketplace. The model emphasises that innovations involve various links and feedbacks between different functions as opposed to the traditional linear model. This highlighted the importance of learning in various forms, and it was recognised that innovation requires more than just technological development. Inputs to the innovative process include learning from market needs, from users, and from different functions in the company. Recent surveys have shown that, among the population of collaborating firms, the mean period of collaboration is in excess of 10 years, which suggests persistent relations that are independent of market fluctuations. Even firms in low-technology industries interact in innovation, and do so with universities and technological research institutes (Basri, 2001).

Very narrowly defined, a system of innovation consists of the organisations and their relationships that deliberately promote the accumulation of knowledge in society, such as universities, research institutions and corporate R&D departments. A wider perspective recognises that these organisations are influenced by a much larger socio-economic system, in which political and cultural factors and economic policies partially determine the success of innovative activities (Freeman, 2002). Thus, a broad perspective on systems of innovation would also include those organisations with a supporting function, such as patent offices, venture capital firms and government agencies. Moreover, the organisations and their relationships are influenced by the technology base, such as the skills, artefacts and knowledge base that are characteristic for the system, as well as institutions such as laws, regulations and norms that comprise the set of rules with which they interact. There can be industrial and technological specialisation, which are usually quite specific to particular countries and rest on historical trajectories of development. These usually take the form of clusters of related activities, which are in turn associated with industrial specialisation and educational provision.

Concepts: information / knowledge / knowledge-value society

Specific to the information society is the central position information technology holds in terms of production and economy. The information society is seen as the successor to the industrial society. The term was introduced in the early 1970s by Yojeni Masuda. However, similar concepts had already been discussed in the 1950s and 1960s. For example, Harvard University's Daniel Bell was the first person to put forward the concept of a 'post-industrial society' in 1959. In 1979, he renamed it the 'information society'. Behind Bell's contribution was the discovery that, between 1909 and 1949, in growth rates among the non-agricultural sector, skills contributed 87.5% towards growth, while labour and capital contributed a mere 12.5%.

The term information society is a translation of the Japanese *joko shakai*. In 1980, Masuda published a book *The information society as post-industrial society*. There he refers to information society as the highest stage of societal evolution, seen in analogy to biological evolution.

In the early 1990s, the Institute of Information Studies, made up of the Aspen Institute and other agencies in the US, published an almanac for 1993-94. Its main title was *The knowledge-based economy: the nature of the information age in the 21st century*. The United Nations endorsed the term immediately afterwards, and gave it a clearer definition in 1996. It defines a knowledge-based economy as an economy whose most important elements are the possession, control, production and utility of knowledge and intellectual resources.

The knowledge society produces commodities of high knowledge values. These values bear properties of high technique, art and skill, which increase the value of products and services many times compared with their production costs. Many customers are able to use them at the same time in distant places and they are not worn out. In the knowledge society, there is no principle of par value exchange. The value of knowledge has no direct relation with the production cost. The prices of products are based on markets, tastes or preferences of customers.

The term 'knowledge-value society' was introduced by Taichi Sakaiya in a book he wrote in 1985. The term was defined as 'a society where the value of knowledge is the primary source of economic growth and corporate profits'.

The Japanese nation had devoted all its energies to becoming an industrialised society, based on the mass production of standardised goods. The educational system was built up to foster highly patient and cooperative people with less originality and creativity, perfectly suited for working in standardised mass-production industries. The media and other information sources were centralised in Tokyo, and products manufactured to the same standards spread throughout the nation under the dispatch of identical information. As a result of this process, however, the knowledge value revolution in Japan was delayed. This was because the nation had meticulously developed a government administrative organisation, industrial structure, financial system, employment practices, educational system, and information environment that were appropriate for a standardised mass production society (Sakaiya, 2000).

In the knowledge-value society, creative labour is a major factor. The economy includes mainly intellectual enterprises, high-tech parks in which the entrepreneur is also the scientist. The society is characterised by a positively synergistic interaction of information, knowledge and effect. Leading companies develop holistic models of corporate cultures built upon shifting duties, team structures, and high levels of expedient personnel turnovers. Traditional efforts to manage workers shift to managing relationships with increasingly demanding customers. The unit of analysis for innovation is neither a product nor a technology, but a business concept (Hamel, 2000). Business concept innovation, not only the technology that enables it, is the key to creating new wealth.

New technological advances have diminished transportation, telecommunications and computational costs, increasing the ease of global flows of information. Globalisation is expanding the movement of goods, services, capital investment (portfolio and direct), people, ideas and the diffusion of technology itself. In a globalised world, successful firms, regardless of size, will be those that can tap into a global network and meet global production standards. Many analysts felt that location would become irrelevant in a world of global input-factor arbitrage. Global networks enable industries to source labour, materials and supplies more efficiently while minimising cost. The knowledge-value society takes shape in the context of globalisation, always encountering stiff competition. However, global cooperation will bring efficiency and mutual benefits.

Knowledge-value society is characterised by the emergence of virtual realities to complement empirical realities. In his *Information Age* (1996-1998) trilogy, Manuel Castells made the first effort to grasp systematically the essential features of this fundamental societal transformation. Castells's initial focus was on the development of a new urban sociology, with particular emphasis on the role social movements played in the transformation of the urban landscape across the world.

Knowledge society barometer framework

Methodology

There is a reference group of eight countries: Denmark, Finland, Germany, Japan, the Netherlands, Sweden, the United Kingdom and the US. The following discussion presents 12 measures towards which an innovative society can strive. The 12 measures consist of a large number of indicators. These indicators and the rationale behind them are discussed in the subsequent sections. They are also listed in the Annex.

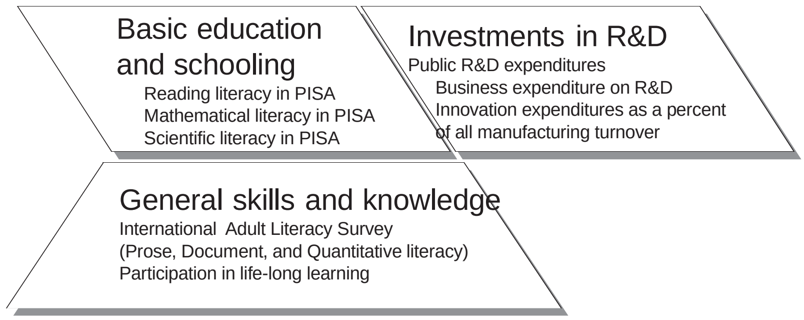
By comparing the performances of the nations for each indicator and aggregating the results, it is possible to arrive at an achievement index for each nation for each of the 12 measures. To calculate these indices, the data are standardised. That is, an average performance within the indicator results in the value of zero and only a very good or a very bad performance results in values of over one or less than minus one. The measures can then be aggregated to see how well each nation does with respect to the information society, knowledge society, knowledge-value society and sustainable development measures. These four themes of the technology barometer are presented in Figure 1.

Figure 1: *Four themes of the technology barometer*

Information society

There is currently no universally accepted concept of what exactly can be termed information society. Most theoreticians agree that a transformation began somewhere between the 1970s and today, and is changing fundamentally the way societies work. Here the focus is on the investments in human and intellectual capital. The level of basic education and schooling are measured, alongside the skills and knowledge of the general public, and both private and public investments in research and development. These are presented in Figure 2.

Figure 2: *Information society measures*



Living and working in an increasingly knowledge-driven economy puts human resources at the forefront of policy debate. In order for a country to maintain its competitive base, to provide quality of life to its citizens, and to create employment opportunities and employable workers, the skills of its workforce require continuous upgrading and are quintessential to the country's economic performance. The measure of persons' capabilities is made of two components. The first evaluates the level of basic education and schooling, and the second measures the skills and competencies of the general public.

Basic education and schooling

The level of basic education and schooling is evaluated by the OECD's Programme for International Student Assessment (PISA). PISA is a collaborative effort among the member countries of the OECD to measure how well young adults, at age 15 and approaching the end of compulsory schooling, are prepared to meet the challenges of today's knowledge societies. PISA measures reading, mathematical and scientific literacy on continuous scales. In PISA scores, Japan leads, together with Finland, while Germany falls behind.

General skills and knowledge

General skills and knowledge is measured by four indices: three literacy skills from the International Adult Literacy Survey (IALS) and participation in life-long learning. Sweden is the leader within this indicator, while the US and the UK fall behind.

- IALS has shown that, instead of enlarging the pool of highly-skilled workers, the tendency is to increase the skills of the already skilled. The reserve employment pool, made up of unemployed people and those currently working in declining industrial sectors, is low skilled. Policies directed towards providing more educational opportunities and increasing skills in that pool must be a necessary part of any industrial growth strategy.
- Similarly, individuals need to continually learn new ideas and skills or to participate in life-long learning. All types of learning are valuable, since it prepares people for learning to learn. The ability to learn can then be applied to new tasks, with social or economic benefits.

Investments in R&D

Investments in R&D are at the very centre of a knowledge-based economy. Its dynamics and competitiveness depend primarily on the production, distribution and exploitation of knowledge and information.

The R&D expenditure of various actors (public, business) measures the efforts devoted to the production and use of knowledge that takes place in the context of research activities. Innovation expenditure includes the full range of innovation activities: in-house R&D, extramural R&D, machinery and equipment linked to product and process innovation, spending to acquire patents and licences, industrial design, training and the marketing of innovations. Overall, the indicator measures total expenditure on many different activities relevant to innovation.

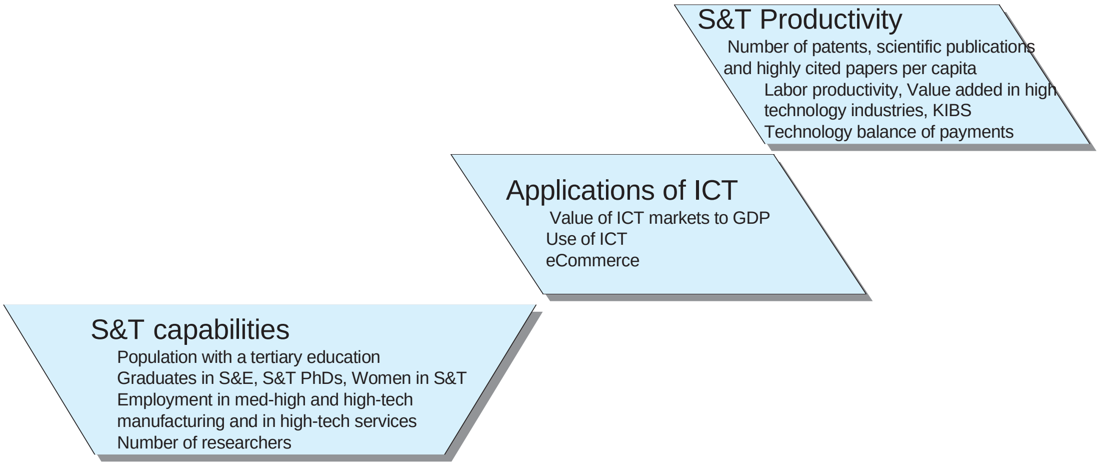
R&D expenditure is only an input factor. It gives no information about the efficiency of producing knowledge outputs, which is determined by the efficiency of the innovation system (research infrastructure, cooperation, interactions, capability to absorb external technology etc). In R&D expenditure, Sweden leads, together with Finland, while the UK falls behind.

Knowledge society

The knowledge society is an economy directed by knowledge, and where the generation and utilisation of knowledge play an outstanding role in the process of producing wealth. The knowledge society develops on the foundation of achievements of science and technology. The rapid development of computers and telecommunications networks boosts information expansion. This enhances knowledge values and thus rapidly develops the global economy. Intellectual property, including patents, brands, advertisements, services and consultancy, plays a significant role.

The knowledge society measures used here assess the preparation of the human and intellectual capital investments towards science and technology, the use of information and communications technologies, and outcomes of these investments. These are presented in Figure 3.

Figure 3: *Knowledge society measures*



S&T capabilities

Science and technology capabilities are an important component of competitiveness. This section looks at whether conditions external to the enterprises are more or less favourable to the production of new knowledge. The measure consists of a number of indicators. Finland leads together with Sweden. Surprisingly, the Netherlands falls behind.

- A population with tertiary education is a general indicator of the supply of advanced skills. Such education is not limited to science and technical fields because the adoption of innovations in many areas, particularly in the service sectors, depends on a wide range of skills.
- The number of new graduates in science and engineering is an indicator of the capacity to produce and of the availability to the enterprise sector of the skills most necessary to produce, to absorb and to use new technology.

- New PhD graduates in science and technology represent the highly qualified output of the education system in disciplines that will be of crucial importance for industry in this new economy.
- The participation of women in the production of knowledge is an important indicator of the extent to which the full potential of human resources is being used in a society.
- The percentage of total employment in medium-high and high technology manufacturing sectors is an indicator of economic activity in manufacturing sectors which are characterised by high levels of innovative activity.
- The high technology services provide services directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy. High tech services, when properly used, can increase productivity in many economic sectors and support the diffusion of a range of innovations, particularly those based on ICT. Overall, only a small percentage of total employment is directly in high tech services.
- The number of research scientists and engineers reflects the current use of human resources in R&D occupations. Research workers are responsible both for producing knowledge and for exploiting it. It is through research workers that firms can appropriate knowledge and use it to produce innovative new products. Moreover, researchers are a key source of new ideas and a crucial channel for learning within the company. They also become an important vector for the transfer of knowledge when they cooperate with other researchers in different institutions/countries, and when they change professions or move from one sector to another. In the public sector, such workers play a vital role in the generation and transmission of basic research.

Applications of ICT

Information and communication technologies (ICT) currently constitute one of the prime focuses of R&D in industrialised nations. Close to 30% of all R&D budgets, both public and private, are devoted to such technologies. The level of spending, however, varies considerably from one country to another: the US and Japan have a sizeable lead over European countries, whose R&D budgets, although disparate, remain limited overall (Pouillot and Puissochet, 2002).

Three indicators are used for measuring the extent to which IC technologies are applied in a nation. These three indicators combine a number of sub-indicators, especially the use of ICT, which consists of 10 sub-indicators. In this measure, Denmark leads, while Japan falls behind.

- The total volume of ICT markets in the various countries, calibrated by GDP, gives a measure of ICT penetration in the economy and, indirectly, of progress towards the knowledge-based economy.
- In order to evaluate the use of ICT in a nation, a large number of sub-indicators were used. These sub-indicators are presented in Table 1. The Nordic countries are the leaders while Japan falls behind.
- The indicator for eCommerce comprises four sub-indicators: 1) Internet users who have purchased online; 2) percentage of companies selling online; 3) percentage of companies buying online; and 4) number of secure servers.

Table 1: *Indicators measuring the use of ICT*

	Index	Home Internet access	Internet use in the population	Cellular phone subscribers	Internet in schools	Workers who use computers for work
Finland	**0.46**	0.15	0.19	1.10	0.29	0.28
Sweden	**0.21**	1.01	0.67	0.96	0.16	0.88
Denmark	**0.71**	1.10	1.15	0.62	1.78	1.18
Netherlands	**-0.16**	1.10	0.35	0.35	-0.79	-0.03
Germany	**-0.41**	-0.71	-1.58	-0.40	-0.92	-1.38
UK	**-0.57**	-0.62	-0.77	0.21	-0.52	-0.93
USA	**0.05**	-0.45	n/a	-1.63	n/a	n/a
Japan	**-1.39**	-1.57	n/a	-1.22	n/a	n/a

Table 1: (cont.)

	Internet dial-up access costs (residential)	Internet dial-up access costs (business)	ADSL prices	Home ADSL access	Availability of government services online
Finland	1.66	0.62	-0.23	-0.59	1.14
Sweden	-0.90	-1.34	-0.02	0.00	0.71
Denmark	-0.43	-0.02	0.67	0.48	0.63
Netherlands	-1.13	-1.34	0.19	1.07	-1.34
Germany	-0.20	0.25	1.16	0.71	-1.00
UK	0.03	0.51	-1.76	-1.66	-0.14
US	0.96	1.31	n/a	n/a	n/a
Japan	n/a	n/a	n/a	n/a	n/a

S&T productivity

The process of commercialisation and increasing competitiveness is reflected in emerging new activities and new products for the domestic and export markets. This induces restructuring of existing activities through strong structural change towards high tech and knowledge intensive activities, and through the modernisation of the old economy by diffusion of new technologies. Competencies to commercialise the knowledge and complementary assets to knowledge are also required for competitiveness in the knowledge-based economy.

Although measuring the productivity of the workforce in science and technology is a difficult task, several indicators have been developed. In this indicator, the US and Sweden are the leaders while Japan, Denmark and the UK fall behind.

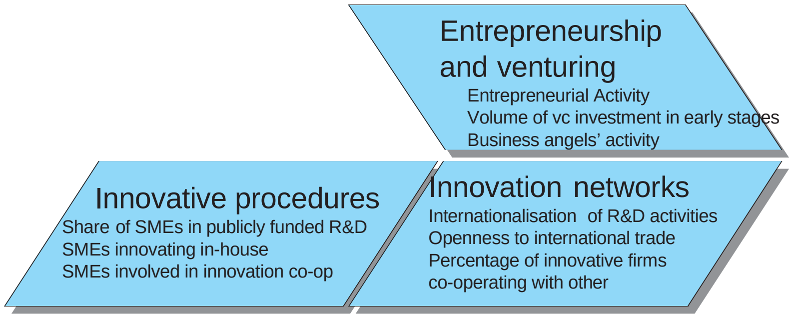
- An application for a patent indicates that there has been a production of new knowledge linked to an invention, and more importantly that this knowledge may have potential economic returns. For a country, patenting therefore reflects part of its inventive activity, and its capacity to exploit knowledge and translate this into potential economic gains.
- The number of scientific publications indicator is very often used as a sign of the research capacity and growing knowledge pool of a country, or of a specific research community etc. Whereas numbers of publications only tell us about quantity, quality is more closely associated with the indicator relating to citation counts.
- Labour productivity is an indicator that measures the added value created by one unit of labour. It is associated with the relative share of activities in high and low productivity sectors. However, it also depends upon the capacity to absorb new technology, and in particular upon the availability of highly qualified workers who are able to exploit the benefits of technological progress.

- Value-added is the best measure of manufacturing output, whereas other indicators such as total production can be biased by ‘screwdriver’ plants with little value-added. Within Europe, Ireland, Sweden, Finland and the UK have the highest share of high technology value-added. The results for Finland and Sweden are due to the explosion of the ICT sector in these two countries, while the UK benefits from aerospace and pharmaceuticals.
- The percentage of high- and medium high-tech industries indicates the strength of an economy in R&D intensive activities and the strength in transforming scientific and technological knowledge into economic activity. They are associated with intensive R&D and the creation of knowledge and new products.
- The share of knowledge intensive services in total economic output indicates the relative importance of knowledge intensive activities and structural change towards a knowledge-based economy. Knowledge intensive services require highly skilled personnel and cover a broad range of activities. Some of these activities provide research services to manufacturing firms and also to other services.
- Technology balance of payments indicator measures the importance of a country’s receipts from exporting technical knowledge and services (including licences, know-how, trademarks, technical services, etc). It indicates a country’s competitive position in the international market for knowledge. The use of this balance of payments data here, in the context of competitiveness, is intended to measure a country’s capacity to sell its intangible knowledge outputs.
- New to market products are a direct output measure of innovation that is not distorted by market speculation. The product must be new to the firm, which in many cases will also include innovations that are world-firsts.

Knowledge-value society

The measure for a knowledge-value society focuses on entrepreneurship and venturing, innovation networking, and adaptations of innovative practices. These are presented in Figure 4.

Figure 4: *Knowledge-value society measures*



Innovation procedures

It can be argued that all large firms innovate. Moreover, multinational corporations tend to operate in more or less the same fashion in all the countries where they have activities. Therefore, when measuring the adaptation of innovative procedures in a country, the focus was on the activities of small and medium-sized companies. In Europe, these are enterprises which have fewer than 250 employees; have either an annual turnover not exceeding ECU 40 million, or an annual balance-sheet total not exceeding ECU 27 million; and which conform to the criterion of independence. The Japanese definition for SMEs concerns companies with fewer than 300 employees. Denmark is the leader in SMEs’ innovative activities, while the UK falls behind.

- The first indicator considers the relative importance of SMEs in executing publicly funded R&D. Supporting SMEs in their research and development activities has become an important policy objective over recent years, and SMEs appear to provide a fertile breeding ground for new ideas and innovative ways. However, their activities can be hampered by lack of resources, and by the relatively high information and administrative costs of participating in research programmes.
- The second indicator focuses on SMEs with in-house innovative activities that either develop product or process innovations themselves or in combination with other firms.
- Complex innovations, particularly in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate in the development of an innovation. The third indicator is the percentage of all manufacturing SMEs (including non-innovators) that had any cooperation agreements on innovation activities with other independent enterprises or institutions. This indicator is a proxy for the existence of knowledge transfer between public research institutions and firms, and between firms and other firms.

Entrepreneurship and venturing

Today employment growth stems from fast-growing small and new firms. In the Netherlands between 1994 and 1998, 60% of new jobs in existing businesses came from just 8% of fast-growing firms. Similarly, in the US some 350,000 firms created two-thirds of the jobs between 1993 and 1996. Entrepreneurship not only delivers jobs. It also stimulates the economy and binds society in weaker regions. It raises productivity and competitiveness, and lowers prices to the consumer.

The variation in entrepreneurial attitudes can be followed through to the point where in the US many of the largest companies today are very young, while in Europe all of the biggest companies in 1998 were already large in 1960. This can be seen in the measure of entrepreneurship and venturing, where the USA is the leader together with the Netherlands. Germany and Japan fall behind.

- The Global Entrepreneurship Monitor (GEM) is a global initiative that explores relationships between entrepreneurship and economic growth. GEM produces globally comparable data on the entrepreneurial potential of countries, thereby providing reference material for economic policymakers interested in entrepreneurship.

The capital market functions imperfectly in financing new, high tech and knowledge intensive activities that are risky and uncertain. This weakness requires that new sources of finance and adequate institutional frameworks are created for financing new, high risk and promising opportunities.

- The economic function of seed and start-up venture capital funding is to provide financing to high risk, promising new high tech and knowledge intensive companies. Although small in relative terms, the volume of venture capital in early stages plays a strategic role in financing innovations and, thus, in supporting structural change towards a knowledge-based economy. In particular, venture capital companies provide not only equity capital, but also managerial skills and competencies that are critical for the success of firms at the early stages of their life cycle.
- The business angels' activity indicator measures the total number of deals done by business angel networks. Business angels are private informal investors who fund projects that are generally too small for venture capital institutions. They often play a mentoring role. Organised networks offer investors the possibility to exchange information and to spread risks.

Innovation networks

Innovation networks and the internationalisation of R&D are linked to strategic issues in the development of a dynamic system of knowledge production and absorption. Globalisation is reflected in the relative importance of foreign sources in the financing of business sector R&D. Crucially, countries can try to attract foreign financing of R&D through their attractiveness as locations of high-tech foreign direct investments (FDIs) with sophisticated R&D activities that potentially create international knowledge spillovers. Differences in economic and institutional structures and, in particular, in the openness of the innovation system influence the structure of financial sources for business sector knowledge investment. Consequently, in some countries, business R&D financed by foreign sources is significant, whereas in others its role is of lesser importance. The Netherlands is a clear leader in this innovation networks measure, while Japan falls behind.

- UNCTAD's inward foreign direct investment (FDI) performance index ranks countries by the FDI they receive relative to their economic size, calculated as the ratio of the country's share in global FDI inflows to its share in global GDP.
- Sources of funds are also available that are external to a transnational corporation (TNC), raised by foreign affiliates in host countries and international capital markets. The expenditure on establishing, acquiring or expanding international production facilities is therefore higher in value than the amount normally captured by FDI flows. The capital base of international production, regardless of how it is financed, is reflected in the value of assets of foreign affiliates.
- The internationalisation of business sector R&D activities is reflected in the increased role of foreign investment in knowledge creation, and also offers the potential for international knowledge spillovers. A first indicator of the extent of any foreign contribution to domestic investment in knowledge is the share of foreign R&D expenditure in a country. The European Commission's structural indicator 'Percentage of GERD (gross domestic expenditure on R&D) financed from abroad' relates foreign R&D investment to domestic R&D investments. It follows that a country benefits if it has a low R&D expenditure ratio. This analysis relates foreign R&D investments to the country's GDP.

Increasing levels of trade and investment are only possible because of the substantial progress made in recent years in opening economies to international competition. Recent research suggests that the value of market openness in terms of fostering innovation and stimulating improvements in competitiveness is vital. Innovation relies on the combination of different sources of knowledge and expertise. Some of this may be external to the firm, and can be acquired through cooperation with other firms, as well as through the exploitation of public research through universities/public research institutes. Such cooperation can help to accelerate the generation of new ideas and their diffusion.

- Market openness creates an opportunity for consumers to be exposed to new products and technologies which would not be available in the absence of international competition (Romer, 1994). More open economies are able to absorb and benefit more rapidly from R&D activities elsewhere (Helpman, 1997). Openness to international competition heightens competitive pressure on domestic clusters, pushing domestic competitors to compete on the basis of innovation or be displaced by imitative lower-cost substitutes from abroad (Porter, 1990 and 1998).
- Innovation cooperation can have important effects on science and technology productivity in firms, through sharing (and thus reducing) the costs of R&D, while at the same time improving the quality of new products and shortening product life cycles.

Sustainable development

By sustainable development is understood the development that meets the needs of the present without compromising the ability of future generations to meet their own need (Brundtland Commission, 1987).

Sustainable development offers a positive long-term vision of a society that is more prosperous and more just, and which promises a cleaner, safer, healthier environment. Achieving this in practice requires that economic growth supports social progress and respects the environment, that social policy underpins economic performance, and that environmental policy is cost-effective. Decoupling environmental degradation and resource consumption from economic and social development requires a major reorientation of public and private investment towards new, environmentally friendly technologies. The sustainable development strategy should be a catalyst for policymakers and public opinion in the coming years and become a driving force for institutional reform, and for changes in corporate and consumer behaviour. Clear, stable, long-term objectives will shape expectations and create the conditions in which businesses have the confidence to invest in innovative solutions, and to create new, high-quality jobs.

This study uses three broad measures to evaluate the sustainability of the development in a nation. These measures focus on societal values, environmental responsibility and environmental systems. The sustainable development measures are presented in Figure 5.

Figure 5: *Sustainable development measures*

Societal values

Due to the limitations in data, this evaluation of societal values is restricted to the EU Member States in the sample. The societal values measure is based on the report *Social situation in the European Union 2002*. National results in the four societal value indicators are summarised in Table 2. Each indicator comprises a number of sub-indicators. Within this group of countries, Sweden is the leader, while the UK falls behind.

Table 2: *Scores in societal values*

	Index	Life and health expectancies	Social protection expenditure	Employment	Equality by gender
Finland	**-0.26**	-0.81	0.56	-0.81	0.03
Sweden	**0.77**	1.61	0.32	0.24	0.89
Denmark	**0.31**	-0.54	0.61	0.15	1.01
Netherlands	**0.16**	0.26	0.46	0.20	-0.26
Germany	**-0.34**	0.54	-0.44	-0.98	-0.47
UK	**-0.65**	-0.25	-1.51	0.37	-1.19

Environmental responsibility

The environmental responsibility is evaluated by three indicators. In this measure, Sweden is a clear leader while the US falls behind. Measures of private sector responsiveness are included, as private sector activity has a major influence on the environment and on the ability to manage environmental challenges effectively. Additionally, the degree to which the private sector is usefully responding to the challenges of environmental sustainability varies from country to country.

- The indicator number of ISO14001 certified companies permits quantitative measures of private sector responsiveness to environmental challenges for each country.

Appreciation of the severity of the climate change problem has steadily increased over the past 20 years. The consensus that has emerged both scientifically and politically guarantees that this issue will be central well into the future.

- Two sub-indicators dealing with emissions of carbon dioxide are calculated: economic carbon efficiency is the amount of CO_2 emitted per unit of GDP; and lifestyle carbon efficiency is the amount of CO_2 emitted per capita.
- Countries vary considerably in how efficiently they use natural resources in order to produce the goods and services consumed locally or for export. The eco-efficiency indicator measures the amount of energy consumed per unit of GDP, and the degree to which an economy relies upon renewable sources of energy. For the energy sector, these are robust measures with reliable data and good country coverage. They are widely used in indicator efforts.

Environmental systems

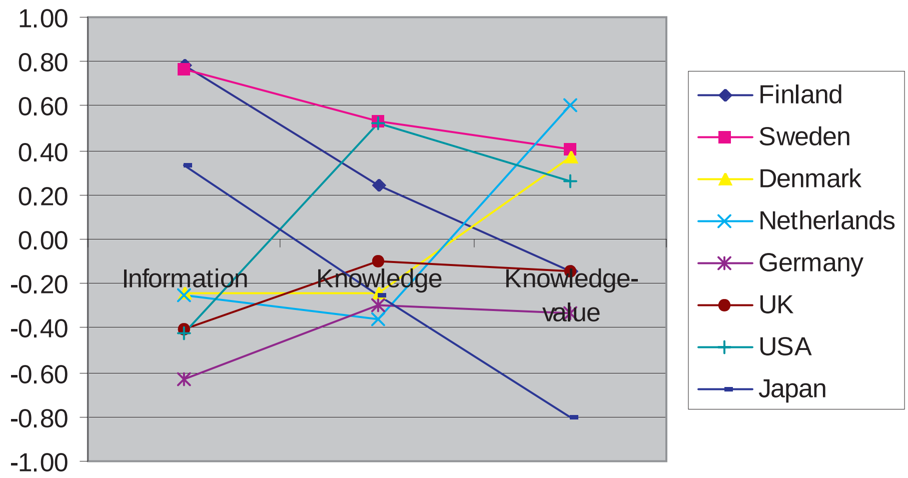
The environmental systems component represents the current status of a nation's biophysical environment. This component comprised three indicators: air quality, water quality and biodiversity. This grouping of indicators draws on relatively standard datasets. It is similar to other indicator efforts, including the Ecosystem Well-being Index and the Commission on Sustainable Development's indicator set. Here, Finland and Sweden are the leaders while Japan falls behind.

- Ambient air quality is a critical factor in determining the condition of an environmental system. The air quality indicator incorporates measures of urban air quality using four concentration variables: sulphur dioxide (SO_2), nitrogen dioxide (NO_2), non-methane volatile organic compounds (VOCs) and total suspended particulates (TSP). The European Commission and US local and federal agencies use the same indicators.
- Water is vital to a whole range of environmental processes, and plays a crucial role in agriculture and industrial processes. The manner in which a country manages its water resources is arguably the single most important indicator of its environmental sustainability. This indicator addresses the ability of a nation to minimise threats to water quality, including intensive use of agricultural fertilisers and pesticides, industrial waste, and sewage pollution. Four variables are included: fertiliser consumption per hectare of arable land, pesticide use per hectare of cropland, industrial organic pollutants per available freshwater, and phosphorus concentration.
- The biodiversity indicator is composed of two variables describing the number of known species that are endangered or threatened in two categories of species for which data are available. The variables used - percentage of known mammals threatened and percentage of breeding birds threatened - are reasonable proxies for species more generally.

From information society towards knowledge-value society

It is now possible to compare the performance of the sample countries in the study in terms of information society, knowledge society, knowledge-value society and sustainable development measures. An overview can be seen in Figure 6.

Figure 6: *Sample countries' performance on information society, knowledge society and knowledge-value society measures*



Sweden is ahead in all measures. Finland and Japan lead in the information society measures but then lose their dominance, Japan falling quite steeply. Germany and the United Kingdom show poor performance. The Netherlands, Denmark and the US fall behind in the information society measures but improve their performance moving towards the knowledge-value society measure. It is worth noting that these eight countries have among the highest GDP per capita (on purchasing power parity basis) and the lowest unemployment.

The information society measure consists of three components. These components first evaluate the level of basic education and schooling and the skills and competencies of the general public, and then focus on investments in science and technology. Finland and Sweden lead in investing in human resources while Germany falls behind.

Table 3: *Information society measures*

	Index	Basic education and schooling	General skills and knowledge	Investment in R&D
Finland	**0.78**	1.08	0.25	1.01
Sweden	**0.77**	-0.10	1.37	1.03
Denmark	**-0.24**	-0.74	0.38	-0.36
Netherlands	**-0.25**	n/a	-0.01	-0.49
Germany	**-0.63**	-1.22	-0.57	-0.09
UK	**-0.41**	0.53	-0.76	-1.00
USA	**-0.42**	-0.69	-0.89	0.32
Japan	**0.33**	1.13	n/a	-0.46

A country’s development towards a knowledge society is based here on three measures: pool of human resources in science and technology, applications of IC technologies, and the impact which R&D has on national economic competitiveness and employment. The results are presented in Table 4. Here, Sweden and the US lead, while the Netherlands falls behind.

Table 4: *Knowledge society measures*

	Index	S&T capabilities	Applications of ICT	Impact of R&D
Finland	**0.24**	0.95	-0.32	0.09
Sweden	**0.53**	0.58	0.54	0.47
Denmark	**-0.25**	-0.35	0.01	-0.41
Netherlands	**-0.36**	-1.05	-0.25	0.22
Germany	**-0.29**	-0.37	-0.50	-0.02
UK	**-0.10**	-0.01	0.13	-0.41
USA	**0.52**	0.26	0.75	0.56
Japan	**-0.26**	-0.05	-0.30	-0.42

The three measures to evaluate the knowledge-value features of a society include the adaptation of innovative procedures, level of entrepreneurship and venturing, and the role which innovation networks play in the society. The results are presented in Table 5. Here, the Netherlands leads, followed by Sweden, while Japan falls behind.

Table 5: *Scores on knowledge-value society measures*

	Index	Adaptation of innovative procedures	Entrepreneurship and venturing	Innovation networks
Finland	**-0.14**	-0.03	0.04	-0.43
Sweden	**0.41**	0.27	0.55	0.41
Denmark	**0.37**	1.29	-0.13	-0.05
Netherlands	**0.60**	-0.07	0.83	1.04
Germany	**-0.33**	-0.13	-0.69	-0.17
UK	**-0.15**	-0.72	-0.23	0.51
USA	**0.26**	n/a	0.81	-0.29
Japan	**-0.80**	n/a	-0.67	-0.93

Sustainable development

In order to evaluate a nation’s performance with respect to sustainable development, measures were used in line with the vision of a society that is more prosperous and more just, and which promises a cleaner, safer, healthier environment. Sweden is the leader, while the US falls behind.

Table 6: *Scores in sustainable development*

	Index	Societal values	Environmental responsibility	Environmental systems
Finland	**0.24**	-0.26	0.09	0.89
Sweden	**0.94**	0.77	1.31	0.74
Denmark	**0.32**	0.31	0.48	0.19
Netherlands	**-0.22**	0.16	-0.37	-0.45
Germany	**-0.19**	-0.34	-0.20	-0.04
UK	**-0.45**	-0.65	-0.12	-0.58
USA	**-0.62**	n/a	-1.30	0.05
Japan	**-0.36**	n/a	0.12	-0.83

One wonders whether Sweden pays a price for its substantial sustainability measure in its GDP per capita result. Swedish investments in knowledge capital would be expected to translate into high technology exports and, hopefully, rapid economic growth for a highly export-dependent economy. However, while R&D investments have soared, Swedish exports have remained specialised to a large extent in medium and low technology products; and Sweden has moved from being one of the richest countries in the world, in terms of GDP per capita, to a position below the OECD average.

There may be a low transformation pressure in the Swedish economy. A large share of service production is performed by the public sector in Sweden, which accounts for 30% of total employment. To some extent, this may mean that the contribution of this production to GDP is underestimated, but at the same time this large public sector lacks important incentives for increasing productivity, as it is not exposed to competition. The same problem applies to parts of the private sector, which are characterised by strong regulation and weak competition.

Both the rate of formation of new high-technology firms and growth rate of such firms is low in Sweden (Rickne and Jacobsson, 1999). None of the 50 largest Swedish corporations has been founded after 1970, and more than 60% were founded before the First World War. Several explanations for this lack of entrepreneurship have been mentioned (see Johansson, 2002): the tax system strongly favours institutional ownership of firms, while both individual owners, business angels, venture capital and stock options are punished by double or triple taxation. In addition, unemployment benefits are strongly tied to seniority in permanent employment. Labour market legislation tends to increase the transaction costs involved in hiring staff, which puts a special burden on new and expanding firms. A very flat wage structure has lowered the wage premium on education – the share of young persons going into tertiary education has decreased – while high taxation tends to lower the utilisation of the educated workforce.

Innovative society

The knowledge society barometer can also be examined with respect to human, organisational and economy-wide dimensions. This is depicted in Figure 7. First, measures focus on a person's capabilities and attitudes. Then, an organisation's investments are evaluated – be they directed towards research and development, adaptation of ICT, establishing innovative procedures in the firm, or setting up environmentally sustainable processes.

Figure 7: *Knowledge society barometer framework*

For example, three measures evaluate the innovation of society. These measures are the impact R&D has on economic competitiveness and employment, the level of entrepreneurship and venturing in the nation, and the role innovation networks play in the society. The results with respect to these three measures are presented in Table 7. Here, the Netherlands is the leader, followed by Sweden, and Japan falls behind.

Table 7: *Scores on innovative society*

	Index	Impact of R&D	Entrepreneurship and venturing	Innovation networks
Finland	**-0.10**	0.09	0.04	-0.43
Sweden	**0.48**	0.47	0.55	0.41
Denmark	**-0.19**	-0.41	-0.13	-0.05
Netherlands	**0.70**	0.22	0.83	1.04
Germany	**-0.29**	-0.02	-0.69	-0.17
UK	**-0.04**	-0.41	-0.23	0.51
USA	**0.36**	0.56	0.81	-0.29
Japan	**-0.67**	-0.42	-0.67	-0.93

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Annex

Human resources in R&D and attraction of S&T professions

Basic education and schooling		
Programme for international student assessment (PISA)		
	Reading literacy score	PISA
	Mathematical literacy score	PISA
	Scientific literacy score	PISA
General skills and knowledge		
International adult literacy survey		
	Prose literacy score	IALS
	Document literacy score	IALS
	Quantitative literacy score	IALS
Participation in life-long learning (% age classes between 25 and 64 years)		Eurostat
Science and technology capabilities		
Population with a tertiary education (% of 25-64 years age classes)		Eurostat and OECD
Number of new graduates in science and engineering		Eurostat, US Bureau of Census
Number of new science and technology PhDs in relation to the population in the corresponding age group		Unesco, OECD, Eurostat
Women in S&T		Eurostat
Employment in med-high and high-tech manufacturing (% of total workforce)		Eurostat
Employment in high-tech services (% of total workforce)		Eurostat
Number of researchers in relation to the total workforce		OECD MSTI, USA (NSF), Japan (Nistep)

Competent organisations: investment in R&D and adaptation of ICT

R&D expenditure and financing		
Public R&D expenditures (GOVERD and HERD) (% GDP)		Eurostat
Business expenditure on R&D as a percentage of GDP		Eurostat
Innovation expenditures as a percentage of all manufacturing turnover		CIS
Applications of IC technologies		
Value of ICT markets to GDP		EITO
Use of ICT		
	Internet use in the population	Eurobarometer
	Cellular phone subscribers	ITU
	Home Internet access (% of all households)	EITO
	Computer penetration in businesses	Eurobarometer
	Internet dial-up access costs residential user	
	ADSL prices	
	Home ADSL access (% of all households)	
	Availability of government services online	
eCommerce		
	Internet users who have purchased online	Eurobarometer
	Percentage of companies selling online	Eurobarometer
	Percentage of companies buying online	Eurobarometer
	Number of secure servers	OECD
Adaptation of innovative procedures		
Share of SMEs in publicly funded R&D executed by the business sector		OECD
SMEs innovating in-house (% of manufacturing SMEs)		CIS
Manufacturing SMEs involved in innovation cooperation		CIS

Innovative society

Impact of R&D on economic competitiveness and employment		
Scientific and technological productivity		
	EPO high-tech patent applications (per million population)	Eurostat
	EPO high-tech patent applications (per million population)	Eurostat
	Number of scientific publications	CWTS
	Number of highly cited papers per capita	ISI
	Labour productivity	Eurostat, OECD
	Percentage manufacturing value added in high technology industries	Eurostat
	High-tech and medium high-tech industries: – Share of total output	Eurostat
	Knowledge intensive services: – Share of total GDB	Eurostat
	Technology balance of payments receipts as a proportion of GDP	OECD
	Balance of payments of high-tech products	Eurostat
	'New to market' products (percentage of all manufacturing sales)	Eurostat
	Share of high technology products in total exports	
	Growth in a country's world market share of exports of high-tech products	
Entrepreneurship and venturing		
GEM measures of entrepreneurial activity		GEM
Volume of venture capital investment in early stages (seed and start-up) in relation to GDP		Venture capital associations
Business angels' activity		EBAN
Innovation networks		
Inward foreign direct investment (FDI)		
	Inward foreign direct investment performance index	UNCTAD
	FDI inward stock to assets of foreign affiliates ratio	UNCTAD
Internationalisation of R&D activities		Eurostat
Openness to international trade		UNCTAD
Percentage of innovative firms cooperating with other firms/universities/public research institutes		CIS

Sustainable development

Societal values		
Life and health expectancies		
	Life expectancy at birth: men and women	Eurostat
	Disability-free life expectancy (at birth): men and women	Eurostat
Social protection expenditure		
	Distribution of income (S80/S20 ratio)	Eurostat
	Risk of poverty rate before social transfers	Eurostat
	Risk of poverty rate after social transfers	Eurostat
	Regional cohesion	Eurostat

Employment		
	Employment rate	Eurostat
	Employment rate of older workers	Eurostat
	Unemployment rate	Eurostat
	Youth unemployment (15-24 years)	Eurostat
	Long-term unemployment	Eurostat
	Taxation of labour income	
Equality between genders		
	Female share in national parliaments	Eurostat
	Female share in national governments	Eurostat
	Female employment rate	Eurostat
	Gender pay gap	Eurostat
Environmental responsibility		
Private sector responsiveness		
	Number of ISO14001 certified companies	
Climate change		
	Carbon lifestyle efficiency (CO_2 emissions per capita)	
	Carbon economic efficiency (CO_2 emissions per unit GDP)	
Eco-efficiency		
	Amount of energy consumed per unit of GDP	
	Relying upon renewable sources of energy	
Environmental systems		
Air quality		
	Concentration of sulphur dioxide (SO_2)	
	Concentration of nitrogen dioxide (NO_2)	
	Concentration of non-methane volatile organic compounds (VOCs)	
	Concentration of total suspended particulates	
Water quality		
	Agriculture nitrate emissions	
	Phosphorus concentrations	
	Industrial organic pollutants per available freshwater	
	Pesticide use per hectare of cropland	
Biodiversity		
	Current mammal species diversity	
	Current avian species diversity	

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