Chapter 1

Fostering Innovation: The Policy Challenge

This chapter presents the innovation policy context and discusses why governments need to develop a strategic approach to fostering innovation. It shows that innovation, broadly defined, is a key driver of growth performance and of economic growth. It indicates that it is essential for all governments to develop policies to strengthen innovation performance and outcomes. Because innovation takes various forms, they can adopt different policies and instruments. The mix of appropriate policies to foster innovation depends on many factors; it is important to recognise that "one size does not fit all".

Challenges ahead

Today's world faces unprecedented challenges. The effects of the economic downturn will be felt around the globe for years to come. Even before the economic crisis, lagging productivity growth was a serious threat to prosperity and competitiveness in many countries. The crisis has made it even more imperative for countries to find new and more sustainable sources of growth. In the current difficult budgetary environment, governments are looking for policies and actions that can help accelerate economic growth and ensure future prosperity and progress.

Innovation and the creation and application of knowledge is an important area for government action. Such action is essential if firms and countries are to thrive in an increasingly competitive global economy, and it is here that advanced countries find their greatest comparative advantage. Investing in knowledge creation and enabling its diffusion is the key to creating high-wage employment and enhancing productivity growth. Less advanced economies also look to innovation as a way to enhance their competitiveness and shift to higher value added activities.

Stronger growth performance is not the only major public policy objective that can be served by innovation. Many of society's most pressing challenges know no borders and cannot be met by a single country. The ability to address increasingly urgent issues such as climate change, health, food security and poverty depends on stronger innovation and new forms of international collaboration. Global challenges require collective and innovation-driven responses.

In today's constrained budgetary environment, governments need to find ways to do more with less. Public investment in innovation-related spending – *e.g.* education, research and technology – is a priority in many OECD countries and it has increased in some as part of recent stimulus packages. Clearly, investing in future sources of growth is important and investments in innovation need to be prioritised. However, there is also much scope to do more with existing resources, improve the efficiency of public spending and enhance the functioning of the overall innovation effort.. This suggests that even countries with constrained public finances can take steps to improve their innovation performance.

In elaborating their policies for innovation, governments must ensure that the policy framework for innovation keeps pace with changes in the global economy and changes in the innovation process. In the aftermath of the financial and economic crisis, society – including business – is looking to government to create frameworks that encourage experimentation and growth but also provide some security in case of failure. At the same time, innovation is increasingly looked to as a way to improve the quality of life and address major social and global problems. Policy can provide the framework for channeling innovation towards applications that make life better for individuals, businesses and society at large.

The process of developing, producing, commercialising and diffusing significant innovations – *e.g.* the invention of the transistor, the invention of antibiotics, the introduction of organisational changes in the workplace – has never been simple or risk-free. Nor is it, as it once appeared, a linear progression from scientific research to discovery to technological improvements to finished products to their diffusion across society. Today, it is explicitly recognised that innovation is a broad and complex phenomenon involving many interactive processes. These dynamic processes take place in a range of contexts and landscapes.

Establishing a rationale for government intervention is important. The idea that "market failure" leads to under-investment in research has been the principal rationale for government funding of research and development (R&D) since the early 1960s. In an innovation systems perspective, the presence of bottlenecks or other failures that impede the operation of the innovation system can constitute crucial obstacles to the effectiveness of R&D as well as growth and development. Accordingly, the scope for failure is considerable, an issue that is discussed in further detail in Chapter 7.

The mix of policies for innovation depends on many factors and "one size does not fit all". Firms' innovation performance and characteristics differ both across countries and within industries. The particular strengths and weaknesses of a country, and the opportunities and threats it faces, are also a major factor. Countries also update their policy mix at different speeds, so differences can be observed even if the goal is the same. Differences in political orientations and objectives, as well as policy processes and institutional capacities, play a role. Countries' innovation systems are characterised by a mix of policies which affect firms' behaviour and firms adopt multiple paths to innovation. The economic and industrial history of a country will also shape policy approaches. Finally, the different forms of innovation require a broad range of policy instruments (Box 1.1).

Box 1.1. Customising policies to different forms of innovation

Factors such as a country's economic structure, its firm demography (*e.g.* number of SMEs), its geography and resource endowment, its infrastructure, stage of socioeconomic development, general framework conditions (*e.g.* macroeconomic conditions, regulatory policies and markets) and institutional environment (*e.g.* the education system and science and research base) all play a role in shaping innovation. In addition, innovation differs widely across sectors. Sectors such as pharmaceuticals, chemicals and semiconductors are closely linked with science, while standards have an important impact on innovation in telecommunications and software. Some sectors are dominated by large established firms while others are driven by the entry of smaller specialised firms. The diversity of innovation actors, learning processes, linkages, knowledge bases, institutions and organisation needs to be carefully considered when formulating policy (Malerba, 2005).

Moreover, innovation policy can be characterised in various ways (OECD, 2010). One distinction is between "supply-side" and "demand-side" policy. Another is between "mission-oriented" and "diffusion-oriented" policy. Policy instruments include financial instruments (*e.g.* R&D tax credits) and regulatory instruments such as laws and binding regulations (*e.g.* the use of safety equipment for children in cars). Innovation policy encompasses a wide range and many types of innovations. Distinctions for characterising innovation include: the type of innovation – technological (product and process) or non-technological (organisational and marketing); the mode of innovation – novel innovator (strategic and intermittent), technology modifier, and technology adopters (Arundel and Hollanders, 2005); and the socioeconomic impact – incremental, disruptive or radical.

The impact of an innovation varies markedly. It may lead to radical structural change and strongly affect the entire value chain from suppliers to end users or it may involve incremental modifications to existing products, processes or practices. At the same time, innovation policy is affected by various policy sub-systems whose structural characteristics and governance arrangements influence policy processes and outcomes. This implies that governments need to develop a coherent, interdisciplinary set of policies for innovation, one that is flexible enough to include different policy approaches to different forms of innovation and associated activities.

Because innovations are of different types, occur in many different ways, and have varying effects, they call for different policy responses. For example, research has found that policies that address the tail end of the innovation cycle and encourage demand for innovation are more likely to stimulate incremental innovation than to foster radical innovation (Nemet, 2009). The latter is better induced through technology- (or supply)-push policies (OECD, 2009). For example, some analysts note that addressing climate change and developing alternatives to hydrocarbon technologies require innovation policies that support radical innovation and a technological regime shift (Smith, 2009). Others suggest a number of policy options to combat climate change, such as providing support for many different technologies as well as improving existing ones, introducing supportive price and regulatory policies, using public procurement to catalyse and support demand, and encouraging the broad dissemination of public scientific and technological knowledge (Mowery *et al*., 2009).

Innovation drives long-run economic growth

Innovation – the introduction of a new or significantly improved product (good or service), process, or method (Box 1.2) – has long been viewed as central to economic performance and social welfare, and empirical evidence has confirmed the links between innovation and growth (Box 1.3). This means that all governments must understand the importance of innovation and develop policies to strengthen its efforts and outcomes.

Box 1.2. Defining and measuring innovation

The latest (3rd) edition of the *Oslo Manual* defines innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD and Eurostat, 2005). This definition captures the following four types of innovation and is used for measurement purposes:

- Product innovation: the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.
- Process innovation: the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- Marketing innovation: the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- Organisational innovation: the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

Innovation activities vary greatly in their nature from firm to firm. Some firms engage in well-defined innovation projects, such as the development and introduction of a new product, whereas others primarily make continuous improvements to their products, processes and operations. Both types of firms can be innovative: an innovation can consist of the implementation of a single significant change or of a series of smaller incremental changes that together constitute a significant change. By definition, all innovation must contain a degree of novelty. The *Oslo Manual* distinguishes three types of novelty: an innovation can be new to the firm, new to the market or new to the world. The first covers the diffusion of an existing innovation to a firm – the innovation may have already been implemented by other firms, but it is new to the firm. Innovations are new to the market when the firm is the first to introduce the innovation on its market. An innovation is new to the world when the firm is the first to introduce the innovation for all markets and industries.

Innovation is a continuous process rather than a static activity. This makes it difficult to measure. Firms constantly make changes to products and processes and collect new knowledge. In order to capture this process, the *Oslo Manual* (OECD and Eurostat, 2005) focuses on measurable indicators such as expenditures, linkages and factors that influence innovation activities.

Innovation, thus defined, is clearly a much broader notion than R&D and is influenced by a wide range of factors, some of which can be affected by policy. Innovation can occur in any sector of the economy, including government services such as health or education. The current measurement framework applies to business innovation, however, even though innovation is also important for the public sector. Consideration is being given to extending the methodology to public sector innovation and social innovation, so as to correspond to the reality of innovation today. Fostering innovation requires not only consideration of a wide range of innovation activities but also of the many actors engaged in innovation.

Innovation has long driven rises in living standards. However, until recently, empirical analysis of economic growth provided little hard evidence on the role of innovation in growth performance. Studies primarily considered labour input (often measured as total hours worked) and physical (tangible) capital, such as machinery and equipment, as the factors driving economic growth. Innovation was typically regarded as affecting overall efficiency in the use of capital and labour in the production process – known as multi-factor productivity (MFP) – although the relation between innovation and MFP growth was not well understood and few growth policies explicitly sought to strengthen it. Recent work has expanded the analytical framework in several ways, clarifying several dimensions of the role of innovation (Box 1.3).

Box 1.3. Innovation and growth: a brief overview

The question of what drives economic growth and how to sustain it in the long run is at the core of economics. Neoclassical growth models (*e.g.* Solow, 1957) assert that growth results from the input of physical capital, *i.e.* the stock of machinery, equipment and buildings, labour, and "knowledge" in the production process. However, because of diminishing returns to capital, long-run growth cannot result from the simple accumulation of physical capital, which can only guarantee growth in the short run. Long-run growth can only be achieved by knowledge accumulation and technological progress. Early growth models assumed, however, that technological progress would fall like "manna from heaven" as an exogenously provided public good. This technological progress was considered to be non-excludable, implying that the holder could not withhold the benefits associated with the technology from others. It was also considered non-rival, *i.e.* that use of that good by one agent would not preclude simultaneous use of the same good by another agent. Thus, in the neoclassical growth model knowledge is freely available to all firms and individuals in the economy and exogenous to the system, and its accumulation does not depend on the economic decisions of individuals and firms. Clearly, this was a very simplified and incomplete theory of growth and the role of innovation.

Advances in growth theory have recognised the endogeneity of the accumulation of knowledge capital and human capital: human and knowledge capital derive from investment decisions of individuals and firms in response to economic incentives and therefore to policies and institutions. Current growth models consider knowledge capital to be non-rival but partially excludable. An immediate consequence of the non-rival nature of knowledge is that externalities, in the form of knowledge spillovers between locations and across time, will play an important role in the accumulation of knowledge and growth. Partial excludability, through formal (*e.g.* patent protection) and informal (*e.g.* secrecy) methods of intellectual property protection give innovating firms temporary monopoly power which allows them to recoup the costs they incurred to innovate.

Technical progress has been modelled both as "horizontal"; *i.e.* as a continuous expansion of the varieties of inputs (of unchanging quality) that firms can use (*e.g.* Romer, 1990); and as "vertical", *i.e.* as progressive improvement in the quality of a fixed number of goods (*e.g.* Aghion and Howitt, 1992). An important feature of vertical innovations is creative destruction, since innovations make prior innovations obsolete and allow innovating firms to capture monopoly markets that were previously held by incumbent innovators. Firms' innovation investment decisions will therefore be affected by expectations about the pace of future innovations, since this will affect the profitability of current innovations. Entry and competition therefore play a crucial role in shaping innovation decisions (and therefore long run growth) in these models.

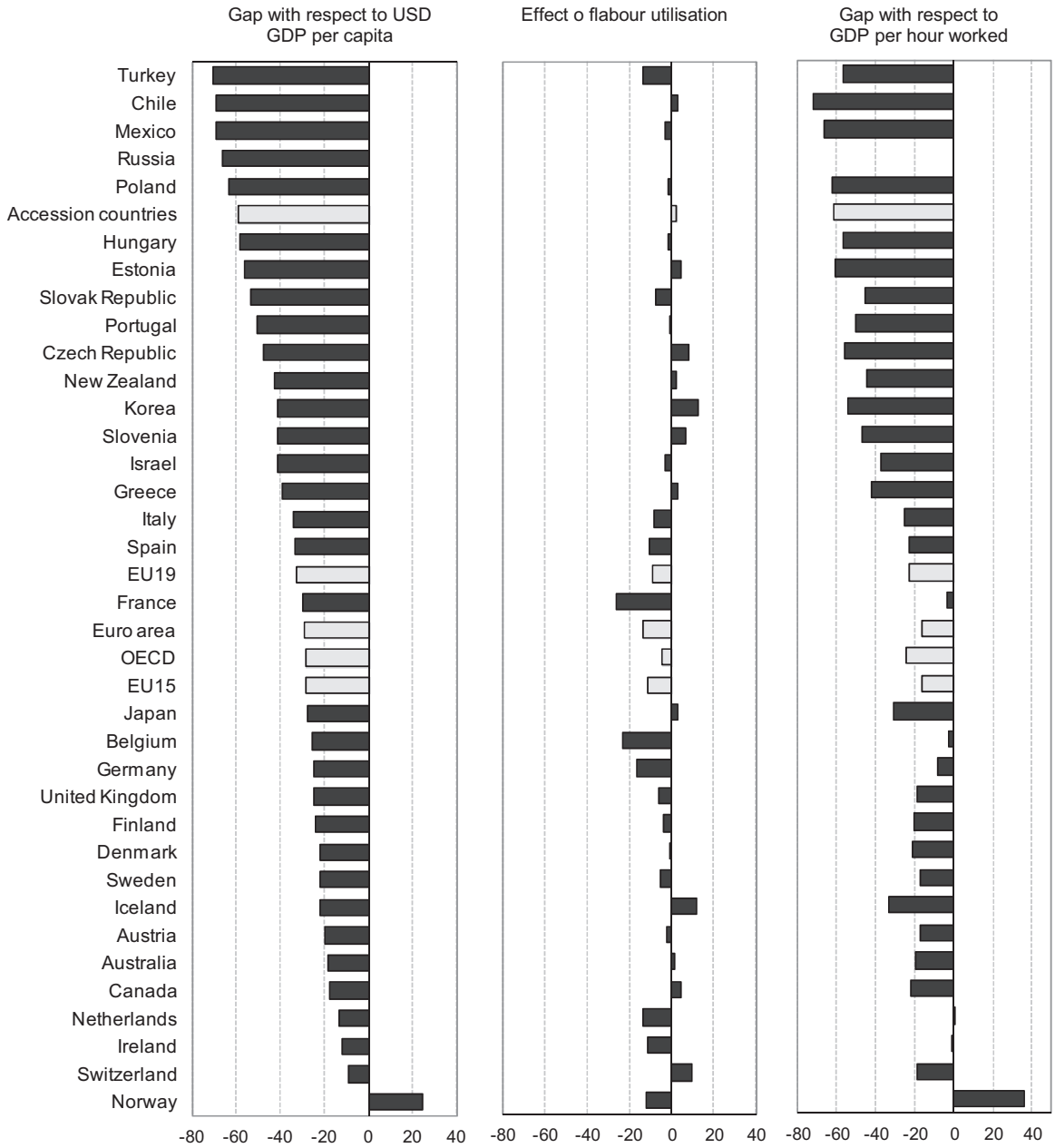
Theoretical and empirical analyses at the macroeconomic and microeconomic level have investigated both the determinants that drive innovation and its contribution to firm performance, measured as productivity growth and/or market value. For many years the focus of both theoretical and empirical contributions has been on technological innovation and on formal R&D. However, attention has widened to broader measures of innovation, to the diffusion of new product and processes, and to investments in innovation other than R&D. Including these broader measures of innovation does create some problems, starting with their measurement

Innovation helps to reduce cross-country income gaps

Innovation not only contributes strongly to growth performance over time, it also plays a major role in explaining differences in income and productivity levels across countries. OECD data show that the income gaps between OECD countries are mainly due to differences in labour productivity (Figure 1.1). While there is considerable scope to improve labour market performance in several countries (particularly since the recent crisis), most of the scope to reduce gaps in income levels is related to improvements in labour productivity. In turn, and as noted above, these are closely associated with innovation.

Figure 1.1. Productivity and income levels, 2008

Percentage point differences with respect to the United States



Notes: Labour productivity and income levels are calculated using GDP at current prices and converted into USD using 2008 purchasing power parities. Labour utilisation is measured as total hours worked per capita. The accession countries aggregate excludes the Russian Federation for which hours worked series were not available at the time of publication. The euro area includes Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. France includes overseas departments. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Source: OECD, Productivity Database, December 2009.

This is clearly illustrated in Table 1.1, which provides a breakdown of the contributions of total (or multi-) factor productivity, human capital, physical capital intensity and employment to income levels for key OECD countries and regions and for selected non-OECD countries. It shows that income gaps are mostly associated with gaps in total factor productivity (a close proxy for differences in technology and innovation) and with gaps in human capital. This suggests that reducing income gaps between OECD countries and non-OECD countries will heavily rely on improved innovation performance.

Table 1.1. Breakdown of cross-country differences in GDP per capita into their broad determinants, 2005[1,2]

United States = 100

	GDP PPP per capita	TFP	Human capital	Physical capital	Employment
	Y/Pop	*A*	*h*	$(K/Y)^{\alpha/(1-\alpha)}$	*L/Pop*
United States	100.0	100.0	100.0	100.0	100.0
Canada	83.5	72.0	103.3	105.8	106.0
Japan	72.6	52.6	100.4	130.7	105.1
China	9.8	13.6	57.3	105.2	119.5
India	5.2	12.7	47.7	98.3	87.1
Brazil	20.5	29.3	70.1	103.1	96.8
Russian Federation	28.6	31.5	84.9	97.4	99.3
Australia-New Zealand[3]	78.3	64.1	101.5	114.8	104.5
EU27+EFTA[3]	64.7	67.8	91.2	114.1	91.3
Rest of the world[3]	12.3	20.9	59.7	103.6	81.7
Total world[3]	22.8	27.9	64.2	104.2	95.8

1. While equal in principle, Y/Pop and the product of A, h, $(K/Y)^{\alpha/(1-\alpha)}$ and L/Pop can differ in practice for two reasons. First, for countries in which fossil fuel extraction makes a sizeable share of overall output (Russian Federation and a number of countries in the Rest of the World aggregate), TFP levels were estimated for total output excluding the mining and quarrying sector, for reasons explained in the text. Second, geographical area aggregates are computed as arithmetic averages, while geometric means would have to be used for the equality $Y/Pop=Ah\ (K/Y)^{\alpha/(1-\alpha)}\ L/Pop$ to hold.

2. The long-term growth framework is applied at the individual country level. The geographical disaggregation of the world economy presented here matches that of the OECD ENV-Linkages model, as used in Burniaux *et al.* (2008).

3. Population-weighted arithmetic averages.

Source: R. Duval and C. de la Maisonneuve (2009), "Long-Run GDP Growth Framework and Scenarios for the World Economy", *OECD Economics Department Working Papers* No. 663, OECD, Paris.

Innovation and employment

In the current economic climate of increasing budgetary pressure and high unemployment rates, policy makers face two particular challenges: to ensure that policies for innovation represent good value for money and to achieve long-run sustainable growth accompanied by robust job creation. Innovation can affect employment in several ways. Broadly speaking, investment in innovation, or the introduction of new or improved products and processes or new organisational or marketing methods, allows firms to increase their output and tap into new markets. This may be associated with job creation, although firms may also produce more output with their existing labour force. In most cases, innovation will raise labour productivity, allowing for higher wages. As part of the implementation of innovation, some workers may be redeployed within firms to provide new products and services. Others may find their skills no longer required and must seek

work elsewhere. This is why effective labour markets and active labour market and training policies are an important part of the policy mix for innovation.

Innovation is also often associated with the setting up of new enterprises to provide the market with new offerings and the creation of new jobs. Evidence for the United States, for example, shows that firms less than five years old accounted for over two-thirds of net new jobs in 2007 (Haltiwanger *et al.*, 2009). Moreover, over time, in addition to the creation of new firms, innovation can lead to the expansion of existing firms because of increased demand for their products or their greater competitiveness. At the same time, innovation can lead to firm closures, if their products or services become obsolete or if they are displaced by more competitive offerings.

In spite of the channels for job creation through innovation highlighted above, it is sometimes feared that the introduction of policies that foster innovation and technological change may lead to fewer jobs overall or threaten the employment of certain groups, such as the low-skilled and those who do routine tasks. One long-standing concern has been that innovation may fuel an increase in demand for skilled workers (as complements to new technologies) and a relative decrease in demand for unskilled or less skilled workers (whose jobs could be replaced by automated processes). More recently, attention has turned to the scope for innovation that involves computerisation and automation to change the nature of tasks within jobs, with a shift in the balance of jobs away from blue-collar and clerical work and changes in the types of things people do at work. Organisational changes may call for new sets of skills and place higher value on different tasks. As a result of information and communication technologies (ICTs), the organisational structures of firms and other entities have changed, bringing increased decentralisation of decision making and new working practices. Evidence suggests that only when they have introduced organisational innovations can firms fully exploit the potential productivity benefits of new technologies.

The empirical evidence on innovation and employment suggests that such concerns should not be overemphasised. In terms of overall employment, the evidence suggests that innovation is associated with employment growth. Studies have shown positive relations between R&D, patents or innovation counts and employment and between ICT and employment (*e.g.* Doms *et al.,* 1995; Van Reenen, 1997; Blanchflower and Burgess, 1998 and Fung, 2006). In terms of changes in demand for workers in different skill categories, there is some empirical support for increased demand for highly skilled workers and decreased demand for low-skilled workers. However, there is also evidence that low-skill occupations are not disappearing. Studies of workers in the United States, the United Kingdom and other European countries suggest that growth in occupations is at the top end of the skill and earnings distribution (*e.g.* scientists, lawyers and managers) and at the bottom end (predominantly service occupations, *e.g.* childcare). Middle skill jobs such as accounting, clerical and routine production jobs are those that are experiencing relative declines (Autor *et al.*, 2006, 2008; Goos and Manning, 2007; and Goos *et al.*, 2009). This is consistent with the view that technological change due to computerisation is changing the task components of occupations. In particular, routine, easily codified tasks may be automated, leaving workers to perform more non-routine tasks, such as those requiring creativity and abstraction or providing interpersonal service.

From a policy perspective, changes in demand for different types of workers and changes in organisational structures highlight the importance of providing workers with a robust set of skills and enabling people to continue to maintain and augment their competences throughout their lives. This calls for strong numeracy and literacy, as well as

problem solving, deductive reasoning, and strong communication and collaboration skills (see Chapter 3). Providing these skills requires investment by firms and workers in training and lifelong learning and government's active role in ensuring formal recognition of these investments. Augmenting workers' skills improves their productivity and can have important positive spillovers by facilitating workers' adaptability and mobility and enabling new entrants' smooth integration into the labour market. In addition, labour market and social policies must enhance the adjustment capacity of the economy and make it easier for displaced workers to move into new jobs.

Innovation policies may need to take account of the different effects of different types of innovation on employment in industry sectors. Evidence of the impact of product innovation on employment suggests a positive relationship; recent firm-level data from country innovation surveys in Chile, France, Germany, Italy, Spain and the United Kingdom show that the increase in total sales associated with product innovation contributes to employment growth at the firm level (Benavente and Lauterbach, 2008; Hall *et al.*, 2008; Harrison *et al.*, 2008; Greenan and Guellec, 2001). Industry-level evidence supports this, suggesting that policies that foster experimentation and enable new or existing firms to launch new products are conducive to higher productivity growth and job creation.

Evidence on the impact of process innovation on employment is more mixed; firm-level studies find no significant relationship between this type of innovation and employment, while industry-level studies differ depending on the sectors and countries analysed. To some extent, the impact may be due to natural industry life cycles, with early industry expansion associated with strong product innovation and industry growth, and more mature industries seeking higher productivity more through process innovations (Tether *et al.*, 2005). Recent work by Mastrostefano and Pianta (2009) suggests that for industries in Europe that innovate little innovation tends to have a negative effect overall on employment because of the dominance of process innovations, while industries with a high level of innovation undertake more product innovation and experience a virtuous circle of growing demand, output, jobs and wages. Clearly, both types of innovation contribute to firm survival; however, process innovation may have greater impacts on workers and will thus make greater demands on public policy to facilitate their smooth redeployment.

Finally, in discussing the employment effects of innovation, it is important to recognise other important influences on demand for labour. Of particular note are trade patterns and increasing globalisation; also influential are institutional factors such as minimum wages and labour market regulations, competition policy, and the composition of public spending. Overall, it is important to keep in mind that in this area there are many channels of influence and many interactions with other economic trends.

Key findings and structure of the report

Innovation is a key driver of growth performance, and its contribution to economic growth is likely to increase. Because many OECD countries have stagnating or declining populations, long-term increases in labour input are likely to play a limited role in driving future economic growth. Moreover, investments in physical capital have diminishing returns and cannot strengthen long-run economic growth. An increasing share of economic growth in OECD countries has to come from R&D and innovation. In developing

countries, including those with low incomes, innovation is a way of catching up and propelling development.

It is time for a strategic approach to fostering innovation to achieve the core objectives of public policy. It is the aim of the OECD Innovation Strategy to move towards this common goal. It takes a broad, system-wide approach to innovation, bringing together policies and principles in a mutually supportive manner. It recognises the fundamental role of people in both the public and private spheres, of firms, operating in an interconnected world where markets are more sophisticated and demanding than ever before, and of knowledge creation and diffusion. Its aim is not a one-size-fit-all, linear approach. Rather, its message is that a mobilising vision – and the ambition to achieve it through policy coherence and effective co-ordination – can help governments improve economic performance, address societal challenges and enhance welfare, through innovation. This calls for horizontal as well as vertical co-ordination of policies. With appropriate policies, innovation will result in win-win outcomes and greater well-being at both national and global levels. To this end, this report studies key elements of the innovation landscape and of the policies that affect and drive innovation.

This report draws on the analytical literature, presents the most recent available data and brings together a wide range of OECD studies. More than 15 policy committees from the OECD participated in and contributed to the project. It also benefited from substantial specialist input via an expert advisory group, numerous workshops, a series of country roundtables with policymakers, and extensive stakeholder consultation. A web-based "innovation portal" was developed to encourage an open, informal exchange of ideas among the broader innovation community. Annex A provides further details on these initiatives. In what follows, Chapter 2 presents a snapshot of the innovation landscape with a selection of data that show how innovation is occurring today. Chapters 3 to 7 are built around five priorities for government action that emerged during the project:

- empowering people to innovate (Chapter 3);
- unleashing innovation (Chapter 4);
- creating and applying knowledge (Chapter 5);
- addressing global and social challenges through innovation (Chapter 6); and
- improving the governance and measurement of innovation (Chapter 7).

Finally, Chapter 8 draws the work together and offers suggestions on the way forward and actions needed to implement the OECD Innovation Strategy.

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