Chapter 1.

Knowledge-based capital, innovation and resource allocation

Investment in knowledge-based capital (KBC) – assets that lack physical embodiment, such as computerised information, innovative property and economic competencies – has been rising significantly. This has implications for innovation and productivity growth and requires new thinking on policy. The returns to investing in KBC differ significantly across countries and are partly shaped by structural policies, which influence the ability of economies to reallocate scarce resources to firms that invest in KBC. Well-functioning product, labour and venture capital markets and bankruptcy laws that do not overly penalise failure can raise the expected returns to investing in KBC by improving the efficiency of resource allocation. The same is true for lower barriers to international trade and investment, which also stimulate innovation through greater market size and knowledge diffusion across borders.

While structural reforms offer the most cost-effective approach to raising investment in KBC, there is a role for innovation policies to raise private investment in KBC towards the socially optimal level(s). Indeed, R&D tax incentives and, as a finding that contrasts with previous research, direct support measures can be effective, but design features are crucial in order to minimise the fiscal cost and unintended consequences of such policies. Well-defined intellectual property rights (IPR) are also important to provide firms with the incentive to innovate and to promote knowledge diffusion via the public disclosure of ideas. However, such IPR regimes need to be coupled with pro-competition policies to ensure maximum effect while the rising costs of the patent system in emerging KBC sectors may have altered the trade-off inherent to IPR between the incentives to innovate and the broad diffusion of knowledge.

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.

Innovation-based growth, underpinned by investments in a broad range of knowledge-based capital (KBC), is central to raising long-term living standards. This is especially the case in advanced economies that are relatively close to the technological frontier, where future growth will increasingly need to come from improvements in multi-factor productivity (MFP) (OECD, 2012).

While investment in innovation has traditionally been proxied by indicators such as spending on research and development (R&D) and the purchase of capital embodying new technologies, innovation-based growth relies on a much broader range of KBC. These include employee skills, organisational know-how, databases, design, brands and various forms of intellectual property, and have been classified more formally under three broad categories: computerised information, innovative property and economic competencies (Corrado et al*.,* 2005; Table 1.1).

Table 1.1. The classification of KBC and its possible effects

Type of KBC asset	Mechanisms of output growth for investor in the asset
Computerised information	
Software	Improved process efficiency, optimised vertical and horizontal integration
Databases	Better market segmentation and appropriation of consumers' rent. Optimised vertical and horizontal integration. The use of information to improve logistics and production efficiency.
Innovative property	
Research & Development	New products and services. Quality improvements to existing ones. Better ways of producing output. New technologies.
Copyright and license costs	Knowledge diffusion (inventions and innovative methods).
New product development in the financial industry	More accessible capital markets. Reduced information asymmetry and monitoring costs.
New architectural and engineering designs	Fixed cost leading to production in future periods. Quality improvements, novel designs, enhanced processes.
Economic competencies	
Brand-building advertisement	Price premium. Increased market share. Changes in consumers' preferences.
Market research	Targeted products and services. Increased market share.
Workers' training	Improved production capability of workers. Increased skill levels.
Management consulting	Faster and better decision making. Improved production processes.
Organisational capital	Faster and better decision making. Improved production processes.

Source: Based on the classification in Corrado et al. (2005), "Measuring Capital and Technology: An Expanded Framework", in *Measuring Capital in the New Economy*, C. Corrado, J. Haltiwanger and D. Sichel (eds.), *Studies in Income and Wealth*, Vol. 65, The University of Chicago Press, Chicago, IL.

There are important differences among OECD economies in investment in – and returns to – KBC and innovative capacity. These cannot be explained solely by differences in specialisation patterns. Differences at the country level are associated with diverging patterns of firm performance, with some countries better able to channel resources to innovative and high-growth firms than others. In this context, a key question is the extent to which national institutions and international arrangements can facilitate the reallocation of resources to new sources of growth based on KBC. This chapter therefore explores how public policies shape patterns of resource allocation and investment in KBC, and the role of reallocation mechanisms in promoting the growth of innovative firms. More broadly, these issues have relevance for emerging economies aiming to move up the global value chain.

The chapter is organised as follows. A stylised framework first depicts conceptually how public policies shape incentives to accumulate KBC and innovate, as well as the efficiency of resource allocation and the links between innovation and reallocation. Next, some stylised facts on KBC and innovation at the aggregate level are presented, along with some links to firm performance within countries, including indicators of the efficiency of resource allocation. Existing and new OECD empirical evidence on how public policies shape the KBC-innovation-reallocation nexus are then reviewed; new OECD empirical research undertaken for this project is described in Box 1.2. Finally, the chapter offers some general policy conclusions.

The KBC-innovation-reallocation nexus

Recent research emphasises the growing importance of KBC as a source of productivity gains, and the contribution of efficient resource allocation to this process (Andrews and de Serres, 2012). Owing to the non-rivalrous nature of knowledge, the costs incurred in developing new ideas – typically through R&D – are not incurred again when these are combined with other inputs to produce goods or services. This combination can lead to increasing returns to scale, an important property that makes ideas and knowledge an engine of growth (Jones, 2005). Realising this growth potential depends on the ability to reallocate labour and capital to their most productive uses. Efficient mechanisms to reallocate tangible resources take on heightened importance, given that KBC is prone to misallocation (Box 1.1).

Box 1.1. The significant scope for misallocation of KBC

Given the limitations of market mechanisms for allocating intangibles, KBC is prone to misallocation. The heterogeneous nature of KBC – e.g. patents are far from homogenous – is a key barrier to the efficient allocation of KBC. Efficient outcomes would require transparent environments with opportunities to trade with a wide range of potential transactors (thick markets), thereby creating the pre-conditions for effective matching (Roth, 2008). However, because the prices of transactions in the secondary market for patents are often not publicly disclosed, the resulting information asymmetries undermine the development of a more liquid market. The extent to which transactions in the secondary market allocate patents to more productive uses is also unclear, especially in the IT sector. Moreover, the bilateral environment in which the details of a licence are negotiated lacks a transparent price discovery process to reveal the "fair" price of the patent and may lead to a poor match. For these reasons, facilitating transactions in the market for patents is difficult and the market is subject to significant transaction costs (Gambardella, 2008; Eisenberg and Ziedonis, 2010).

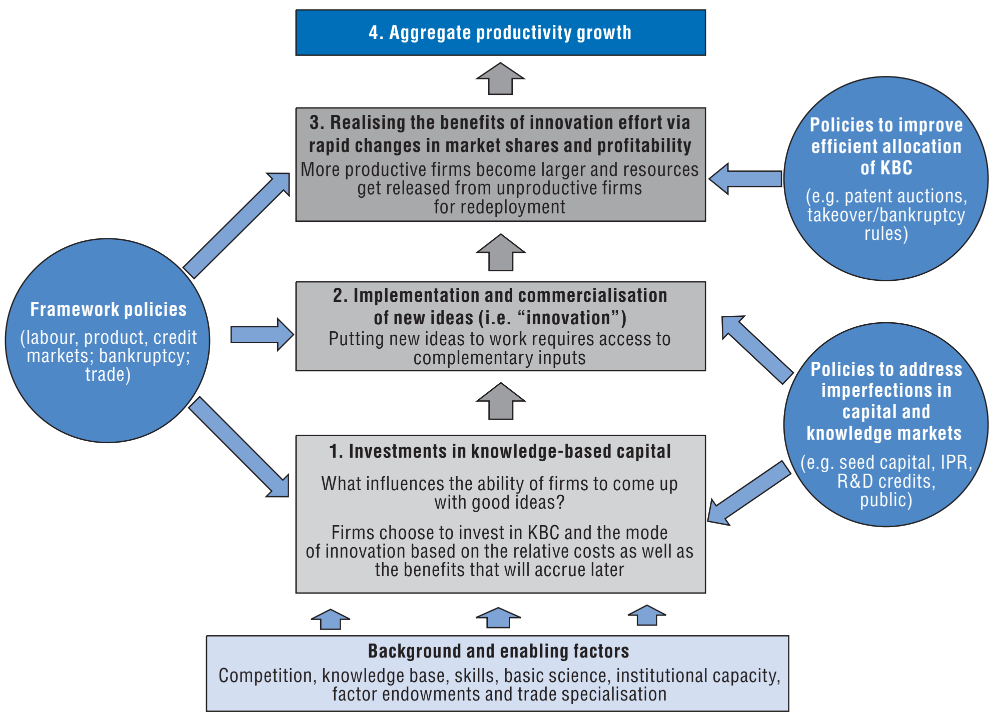
Tacit knowledge is embodied in individuals and therefore lacks separability; this undermines its transferability. The mechanisms for allocating tacit, human-capital based, or even codified but not legally protected KBC, are even less efficient. Firms have two main options: corporate takeovers or selective recruitment (poaching) of specialists. However, both of these strategies entail important risks. For instance:

- A company acquiring an entity in which most intangible assets are human capital-based has to retain the employees of interest (and their teams) in the post-acquisition environment. This is risky given the capital outlays involved and the fact that the acquiring company has less than perfect control of the targeted asset, since it is embedded in individuals.
- Accessing external sources of KBC via the selective recruiting of specialists is complicated by the usual obstacles to labour mobility – e.g. binding non-compete covenants and pension and health care portability – and the need for recruiting firms to possess at least some internally generated technological knowledge in order to assess these external sources effectively and to absorb the acquired knowledge.

Efficient resource allocation in a knowledge-based economy

Figure 1.1 sketches the key elements of the KBC-innovation-reallocation nexus. The basis of the framework is three inter-related building blocks, broadly aligned with the different stages of the innovation process: the development of new ideas (or adaptation of foreign technologies); the implementation and commercialisation phase; and reaping the benefits of new ideas through changes in market share and profitability. Of course, the framework takes as given a number of enabling factors – such as workforce skills – which are clearly crucial to innovation but are beyond the scope of this chapter.[1]

Figure 1.1. The KBC-innovation-reallocation nexus and public policies



Source: Andrews and Criscuolo (2013), "Knowledge-Based Capital, Innovation and Resource Allocation: A Going for Growth Report", *OECD Economic Policy Papers*, No. 4, OECD Publishing, doi: http://dx.doi.org/10.1787/5k46bh92lr35-en

Implementing new ideas (stage 2) can take the form of new processes or new organisations that allow the firm to produce more outputs with the same amount of inputs and increase multi-factor productivity, thus lowering marginal costs of production. Ultimately, firms are able to offer their outputs at a lower price and gain market shares through price competition (stage 3). Similarly, firms can introduce new goods or make quality improvements to existing goods and thus compete on quality (e.g. charging higher prices for their new or differentiated product without losing market shares). In the short to medium term, innovations increase a firm's profitability (Geroski et al*.,* 1993), but as other firms also compete on quality, the profit margins gained by a firm from its innovation are likely to be steadily eroded in markets that function efficiently.[2]

Removing obstacles to experimentation with new products, processes and business models encourages investment in KBC by start-ups and by incumbent firms operating at the frontier that face competitive pressures, e.g. in order to exploit information and communication technology (ICT) and so-called "big data" efficiently. The competitive edge gained in this way and the appropriation of any returns to successful innovations justifies their innovative efforts (Schumpeter, 1942). Competition pushes frontier firms to continue to innovate to stay abreast of new technological developments (Aghion and Howitt, 1992), while further from the frontier, investments in KBC are necessary to facilitate the adoption of the most productive technologies (Griffith et al., 2004). Firms that fail to do so may have to downsize or exit the market, releasing resources for use by firms with the most efficient technologies.[3] When resource allocation is more efficient (Olley and Pakes, 1996), the most productive firms will have the largest market shares and the largest gains in efficiency will be achieved when innovative firms rapidly gain market share at the expense of unsuccessful or stagnant competitors (Bartelsman and Hinloopen, 2005).

The ability to expand the tangible capital base and the workforce rapidly is particularly important in a knowledge-based economy. For firms that invest in KBC, the profitability of successful new ideas depends on the ability to exploit the strong returns to scale that characterise this type of capital (Bartelsman et al., 2010; Bartelsman and De Groot, 2004). For example, they may scale up innovative production methods (e.g. ICT-related business investments) that have proved successful in smaller-scale experiments (Brynjolfsson et al., 2008). Conversely, the ability to scale down operations rapidly – via divestitures of labour and capital – and to maximise salvage value makes exit easier in the event of failure (Bartelsman et al., 2008).[4] In this context, facilitating the expansion of successful innovative start-ups is particularly important for long-run growth, because firms that drive one technological wave often tend to concentrate simply on incremental improvements in the subsequent one (Benner and Tushman, 2002) and young firms possess a comparative advantage in commercialising radical innovations (Henderson, 1993; Tushman and Anderson, 1986).[5]

Openness to trade is also crucial because it leads to more innovation via market-size effects, tougher product market competition and larger knowledge flows. Larger market size stimulates investment in KBC by magnifying the expected profits in the event of successful ventures (Schmookler, 1966; Acemoglu and Lin, 2004). However, globalisation means that firms have to differentiate their goods or lower their costs in order to stay competitive (see below). It also promotes productivity-enhancing reallocation via the expansion of the most productive firms into foreign markets (via exports or by becoming multinationals) and the exit of low-productivity firms that are unable to compete in the global market or undertake the costs required to enter the foreign markets (Melitz, 2003; Melitz and Ottaviano, 2008; Melitz and Trefler, 2012). Finally, trade and foreign direct investment (FDI) are associated with increased flows of knowledge from global customers and suppliers (Crespi et al., 2008; Duguet and MacGarvie, 2005) and from the activities of multinational enterprises (MNEs).[6]

Misallocation and the role of policy

In practice, frictions are likely to arise from market failures related to knowledge and rigidities in factor markets. Specific features likely to distort investment in KBC include the following:

- Private investment in KBC may be below the socially desirable level if the non-rival and only partially excludable nature of some forms of KBC means that firms cannot fully appropriate the returns from their investments, as some knowledge will spill over to other firms.
- KBC is difficult to collateralise and its inherent riskiness reinforces traditional market failures in capital markets (e.g. information asymmetries), which may inhibit the implementation and commercialisation of new ideas, especially for KBC-intensive firms.

- The scale economies that arise from the non-rival nature of KBC can be reinforced by network externalities (i.e. the value of a product increases with the number of users). In extreme cases this may lead to a winner-takes-all outcome. Network effects create a natural monopoly or high barriers to entry and limit competition in areas in which competitive pressures might raise efficiency.

These features are the source of (still unresolved) inefficiencies in knowledge markets and thus place heightened importance on the efficient reallocation of tangible resources. Frictions for reallocating capital and labour are likely to lower the expected net benefits of innovative investment by making it more difficult for successful innovators to attract the resources they need to implement and commercialise new ideas. Moreover, if the innovative effort fails, rigidities may make downsizing and exiting more costly and make it difficult for entrepreneurs to move on and experiment with new ideas. More broadly, as new and young firms are an important source of new ideas, barriers to entry in domestic and international markets will lower the supply of KBC. They will also dampen competitive pressures on incumbents to generate KBC and raise the cost and/or lower the quality of the inputs required by innovative firms to expand.

Ease of reallocation influences firms' business strategies

Policies would appear to affect the different stages of the innovation process and productivity growth sequentially. However, firms' initial investments in KBC are likely to be shaped by their perceptions of the expected costs of implementing and commercialising new ideas and their ability to capitalise on the expected benefits or to exit at low cost (both of which depend on the ease of reallocation).[7] In particular, firms' innovation strategies will be influenced by their views on the extent of rigidities in the reallocation process. If they find that the costs of reallocation are high, entrepreneurs may focus on incremental innovations, rather than experiment with disruptive technologies, because it would be more difficult to realise the benefits of risky technologies if they succeed and contain losses if they fail (Bartelsman, 2004).

In addition, some entrepreneurs may choose not to enter the market because it may not appear profitable or sustainable to enter with just an incremental innovation (Shane, 2001; Bhide, 2000). The extent of specialisation in sectors that rely more on reallocation – such as more innovative or ICT-intensive sectors – may therefore vary across countries (Bartelsman et al.*,* 2010), partly as a result of how different policy settings influence the nature of resource flows across incumbents and new entrants and thus the scale of production in these sectors.

Policies may have unintended consequences

An important implication of Figure 1.1 is that different policies affect different stages of the innovation process (Jaumotte and Pain, 2005a; OECD 2010) so that a range of policy tools may be required to encourage innovation. However, the policy instruments are likely to interact, raising the potential for policy complementarities and trade-offs.

Policies designed to address market failures in knowledge markets (e.g. R&D tax incentives) may unintentionally undermine an economy's reallocation dynamics. More generally, policies that might appear to be neutral in design (e.g. trade liberalisation) may have non-neutral impacts on firms because of the diversity of firms' characteristics, even within narrowly defined industries. Indeed, policies may unintentionally make the cost of inputs disproportionately lower for certain firms or shift the tax burden towards others. For example, regulations that impose a fixed cost on firms may disproportionately affect young firms, which typically have fewer resources to absorb this cost. These considerations are particularly relevant for policies that affect the efficiency of labour and financial markets (to be discussed below).[8]

Side effects of the knowledge-based economy

Gearing public policy to maximise the growth potential of KBC may not have unambiguously positive effects and may lead to trade-offs with other policy goals. First, some forms of KBC may have undesirable side effects: firms may undertake expenditures on marketing and intellectual property rights (IPR) to create significant upfront costs and deter entry by other firms, or they may engage in rent-seeking behaviour (also an intangible investment from a firm's perspective) (Hunter et al., 2005). Second, while efficient reallocation raises returns to KBC, the shifting of resources entails costs for firms, workers and governments so that excessive reallocation is no more desirable than trapping resources in inefficient activities. Third, there may be a tension between policies that promote experimentation and raise the returns to innovation and equity concerns.

The knowledge-based economy rewards high-level skills. This is likely to reinforce rising income inequalities via skill-biased technological change. Technological progress has made some routine and medium-level work redundant, thereby displacing workers, while increasing the value of other "new economy" tasks (Autor et al.*,* 1998). As part of these changes, firms have tended to introduce information technologies against a backdrop of organisational restructuring made possible by KBC (see the following section). This has shifted the mix of skills firms require towards non-routine tasks (e.g. organisational and management tasks; Bresnahan et al.*,* 2002).

Rising investment in KBC can also create winner-takes-all opportunities for a very few (Brynjolfsson and McAfee, 2011). Digital technologies – which allow the replication of informational goods and business processes at near zero marginal cost – can allow the top provider to capture most, if not all, of its market, with only a tiny fraction accruing to the next best (even if they are almost as good). Besides generating disproportionately strong income growth at the very top end of the income distribution, such outcomes may undermine work incentives by detaching effort from reward and creating concerns from a competition policy perspective.

Finally, by codifying previously tacit knowledge, knowledge-based assets such as IPR and software have facilitated the decoupling of (codified) knowledge from the producer of that knowledge. With the caveats in Box 1.1 in mind, this has given owners of capital opportunities to trade and appropriate (part of) the rents from that knowledge, thereby creating tensions between owners of capital and owners of knowledge.

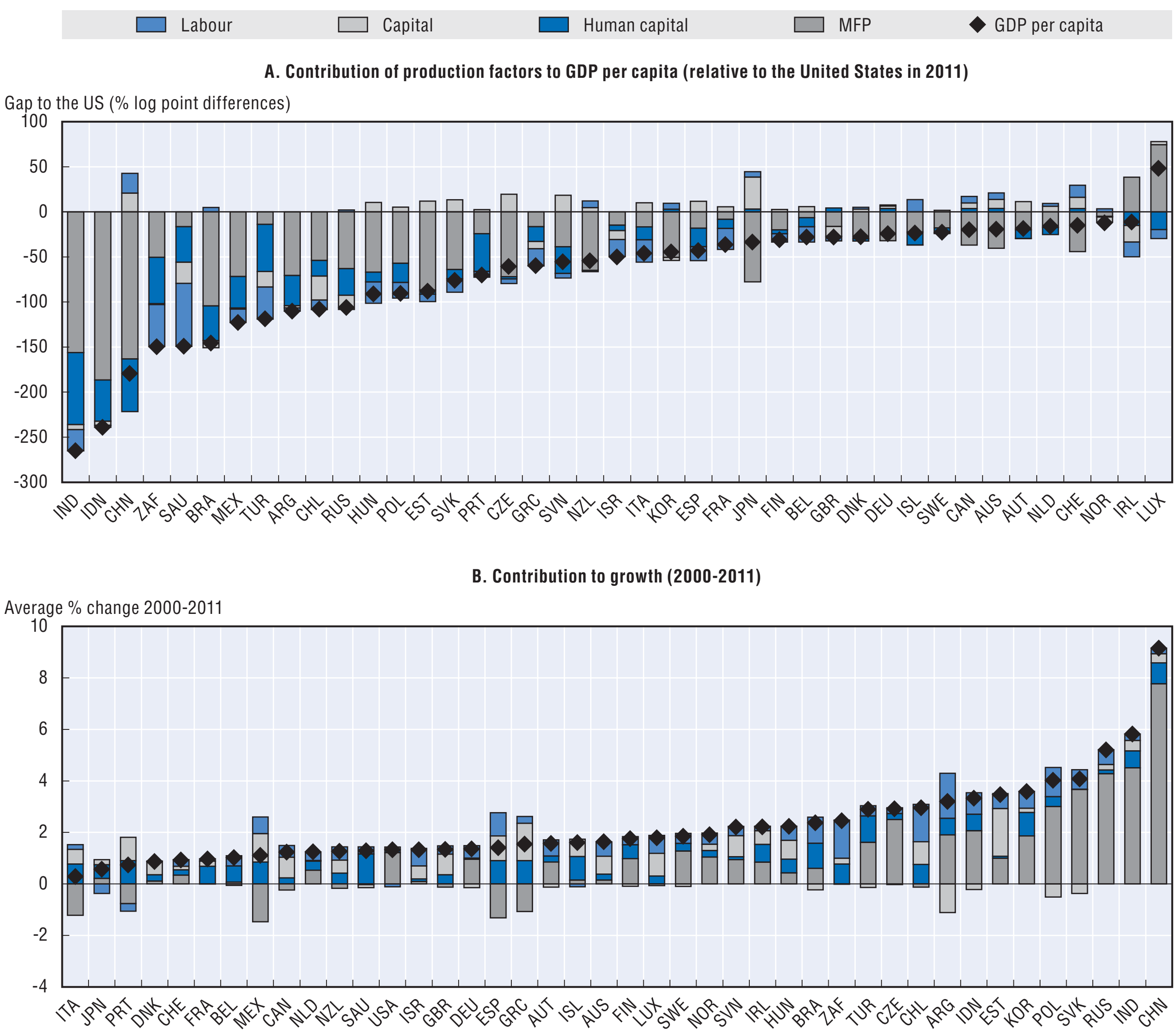
Investment in KBC, reallocation and productivity growth

Links with aggregate growth

Wide and persistent differences in the level of MFP account for the bulk of income per capita gaps across countries (Figure 1.2, Panel A; Easterly and Levine, 2001).[9] Countries that have succeeded in converging towards high-income countries in recent years have often done so on the basis of convergence in MFP and the stock of knowledge (Figure 1.2, Panel B). In theory, MFP reflects the efficiency with which inputs are used, via improvements in the management of production processes, organisational change, or R&D and innovation. It is therefore natural to examine the link between gaps in MFP growth and differences in countries' investment in KBC, which, as discussed below, tend to be significant.

Once estimated KBC is incorporated in growth accounting, the contribution of MFP growth to labour productivity growth tends to fall.[10] Over the period 1995-2006, incorporating KBC is estimated to reduce the contribution of MFP by close to one-half in Sweden; one-quarter in the United States and Finland; roughly one-fifth in France, the United Kingdom, the Czech Republic and Australia; and by one-tenth or less in Austria, Denmark, Germany and Japan (van Ark et al., 2009; OECD 2011a).

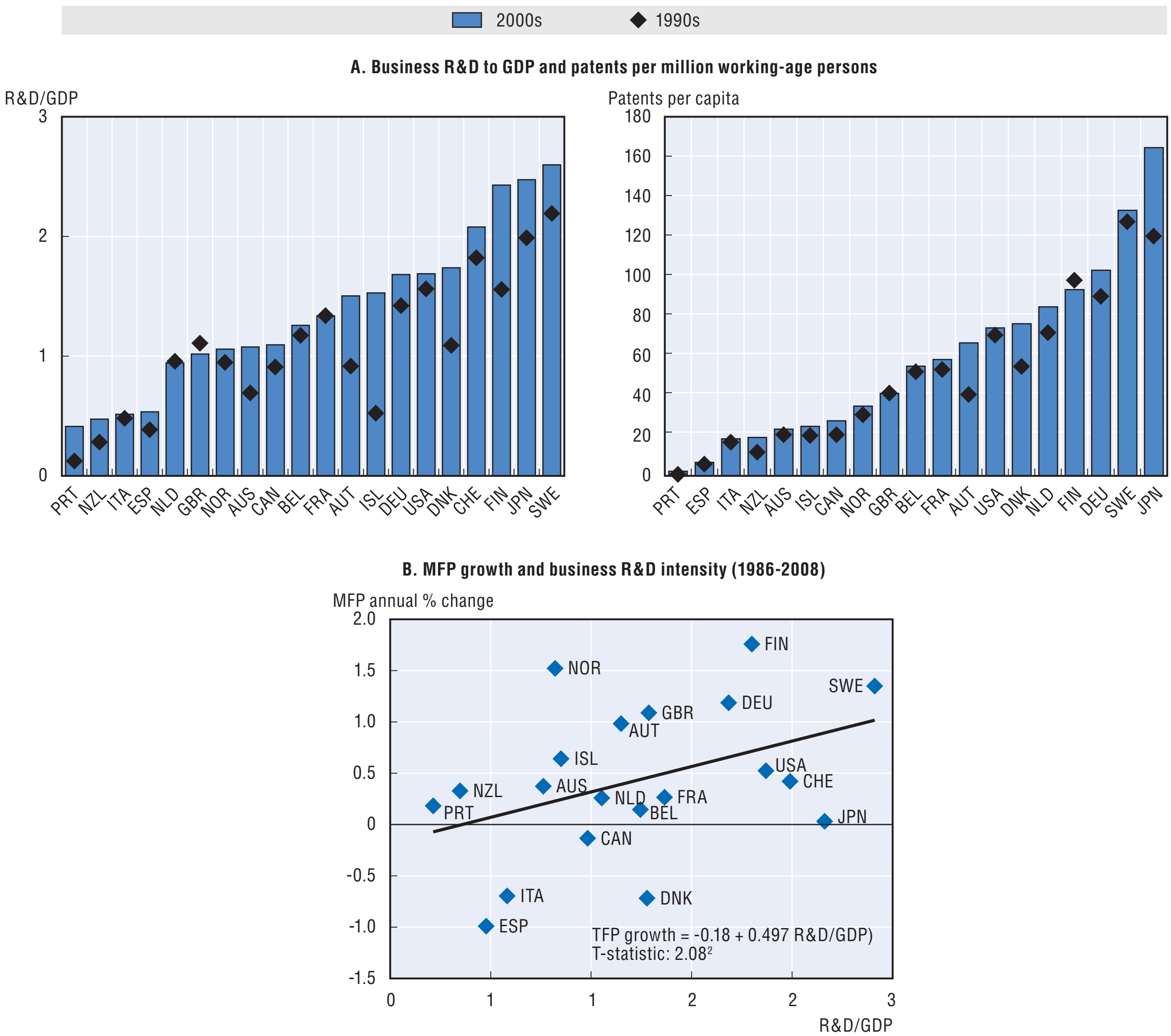
Figure 1.2. Multi-factor productivity drives cross-country differences in GDP per capita



Source: Johansson et al. (2013), "Long-Term Growth Scenarios", *OECD Economics Department Working Papers*, No. 1000, OECD Publishing, doi: http://dx.doi.org/10.1787/5k4ddxpr2fmr-en.

There are important differences among countries in the contributions of MFP and KBC to growth of gross domestic product (GDP). This reflects both differences in the amount of investment in intangible assets and differences in the returns (i.e. marginal product) to these investments.[11] For example, there are persistent differences in the intensity of business R&D and patenting across countries even after controlling for differences in industrial structure, suggesting that variations in the use of KBC cannot be explained solely by structural differences such as trade specialisation patterns (Figure 1.3).[12] These differences are important because business R&D intensity and patenting have been closely linked to productivity performance (Bloom and Van Reenen, 2002; Hall et al*.,* 2010; Westmore, 2013). For economies far from the technology frontier, R&D is still necessary to facilitate the adoption of foreign technologies (Griffith et al*.,* 2004).

Figure 1.3. Business R&D, patenting and MFP performance



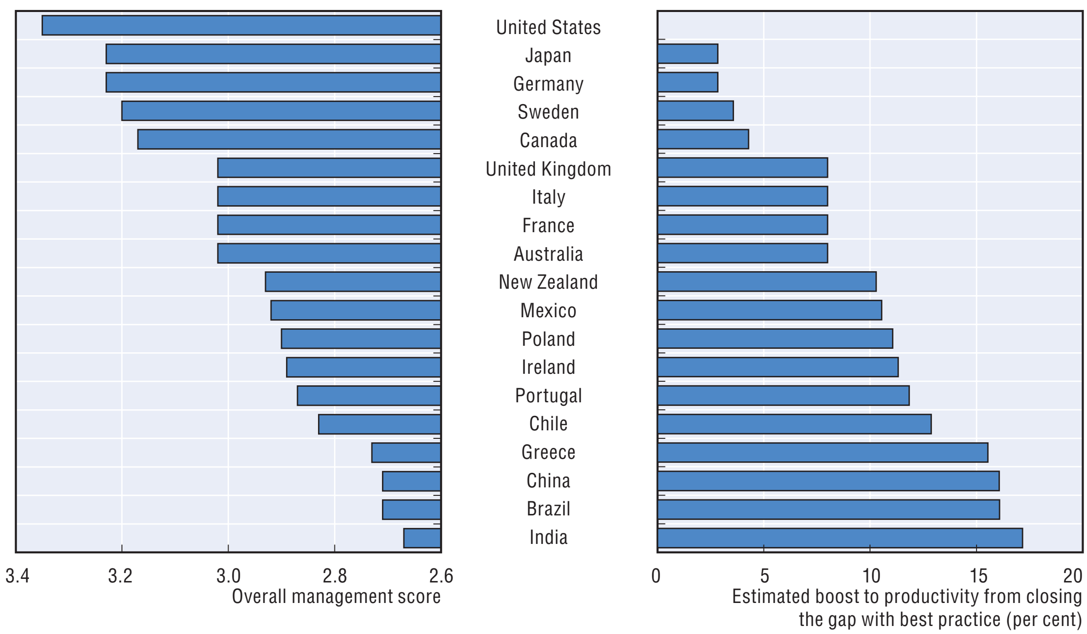
Notes: The patent measure is based on triadic patents, which refer to a series of patents for a single invention filed at the European Patent Office, the United States Patent and Trademark Office and the Japan Patent Office. The patents are a yearly average per million working age (15-64) members of the population. The value is an average per year for the 1990s and an average over the years with available data during the 2000s.

Source: OECD (2011a), *OECD Science, Technology and Industry Scoreboard 2011*, OECD Publishing, doi: http://dx.doi.org/10.1787/sti_scoreboard-2011-en; OECD Productivity Database; and OECD calculations, based on Johansson et al. (2013), "Long-Term Growth Scenarios", *OECD Economics Department Working Papers*, No. 1000, OECD Publishing, doi: http://dx.doi.org/10.1787/5k4ddxpr2fmr-en. See Westmore (2013) "R&D, Patenting and Growth: The Role of Public Policy", *OECD Economics Department Working Papers*, No. 1047, OECD Publishing, doi: http://dx.doi.org/10.1787/5k46h2rfb4f3-en for more details.

At the same time, estimates of managerial quality, based on interviews of middle management from randomly drawn samples of firms, also vary widely across OECD countries (Figure 1.4) and recent research find that managerial quality has a causal effect on firm productivity (Bloom et al., 2013a). For example, raising managerial quality from the median level (roughly corresponding to New Zealand in Figure 1.4) to the level in the United States could increase the average level of productivity in manufacturing by as much as 10% (Bloom et al., 2012a).

Figure 1.4. Managerial quality differs across countries with important implications for productivity

Average management quality score in the manufacturing sector; selected countries

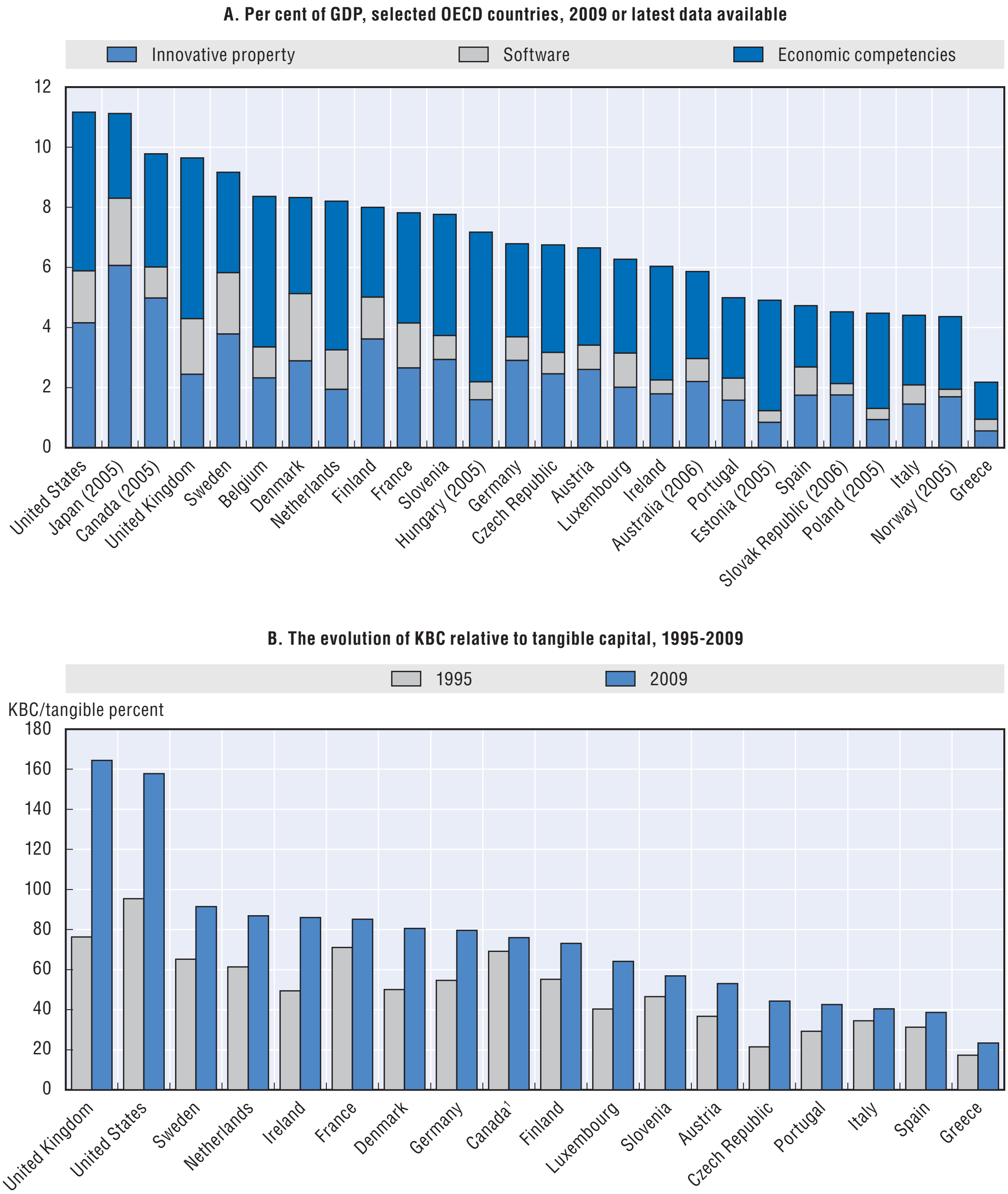


Notes: The overall management score is an average of responses to 18 survey questions that are designed to reveal the extent to which firms: i) monitor what goes on inside the firm and use this information for continuous improvement; ii) set targets and track outcomes; and iii) effectively utilise incentive structures (e.g. promote and reward employees based on performance). The estimates in the right panel are calculated from the difference in management score between each country and the United States and the estimated coefficient on the management score term in a firm-level regression of sales on management scores, capital and employment. The sample is based on medium-sized firms, ranging from 50 to 10 000 employees.

Source: OECD calculations based on the management scores and estimated coefficients in Bloom et al. (2012a), "Management Practices Across Firms and Countries", *NBER Working Paper*, No. 17850.

These cross-country differences in R&D, patents and managerial quality are reflected in broader estimates of KBC, which also include computerised information, creative property, design, brand equity and firm-specific human capital (Figure 1.5).[13] For example, English-speaking countries (particularly the United States), Japan and Sweden invest relatively heavily in KBC; this translates into a relatively larger contribution of intangible capital deepening to labour productivity growth (Figure 1.6). By contrast, the resources devoted to KBC and their contribution to productivity growth tend to be smaller in some continental and southern European economies (van Ark et al., 2008).

Figure 1.5. Investment in KBC varies significantly across countries



Notes: The estimates refer to the market sector and include each of the types of KBC listed in Table 1.1 and mineral exploration. * Data for Canada in Panel B refer to 1998 and 2005.

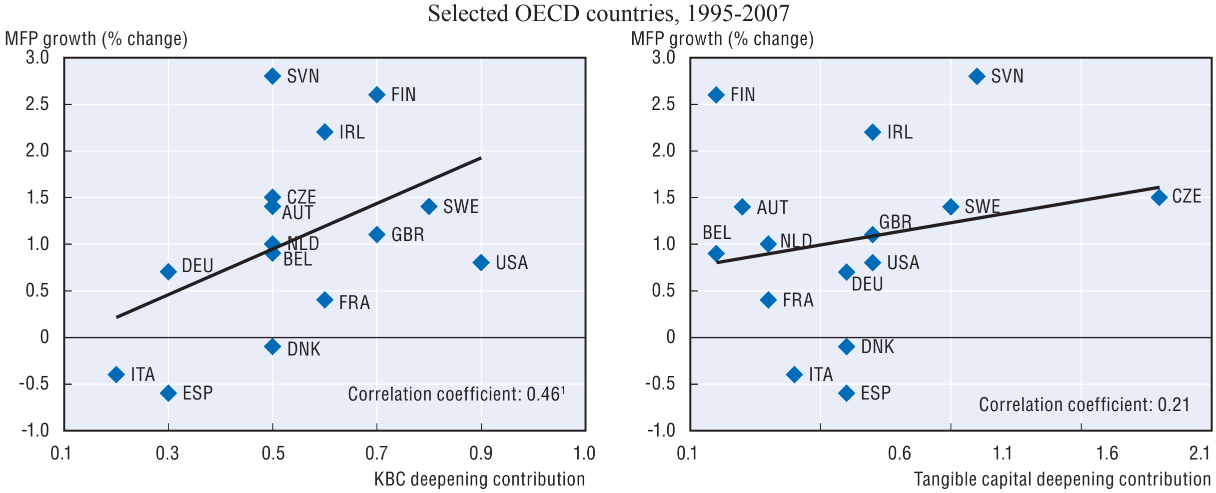
Source: Corrado et al. (2012), "Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results", mimeo, INTAN-Invest.

Beyond their direct effect on capital accumulation, these cross-country differences matter because KBC is often only partially excludable so that privately created knowledge diffuses beyond its place of creation and creates wider benefits. While it is difficult to estimate knowledge spillovers, empirical studies that focus on R&D have generally found these effects to be relatively large (Hall et al., 2010; Australian

Productivity Commission, 2007). Furthermore, the positive association between the contribution of capital deepening and MFP growth is clearer for KBC than for tangible capital, which provides suggestive – albeit crude – evidence of such spillover effects (Figure 1.6).

Figure 1.6. Knowledge-based capital and spillover effects

Selected OECD countries, 1995-2007



Note: Labour productivity growth can be broken down into the contribution of capital deepening and the contribution of MFP. The chart plots the contribution of KBC/tangible capital deepening to labour productivity growth against the growth rate of MFP. The correlations are robust to individually dropping outliers, such as the Czech Republic, Finland and Slovenia. Unlike conventional growth accounting exercises (e.g. Figure 1.2), the MFP estimates are based on a value-added series that capitalises the full set of KBC indicators outlined in Table 1.1.

* denotes statistical significance at the 10% level.

Source: Corrado et al. (2012), "Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results", mimeo, INTAN-Invest.

There are also important complementarities between organisational capital and investment in ICT capital. They are particularly significant because cross-country differences in aggregate growth in OECD countries depend to a considerable extent on the performance of key ICT-intensive sectors (van Ark et al., 2008). To extract the maximum benefit from ICT, firms typically need to adopt ICT as part of a "system" of mutually reinforcing organisational changes (Brynjolfsson et al., 1997), which will be easier to accommodate in firms with better organisational capital. In fact, Bloom et al. (2012b) attributed at least one half of the US-"Europe"[14] difference in labour productivity growth between 1995 and 2004 to superior management practices, which significantly raised the productivity of ICT capital in the United States. The findings are confirmed by a study of firm-level MFP growth for a broader sample of OECD countries (Andrews, 2013; see Annex 1.A1). For example, in sectors that use ICT intensively, increases in organisational capital intensity are associated with swifter firm MFP growth than in other sectors.

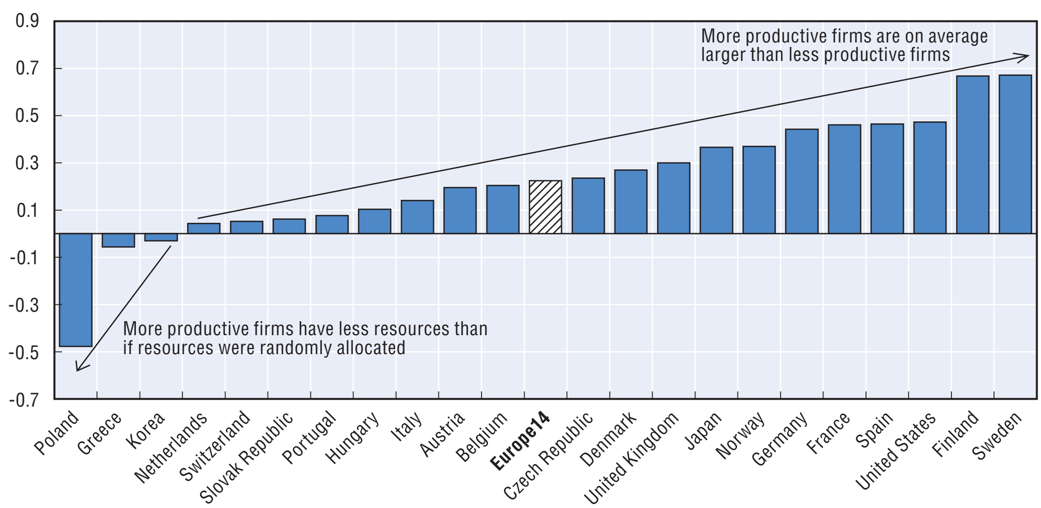
From macro to micro: KBC, innovation and resource allocation

Differences in resource allocation are correlated with KBC use

Cross-country differences in KBC deepening at the aggregate level tend to coincide with diverging patterns of firm performance within countries, which reflect the scope and ease of reallocation and the prevalence of certain innovation strategies. Empirical evidence suggests that some countries are more successful than others in channelling resources towards innovative and high-productivity firms. One consequence of this is that, other things being equal, the extent to which the most productive firms have the largest market shares – a metric that has been taken to represent the degree of allocative efficiency in an economy (Olley and Pakes, 1996) – also tends to vary across countries. For instance, new OECD estimates suggest that more productive firms are likely to account for a much larger share of manufacturing employment in the United States and some Nordic countries than in some continental European countries (Figure 1.7). Moreover, an emerging literature links these sizeable differences in allocative efficiency across countries to policy distortions, with important consequences for aggregate performance. For example, estimates suggest that if China and India aligned the efficiency of their resource allocation to that of the United States, manufacturing total factor productivity (TFP) could rise by 30-50% in China and 40-60% in India (Hsieh and Klenow, 2009).

Figure 1.7. OECD countries differ in their ability to allocate labour to the most productive firms

Covariance across firms between firm size and labour productivity; log points, selected OECD countries, 2005



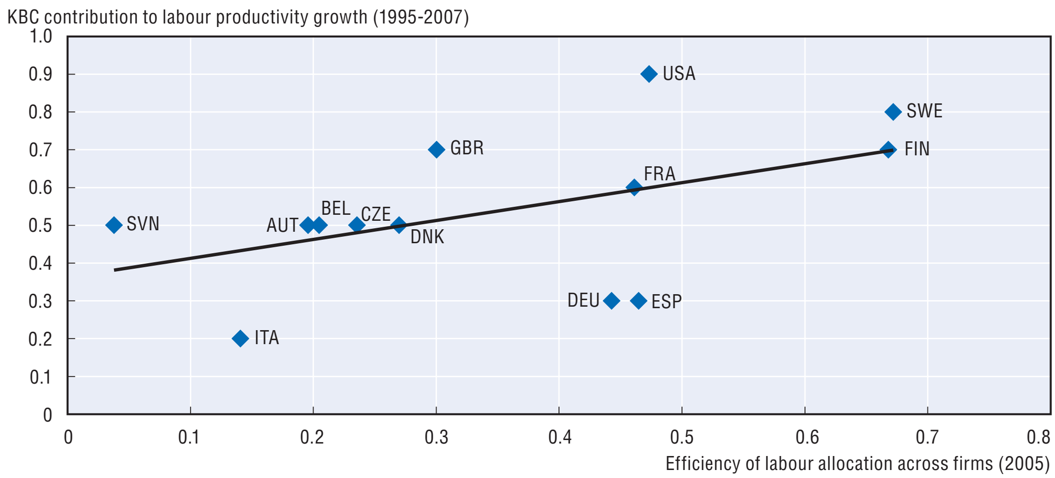
Notes: the estimates show the extent to which the firms with higher than average labour productivity have larger employment shares. In most countries, the covariance between productivity and employment share is positive, suggesting that the actual allocation of employment boosts manufacturing labour productivity, compared to a situation in which resources are allocated randomly across firms (this metric would equal zero if labour was allocated randomly). For example, manufacturing labour productivity in the United States is boosted by around 50% due to the rational allocation of resources. Europe-14 includes: Austria, Belgium, Czech Republic, France, Greece, Germany, Hungary, Italy, Netherlands, Portugal, Poland, Spain, Slovak Republic and Switzerland. The result is obtained by aggregating the respective allocative efficiency indicators by each countries share in manufacturing sector employment.

Source: Andrews and Cingano (2012), "Public Policy and Resource Allocation: Evidence from Firms in OECD Countries", *OECD Economics Department Working Papers*, No. 996, OECD Publishing, doi: http://dx.doi.org/10.1787/5k9158wpf727-en.

Countries that are more successful at channelling resources to the most productive firms also tend to invest more in KBC. As argued above, incentives to invest in KBC partly depend on perceptions about the ease with which labour and capital will flow to successful firms (can be reallocated from less productive to more productive firms) and ultimately result in a more efficient allocation of resources in an economy. Figure 1.8 provides *prima facie* evidence of a positive correlation between investment in KBC and the efficiency of allocation, based on the indicator introduced in Figure 1.7.[15] This evidence is confirmed by more formal empirical analysis, described below.

Figure 1.8. Knowledge-based capital deepening and efficiency of resource allocation

Selected OECD countries



Source: Details on the intangible capital and resource allocation estimates are contained in Figures 1.6 and 1.7, respectively.

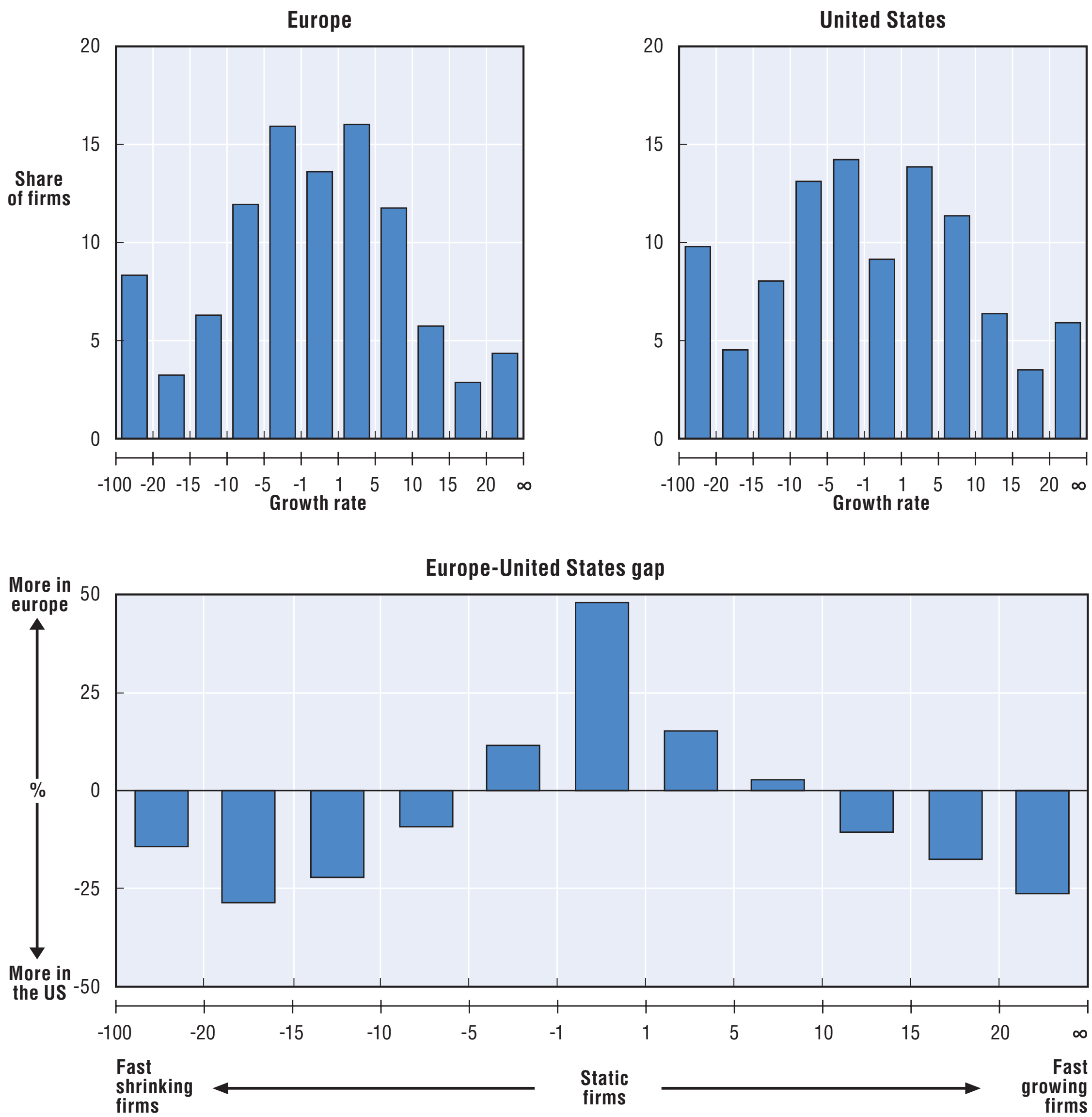
The extent to which innovative firms attract resources differs across countries

Cross-country differences in the post-entry performance of firms tend to be more marked than differences in entry and exit patterns (Bartelsman et al., 2003). In fact, there are large differences in the extent to which young firms grow over their life cycle (Hsieh and Klenow, 2012). For example, from birth to 35 years, employment in the typical (surviving) manufacturing plant increases by a factor of ten in the United States, of two in Mexico and actually declines in India, while productivity increases by a factor of eight in the United States, but only of two in India and Mexico. One interpretation of these findings is that firms with the potential to become larger are likely to face higher marginal input costs in some countries than others. This could occur if public policies are size-contingent or financial market frictions prevent efficient capital reallocation. Another interpretation is that a lack of market integration lowers the returns to innovation (Hsieh and Klenow, 2012).

Firm-level empirical studies also reveal important differences among higher-income countries. Entering and exiting firms tend to be smaller in the United States than in Europe and successful young firms tend to expand relatively more quickly in the United States than elsewhere (Bartelsman et al., 2012). This is consistent with the more dynamic distribution of firm growth in the United States, where successful firms grow faster and unsuccessful firms shrink faster than in Europe (Figure 1.9). Firm productivity within industries also tends to be more dispersed in the United States than in Europe (Bartelsman et al., 2004), though recent evidence points to important differences in productivity dispersion in Europe (Altomonte, 2010). These differences may be due to greater experimentation and "learning by doing" in the United States, given that the largest differences are in high-technology and emerging sectors where experimentation and intensive use of KBC are likely to be strong (Bartelsman et al., 2008). This suggests that institutional differences, which shape differences in the cost of reallocating resources, may explain why some European countries have been relatively slow to capitalise on the ICT revolution (Bartelsman et al., 2010; Conway et al., 2006), and enjoy the growth potential of KBC.[16]

Figure 1.9. The distribution of firm employment growth

United States and selected European countries; 2002-05

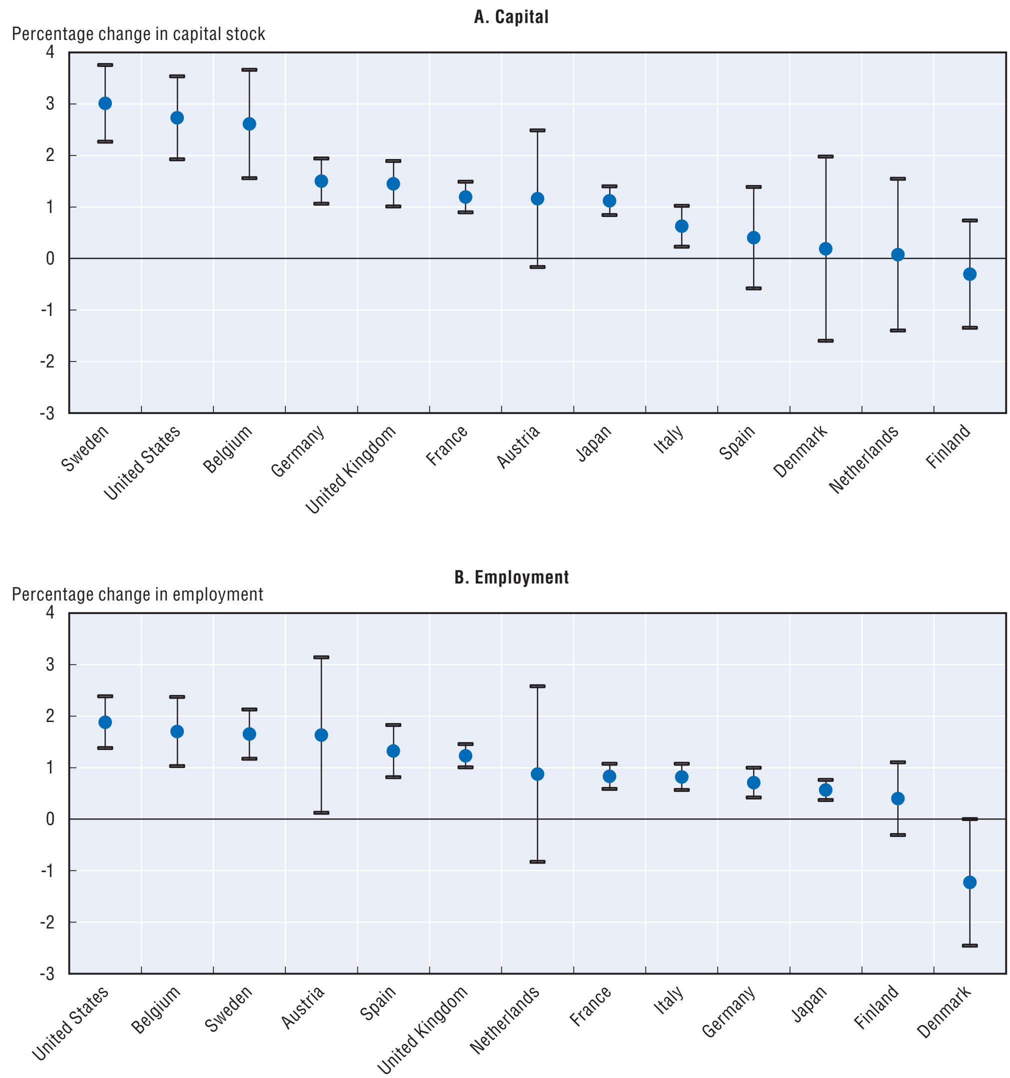


Notes: The figure compares the distribution of firm employment growth between the United States and the average of Austria, Denmark, Spain, Finland, Italy, Netherlands and Norway (countries for which data were available). The European countries in the sample have a larger share of static firms (growing between -5% and 5% a year) than the United States where more firms grow more than 5% or shrink more than 5% a year. The bottom panel shows the Europe-US differential in percentage terms. For example, the share of firms with employment growth above 20% is 5.9% in the United States and 4.3% in Europe, which translates into a differential of around -26%.

Source: Bravo-Biosca (2010), "Growth Dynamics: Exploring Business Growth and Contraction in Europe and the US", research report, NESTA and FORA, London, based on national business register data.

Figure 1.10. Do resources flow to more innovative firms?

Additional inputs attracted by a firm that increases its patent stock by 10%, selected OECD countries, 2002-10



Note: The black dot shows the country-specific point estimate and the grey bands denote the 90% confidence interval (the confidence interval varies across countries owing to differences in the number of observations). These estimates are obtained from the following baseline fixed effects regression specification:

$$\ln Y_{i,s,c,t} = \beta_1 \ln(PatS_{i,s,c,t}) + \eta_i + \mu_{s,c,t} + \varepsilon_{i,s,c,t}$$

where Y is the economic characteristic (employment or capital) for firm i, in sector s, in country c at time t and $PatS$ is the depreciated patent stock of firm i. The specification also includes firm fixed effects and industry*country*year fixed effects. To obtain the country-specific estimate, $PatS$ is interacted with various dummy variables for each country.

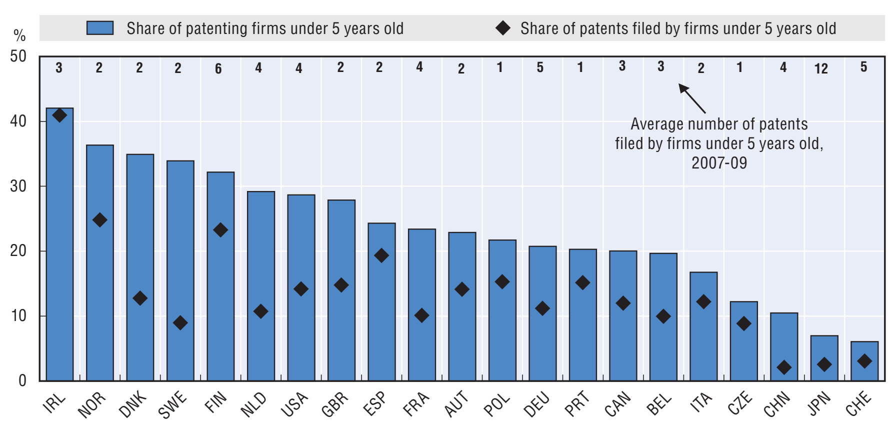
Source: OECD calculations based on firm-level data from the ORBIS-Patstat Database for the non-farm business sector. See Andrews et al. (2013), "Do Resources Flow to Innovative Firms? Cross-Country Evidence from Firm-Level Data" *OECD Economics Department Working Papers*, forthcoming, OECD, Paris.

To implement and commercialise new ideas, firms require a range of complementary tangible resources to test ideas (e.g. to develop prototypes and business models), develop marketing strategies and eventually produce on a commercially viable scale (Figure 1.10). New OECD evidence (Andrews et al., 2013) uses longitudinal data to explore what happens to important economic variables when firms patent (see Box 1.2 for details). It reveals important differences among countries in the extent to which capital and labour flow to innovative firms. For example, a 10% increase in the patent stock is associated with an increase in the typical firm's capital stock of about 3% in Sweden and the United States; 1.5% in the United Kingdom and Germany; and a 0.5% in Italy and Spain (Figure 1.10, Panel A). Similarly, patenting firms in the United States can attract labour roughly twice as easily as in the average OECD country (Figure 1.10, Panel B).[17]

Cross-country differences tend to be driven by younger firms. The sensitivity of capital to patenting is about five times greater in the United States than in Italy for young firms but only about double for older firms. Caution should be used when drawing conclusions from these differences owing to the limitations of the data. However, their significance is enhanced by the differences across countries in patenting by young firms (Figure 1.11), which are also more much more likely to file a radical patent than older firms (Andrews et al., 2013). Moreover, the resource flows associated with radical patents are around two times larger in Sweden and the United Kingdom than in Italy. One interpretation of these findings is that firms in countries in which reallocation costs are lower may be more willing to experiment with disruptive technologies than in those in which they are higher.

Figure 1.11. Patenting activity by young firms

Selected OECD countries, 2007-09



Note: Refers to patents filed at the European Patent Office and United States Patent and Trademark Office.

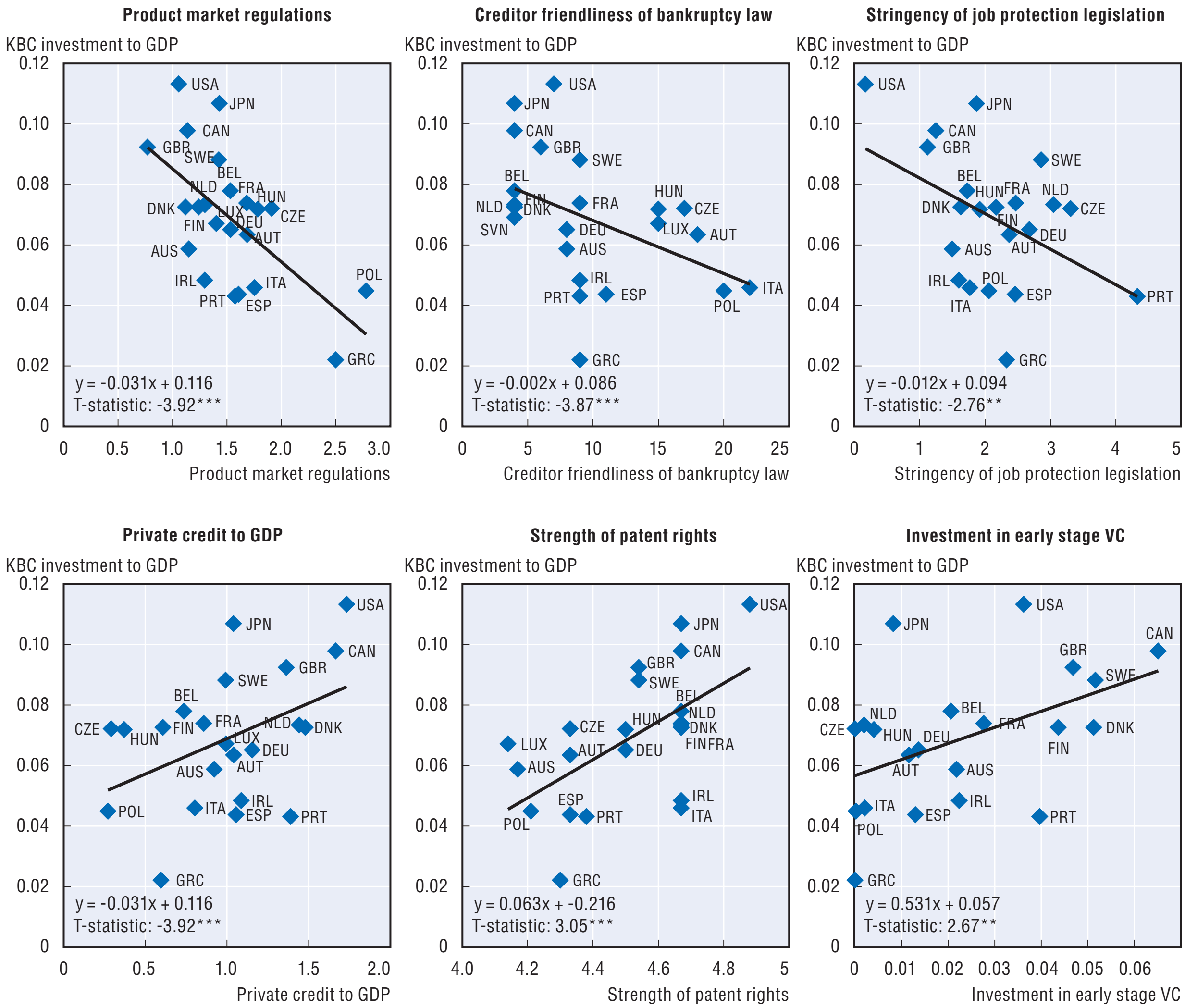
Source: OECD (2011a), *OECD Science, Technology and Industry Scoreboard 2011*, OECD Publishing, doi: http://dx.doi.org/10.1787/sti_scoreboard-2011-en.

The role of public policy

While a wide range of policy instruments may affect the KBC-innovation-reallocation nexus, this section focuses on a key subset of policies affecting the business environment and innovation using the framework developed above. For each policy considered, it examines the direct and indirect impact on the three building blocks: developing and adopting new ideas; implementing and commercialising new ideas; and reaping the benefits of new ideas through changes in market share and profitability. For illustrative purposes, Figure 1.12 shows some preliminary evidence on the links between selected public policies and investment in KBC from a recent study by Corrado et al. (2012). While the correlations are only suggestive (and subject to reverse causality), countries with less stringent regulations in product and labour markets and deeper financial markets tend to have higher rates of investment in KBC, while investment in KBC is positively correlated with debtor-friendly bankruptcy codes and higher seed and early-stage venture capital.

Figure 1.12. Investment in KBC and selected public policies

Share of GDP, selected OECD countries, 2005



Note: Intangible investment to GDP is measured in 2005, while the policy indicators refer to either 2003 (product market regulation [PMR], employment protection legislation [EPL], Bankruptcy Law and Private Credit to GDP) or 2005 (Patent rights and early stage venture capital [VC]).

Source: OECD calculations based on intangible capital estimates from Corrado et al. (2012), "Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results", mimeo, INTAN-Invest; and policy indicators from: OECD (PMR, EPL and Early Stage VC); World Bank (Bankruptcy Law and Private Credit to GDP); and Park (2008; patent rights).

This section explores in greater depth the links between policies, investment in KBC (including innovation) and the underlying reallocation of resources using the empirical approaches described in Box 1.2. Given that the measures of KBC in Figure 1.12 are only available on a consistent basis for a limited set of countries and time periods, the policy analysis is based on partial measures of KBC – such as R&D and patents – and on MFP for which internationally comparable data are more readily available at the firm, sectoral and aggregate levels.[18]

Box 1.2. Empirical approaches

The empirical research on which this chapter is based exploits country-, sector- and firm-level data to explore how policies affect reallocation and innovation outcomes. While studies based on aggregate and sectoral data use OECD data, micro-aggregated analyses use country-specific business registers, and firm-level analyses uses commercial databases (e.g. ORBIS, ThomsonONE) matched with administrative patent data. These data have been harmonised to improve cross-country comparability (see Gal, 2013, for details with respect to ORBIS).[1] Details on the country and time coverage for each study are contained in Table 1.2.

Aggregate level analysis

Westmore (2013) uses cross-country error-correction (ECM) panel estimation to explore the policy determinants of R&D expenditure and patenting, an approach similar to that of Jaumotte and Pain (2005b). The links between R&D and patents and total factor productivity are identified, as is the extent to which policies shape the returns to knowledge. Overall, this research provides evidence on the average impact of policies on innovation but not on the channels through which policies operate.

Sectoral level analysis

The impact of framework and innovation-specific policies on R&D expenditure at the industry level, by embedding a differences-in-differences estimation strategy in the ECM approach employed in Westmore (2013). While the results are generally inconclusive, an effect of labour market regulations on R&D expenditure was found. See Appendix 2 of Andrews and Criscuolo (2013) for details.

Using a neo-Schumpeterian growth framework in which a sector's MFP growth is determined by the sector's distance from the productivity frontier as well as the growth at the productivity frontier, Bas et al. (2013) find that tariffs on intermediate inputs in upstream sectors affect productivity growth in downstream manufacturing industries. They also explore whether the estimated effects vary with a sector's distance to the productivity frontier and the technological content of the intermediate inputs.

Micro-aggregated and firm level analysis

Bravo-Biosca et al. (2013) use administrative firm-level data from national business registers to explore how public policies shape the distribution of firm growth. For each country-industry, indicators that depict the distribution of employment growth (e.g. the share of high growth, growing, static and shrinking firms) are related to country-level policies using a differences-in-differences estimator.

Andrews and Cingano (2012) use ORBIS data to construct an index of allocative efficiency at the sectoral level, which measures the extent to which firms with higher levels of labour productivity in an industry also have higher market (employment) shares (see Figure 1.11 for an example). In turn, these indicators are related to country-level policies in a differences-in-differences econometric framework and to sectoral policies in a narrower sample of services sectors.

Andrews (2013) explores the extent to which framework policies and innovation-specific policies affect MFP growth at the firm level, using a neo-Schumpeterian growth framework. The impact of country-level policies is identified using a differences-in-differences estimator, and the heterogeneous effects of policies are explored by allowing the impact of the policy to vary with a firm's distance to the productivity frontier. See Annex 1.A1 for details.

Using a fixed effects regression framework, Andrews et al. (2013) exploit firm-level panel data on key economic performance variables and patenting activity to explore the association of changes in the patent stock over time with flows of capital and labour to patenting firms (firms in ORBIS are matched to firms in PATSTAT). The role of policy in explaining the observed cross-country differences in the magnitude of these flows is explored by introducing interaction terms between the firm-level patent stock and framework policies. The paper also looks at differences in policy impacts according to the age of the firm.

Criscuolo and Menon (2013) explore the drivers and the characteristics of risk finance in the Cleantech sector, with a focus on the role of supply-side, demand-side and fiscal environmental policies. They use comprehensive commercial deal-level information on businesses seeking investment in this sector, matched with patent-level data and indicators of renewable policies and government R&D expenditures.

Da Rin et al. (2013) explore the contribution of supply-side policy initiatives to cross-country differences in the supply of seed and early-stage financing. They exploit information at the deal level from the ThomsonOne database and use a panel econometric specification to explore the correlation of policies with the volume of seed and early-stage financing and indicators of the structure of seed and early-stage financing (e.g. the age at which the firm receives financing). See Annex 1.A2 for details.

…/…

Box 1.2. Empirical approaches *(continued)*

Table 1.2. Country and period coverage in the empirical analysis

	Westmore (2013)	Bas et al., (2012)	Bas (2012)	Andrews & Cingano (2012)	Andrews (2013)	Andrews et al., (2013)	Bravo-Biosca et al., (2012)	Criscuolo & Menon (2013)	Da Rin, et al. (2013)
Australia	X	X	X					X	X
Austria	X	X	X	X	X	X	X	X	X
Belgium	X	X	X	X	X	X		X	X
Canada	X	X	X				X	X	X
Chile									X
Czech Republic		X		X	X	X		X	X
Denmark	X	X	X	X	X	X		X	X
Estonia									X
Finland	X	X	X	X	X	X	X	X	X
France	X	X	X	X	X	X		X	X
Germany	X	X	X	X	X	X		X	X
Greece			X	X	X	X			X
Hungary				X	X				X
Iceland			X						X
Ireland	X		X					X	X
Israel								X	X
Italy	X	X	X	X	X	X	X	X	X
Japan	X	X	X	X		X		X	X
Korea			X	X	X			X	X
Luxembourg									X
Mexico									X
Netherlands	X	X	X	X	X	X	X	X	X
New Zealand									X
Norway	X		X	X	X	X	X	X	X
Poland				X		X			X
Portugal	X			X	X	X			X
Slovak Republic				X	X	X			X
Slovenia									X
Spain	X	X	X	X	X	X	X	X	X
Sweden	X	X	X	X	X	X		X	X
Switzerland	X			X		X		X	X
Turkey									X
United Kingdom	X	X	X	X	X	X	X	X	X
United States	X	X	X	X	X	X	X	X	X
Number of countries	19	16	20	22	19	20	9	26	xx
Time period	1983-2008	1996-2007	1991-2009	2005	1999-2009	2002-2010	2002-2005	2005-2010	1995-2011

Note: Criscuolo and Menon (2013) also include Brazil, China, India, Hong Kong (China) and Singapore. Data for the United States are available for each exercise. However, when a differences-in-differences estimation framework is employed, the United States is excluded from the sample (except by Bravo-Biosca et al., 2013, who use an instrumental variable approach).

1. The empirical studies that use ORBIS data have benefited greatly from the efforts of Gal (2013), "Measuring Total Factor Productivity at the Firm Level using OECD-ORBIS", *OECD Economics Department Working Papers*, No. 1049, OECD Publishing, doi: http://dx.doi.org/10.1787/5k46dsb25ls6-en.

Framework policies have pervasive impacts on the KBC-innovation-reallocation nexus

Product market regulations

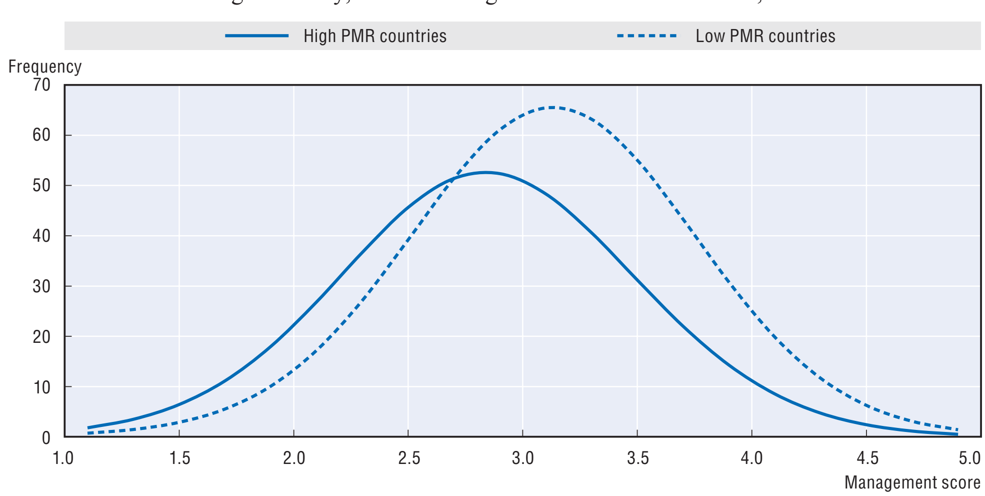
Product market regulations (PMR) have a pervasive impact at each stage of the innovation process, and empirical studies show a negative relationship between PMR and productivity at the aggregate level (Bouis et al., 2011) and at the firm and sectoral levels (Aghion et al., 2004; Bourlès et al., 2010) as well as an inverted U-shaped relationship between indicators of competition and innovation (Aghion et al., 2005).

PMR influence the formation of new ideas (Figure 1.1, stage 1) through their effects on innovative effort. Lower entry regulations increase the supply of new ideas by raising firm entry rates (Fisman and Sarria-Allende, 2010; Klapper et al., 2006; Ciccone and Papaioannou, 2007). This raises competitive pressure and increases pressure on incumbent firms to innovate. New OECD evidence shows that a modest reduction in PMR in the energy, transport and communications sectors – corresponding to the difference in regulation between Australia and Austria in 2008 – could result in a 5% increase in the stock of business enterprise R&D and a 3% rise in patents per capita in the long run (Westmore, 2013). This can be expected to raise annual MFP growth by around 0.1% but would take some time to materialise given the relatively sluggish adjustment of R&D to shocks. Similarly, the positive impact of knowledge spillovers from abroad on domestic patenting activity is significantly higher in countries in which barriers to entry for new firms are relatively low (Westmore, 2013). This suggests that reforms to PMR can raise incentives for firms to incorporate foreign technologies (Parente and Prescott, 2000; Holmes et al., 2008).

Product market reforms affect innovation and its implementation through improved managerial performance that enhances the ability of firms to undertake the internal reallocations required to implement new technologies and to sustain the innovation process. Pro-competition policies are likely to improve management performance by imposing greater market discipline, which truncates the tail of poorly managed (and unproductive) firms (Schmitz, 2005; Bloom and Van Reenen, 2010). The tail of poorly managed firms in countries with less stringent product market regulations, such as the United States, is smaller than in countries where product market regulations are generally more cumbersome (Figure 1.13).

Figure 1.13. Product market regulation and the distribution of managerial practices across firms

Increasing efficiency, manufacturing firms in selected countries, 2004-10

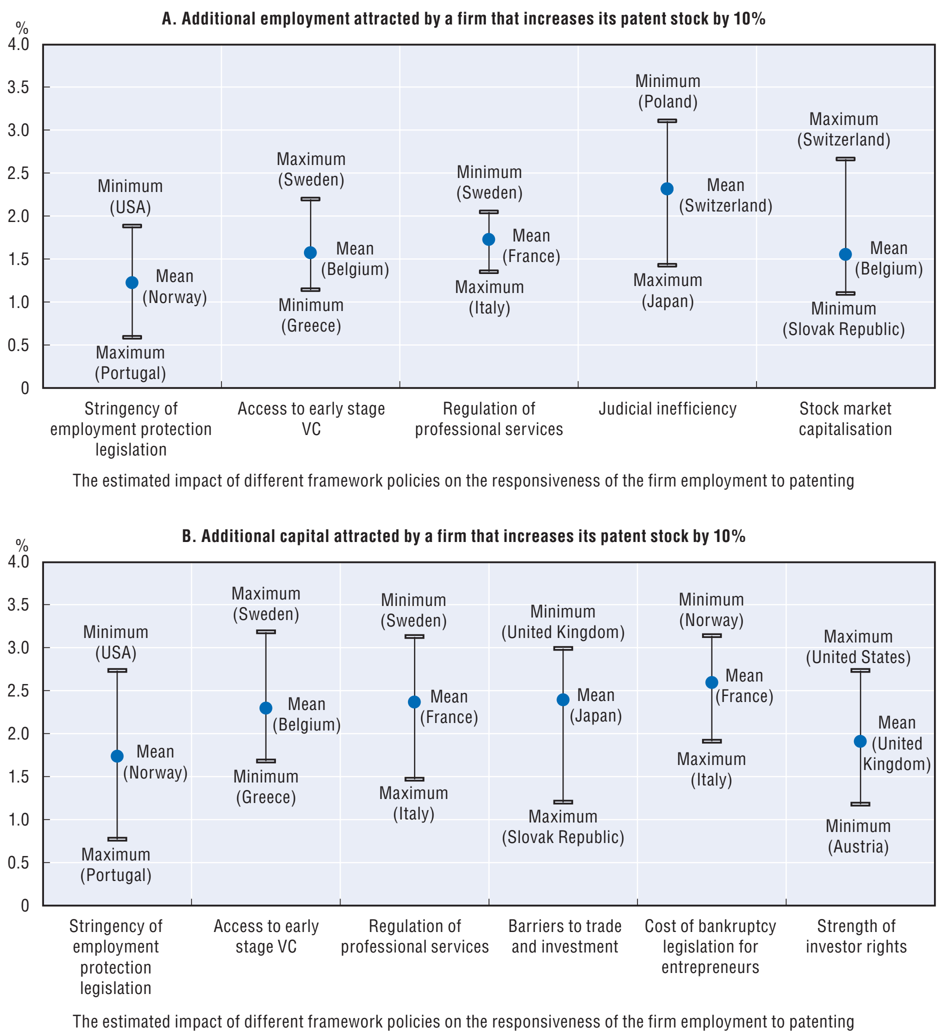


Notes: Countries are grouped according to their ranking in the overall OECD product market regulation index in 2008. Countries in the low PMR group include: Australia, Canada, Germany, Japan, New Zealand, Ireland, Sweden, United Kingdom and the United States. Countries in the high PMR group include: Brazil, Chile, China, France, Greece, India, Italy, Mexico, Poland and Portugal. Since the number of firms in the underlying dataset varies across countries, the management score distributions are scaled to a common number of firms in each country prior to aggregation. See Figure 1.4 for details on management score data.

Source: OECD calculations based on management score data from Bloom et al. (2012a), "Management Practices Across Firms and Countries", *NBER Working Paper*, No. 17850; and OECD PMR indicators.

Product market regulations also influence the ability of firms to attract the tangible resources they need to implement and commercialise new ideas (Figure 1.1, stage 2). Figure 1.14 shows how the estimated flow of resources to patenting firms (a concept first introduced in Figure 1.10) varies under different policy settings based on new OECD econometric modelling (Andrews et al., 2013). For example, a policy reform that would reduce the stringency of regulations affecting business services from the OECD average (i.e. France) to the low level in Sweden is associated with an increase in the size of innovative firms by 20% in terms of employment and 30% in terms of the capital stock.[19]

Figure 1.14. Framework policies and resource flows to patenting firms, 2002-10



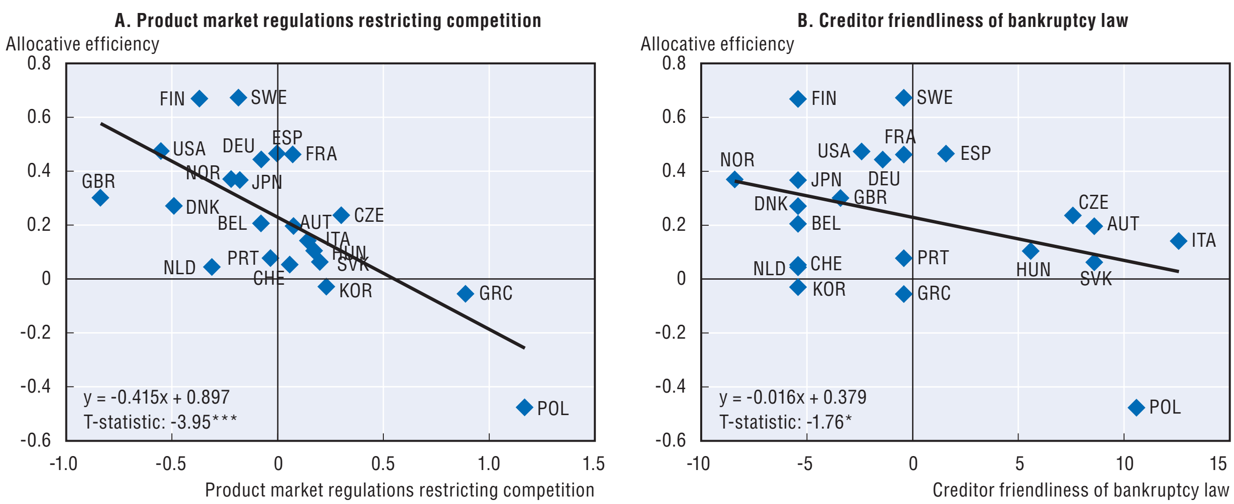
Note: The figure shows that the sensitivity of employment and capital to changes in the patent stock varies according to the policy and institutional environment. The estimates are obtained by including an interaction term between the patent stock (PatS) and policy variables in the baseline equation outlined in the notes to Figure 1.10. All policy terms are statistically significant at least at the 10% level. Panel A shows that the sensitivity of firm employment to patenting is three times larger when EPL is at the sample minimum (i.e. the United States), than when it is at the sample maximum (i.e. Portugal).

Source: OECD calculations based on matched ORBIS-PATSTAT data. See Andrews et al. (2013) for details. EPL is the OECD employment protection legislation sub-index of restrictions on dismissal of individual workers with regular contracts; regulation of professional services and barriers to trade and investment are sourced from the OECD PMR Index; stock market capitalisation is expressed as a percentage of GDP and is sourced from the World Bank along with judicial efficiency and strength of investor rights. Judicial efficiency refers to the cost of enforcing contracts, which measures the court costs and attorney fees as a percentage of debt value. Strength of investor rights takes into account the extent of corporate disclosure, directors' liability and ease with which shareholder can sue company officers. See Figure 1.12 for details on early-stage VC and bankruptcy legislation.

Product market regulations influence the ability of economies to capitalise on innovation via rapid changes in market shares of successful firms (Figure 1.1, stage 3). Across OECD countries, less stringent product market regulations tend to be associated with higher allocative efficiency in manufacturing sectors (Figure 1.15A), a relationship confirmed by econometric analysis (Andrews and Cingano, 2012). Inappropriate service regulations also have a sizeable negative effect on aggregate productivity, owing to the trickle-down effect of inefficiencies in resource allocation in the service sector. For example, a highly regulated country such as Spain would eventually experience a 4% increase in aggregate productivity if it reduced anti-competition barriers in the services sector to the level of Denmark. Reforms to regulation in the services sector tend to have stronger effects on resource allocation when labour and credit markets are more responsive. This indicates that the benefits of higher entry and competition are more fully realised when barriers that hinder the flow of labour and capital to their most productive use are also low (Andrews and Cingano, 2012).

Figure 1.15. Allocative efficiency and framework policies

Selected OECD countries, 2005



Note: Allocative efficiency measures the contribution of the allocation of employment across firms to manufacturing labour productivity in 2005 (see Figure 1.11). Product market regulation refers to the overall index of the OECD PMR for 2003. For details on the cost to close a business, see Figure 1.12.

Source: Andrews and Cingano (2012), "Public Policy and Resource Allocation: Evidence from Firms in OECD Countries", *OECD Economics Department Working Papers*, No. 996, OECD Publishing, doi: http://dx.doi.org/10.1787/5k9158wpf727-en.

Trade and investment restrictions

The liberalisation of barriers to international trade and investment stimulates aggregate productivity (Bouis et al., 2011) by raising the scope for knowledge diffusion and technological transfer across borders (Coe and Helpman, 1995), by encouraging more efficient resource allocation (Caves, 1985) and by expanding market size, which raises the returns to innovation, as discussed above.

With respect to the formation of new ideas (Figure 1.1, stage 1), recent evidence from a sample of European firms shows that the removal of product-specific quotas (on Chinese imports into Europe) following China's accession to the WTO triggered a significant increase in R&D, patenting and productivity (Bloom et al., 2011). Domestic innovation is also driven by knowledge spillovers from abroad, which depend on the extent of openness to trade and absorptive capacity. For example, an increase in exposure to trading partners' R&D stocks – which measures how intensively a country trades with countries that do R&D – from the average level in Spain (around the OECD average in 2005) to the higher level in Canada (corresponding to the 75th percentile across countries) is estimated to boost patents per capita by around 20% in the long run (Westmore, 2013).

Trade liberalisation is also likely to increase the scope for technology transfer and the potential for adoption of frontier technologies. As such knowledge spillovers are partly embodied in imported intermediate goods, reductions in tariffs on intermediate inputs are associated with a (statistically and economically) significant increase in productivity growth in downstream manufacturing sectors (Bas et al., 2013). Moreover, to the extent that the benefits of foreign knowledge diffuse through the direct transmission of ideas rather than through trade in goods and services that embody them, barriers to foreign direct investment hinder knowledge adoption and growth.

For the subsequent stages of the innovation process in Figure 1.1, reductions in barriers to trade and investment increase the ability of patenting firms to attract the capital needed to implement and commercialise new ideas (Figure 1.14, Panel B). Moreover, reforms to trade and investment policy improve the ability of national economies to leverage the benefits of innovation at the firm level through increases in the market share of successful firms. Across the services sector in OECD countries, higher restrictions on FDI are associated with lower allocative efficiency (Andrews and Cingano, 2012). These findings imply that lowering FDI restrictions from the relatively high levels of Poland to the levels of Germany could lead to a rise in aggregate productivity of around 2%.

Job protection legislation

By raising labour adjustment costs, stringent employment protection legislation slows the reallocation process (Haltiwanger et al., 2006) and aggregate productivity growth (Bassanini et al., 2009; Autor et al., 2007).[20] At the same time, EPL has important effects on the nature of innovation. For example, by raising exit costs, stringent EPL makes experimentation with uncertain growth opportunities – which is essential for promoting investment in KBC – less attractive. From this perspective, strict EPL curbs incentives to develop new ideas through its negative effects at the later stages of the innovation process (Figure 1.1).

New OECD evidence shows that more stringent EPL lowers productivity growth by handicapping firms that operate in environments subject to frequent technological change and place high value on flexibility in order to experiment with uncertain technologies. As Figure 1.14 shows, stringent EPL significantly reduces the ability of innovative firms to attract the tangible resources they need to implement and commercialise new ideas (Figure 1.1, stage 2). Moreover, the burden falls disproportionately on young firms. This reinforces the idea that stringent EPL reduces the scope for experimentation with radical innovation.

These findings are in line with firm-level evidence that more stringent EPL is associated with lower MFP growth in ICT-intensive sectors in which experimentation is common, particularly in firms close to the technology frontier (Andrews, 2013; see Annex 1.A1). In fact, countries with stringent EPL tend to have smaller high-risk innovative sectors associated with intensive use of ICT (Bartelsman et al., 2010). MNEs tend to concentrate more technologically advanced innovation in countries with low EPL that accommodate disruptive shifts in resources more readily (Griffith and Macartney, 2010). More stringent EPL also disproportionately reduces R&D expenditure, one indicator of the investment in the formation of new ideas (stage 1), in sectors with higher rates of patenting intensity and particularly in more turbulent sectors where reallocation needs are likely to be more intense (see Appendix 2 of Andrews and Criscuolo, 2013).

EPL also affects the ability of national economies to gain from successful innovations through increases in the market share of innovating firms (Figure 1.1, stage 3). For example, in sectors with naturally higher reallocation needs, as measured by job layoffs, firm turnover and ICT intensity (e.g. electrical and optical equipment), less stringent EPL disproportionately raises allocative efficiency (Andrews and Cingano, 2012) relative to other sectors. Similarly, in more R&D-intensive industries, less stringent EPL raises productivity growth because it is associated with a more dynamic firm growth distribution, that is, a lower share of static firms and higher share of growing and shrinking firms (Bravo-Biosca et al*.,* 2013; Figure 1.16).

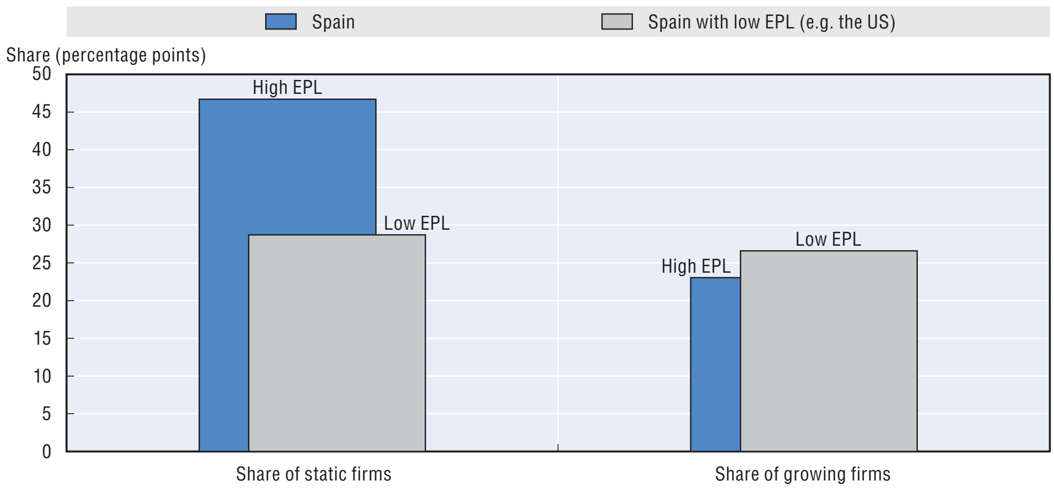
In Europe, stringent EPL also stunts the development of venture capital (VC) financing in highly volatile sectors (Bozkaya and Kerr, 2013). This is because strict EPL hinders the overall development of the high-growth sectors in which VC specialises and weakens the core VC business model, which relies on the aggressive reallocation of resources across the investment portfolio from failing to high-performing ventures. However, there is no such trade-off between VC and social protection in countries that rely more on labour market expenditures (e.g. unemployment insurance benefits) than on EPL to protect workers against labour market risk. This is because the costs of the higher general taxation required to finance labour market expenditures are not concentrated on a single margin of adjustment (like EPL), but are shared throughout the economy. Thus, well-designed social safety nets and the portability of health and pension benefits can help workers displaced by reallocation without imposing significant costs in terms of resource flexibility and innovation.

While stringent EPL is undesirable from the perspective of promoting experimentation and thus investment in KBC, employment protection may also raise worker’s commitment and firm’s incentives to invest in firm-specific human capital and potentially raise within–firm productivity (Autor, 2003; Wasmer, 2006). While empirical evidence for this hypothesis is scarce (see below), it nonetheless suggests that labour market reforms should be designed and implemented in a broad-based fashion. Indeed, the asymmetric liberalisation of employment protection for temporary contracts while leaving in place stringent regulations on permanent contracts – which took place in many European countries – may have adverse effects on the accumulation of firm specific human capital, to the extent that firms substitute temporary for regular workers and temporary workers are less likely to participate in job-related training (see Martin and Scarpetta, 2012).

Empirical evidence for the hypothesis that stringent EPL might be beneficial to innovation and within–firm productivity via these channels is scarce. Acharya et al., (2010) find a positive relationship between EPL and patenting based on a sample of five countries and argue that strict EPL fosters innovation by making firms less likely to dismiss workers in the event of short-run project failures. New OECD research, however, does not confirm this relationship for a broader sample of countries (Westmore, 2013). Nevertheless, there is some evidence to support the idea that stringent EPL is less detrimental in industries characterised by cumulative innovation processes, where innovation-driven labour adjustments are more likely to be accommodated by upgrading the skills of existing employees than by worker turnover. For example, Andrews and Cingano (2012) find that while strict EPL has an adverse effect on resource allocation in turbulent innovative sectors, this is not the case in sectors characterised by cumulative patterns of innovation (such as the chemicals sectors).

Figure 1.16. More flexible EPL is associated with a more dynamic distribution of firm growth in R&D-intensive industries

The differential impact of EPL on the share of firms in each employment growth grouping



Note: The darker columns show the estimated shares of static and growing firms in an R&D-intensive industry (electrical and optical equipment; NACE Rev.1.1. 30-33) in a country with stringent EPL (e.g. Spain). The lighter columns show the estimated shares of static and growing firms in the electrical and optical equipment sector if Spain adopted more flexible EPL (e.g. corresponding to the policy setting in the United States). Higher EPL also has modest negative effects on the share of shrinking and high-growth firms but these effects are not shown. Therefore, the shares presented in the figure do not sum to 100.

Source: Bravo-Biosca et al. (2013), "What Drives the Dynamics of Business Growth?", *OECD Science, Technology and Industry Policy Papers*, No. 1, OECD Publishing. doi: http://dx.doi.org/10.1787/5k486qtttq46-en.

Bankruptcy legislation and judicial efficiency

Like stringent EPL, bankruptcy laws that impose excessively high exit costs in the event of business failure may make entrepreneurs less willing to experiment with risky technologies. At the same time, bankruptcy codes that provide no safeguards for creditors may reduce the supply of credit. Therefore, some balance is required.

Bankruptcy regimes that severely penalise failed entrepreneurs, whether by forcing liquidation more often or limiting entrepreneurs' ability to start new businesses in the future, are likely to reduce the willingness to take risks and thus the supply of new ideas (Peng et al., 2010; de Serres et al., 2006).[21] Similarly, studies that control for the possibility that economic outcomes influence bankruptcy regimes (i.e. reverse causality) find that more debtor-friendly bankruptcy codes are associated with greater intensity of patent creation, patent citations and faster growth in countries relatively more specialised in innovative industries (Acharya and Subramanian, 2009). More debtor-friendly bankruptcy codes are also associated with more rapid technological diffusion, which enables laggard countries to catch up to the technological frontier (Westmore, 2013).

The right balance between leniency and protection of creditors in bankruptcy legislation will also depend on specific features of entrepreneurs' activities. Bankruptcy legislation that does not excessively penalise failure – as measured by a lower cost to close a business – can promote the flow of capital to more innovative firms (Figure 1.14, Panel B; Andrews et al., 2013), by reducing entrepreneurs' expectations that they will be heavily penalised in case of failure. By contrast, if the cost of winding down a business is very high, risky entrepreneurial ventures may not be brought to the market to avoid incurring high exit costs in case of failure. Indeed, bankruptcy codes that heavily penalise failure are negatively associated with MFP growth and the share of high-growth firms in capital-intensive industries (Bravo-Biosca et al*.,* 2013). Finally, across OECD countries, less stringent bankruptcy legislation is associated to some extent with higher allocative efficiency (Figure 1.15, Panel B). This effect is particularly strong in sectors with naturally higher firm turnover rates where regulations affecting exit costs are most likely to bind (Andrews and Cingano, 2012).

Swift reallocation of resources from failed ventures will also be affected by the time required to complete legal procedures to wind up a business and by obstacles to the use of out-of-courts arrangements. In extreme cases, legal procedures may take years to complete, and would undermine effective reallocation and the accumulation of entrepreneurial capital.

Finally, well-designed legal systems can support efficient resource allocation (Haltiwanger, 2011) and raise returns to innovation (Nunn, 2007).[22] For example, in countries with more efficient judicial systems – proxied by a lower cost of enforcing contracts[23] – labour flows more readily to patenting firms (Figure 1.14, Panel A).[24]

Innovation-specific policies are important but generate trade-offs

Private investment may be at or above the socially desirable level for some types of KBC (e.g. branding), but government intervention is warranted to compensate for market failures in innovative efforts such as R&D. This section discusses a range of innovation policies and focuses on their effects on the formation of new ideas (Figure 1.1, stage 1), and the possible unintended consequences for the reallocation mechanisms that are central to the later stages. Key risks for innovation policies are that they might: i) support activities that would take place in the absence of support; ii) distort or reduce innovation effort; and iii) be prone to rent seeking. Such schemes should therefore aim to minimise wasteful expenditures (OECD, 2006). As robust evidence on the effectiveness and optimal design of innovation policies is scarce, more effective cost-benefit analyses of policies are required.

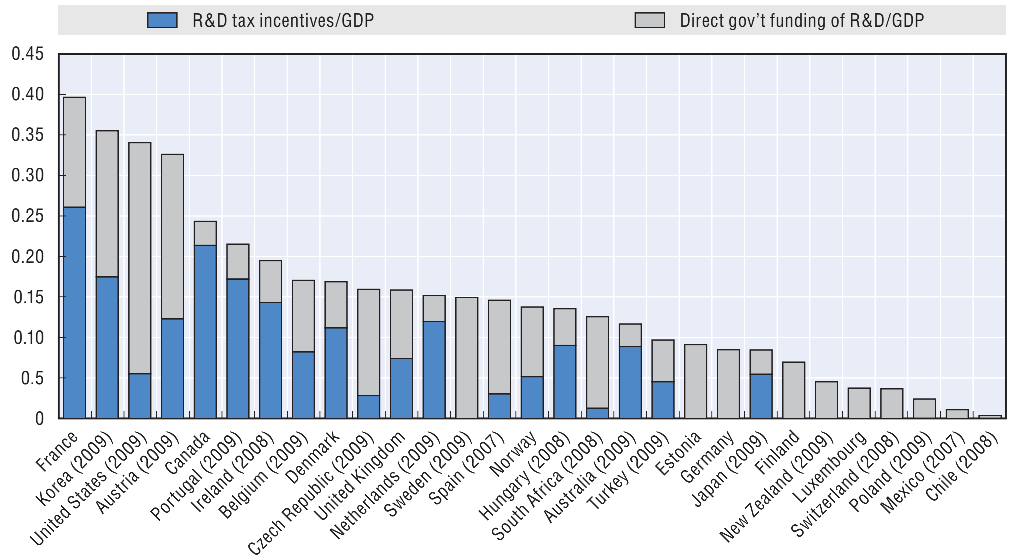
Fiscal incentives for R&D

R&D tax incentives, a non-discriminatory tool that aims to reduce firms' marginal cost of R&D activities, are provided in 27 of the 34 OECD member countries and in Brazil, China, India and the Russian Federation.[25] Support for business R&D through the tax system is typically combined with a broader set of direct support policies (e.g. grants, loans, loan guarantees) to address market failures related to investment in innovation. While there are significant cross-country differences in the policy mix (Figure 1.17), there has recently been a shift away from direct support (Figure 1.18) and towards more generous R&D tax incentives (OECD, 2009b).

These trends should be assessed in light of new evidence suggesting that while R&D tax incentives remain a useful policy instrument, direct support measures may be more effective in encouraging R&D than previously thought. It also appears that the features of both kinds of policies determine their cost to tax payers and their unintended consequences. It would seem, therefore, that issues related to the design of these schemes should take precedence over increases in their generosity.

Figure 1.17. Direct government funding of business R&D (BERD) and tax incentives for R&D

Budget impact as a percentage of GDP; 2010 or latest available year

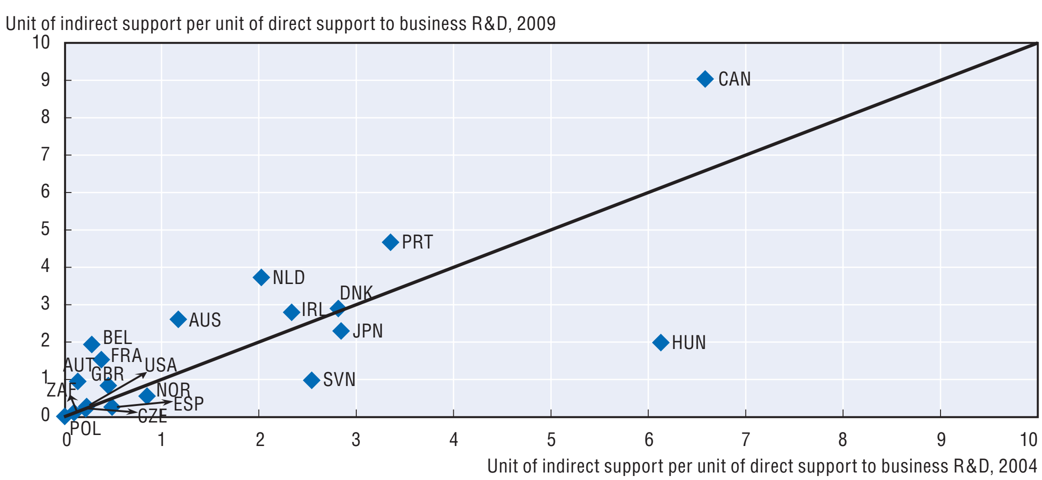


Notes: Countries ranked from highest to lowest R&D tax incentives/GDP. R&D tax incentives do not include sub-national incentives. Direct government funding includes grants and public procurement of R&D and excludes repayable loans. Figures are not shown for Greece, Israel, Italy, the Slovak Republic, China and the Russian Federation, which provide R&D tax incentives, but cost estimates are not available. For the United States, direct government funding of R&D includes defence spending on R&D by the government in the form of procurement contracts or the subcontracting by government agencies of non-classified projects to private firms. That is, it includes only R&D spending not directly performed by national or publicly funded institutions (e.g. military laboratories etc). If a project is conducted by the private firm in direct collaboration with the government, publicly funded institutions or universities, only the part that is done by the private firm and paid to her would be included.

Source: OECD, Main Science and Technology Indicators (MSTI) Database, June 2012; OECD R&D tax incentive questionnaires of January 2010 and July 2011; OECD (2011a), *OECD Science, Technology and Industry Scoreboard*, OECD publishing, Paris, doi: http://dx.doi.org/10.1787/sti_scoreboard-2011-en; and national sources.

Figure 1.18. R&D tax incentives versus direct support to business R&D, 2004 and 2009

Foregone tax revenues on R&D for USD 1 of direct support



Source: OECD (2011a), *OECD Science, Technology and Industry Scoreboard 2011*, OECD Publishing, doi: http://dx.doi.org/10.1787/sti_scoreboard-2011-en.

There are, moreover, cross-country differences in the design and administration of both R&D tax incentives and direct support measures. R&D tax incentives differ significantly in terms of their targets (Table 1.3), and the composition of direct programmes (loans, loan guarantees, grants, etc.) varies across countries. These differences should be kept in mind for the following discussion.[26]

Effectiveness of R&D tax incentives and direct support measures

Estimates of the private "R&D price elasticity" indicate that a 10% reduction in the user cost of R&D increases the volume of private-sector R&D spending by about 1% in the short run and 10% in the long run (Bloom et al., 2002).[27] The greater responsiveness in the long run reflects adjustment costs (Hall and van Reenen, 2000) and is consistent with limited effectiveness of an R&D tax incentive if the supply of scientists and engineers is not sufficiently elastic (Goolsbee, 1999). New OECD evidence broadly supports these conclusions. For example, a 6% increase in the generosity of R&D tax incentives – e.g. from the level in the United States to the level in Japan in 2008 – is estimated to increase the level of R&D by about 6% in the long run (Westmore, 2013).

Table 1.3. Differences in R&D tax incentives schemes across selected countries, 2013

Design of the R&D tax incentive scheme	*Volume-based R&D tax credit*	Australia*, Austria, Belgium (capital), Canada, Chile, Denmark, France, Norway
	Incremental R&D tax credit	United States (mostly)**
	Hybrid of a volume-based and an incremental credit	Ireland, Italy, Japan, Korea, Portugal, Spain
	R&D tax allowance	Belgium (Capital Region), Brazil, China, Chile, Columbia, Czech Republic, Finland, Hungary, India, Netherlands, Russian Federation, Singapore, Slovenia, South Africa, Turkey, United Kingdom
Payroll withholding tax credit for R&D wages		Belgium, Hungary, Netherlands, Spain, Turkey
R&D tax incentive is not refundable		Brazil, China, Chile, Columbia, Czech Republic, India, Italy, Japan, Korea, Poland, Portugal, Russia, Singapore, Slovenia, South Africa, United States (mostly)**
R&D tax incentive does not contains carry-over provisions		Austria, Brazil, Columbia, Italy, Norway.
More generous R&D tax incentives for SMEs		Australia, Canada, France, Hungary, Japan, Korea, Netherlands, Norway, Portugal, United Kingdom
Targeting	*Special for energy*	United States (volume-based)
	Special for collaboration	Hungary, Italy, Japan, Norway
	Special for new claimants	France
	Special for young firms and start-ups	Belgium, France, Netherlands, Portugal
Ceilings on amounts that can be claimed		Austria, Denmark, France, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Singapore, Spain, United Kingdom, United States
R&D income-based R&D tax incentives		Austria (individuals), Belgium, China, France, Hungary, Luxembourg, Netherlands, Spain, Switzerland, Turkey, United Kingdom
Special treatment of technology acquisitions (capital cost)		Poland
No R&D tax incentives		Estonia, Germany, Israel, Mexico (repealed), New Zealand (repealed), Sweden

Note: R&D tax allowances are tax concessions up to a certain percentage of the R&D expenditure and can be used to offset taxable income; R&D tax credits reduce the actual amount of tax that must be paid. No R&D tax incentives means no R&D tax credit or allowance but does not preclude accelerated depreciation allowances. * In 17 February 2013, the Australian Government announced that companies with aggregated turnover of USD 20 billion (about USD 21 billion) or more will no longer be eligible for the R&D tax incentive. This change will apply to income years commencing on or after 1 July 2013, but is yet to be legislated. **Qualified energy consortia in the United States are eligible for a volume-based R&D tax credit.

Source: OECD Directorate of Science, Technology and Industry. Based on information available as of March 2013.

The effectiveness of R&D tax incentives also depends on the stability of the policy regime over time (Guellec and van Pottelsberghe, 2003). In countries that have experienced a high number of R&D tax policy reversals, the estimated impact of R&D tax incentives on private R&D expenditure appears to be greatly diminished (Westmore, 2013).

New OECD research also shows that direct government subsidies can encourage additional business R&D (Westmore, 2013). However, this result does not hold when the analysis is conducted on data pre-dating the 2000s; this is consistent with earlier research that did not find a significant relationship between direct R&D subsidies and additional private R&D spending over the period 1982-2001 (Jaumotte and Pain, 2005b). The estimated increase in the effectiveness of R&D direct support may reflect a shift in the structure of public support, which has become more focused on subsidies for commercial R&D activities and has seen matching grants become a more common feature of government funding programmes (Blanco Armas et al., 2006; Hall and Maffioli, 2008). [28]

Evidence on the relative effectiveness of these policy instruments in stimulating intramural R&D is scarce. A study for Norway (Hægeland and Moen, 2007) suggests that an additional dollar of tax credits had a somewhat larger effect on R&D than an additional dollar of direct support. While estimating these "bang for the buck" multipliers in a cross-country setting is more complicated and requires a number of restrictive assumptions, the available evidence suggests that direct support has a larger impact than volume-based tax incentives on R&D (Westmore, 2013).[29] As discussed below, however, the impact of R&D tax incentives and direct support mechanisms may vary across different types of firms.

While R&D tax incentives and direct support boost R&D expenditure, it is important that they ultimately raise productivity growth to the extent that such programmes carry associated compliance and administration costs. They can be expected to have positive effects on productivity growth, since both lead to additional business R&D and business R&D has important effects on productivity growth (Westmore, 2013). However, direct empirical evidence on the impact of R&D tax incentives and direct support on productivity growth is not clear-cut (Brouwer et al., 2005; Lokshin and Mohnen, 2007; Westmore, 2013).

The failure to find that these fiscal incentives have a clear direct positive effect on productivity growth may be due to measurement and identification issues, but may also arise if:

- These fiscal incentives lead to an increase in the price of R&D (e.g. via higher wages of scientists) rather than the volume of R&D. Recent estimates suggest that a wage effect could reduce the effectiveness of R&D tax incentives (in terms of the volume of R&D) by 10% (Lokshin and Mohnen, 2008) to 30% (Haegeland and Møen, 2007). In this case, the effectiveness of such schemes could be enhanced by education policies that raise the supply of skilled workers.
- Projects financed by R&D tax incentives have lower than average marginal productivity (Hægeland and Moen, 2007) and may not have the highest social rate of return (i.e. the most knowledge spillovers). For example, evidence suggests that R&D tax incentives have a positive effect on incremental innovations that are new to the firm (e.g. Czarnitzki et al., 2005; De Jong and Verhoeven, 2007) but not on innovations new to the market (Cappelen et al., 2012).
- R&D tax incentives may lead to duplication of R&D or relabeling of non-R&D activities as R&D investment (Lemaire, 1996; Hall and Van Reenen, 2000). However, tentative evidence suggests that such policies are unlikely to lead to significant increase in relabeling of investment (Westmore, 2013).
- Information problems can limit governments' ability to channel direct support measures to projects with the greatest potential.

- The firms that benefit the most from these fiscal incentives are those for which R&D is less likely to generate large spillovers and significant increases in aggregate productivity growth. While smaller – but not necessarily younger – firms tend to be more responsive to R&D tax incentives than larger firms (Lokshin and Mohnen, 2007; Hægeland and Moen, 2007)[30] the aggregate impact of R&D tax incentives might be dwarfed if such firms focus on niche markets (Bloom et al., 2013b).

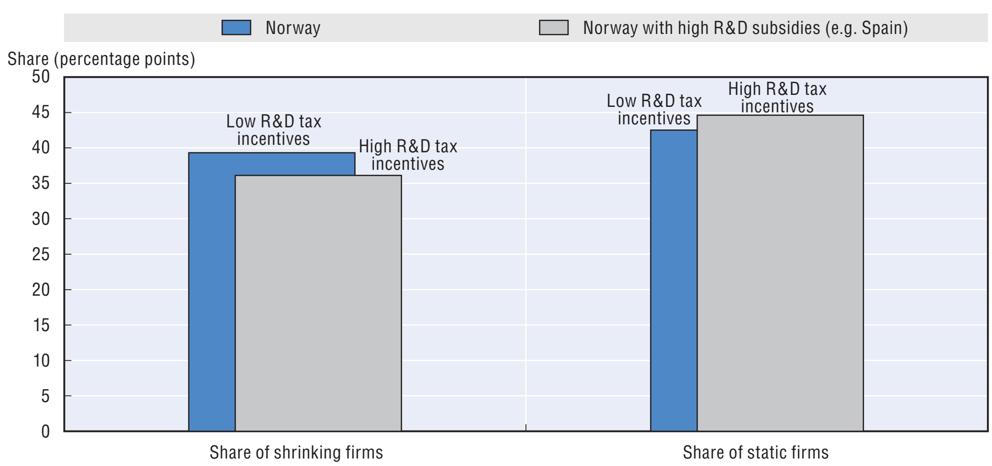
The importance of policy design

These issues are likely to be affected by the design of innovation policies. Design also plays an important role in minimising the cost to tax payers and the unintended consequences of these policies.[31]

New OECD evidence suggests that R&D tax incentives protect incumbents at the expense of potential entrants, thus slowing the reallocation process (Bravo-Biosca et al., 2013). Figure 1.19 shows that more generous R&D tax credits are associated with a less dynamic distribution of firm growth in R&D-intensive sectors, i.e. a higher share of stagnant firms and a lower share of shrinking firms. They thus benefit disproportionately the slowest-growing incumbent firms. This suggests that R&D tax incentives may involve an important trade-off from the perspective of the KBC-innovation-reallocation nexus. At the same time, differences in the extent of direct support – as measured by the share of business R&D financed by government – do not appear to shape the distribution of firm employment growth, suggesting that such policies have a more neutral impact on incumbents than on entrants.[32]

Figure 1.19. More generous R&D fiscal incentives are associated with a more static distribution of firm growth in R&D-intensive industries

The differential impact of R&D tax incentives on the share of firms in each employment growth grouping



Note: The figure gives a numerical example of how more generous R&D tax incentives affect the distribution of firm employment growth, based on the (statistically significant) coefficient estimates in Bravo-Biosca et al. (2013). The darker columns show the estimated shares of shrinking and static firms in an R&D-intensive industry (electrical and optical equipment; NACE Rev.1.1. 30-33) in a country with relatively low R&D tax incentives (Norway). The lighter columns show the estimated shares of shrinking and static firms in the electrical and optical equipment sector if Norway adopted more generous R&D tax incentives (corresponding to the level of R&D tax subsidies in Spain).

Source: Bravo-Biosca et al. (2013), "What Drives the Dynamics of Business Growth?", *OECD Science, Technology and Industry Policy Papers*, No. 1, OECD Publishing. doi: http://dx.doi.org/10.1787/5k486qtttq46-en.

When countries' R&D tax incentive schemes lack immediate cash refunds and/or carry-over provisions (Table 1.4), they may provide less assistance to young firms, which are typically in a loss position in the early years of an R&D project. In fact, the lack of an immediate refund may significantly reduce the effective rate of the tax subsidy to R&D, even in countries that apparently provide relatively generous support (Elschner et al., 2011). The use of payroll withholding tax credits for R&D wages, whereby firms receive an immediate refund for expenditure on the wages for R&D personnel, is another way to provide support for (young) firms in a loss position.

Even if R&D tax incentive schemes are refundable and contain carry-over provisions, young firms may not fully benefit if they lack the upfront funds required to start an innovative project. Direct public funding might be more beneficial than R&D tax incentives for young, financially constrained firms (Busom et al., 2012) if direct support helps to certify the quality of young firms and projects. This could reduce problems associated with information asymmetry (e.g. Lerner, 1999; Blanes and Busom, 2004), which tend to be much more pronounced for radical than for incremental innovations (Czarnitzki and Hottenroot, 2011). This would lower the cost of capital for the firms that receive grants when they apply for external sources of financing.

Table 1.4. Characteristics of R&D tax incentive schemes with respect to refunds and carry-over provisions

Selected countries, 2013

	Refundable	Carry-over provisions
Austria	This benefit is refundable to the extent the credit exceeds the amount of the tax liabilities.	No
Australia	Small firms can claim a refund; any excess non-refundable R&D tax credts can be forward indefinitely but not carried back	Carry-forward available for all firms
Belgium	A payroll withholding tax credit or allowance works in practice like a fully refundable system since the remission (tax benefit) is immediately implemented through the wage tax system, while unused credit (from the tax credit scheme) can be refunded after 5 years.	Investment deduction may be carry forward indefinitely or converted into a tax credit refundable after 5 years
Brazil	No	No
Canada	Cash refund for small Canadian-owned firms, but with a cap (baseline limit is CAD 3 million and is reduced according to a function of taxable income and taxable capital.)	Carry-back (3 years) and carryforward (20 years) available for all firms
China	No	Tax losses attributable to R&D super deduction claims can be carried forward up to 5 years
Chile	No	Carryfoward (10 years)
Colombia	No	No
Czech Republic	No	Carry-forward for 3 years available for all firms
Denmark	25% of any deficit related to R&D expenses (2012 reform)	n/a
France	2009: immediate refund of all unused credit for all firms (instead of 3 years waiting period) as a temporary measure.Otherwise only refundable for SMEs; new companies; YICs and financially distressed companies	Carry-over (3 year) available
Finland	n/a	n/a
Hungary	A payroll withholding tax credit or allowance works in practice like a fully refundable system since the remission (tax benefit) is immediately implemented through the wage tax system	R&D benefits can be claimed retrospectively within the statute of limitations
India	No	Unused benefits may be carried forward for the next eight years, but cannot be carried back to earlier years.

Table 1.4. Characteristics of R&D tax incentive schemes with respect to refunds and carry-over provisions (*continued*)

	Refundable	Carry-over provisions
Ireland	Refunds available for all firms to be paid over a period of 3 years (Refunds are limited to the greater of the total corporation tax paid by the company for the 10 years prior to the period for which the company is making the claim or the payroll tax liabilities for the specific period in which the expenditures were incurred).	Carry-back (1 year) and indefinite carry-forward also available.
Italy	No	No
Japan	No	Carry forward for 1 year available only if R&D expenditures are higher than the prior year. 2009 to 2010: carry-forward available for 3 years.2010-2011: carry-forward available for 2 years.
Korea	No	Carry-forward up to 5 years.
Netherlands	A payroll withholding tax credit or allowance works in practice like a fully refundable system since the remission (tax benefit) is immediately implemented through the wage tax system	Unused credit (from the innovation income box) can be carried-forward up to 5 years.
Norway	Refund available for all firms within the year the expenses are incurred.	No
Poland	No	Carry-forward for 3 years for new technology (intangible assets) acquisitions available for all firms.
Portugal	No	Carry-forward up to 6 years.
Russia	No	Carry-forward 10 years
Singapore	No	Unutilised R&D expenditures may be carried forward indefinitely, subject to substantial shareholders' test. They may also be carried back subject to certain restrictions.
Slovenia	No	Unused business losses may be carried forward for 3 years
South Africa	No	n/a
Spain	A payroll withholding tax credit or allowance works in practice like a fully refundable system since the remission (tax benefit) is immediately implemented through the wage tax system	Carry-forward up to 15 years.
Turkey	A payroll withholding tax credit or allowance works in practice like a fully refundable system since the remission (tax benefit) is immediately implemented through the wage tax system	Indefinite carry-forward, but with cap
United Kingdom	Refund available for SMEs (refund of GBR 25 by GBR 100 of eligible R&D after April 1 2011). Large companies will become eligible for refundable tax credits beginning in 2013.	Carry-forward (infinite) available for all firms.
United States	No (but available for certain energy research)	Carry backward 1 year (5 years for SMEs). Carry-forward for 20 years available for all firms

Source: OECD Directorate of Science, Technology and Industry. Based on information available as of February 2013. "n/a" denotes that no recent information on policy design was available.

Allocation of direct support should not be automatic but based on a competitive, objective and transparent selection, e.g. by involving independent international experts in the selection process. While this obviously means administrative and compliance costs, subsidies allocated on a selective basis tend to have larger direct effects on firm productivity than automatic subsidies and enable recipient firms to signal their quality to potential investors (Colombo et al., 2011). More broadly, a well designed and transparent system of direct support measures may complement R&D tax incentives as it may help direct public funding to high-quality projects with high social returns (e.g. relevant to green growth and population ageing) and through targeting, may limit forgone tax revenues.

Design issues are also important to minimise the fiscal cost of public support for innovation:

- Incremental tax incentives (which only apply to R&D expenditures above some baseline amount) are more effective in inducing additional business R&D spending than volume-based tax credits (Parsons and Phillips, 2007; Lokshin and Mohnen, 2009). They are less costly from a fiscal perspective since they are less likely to subsidise R&D that would have been conducted in any case. While incremental tax incentives are likely to be preferable to volume-based schemes, their uptake by young and small firms may be limited by the associated compliance costs (e.g. they might need an accountant).
- Governments should recognise that the actual cost will depend on the success/uptake of the policy. This may be difficult to predict when the policy is designed, especially if it triggers a response from multinational enterprises, because, other things being equal, more generous R&D tax incentives abroad are associated with lower levels of domestic R&D. This is because R&D tax incentives tend to tilt MNEs' decisions on the location of their R&D activities amongst very similar locations (Criscuolo et al., 2009). At the same time, new OECD research shows that MNEs can use cross-border tax strategies to shift profits generated by KBC across countries (Chapter 2; Karkinsky and Riedel, 2012), and that this might lead to unintentionally high levels of total tax support for R&D.[33] In addition, R&D tax incentives may unintentionally create scope for rent-seeking behaviour that may adversely affect resource allocation and lead to tax competition. Indeed, the increasing generosity of R&D tax incentives in comparable countries may pressure countries that do not offer them to introduce similar measures.

While the evidence presented above suggests that a policy mix of incremental R&D tax incentives and selective direct grants might be optimal, it is important to keep in mind that the related administrative and compliance costs might be higher than for volume and automatic subsidies. However, it is unlikely that they would be as high as the foregone tax revenue associated with policy measures that support activity that would have taken place in absence of the scheme.

Finally, to evaluate the effectiveness of these policies, monitoring and evaluation are essential: the evaluation of these policies should be part of the policy design. This can be done at a relatively low cost and will help to ensure good value for money in the longer run. The evaluation could entail, for example, *ex ante* collection of data and *ex post* access to data and disclosure of relevant information for academic researchers and independent evaluation agencies as well as *ex ante* experimental policy design (randomisation of participants, use of pilot phases, etc.).

Non-business sector R&D and collaborative research

Some R&D activities have potentially high social value, but much uncertainty may surround their possible commercial applications and the appropriability of potential benefits. Such basic research can lead to future innovations and generate significant economic benefit. In such circumstances, governments may perform (as well as fund) research through universities or public laboratories.

While public research has been at the root of some revolutionary technologies (Sheehan and Wyckoff, 2003), the lags can be long and variable.[34] Some evidence shows that basic research has a positive effect on private R&D investment (Falk, 2004; Jaumotte and Pain, 2005b) while other evidence shows significant crowding out (Guellec and Van Pottelsberghe, 2003). New OECD research finds that increases in government spending on basic research (as a percentage of GDP) are associated with higher firm-level MFP growth in R&D-intensive sectors (Andrews, 2013; see Annex 1.A1). This is in line with survey-based evidence (Cohen et al., 2002).

The initial stage of idea formation (e.g. Figure 1.1, Stage 1) may also involve collaboration between private firms and public research entities, especially for young firms that are less likely to have access to their own research facilities. Indeed, collaboration on R&D by private firms and public research entities has become increasingly common in OECD countries (OECD, 2002) with the growing complexity of innovation and the need for complementary knowledge. New OECD evidence shows that more collaboration, as proxied by the share of higher education R&D financed by industry, is also associated with stronger productivity growth in firms in R&D-intensive sectors (Andrews, 2013; see Annex 1.A1).

Some countries seek to foster these linkages through fiscal incentives for firms that collaborate with a public research institution. Public support is often justified on the basis that: i) co-operative projects are more akin to basic research than other projects; and ii) universities produce knowledge that is more valuable to firms than firms realise. However, it is unclear whether fiscal incentives for collaboration can be justified on the basis of a traditional market failure argument and evidence on the effectiveness of such policies is scarce (Criscuolo et al., 2009).[35]

The role of intellectual property rights

The legal means to protect the intellectual property (IP) embedded in different types of KBC include patents, copyrights, trademarks and design rights. In each case, the primary aim is to preserve incentives to innovate by granting holders the (temporary) ability to exclude others from using an invention. By pushing firms to innovate, competition also plays an important role in fostering innovation. The central policy challenge is to strike a balance between exclusive rights and competition so that the one does not undermine the other. While this is a long-standing issue, a key question today is whether the growing importance of information technology and other KBC-intensive industries has altered the nature of the trade-off. Certain factors suggest that this may be the case, at least for patents.[36]

Balancing incentives to innovate with broad diffusion of knowledge

Patents grant temporary monopolies to inventors in exchange for public disclosure of the technical information relating to the innovation. Such public disclosure is important for fostering further technological advancement, as follow-on innovators may learn from and build upon the patented invention. The patent system can also play a role in easing financial constraints for young firms, as patents may serve as collateral or signals/certification to investors (Häussler et al., 2012; Danguy et al., 2009). Since markets for KBC are underdeveloped, the sale or licensing of patents also serves to facilitate technology trade.

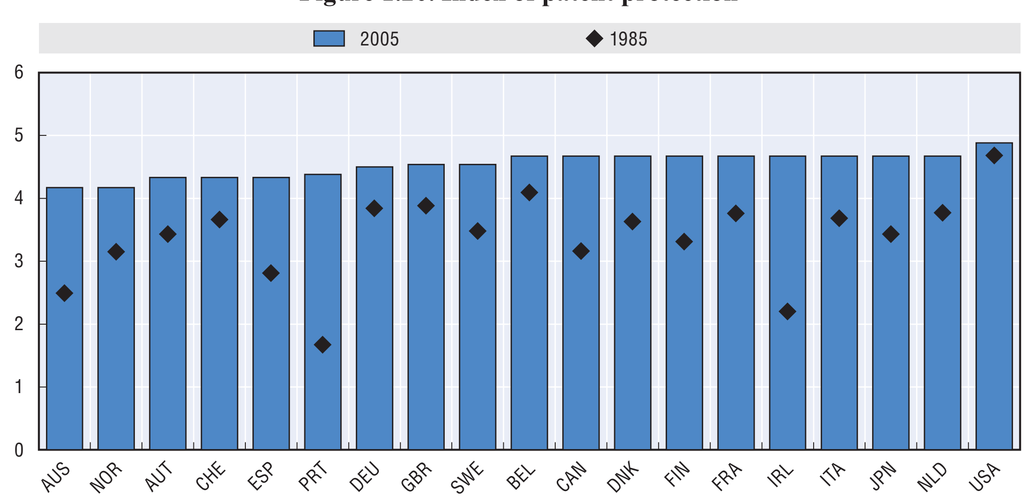
Patents also entail costs. Exclusivity can give the rights holder market power, the impact of which varies with the importance of the protected innovation as an input to other activities and the availability of alternatives. Patents can also raise transactions costs for follow-on innovators, via search costs to ensure that they are not infringing patent rights and legal costs in case of litigation.

While the strengthening of patent protection in recent years (Figure 1.20) has been accompanied by a substantial increase in the number of patents, it is unclear whether this reflects more innovation or more widespread use of patents (Lerner, 2002). Evidence from the United States suggests important differences across sectors, with patents more likely to be associated with increased innovation in the pharmaceutical, biotechnology and chemical sectors (Arora et al., 2001; Graham et al., 2009). This is consistent with the fact that innovation boundaries may be clearer in these sectors and the fact that the invention process is neither particularly cumulative nor highly fragmented (Hall and Harhoff, 2012). This contrasts with information technology industries, where it is common to see products composed of many components, each covered by numerous patents (FTC, 2011)

Complementarities with competition policy

Given the strengthening of patent protection, it is essential not to stifle the competitive forces that motivate innovation or the diffusion of ideas. The complementarity of patent protection and product market regulation settings is highlighted by the positive relationship between the strength of patent regimes and the number of patent applications per capita, but only in countries with pro-competition product market regulations (Westmore, 2013; OECD, 2006). Similarly, increases in patenting rates have a stronger association with MFP growth when product market regulations are lower as it is easier to implement and commercialise new ideas in more competitive markets. More firms can also capitalise on the related knowledge spillovers when barriers to entry are low (Westmore, 2013).[37] While pro-competitive product market regulations are crucial, patent systems can also address market power concerns through safeguards such as compulsory licensing. However, there is little evidence on the impact of such provisions (Box 1.3).

Figure 1.20. Index of patent protection



Source: Park (2008), “International Patent Protection: 1960-2005”, *Research Policy*, Vol. 37, pp. 761-766.

Box 1.3. Compulsory licensing in OECD countries

Patent regimes in many OECD countries contain safeguards such as compulsory licensing, which compels a patent owner to license its innovation to another party in certain circumstances. The grounds for compulsory licensing of patents in most OECD countries generally include at least one of the following (WIPO 2010): i) the non-working of a patent; ii) dependent patents (i.e. a patent that cannot be worked without exploiting an earlier patented invention); iii) patent abuse (i.e. refusing to deal with applicants for a licence); iv) public interest (e.g. national emergencies and pharmaceuticals); and v) breaches of competition law. Compulsory licences have seldom been granted in most OECD countries, and most frequently in the United States, often to remedy anticompetitive conduct and patent infringement (Australian Productivity Commission, 2012).[1]

A key issue is whether compulsory licensing blunts the incentives to innovate. However, the empirical evidence is limited and dated. In the United States in the 1970s companies that were subject to compulsory licensing did not undertake less R&D than firms of similar size in the same industry (Scherer, 2000). In contrast, survey results from the United Kingdom suggested adverse effects on R&D in the pharmaceuticals industry (Taylor and Silberston, 1973). Moser and Voena (2012) find that compulsory licensing encourages domestic invention in the licensing country but do not find a clear long-run effect on invention in the country in which the invention originated. These findings should be interpreted with caution because the effects of compulsory licensing on innovation are likely to be context-specific and at least partly dependent on the how licensing fees are determined.

1. Compulsory licensing has also been used in the United States to gain access to patented inventions for national security purposes. In the European Union, compulsory licensing has been more frequent for copyrights, particularly for software.

The patent system and the KBC economy

While patents are important for encouraging firms to innovate, they may have unintended consequences in some sectors. In rapidly growing domains such as ICT, the patent system may favour incumbents at the expense of young firms and lessen incentives to invest in KBC. Evidence from the United States suggests, for example, that the cost of litigation exceeded the profit from patents in the late 1990s in industries other than pharmaceuticals and chemicals (Bessen and Meurer, 2008). Moreover, the emergence of "patent aggregators" (PAs) that accumulate software patents in order to extract rents from innovators may affect innovation activities (Bessen et al*.,* 2011). While PAs can improve the reallocation of KBC,[38] litigations prompted by PAs show substantial deadweight losses (Bessen et al*.,* 2012).

Finally, with the emergence of "patent thickets"[39] firms may have to pay licensing fees to several parties or hold up production before they can commercialise new technology (UK IPO, 2011). Such patent thickets may affect market entry and disproportionally disadvantage young firms with little bargaining power (Cockburn et al*.,* 2009). They also reduce the ability of young firms to obtain financing (Cockburn and MacGarvie, 2007).

Financing and corporate reporting in the knowledge-based economy

For knowledge-based firms, profitability partly depends on the ability to leverage investments in KBC through rapid increases in the scale of production. This requires access to complementary tangible resources, typically through external finance. Through their effect on reallocation mechanisms, deeper financial markets play an important role in helping firms to implement and commercialise new ideas, thus raising the returns to innovation. For example, resource flows to innovative firms tend to be stronger in countries with a higher ratio of stock market capitalisation to GDP (Figure 1.14, Panel A; Andrews et al., 2013). Similarly, deeper financial markets are associated with a more dynamic distribution of firm growth (i.e. more growing and shrinking firms and fewer static firms) in industries that are highly dependent on external finance (Bravo Biosca et al*.,* 2012).[40]

While the size and development of financial markets matter for innovative firms (Aghion et al., 2005), insufficient collateral may limit access to external financing for firms that rely heavily on KBC. Traditional debt and equity markets primarily rely on tangible assets with well-defined market prices that can serve as collateral. KBC assets are less easy to define and often non-separable and non-transferable, two impediments to the mobility of any single asset across parties and the realisation of full salvage value in the event of bankruptcy.[41] Difficulties in collateralising KBC also arise from the uncertainty and perceptions of risk that characterise KBC, which tend to amplify information asymmetries in lending markets. The importance of collateral is well documented in modern macroeconomic theory; a long line of literature, beginning with Kiyotaki and Moore (1997), draws on the magnifying effects of the availability of collateral to explain business cycle fluctuations.

Corporate reporting of KBC

Such capital market imperfections are often addressed through greater corporate disclosure, such as the release of financial accounting statements (Healy and Palepu, 2001). Good corporate disclosure regimes can promote more efficient resource allocation (EC, 2003) and growth in sectors that are more dependent on external finance (Rajan and Zingales, 1998). The benefits of corporate disclosure are more difficult to achieve for firms that rely heavily on KBC. As excludability is only partial, these firms cannot address asymmetric information via full disclosure because of the risk that imitators will appropriate the rents arising from their KBC. More fundamental, perhaps, is the inability of current corporate accounting frameworks to deal properly with KBC. To be recorded in company accounts, intangibles must adhere to five criteria (Box 1.4) but there is a clear disconnect between these criteria and the economic characteristics of KBC (Hunter et al., 2005). For example, its non-separability, which is partly due to the tendency for KBC to be embodied in people, is clearly at odds with identifiability (as defined in Box 1.4).[42]

Box 1.4. Treatment of intangible assets in International Accounting Standards (IAS)

As outlined in Hunter et al. (2005), intangibles are only recorded in the accounting system as assets if the items, first, meet the asset definition criteria and, second, meet the asset recognition criteria.[1]

Asset definition criteria for intangibles have three attributes:

1. Identifiability: i) the asset is separable, being capable of being separated or divided from the entity and sold, transferred, licensed, rented or exchanged, either individually or together with a related contract, asset or liability; or ii) the asset arises from contractual or other legal rights, regardless of whether those rights are transferable or separable from the entity or from other rights and obligations.[2]
2. Control: "an entity controls an asset if the entity has the power to obtain the future economic benefits flowing from the underlying resource and to restrict the access of others to those benefits."[3]
3. Future economic benefits: benefits flowing from an intangible asset that may include revenue from the sale of products or services, cost savings, or other benefits resulting from the use of the asset by the entity.[4]

Asset recognition criteria for intangibles have two attributes:

1. It must be probable (presumably more than 50% probable) that the economic benefits embodied in the asset will eventuate.
2. The asset must possess a cost that can be measured reliably.[5]

1. IAS 38 Intangible Assets, paragraph 18. 2. IAS 38 Intangible Assets, paragraph 12. 3. IAS 38 Intangible Assets, paragraph 13. 4. IAS 38 Intangible Assets, paragraph 17. 5. IAS 38 Intangible Assets, paragraph 17.

Adherence to such strict accounting criteria leads to an inadequate – but also arbitrary and ad hoc – treatment of KBC in corporate accounting (Hunter et al., 2005). While internally generated intangibles are expensed, otherwise indistinguishable intangibles that are acquired externally (as a complete set) through the market are treated as assets since they are separable and have a verifiable cost.43 These deficiencies in formal accounting for KBC are particularly worrying in the light of evidence showing that in sectors that are more dependent on external finance, growth in R&D expenditure as a share of value added is stronger in countries with good corporate disclosure regimes (Carlin and Mayer, 2000).

Relatively few analysts currently advocate better recognition of KBC in financial statements, but there is a case for encouraging firms to disclose information on their investments in intangibles through so-called narrative reporting (OECD, 2008). Even for narrative reporting, progress has been hampered by the fact that very few jurisdictions have guidelines on such reporting. In principle, policy makers could leverage existing reporting frameworks to encourage firms to report on their intangible assets by developing voluntary national guidelines, but a global dialogue on KBC disclosure is also necessary.

Financing KBC and macro-financial stability

Given the inherent difficulty of collateralising KBC assets, financial markets have been reluctant to provide debt financing to KBC-intensive firms (Jarboe, 2008). KBC has therefore traditionally been financed out of retained earnings (Hall and Lerner, 2009). However, KBC-backed lending rose significantly in the United States up to the financial crisis (Loumioti, 2011). Between 1997 and 2005, the share of secured syndicated loans collateralised by KBC in total secured loans rose from 11% to 24%. This trend was largely underpinned by unregulated lenders – i.e. investment banks – that did not face the same regulatory constraints as commercial banks for valuing KBC as collateral.

The use of KBC as collateral partially alleviated borrowing constraints for large firms, but the practice emerged in a period of excessive expansion of credit. It thus raises the question of whether the collateralisation of KBC was an innovation (with lenders allocating capital prudently) or a symptom of the general deterioration in lending standards. Clearly, this is a difficult hypothesis to test and research is scarce. However, the findings of one econometric study that exploits detailed information on the characteristics of borrowers that received credit over this period are consistent with the hypothesis that the collateralisation of KBC is a credit market innovation (Loumioti, 2011). Rather than ignoring economic considerations in a search for yield and market share, lenders' decisions to accept KBC as collateral appeared "economically rational" in the sense that they: i) prioritised liquid and redeployable KBC (e.g. patents and licensing) as loan collateral, since this is where information asymmetries and moral hazard are less severe; ii) demanded higher compensation for monitoring costs in the form of higher loan spreads; and iii) made loans of similar quality to other secured loans, as measured by *ex post* loan performance (Loumioti, 2011).[44]

Reforms such as Basel III – to the extent that they make banking safer and more stable – are clearly desirable. However, given the risk that more stringent capital requirements could reduce the supply – or increase the cost – of capital for risky business enterprises in the short term (Aghion et al., 2013), it will be interesting to see how this affects the financing prospects of firms that rely mainly on KBC.

Some consequences of the financial crisis for KBC

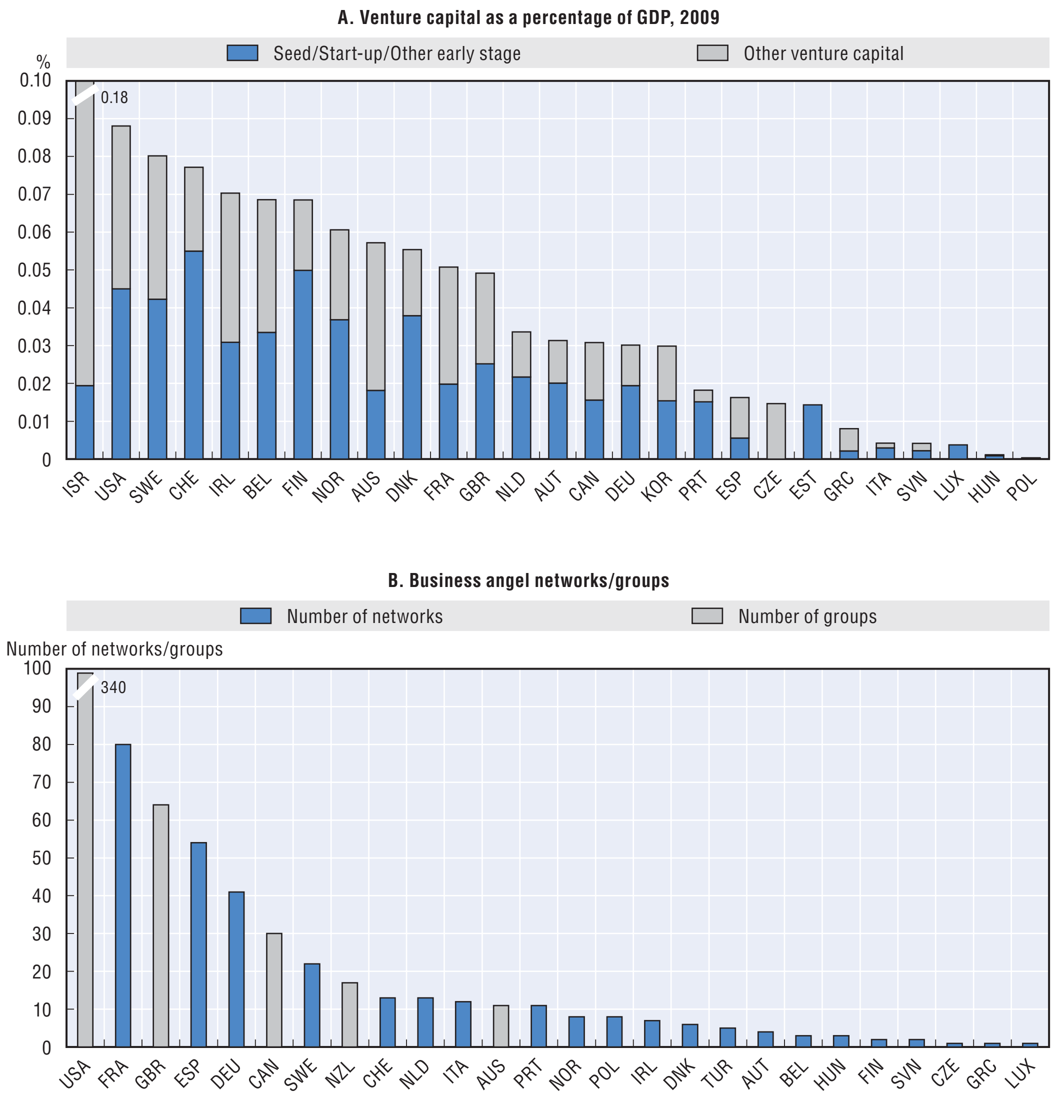
There is little systematic evidence on how firms that rely on KBC have fared in capital markets since the financial crisis. Although recessions typically provide firms with an opportunity to restructure at low cost (Hall, 1991), it is important to recognise the damage that the financial crisis may have done to the financing prospects of KBC-intensive firms. Existing evidence points to the strong adverse effects of financial crises on net (new) firm entry (Caballero and Hammour, 2005), which are likely to reduce the scope for experimentation with new ideas and thus investment in KBC (Ziebarth, 2012; Buera and Moll, 2012). An important risk at present is that the near-zero interest rate policy and distortions in the financial sector sustain highly inefficient firms, thereby preventing the release of resources for the expansion of innovative firms. Aggregate productivity performance in Japan during the 1990s was held back by the tendency for resources to be trapped in "zombie firms", which continued to receive credit despite their poor economic fundamentals (Caballero et al., 2008).

Policies to nurture seed and early-stage financing

Financing constraints tend to be more acute for young firms with limited internal funds and lack of a track record to signal their potential to investors. When asymmetric information problems are large, a "missing markets" problem may arise, and many innovations of young start-up firms may never be commercialised. This financing gap is partly bridged by venture capitalists or business angels, who address information asymmetries by intensive scrutiny of firms before they provide capital and by then monitoring them (Hall and Lerner, 2009; OECD, 2011b). Countries with more developed seed and early-stage venture capital markets tend to invest more heavily in KBC and appear to be more effective at channelling capital and labour to young innovative firms (Figure 1.14).[45] More broadly, econometric studies based on the variation in venture capital (VC) financing that is exogenous to the arrival of entrepreneurial opportunities, tend to find that VC has a sizeable positive impact on innovation and economic growth (Kortum and Lerner, 2000; Samila and Sorenson, 2011b).

Nevertheless, the question of why there is more seed and early-stage VC (SES-VC) financing in some countries remains (Figure 1.21). It is likely that differences in human capital, entrepreneurial attitudes and framework and innovation policies play a role. For example, less stringent employment protection legislation and bankruptcy regimes, with strong exit mechanisms and that do not excessively penalise business failure, can foster the development of SES-VC (Armour and Cumming, 2006), while high rates of taxation on corporate income and capital gains have negative effects on SES-VC (Da Rin et al., 2006). Regulatory barriers may also affect the availability of SES-VC, particularly as regards the ease with which venture capitalists and business angels can organise as limited liability entities (OECD, 2013).[46] Finally, new OECD evidence suggests that regulations that aim to create a market for clean technologies are associated with a higher level of VC investment, while fiscal incentives for investment in these technologies are not effective (Criscuolo and Menon, 2013).[47]

Figure 1.21. Investments in alternative funding mechanisms, 2009



Source: OECD (2011b), *Financing High-Growth Firms: The Role of Angel Investors*, OECD Publishing.
doi: http://dx.doi.org/10.1787/9789264118782-en.

Governments attempt to nurture the market for seed capital through a range of supply-side policy initiatives (Table 1.5). Most OECD countries have some type of government equity finance programme, such as direct public VC funds, "funds of funds" (an investment strategy consisting of holding a portfolio of other investment funds rather than investing directly in companies) and co-investment funds, whereby public funds are matched with those of private investors that are approved under the scheme. These programmes, especially funds of funds and co-investment funds, have grown in importance over the past five years. While fiscal incentives are less common, 17 OECD countries still employ either "front-end" tax incentives or tax deductions for investment in seed and early-stage VC and "back-end" tax relief on capital gains, including rollover or carry-forward of capital gains or losses. Of course, it is important to keep in mind the broader taxation environment – and particularly the existence of capital gains tax – when assessing these fiscal incentives.

Table 1.5. Tax and equity policy instruments to support the market for early-stage financing

Policy setting at mid-2012; change in the policy setting in the last five years

	Fiscal incentives			Government Equity Financing Instruments		
	Young innovative company schemes	"Front-end" tax incentives	"Back-end" tax incentives	Public equity funds	Fund of funds	Co-investment Funds
Australia			unchanged			increased
Austria		decreased	decreased		new	
Belgium	increased	increased	decreased	new & increased	new	new
Canada	unchanged	unchanged	increased	increased	increased	
Chile						unchanged
Czech Republic						new
Denmark			increased	increased	increased	
Estonia				decreased		
Finland				unchanged	unchanged	increased
France	decreased	decreased	unchanged	increased	increased	increased
Germany					increased	unchanged
Greece					unchanged	increased
Hungary				unchanged		increased
Ireland	new	increased		new	new	increased
Israel	new	new	new			new
Italy	new	new	new	new	new	new
Japan		increased				
Korea	increased	increased			increased	
Mexico				increased	new	unchanged
Netherlands						increased
New Zealand					unchanged	unchanged
Norway				increased	increased	increased
Poland					unchanged	
Portugal		decreased			increased	increased
Slovak Republic	yes*	yes*		unchanged	increased	
Slovenia			new		new	new
Spain						
Sweden				increased	unchanged	increased
Switzerland		ceased				
Turkey	unchanged	new	unchanged		new	new
United Kingdom		increased	increased		increased	unchanged
United States						

* The Slovak Republic has both young innovative company schemes and front-end tax incentives but no information is available on changes in the generosity of such schemes over time.

Source: See Wilson and Silva (2013), "Policies for Seed and Early Stage Finance: Summary of the 2012 OECD Financing Questionnaire", OECD DSTI Working Paper *forthcoming*.

Evidence on the contribution of supply-side policy interventions in the market for SES-VC is scarce and research on whether public VC funds crowd out private activity is inconclusive (Da Rin et al., 2012). Given the potential for regulatory capture (Lerner, 2008), however, government funding is likely to be most effective when it is disciplined by private venture capital and does not exert control over business decisions (Brander et al., 2011). This suggests that public co-investment funds and funds of funds might be preferable to public equity funds. However, there is little evidence on this issue and the effect is likely to be contingent on the design of the schemes. More broadly, preliminary, albeit crude, findings (Da Rin et al., 2013; see Annex 1.A2) show that the more support for SES-VC there is in a country – as proxied by the number of tax and equity policy instruments – the lower the age at which firms receive SES financing.[48] Although causation is difficult to establish and the ultimate performance of firms that receive public funding is unclear, this may suggest that such programmes warrant further attention and further analysis of their effectiveness.

Some countries set portfolio restrictions that bar or limit institutional investors (e.g. pension funds, insurance companies) from investing in SES-VC, though comparable cross-country information in this area is incomplete. These restrictions may be important, in light of existing research showing that VC activity in the United States increased significantly following the removal of restrictions on pension funds in 1979 (Kortum and Lerner, 2000). Similarly, the existence of viable exit markets for venture investments, particularly the existence of secondary stock markets (e.g. NASDAQ), increases the expected return to investors and entrepreneurs and stimulates the development of markets for seed capital (Da Rin et al., 2006).[49] This suggests that rules affecting initial public offerings are also important.

Policy reform options for increasing KBC and innovation

Appropriate framework policies raise the returns to investing in KBC

Regulations that promote flexibility in product, labour and credit markets and bankruptcy laws that do not excessively penalise failure can encourage firms to experiment with uncertain growth opportunities and raise the expected net benefits of KBC investment by making it easier for successful firms to implement and commercialise new ideas. While policy reforms that promote competition in domestic and global product markets have pervasive impacts on the KBC-innovation-reallocation nexus, the impact of bankruptcy legislation and EPL is more nuanced and may mean trade-offs with other policy goals.

Less stringent EPL and bankruptcy laws that do not excessively penalise business failure are desirable to the extent that they reduce exit costs and thus encourage firms to experiment with new forms of KBC. Policy reforms along these lines, however, may shift the distribution of risk from entrepreneurs to workers and creditors. For example, reforms to job protection legislation could be accompanied by broader mechanisms to insure workers against labour market risk, such as well-designed social safety nets and portable health and pension benefits. More generally, while efficient reallocation mechanisms raise returns to KBC, the shifting of resources also entails costs for workers and firms. This raises questions regarding the role and best design of structural adjustment packages. Bankruptcy regimes that punish failure less severely are desirable if they encourage experimentation with risky technologies, but they might also discourage investment in KBC because of a possible reduction in credit supply. Striking the right balance between these forces makes the design of bankruptcy provisions complicated. More generally, the issue of bankruptcy legislation and exit costs raises important questions about the optimal level of risk-taking in an economy, which are beyond the scope of this chapter.

Rethinking innovation policies by focusing on policy design

The analysis of innovation policies, which include direct support measures and R&D tax incentives in many countries, demonstrates that design is crucial, not only to achieve maximum effectiveness but also to minimise their fiscal cost and possible unintended consequences. One concrete policy recommendation is that R&D tax incentives should be refundable (or allow for payroll withholding tax credits for R&D wages) and contain carry-over provisions in order to make them more compatible with the needs of young firms. From a fiscal perspective, incremental R&D tax incentives might be more cost-effective than volume-based schemes in raising R&D. It is also likely that well-designed, selective and transparent direct support measures complement R&D tax incentives and may help channel public funding to high-quality projects with high social returns. The administrative costs of such schemes should always be taken into account. Consideration should also be given to the public funding of basic research and to institutional frameworks that foster collaboration on innovative activities, but more policy evaluations in these areas are needed. This reinforces the idea that innovation policies should be designed to allow for the *ex post* evaluation of their effectiveness.

IPR protection should be coupled with pro-competition product market policies to ensure that the market power of incumbents does not stifle the creativity of new entrants. In some KBC sectors with an innovation process that is typically fragmented (e.g. software),[50] the marginal costs of patent protection may outweigh the benefits. While patent aggregators may be able to improve the reallocation of KBC assets, they may also stifle radical innovations owing to the transaction and entry costs they impose on young firms. Given the importance of the patent system to sectors such as pharmaceuticals and chemicals, this creates an important policy dilemma that has yet to be resolved in academic and policy circles.

Trade-offs between KBC and other policy priorities

This chapter has described a policy reform agenda to boost KBC, but it is not clear that gearing public policy to maximise the growth potential of KBC will always have unambiguously positive effects, and trade-offs with other policy goals may arise. For example, there may be tensions between promoting an increasingly knowledge-based economy and keeping a lid on rising inequality. This may increase the focus on education and adult learning policies that facilitate adjusting workforce skills to complement the changes in demand for labour that often accompany technological progress. To the extent that those needs are fulfilled, rising investment in KBC might translate into higher aggregate productivity growth without greatly exacerbating income inequality (Goldin and Katz, 2008).

Annex 1.A1.

MFP Growth and Policies: Firm-level evidence

The effect of framework policies and innovation-related policies on MFP growth at the firm level is explored using a neo-Schumpeterian growth framework and a sample of 18 OECD countries over the period 1999-2009.[51] The impact of policies on firms' MFP is allowed to vary with a firm's distance from the technological frontier to facilitate an analysis of the policies associated with the expansion of the most productive firms – one possible indicator of dynamic allocative efficiency. This exercise is also of interest given the significant contribution that a relatively small number of high-growth firms make to aggregate growth.[52]

Data

The analysis exploits cross-country firm-level data from ORBIS, a commercial database provided to the OECD by Bureau Van Dijk, which contains administrative data on tens of millions of firms worldwide. The financial and balance sheet information in ORBIS is initially collected by local Chambers of Commerce and is relayed to Bureau Van Dijk through some 40 different information providers (Pinto Ribeiro et al., 2010).

While representing a potentially useful tool to analyse cross-country patterns of productivity, ORBIS has a number of drawbacks. The main one relates to representativeness, with firms in certain industries and the many smaller and younger firms typically under-represented. Accordingly, the ORBIS sample of firms was aligned with the distribution of the firm population as reflected in the OECD Structural Demographic Business Statistics (SDBS), which is based on confidential national business registers. Following the procedure first applied in Schwellnus and Arnold (2008) and refined in Gal (2013), re-sampling weights – based on the number of employees in each SDBS industry-size class cell – are applied, which essentially "scales up" the number of ORBIS observations in each cell so that they match those observed in the SDBS.[53] However, since it is not possible to distinguish accurately entry into the market from entry into the sample and exit from the market from exit from the sample using ORBIS, it is important to keep in mind that the analysis pertains to a sample of continuing firms.[54] The sample is restricted to firms in the non-farm business sector – i.e. industries 15-74 according to NACE Rev 1.1, excluding mining and financial intermediation.

Econometric framework

The empirical specification is based on the estimation of the Aghion and Howitt (1998) neo-Schumpeterian growth framework, which has been implemented in a number of studies (e.g. Griffith et al., 2006; Arnold et al., 2011b). Multi-factor factor productivity (A) is assumed to follow an error correction model (ECM) of the form:

$$\Delta \ln A_{icst} = \delta_1 \Delta \ln A_{Fcst} + \delta_2 gap_{icst-1} + \delta_3 RI_{ct-1} + \sum_j \delta_4^j \left(P_{ct-1}^j * E_s^j\right) + \gamma_s + \gamma_{ct} + \varepsilon_{icst}$$

Productivity growth of firm *i* is expected to increase with productivity growth of the frontier firm *F* and the size of the gap – as proxied by $\ln\left(A_{Fcst-1} / \ln A_{icst-1}\right)$ – which measures how far each firm is away from the frontier F. Following Arnold et al. (2011b), the frontier firm is defined as the average MFP of the 5% most productive firms in sector *s* and year *t* in the sample of countries analysed (the frontier firms are excluded from the analysis). The specification controls for both industry and country*time fixed effects and standard errors are clustered by country and sector to allow for correlation of the error term in an unrestricted way across firms and time within sectors in the same country (Moulton, 1991; Bertrand et al., 2004). To compare MFP levels across countries and industries, MFP is estimated using the superlative index number approach (Caves et al., 1982a; 1982b; Griffith et al., 2006) but it should be kept in mind that this approach is based on a number of potentially restrictive assumptions, including constant returns to scale and perfect competition on factor markets. See Gal (2013) for more details.

To explore the impact of policies on MFP growth, regulation impact (RI) – which varies at the sectoral level – is included to control for the knock-on effect of product market regulations in upstream services sectors (Bourlès et al., 2010; Conway and Nicoletti, 2006). For policies that only vary at the national level, however, a differences-in-differences strategy is adopted since the country*time fixed effects will absorb the effects of policies that only vary at the country level over time. To gain within-country variability (over time) in the policy variables of interest, an interaction term between the country-level policy (*P*) and a relevant sectoral exposure variable (*E*) is included. This approach, popularised by Rajan and Zingales (1998), is based on the assumption that there exist industries that have "naturally" high exposure to a given policy (i.e. the treatment group), and such industries – to the extent that the policy is relevant to the outcome of interest – should be disproportionally more affected than other industries (i.e. the control group). In other words, identification will be obtained by comparing the differential MFP growth between highly exposed and marginally exposed industries in countries with different levels of a given policy. It is important to note, however, that this approach does not provide an estimate of the average effect of the policy of interest.

Industry-level indexes of exposure are taken from the large literature exploiting the same framework to infer the relevance of country-level policies on a number of economic outcomes. The exposure indexes are generally computed from US data because the United States is generally perceived to be a low regulation (i.e. "frictionless") country. Accordingly, the United States is excluded from the analysis. See Table 1.A1.1 for details on the country-level policy variables of interest and the corresponding industry-level exposure variables used in the difference-in-differences estimator.

To further explore the heterogeneous impact of policies, the term (*P*E*) is interacted with a firm's gap from the technological frontier to form a triple interaction term.

$$\Delta \ln A_{icst} = \delta_1 \Delta \ln A_{Fcst} + \delta_2 gap_{icst} + \delta_3 RI_{ct-1} + \sum_j \delta_4^j \left(P_{ct-1}^j * E_s^j\right) + \sum_j \delta_5^j \left(P_{ct-1}^j * E_s^j\right) * gap_{icst} + \gamma_s + \gamma_{ct} + \varepsilon_{icst}$$

The parameter combination of interest is $\delta_4 + \delta_5 * gap$. For example, when *P* corresponds to employment protection legislation (EPL), this parameter combination provides estimates of the effect of EPL on the evolution of firm-level productivity across countries, depending on the distance to the technological frontier. If δ_4<0 and δ_5<0, less stringent EPL boosts productivity growth and the effect increases with the distance to the frontier; if δ_4<0 and δ_5>0, the boost to firm productivity from less stringent EPL decreases with distance to the frontier – that is, less stringent EPL enhances productivity growth relatively more (in exposed industries compared to non-exposed industries) for firms that are closer to the technological frontier. This implies that less stringent EPL would be associated with the expansion of the most productive firms, thereby raising dynamic allocative efficiency.

Table 1.A1.1. Structure of the differences-in-differences estimator and data sources

Variable	Country-level variable	Industry-level exposure variable
EPLR	EPLR is the OECD Employment Protection Legislation (EPL) sub-index of restrictions on individual dismissal of workers with regular contracts.	Layoff rates (defined as the percentage ratio of annual layoffs to total employment) at the industry level in the United States. Sourced from Bassanini et al. (2009). Sectoral ICT intensity: the share of ICT capital compensation in total capital compensation. Sourced from EU-KLEMS
Top marginal income tax rate	Sourced from the OECD.	Firm turnover rate (defined as the entry rate + exit rate) at the industry level in the United States. Sourced from Bartelsman et al. (2008). Sectoral ICT intensity: the share of ICT capital compensation in total capital compensation.
Corporate tax rate	Combined (government) corporate income tax rate, sourced from the OECD.	Relative profitability for the United States. Sourced from Schwellnus and Arnold (2008). Sectoral ICT intensity: the share of ICT capital compensation in total capital compensation.
Innovation-related policies	Higher education R&D as a percentage of GDP. Basic research as a percentage of GDP. Percentage of higher education R&D financed by industry. Each variable is sourced from the OECD Main STI Indicators.	Sectoral R&D intensity (R&D/value added) for the United States

Empirical results

While many empirical specifications were estimated, this section reports, for the sake of brevity, some of the key results given in the main text.

Baseline results

The baseline estimates are contained in Table 1.A1.2. The coefficient of the frontier firm's growth is positive while the coefficient on the gap term is also positive, reflecting the fact that as a firm gets closer to the frontier, the speed of catching-up slows down. The key policy results include:

- Lower product market regulation, as measured by regulation impact, is associated with higher firm MFP growth (columns 1-9). This is consistent with the findings of Arnold et al. (2011b) but covers a larger sample of OECD countries.
- In sectors with higher job layoff rates (where reallocation needs are likely to be more intense), lower EPL is associated with higher MFP growth but this effect is not statistically significant (columns 2 and 5).

- In sectors with higher relative profitability (where corporate taxes are most likely to bind), lower corporate tax rates are associated with higher firm MFP growth column 3 and 5) compared to other sectors. This confirms the findings of Schwellnus and Arnold (2008) but covers a larger sample of OECD countries.
- In sectors with higher rates of firm turnover (top marginal income taxes are more likely to bind in entrepreneurial sectors), lower top marginal income tax rates are associated with higher firm MFP growth compared to other sectors (columns 4 and 5).
- In more R&D-intensive sectors, increases in government spending on basic research (as a percentage of GDP) are associated with higher firm-level MFP growth (column 8) compared to other sectors. The same is true for higher rates of R&D performed by universities (column 7) and greater collaboration between industry and universities, as proxied by the share of higher education R&D financed by industry (column 9).

Table 1.A1.2. Firm level productivity growth and framework policies: Baseline results

Dependent variable: MFP growth, selected OECD countries, 1999-2009

	Selected Framework Policies					Selected Innovation Policies		
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)
VARIABLES	PMR	EPL	Corp-Tax	Top MTR	All-in	Higher Ed	Basic	Collab
Gap with frontier (t-1)	0.300***	0.300***	0.300***	0.301***	0.301***	0.281***	0.242***	0.242***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.015)	(0.011)	(0.011)
Growth at the frontier (t)	0.200***	0.200***	0.200***	0.199***	0.199***	0.178***	0.183***	0.183***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.024)	(0.024)
Regulation Impact(t-1)	-0.209**	-0.204**	-0.204**	-0.201**	-0.190**	-0.225***	-0.208***	-0.202***
	(0.094)	(0.092)	(0.089)	(0.094)	(0.086)	(0.074)	(0.060)	(0.062)
EPLR(t-1) X layoff		-0.007			-0.007			
		(0.008)			(0.008)			
Corporate tax rate(t-1) X profitability			-0.003		-0.004*			
			(0.002)		(0.002)			
Top marginal tax rates (t-1) X turnover				-0.000***	-0.001***			
				(0.000)	(0.000)			
Higher education R&D to GDP (t-1) X R&D						1.232***		
						(0.471)		
Basic reseach expenditure to GDP (t-1) X R&D							1.800***	
							(0.471)	
Per cent of HERD financed by industry (t-1) X R&D								0.022*
								(0.012)
Country*year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	16 238 040	16 238 040	16 238 040	16 238 040	16 238 040	15 360 766	15 360 766	15 360 766
R-squared	0.195	0.195	0.195	0.196	0.196	0.167	0.167	0.167

Notes: MFP estimates are based on the superlative index approach. The standard errors are clustered at country*industry cells. Resampling weights are applied to match the observed industry and size class structure for each country from the SDBS (Gal, 2013). The estimation covers all non-frontier firms for the years 1999-2009 for the non-farm business sector, excluding mining. Both TFP measures use uniform, cross-country average labour shares (Solow) or reference values (superlative index) in order to ensure international comparability of productivity levels. The regression includes 18 countries: AT, BE, CZ, DE, DK, ES, FI, FR, GB, GR, HU, IT, KR, NL, NO, PT, SE, SK. The United States is excluded from the regressions since it is the benchmark country for the sectoral exposure variables. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Experimentation and dynamic allocative efficiency: Evidence from ICT-intensive sectors

Experimentation and reallocation may be more important in sectors with high ICT intensity, while there are important complementarities between ICT and KBC assets such as organisational capital, as discussed in the main text. Accordingly, the extent to which the impact of policies varies with the ICT intensity of the sector is explored (Table 1.A1.3).

Table 1.A1.3. Firm level productivity growth and framework policies in ICT-intensive sectors

Dependent variable: MFP growth, selected OECD countries, 1999-2009

	Base model				Policies vary with distance to frontier			Memo
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	EPL	Corp-Tax	Top-MTR	All-in	EPL	Corp-Tax	Top-MTR	Org Cap
Gap with frontier (t-1)	0.276***	0.275***	0.276***	0.277***	0.246***	0.246***	0.250***	0.277***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.020)	(0.021)	(0.021)	(0.014)
Growth at the frontier (t)	0.176***	0.174***	0.175***	0.175***	0.177***	0.174***	0.176***	0.178***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)	(0.017)
Regulation Impact(t-1)	-0.204***	-0.226***	-0.287***	-0.240***	-0.160	-0.199	-0.275*	-0.222**
	(0.065)	(0.079)	(0.078)	(0.071)	(0.121)	(0.140)	(0.142)	(0.087)
EPLR(t-1) X ICT	-0.111***			-0.087**	-0.277***			
	(0.042)			(0.038)	(0.054)			
Corporate tax rate (t-1) X ICT		-0.010*		-0.002		-0.019***		
		(0.006)		(0.006)		(0.006)		
Top marginal tax rate (t-1) X ICT			-0.011***	-0.009**			-0.015***	
			(0.003)	(0.003)			(0.004)	
Regulation Impact (t-1) X Gap with the frontier (t-1)					-0.042	-0.033	-0.015	
					(0.053)	(0.055)	(0.056)	
EPLR(t-1) X ICT X Gap with the frontier (t-1)					0.086***			
					(0.021)			
Corporate tax rate(t-1) X ICT X Gap with the frontier (t-1)						0.005***		
						(0.002)		
Top marginal tax rates (t-1) X ICT X Gap with the frontier (t-1)							0.003***	
							(0.001)	
Org capital stock/employment (t-1) X ICT								0.096**
								(0.048)
Country*year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	17 536 040	17 536 040	17 536 040	17 536 040	17 536 040	17 536 040	17 536 040	15 963 936
R-squared	0.181	0.180	0.180	0.180	0.183	0.182	0.182	0.180

Notes: MFP estimates are based on the superlative index approach. The standard errors are clustered at country*industry cells. Resampling weights are applied to match the observed industry and size class structure for each country from the SDBS (Gal, 2013). The estimation covers all non-frontier firms for the years 1999-2009 for the non-farm business sector, excluding mining. The TFP measures use uniform cross-country reference values (superlative index) in order to ensure international comparability of productivity levels. The regression includes 18 countries: AT, BE, CZ, DE, DK, ES, FI, FR, GB, GR, HU, IT, KR, NL, NO, PT, SE, SK. The United States is excluded from the regressions since it is the benchmark country for the ICT intensity variables. The number of observations is larger than in Table 1.A1.2 owing to the greater industry coverage of ICT intensity relative to the sectoral exposure variables utilised in Table 1.A1.2. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

A number of findings concern the impact of framework policies on firm MFP growth:

- Less stringent EPL is associated with higher firm MFP growth in sectors with higher ICT intensity, compared to other sectors (column 1). This is consistent with the idea that less stringent EPL reduces exit costs, which is likely to increase the incentive to experiment with new and uncertain technologies.[55]

  - To appreciate the relevance of the estimated effect, consider the difference in annual firm MFP growth between a high ICT-intensive sector (such as computers and related activities) and a low ICT-intensive sector (such as rubber and plastics manufacturing). The estimates in column 1 suggest that reducing EPL from the high levels of Portugal to the low level of the United Kingdom implies a gain in the above differential in excess of 0.15 percentage points a year.
  - The triple interaction term EPL*ICT*Gap in column 5 is positive, indicating that the boost to productivity from less strict EPL diminishes the further away a firm is from the frontier. Thus, stringent EPL penalises the most productive firms and undermines dynamic allocative efficiency. The magnitude of this effect is considerably larger than for the average firm example cited above. Additional analysis suggests that the latter result (i.e. as implied by the triple interaction term) is also robust to using job layoff rates (as in Table 1.A1.2) to measure the exposure of each sector to EPL.

- Reductions in corporate taxes are associated with higher firm MFP growth in ICT-intensive sectors (column 2) and this effect is most powerful for firms close to the frontier (column 6). Additional analysis suggests that the latter result is also robust to using relative profitability (as in Table 1.A1.2) to measure the exposure of each sector to corporate tax rates.

- Lower top marginal tax rates are associated with higher firm MFP growth in ICT-intensive sectors (Column 3) and this effect is most powerful for firms close to the frontier (column 7), possibly reflecting the effect of taxes on entrepreneurial activity and risk taking. Additional analysis suggests that the latter result is also robust to using firm turnover rates (as in Table 1.A1.2) to measure the exposure of each sector to top marginal tax rates.

Finally, column 8 of Table 1.A1.3 explores the possible complementarities between organisational capital – a key component of KBC – and ICT. The positive coefficient on the interaction term suggests that in sectors with higher rates of ICT intensity, increases in organisational capital intensity (sourced from Corrado et al., 2012) are associated with swifter firm MFP growth than in other sectors.

Unreported results and robustness tests

The core results are robust to using different measures of MFP, such as Solow residual estimates based on uniform cross-country average labour shares. Unreported results include additional explorations of the impact of policies such as various measures of financial and banking regulation (interacted with the dependency of each sector on external finance); fiscal incentives for R&D (interacted with sectoral R&D intensity); intellectual property rights regimes (interacted with sectoral R&D and patenting intensity); time-invariant measures of bankruptcy law (interacted with firm turnover and the dependency of each sector on external finance). These results were generally inconclusive.

Annex 1.A2.

The market for seed and early-stage financing and supply-side policy initiatives

Governments attempt to nurture the market for seed capital through a range of supply-side policy initiatives (Table 1.4; Wilson and Silva, 2013). This annex summarises empirical work that explores the impact of policy indicators constructed from these data on outcomes in the market for venture capital and seed and early stage financing.

Data

The data on venture capital deals are sourced from ThomsonOne, a commercial database published by Reuters. ThomsonOne is the main available source for venture deals, and collects data based on voluntary reporting by venture capital firms. Therefore, these data constitute a (not necessarily random) sample of the whole population of venture capital deals.

Data collection by ThomsonOne started in the United States in the 1970s. Coverage has increased over time, both within and across countries. While ThomsonOne does not release information about coverage, it has clearly increased since the late 1990s, when venture capital boomed in the "dot.com" bubble years. Since both coverage and venture capital activity increased over time in most countries, it is not possible to tell them apart. It is important to be aware of these data limitations when interpreting the results reported below.

Deal-level data for the 34 OECD countries for 1990-2011 are collected (coverage in the database for 2012 is still incomplete).[56] Of the 124 000 deals in the dataset, nearly 75% are from the period since 2000. The United States accounts for well over half of the recorded deals.

The data have been collected at the country/year level and include the following variables:

- number of venture capital deals and early-stage deals
- company age (all deals) and company age (early-stage deals)
- amount invested (all deals, in USD) and amount invested (early-stage deals, in USD).

The result is a panel dataset that spans 34 countries and 21 years. As some data are not available for some countries or years, that the panel is somewhat unbalanced.

Econometric framework

The goal of this exercise is to assess the effectiveness of public policy support to venture capital financing. For this, the focus is on a variable that counts the number of policy support programmes (NAP) – i.e. tax incentives and government equity finance instruments (see Table 1.4) – active in each country and year. Of course, this policy measure captures only one aspect of policy support and clearly the amount of public money channelled into such programmes is important. Indeed, it is possible that a single, but well-funded, policy initiative could be more effective that several small programmes, but data constraints currently prevent an exploration of this issue. A more refined policy variable would also contain more detailed information on the characteristics of firms that are eligible for support, in order to better capture the incentives created by such interventions. Codifying such programme design features is clearly a difficult task but may become possible as more detailed data are acquired on public support policies for VC and early stage financing.

A fixed effects panel framework of the following form is estimated:

$$y_{ct} = \alpha + NAP_{ct-1} + x'_{ct-1} + \gamma_c + \delta_t + \varepsilon_{ct}$$

where y is the dependent variable, measured at country/year level; all dependent variables are expressed in logs to minimise the effects of outliers. α is a constant. The variable of main interest is *NAP*, the (lagged) policy measure, which varies across countries and years. A vector of (lagged) control variables (x) that vary both across countries and over time is also included. In the baseline specification, x includes GDP per capita and the corporate income tax rate.

Country-fixed effects (γ_c) are included to control for unobserved time-invariant country characteristics that may affect both policy attitudes and the supply of or demand for venture funds, as well factors such as resource endowments, slow-moving labour force skills and ingrained preferences. Indeed, it is possible that a country with a more entrepreneurial culture provides more public support to venture capital, but at the same time also exhibits a higher level of entrepreneurial companies, which in turn attract more venture funding. By exploiting variation within a country over time, such potentially confounding effects can be controlled for. The use of year fixed effects (δ_t) has the advantage of assuaging concerns about the increasing coverage of ThomsonOne over time, in the same way as country fixed effects account for (time-invariant) differential coverage across countries. ε is the error term.

While the panel approach constitutes a defendable strategy to deal with omitted variable issues, it is certainly not exempt from limitations. One particular concern is the endogeneity of policy measures to the state of the venture capital markets. Policy intensity is not random, as assumed by the econometric model, and it could increase in periods following low (or decreasing) venture capital activity. Therefore, the results cannot be interpreted as causal, but rather reflect a correlation, robust to the control of a wider set of variables.

Empirical results

Table 1.A2.1 reports the main results. The number of active programmes (NAP) is positively correlated with the number of VC and early-stage financing deals and negatively correlated with the size of such deals, but none of these effects is statistically significantly. However, NAP is negatively correlated with the average age at which firms receive early-stage financing, suggesting that increases in policy intensity are associated with greater flows of financing to younger firms. Estimates suggest that an additional active programme is associated with a 4.9% decrease in the age of the financed companies. This represents a decline of 2.4 months from the average age (i.e. 51 months) at which early-stage firms in the sample typically receive financing.

Table 1.A2.1. Venture capital and early-stage financing: The role of public support

OECD countries; 1990-2011

	(1)	(2)	(3)	(4)	(5)
ln RD stock (c,s,t-1)	-0.029*** (0.003)	-0.029*** (0.003)	-0.029*** (0.003)	-0.029*** (0.003)	-0.029*** (0.003)
∆ln(RD stock,c,s,t-1)	0.328*** (0.021)	0.327*** (0.021)	0.326*** (0.021)	0.327*** (0.021)	0.327*** (0.021)
∆ln(VA,c,s,t-1)	-0.018* (0.010)	-0.018* (0.010)	-0.017* (0.010)	-0.017* (0.010)	-0.017* (0.010)
EPL (c,t-1) * Job turnover us (s)	0.007 (0.008)				
EPL (c,t-1) * Firm turnover us (s)		0.009 (0.006)			
EPL (c,t-1) * Patents us (s)			-0.002** (0.001)		
EPL (c,t-1) * Patents us (s) * Job turnover us (s)				-0.001** (0.000)	
EPL (c,t-1) * Patents us (s) * Firm turnover us (s)					-0.001** (0.000)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Country-time fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	7,709	7,709	7,709	7,709	7,709
R-squared	0.420	0.420	0.420	0.420	0.420

Note: Robust standard errors in parentheses: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

The results are robust to the inclusion of a range of time-varying policy indicators for which sufficient information is available for all OECD countries and for recent years. These include: the share of government-financed business enterprise R&D expenditure; higher education expenditure on R&D as a percentage of GDP; and average years of tertiary education.

Ideally, time-varying policy indicators that capture regulations affecting the business environment – such as product market regulations – would also be included but this would result in a non-trivial reduction in sample size as these indicators are not available for the full sample period. As an alternative, NAP was interacted with (time-invariant) dummy variables measuring whether a country was in the top or bottom half of the regulation distribution over the sample period. Three measures of regulation were included: the OECD Employment Protection Legislation Index and two variables from the OECD Product Market Regulation Index – the overall index and barriers to entrepreneurship sub-index. These results did not support the hypothesis that the impact of NAP varied with the regulatory environment.

Finally, the evolution of the capital gains tax rate was also controlled for, but this results in a significant reduction in sample size (189 observations, down from 306) since this variable is only available from 2000 (the capital gains tax data are from Achleitner et al., 2012). The capital gains tax rate had a negative relationship with the number of venture capital deals, but the coefficient is not statistically significant.[57] While the sign of the relationship between NAP and the amount and age of early-stage deals remains the same, it loses statistical significance in this smaller sample. This suggests that these results should be treated with caution and that more research is needed to understand the impact of such policies on the market for seed and early-stage financing.

Notes

1. The policy levers to boost the supply of skills in an economy are discussed at length in OECD (2012b).

2. The introduction of new or improved goods may also lead to an increase in measured MFP if MFP is based on sales rather than physical output, with an increase in price leading to an increase in revenue-based MFP. Most product innovations are also associated with process innovations (OECD, 2010), which are directly linked to an increase in (quantity-based measures of) MFP.

3. Only firms that successfully introduce multiple product innovations or continuously improve products over time maintain strong profits in a highly competitive environment (Roberts, 1999).

4. This is important as many successful entrepreneurs experienced business failure in the past (Choi, 2008).

5. The same is true of innovations that appear relatively incremental from a technological point of view but require fundamental organisational restructuring (Henderson and Clark, 1990).

6. More knowledge exchange will take place within the multinational firm (Criscuolo et al., 2010), from headquarters to affiliates and *vice versa*, via reverse technology transfer (Griffith et al., 2006), and from the multinationals to local economic agents and *vice versa* (Puga and Trefler, 2010).

7. Put differently, policies that directly affect the later stages of the innovation process may influence the earlier stages as well. For example, policies may offer direct incentives for within-firm productivity improvements but such incentives may be enhanced by policies that facilitate between-firm reallocations. Thus, the typical distinction between within- and between-firm (i.e. reallocation) contributions to aggregate productivity is blurred: entrepreneurs' efforts to increase within-firm productivity depend on expectations about the ability to benefit from between-firm shifts in resources.

8. Policies have dynamic effects on innovation and growth. Size-contingent policies (e.g. special tax treatment or low firing costs for smaller firms) can distort the incentives of firms to grow beyond the applicable size threshold (Braguinsky et al., 2011), thereby undermining allocative efficiency. Similarly, policies that initially remedy market failures may be increasingly costly over time if they continue to prop up formerly productive but now unproductive entrepreneurs and impede entry (Buera et al., 2013).

9. MFP growth relates a change in output to changes in several types of inputs. MFP is often measured residually, as the change in output that cannot be accounted for by the change in combined inputs.

10. For details on how KBC investment figures are estimated and underlying assumptions, see Corrado et al. (2012).

11. This assumes that the estimated factor share reflects the marginal product of KBC.

12. For example, in a sample of 26 OECD countries in 2008, the rank correlation between headline business R&D (BERD) intensity and BERD adjusted for differences in industrial structure is around 0.80 (see OECD 2011a for details).

13. The estimates were constructed using a variety of sources and techniques, and require assumptions about depreciation rates and deflators. However, the approach is standardised to facilitate cross-country comparisons. For more details, see Corrado et al. (2012).

14. In this study, Europe includes France, Germany, Italy, Poland, Portugal, Sweden and the United Kingdom.

15. The extent to which the most productive firms are also the largest at any point in time will reflect the extent to which resources are reallocated away from less productive to more productive uses over preceding time periods.

16. Cross-country differences in firm growth trajectories may also reflect differences in the extent to which young firms are absorbed by larger incumbent firms. Unfortunately, evidence on this issue is scarce.

17. The low sensitivity of resources to patenting in countries such as Denmark and Finland may reflect the fact that firms in small open economies may expand abroad rather than domestically, but it is difficult to capture this margin of adjustment with the available data. Additional analysis suggests that patenting has a larger effect on average profitability and wages than firm size in these countries, but this cannot explain all of the observed difference.

18. R&D and patents are proxies for investment in KBC and innovation outputs, respectively, and only capture (the technological) part of investment in KBC. However, both measures are comparable across countries: R&D because the definition is well codified and internationally harmonised in the *Frascati Manual* (OECD, 2002) and patents because they come from administrative data. Moreover, macro- and micro-level evidence of the link between R&D, patents and productivity (growth) has been growing steadily since the seminal work of Griliches (1979).

19. By lowering the cost and/or raising the quality of inputs required by innovative firms to underpin their expansion, pro-competitive reforms to regulations in the services sector might disproportionately raise the productivity growth of firms closest to the technological frontier (Arnold et al., 2011b).

20. See Martin and Scarpetta (2012) for a comprehensive review of recent cross-country evidence.

21. While the empirical evidence in this section is drawn from cross-country studies, a country-specific literature is emerging that models the behaviour of the firm in an optimisation framework and calibrates the resulting model to replicate the characteristics of the country's population of firms, e.g. Epaulard and Pommeret (2006) for France.

22. Robust public institutions that provide strong rule of law and minimise corruption and informality support efficient resource allocation (D'Erasmo and Moscoso-Boedo, 2012).

23. The cost of enforcing contracts is sourced from the World Bank and measures the court costs and attorney fees as a share of the debt value.

24. This is consistent with research showing that easier contract enforcement makes it less costly to hire the skilled workers needed to underpin firm growth (Bloom et al., 2013a).

25. The seven OECD countries that do not offer R&D tax incentives are Estonia, Germany, Israel, Mexico, New Zealand, Sweden and Switzerland.

26. Country-specific policy recommendations should take into account not only cross-country evidence but also evaluations of single programmes within countries.

27. User costs are captured by the B-index (Warda, 2001), which measures the present value of before-tax income that a firm needs to generate in order to cover the cost of an initial R&D investment and to pay the applicable income taxes. See Westmore (2013) for details.

28. Bloch and Graversen (2008) note that past government support for R&D often involved contracts whereby governments would fund and procure the output of firms' R&D activity. This may have meant that much of the R&D performed was not directly commercially viable and therefore limited the size of knowledge spillovers across firms and industries.

29. These estimates assume a volume-based R&D tax incentive regime for computational ease. However, caution is warranted in interpreting these results since single-country econometric exercises suggest that the bang-for-the-buck multiplier is much larger for incremental schemes than for volume-based schemes (Lokshin and Mohnen, 2008).

30. This is consistent with the idea that smaller firms are more likely to be credit-constrained.

31. R&D fiscal incentives can also be designed to incorporate a countercyclical dimension (Aghion et al., 2009; López-García et al., 2012). See Andrews and de Serres (2012) for a discussion.

32. This is consistent with recent evidence from Finland and Germany showing that direct support schemes do not preserve the dominance of market leaders but make small firms more likely to undertake R&D (Czarnitzki and Ebersberger, 2010).

33. Tax policy may also be encouraging the migration of KBC to offshore holding companies and the use of KBC in foreign rather than domestic production. In this case, tax revenues from R&D and domestic knowledge spillovers may be lower than they would be in the absence of R&D tax incentives.

34. Furthermore, some public R&D may not seek to foster commercial innovation but may concern areas such as environmental protection, public health and national security.

35. Recently, Belgium, Denmark, Hungary, Italy, Spain, Canada and Japan have offered such inducements.

36. While the focus here is on patents other forms of IP are obviously important. See Andrews and de Serres (2012) and Hargreaves (2011). For a discussion of the international dimension of IPR protection, see Andrews and de Serres (2012).

37. Furthermore, in sectors with higher patenting intensity, less stringent barriers to firm entry are associated with higher allocative efficiency (Andrews and Cingano, 2012).

38. They do so notably by acquiring patents from bankrupt companies, by organising patent auctions and by helping businesses to obtain the rights to use ideas through licensing arrangements (see Chien, 2009).

39. These are webs of overlapping IPRs for which the rights are held by competing firms (Shapiro, 2001). They may be most common in fields in which innovation is relatively cumulative or there is incentive for firms to hold patents for defensive or strategic purposes.

40. Here, the financial market is defined as the sum of the stock and bond market and of private credit by banks, all normalised with respect to GDP.

41. Moreover, the uncertainty surrounding the treatment of intangibles during bankruptcy is likely to accentuate financing difficulties, partly because the value of intangible assets is more prone to erosion during asset "fire sales" given the greater tendency of intangible assets to generate firm-specific value (e.g. growth opportunities, managerial and firm-specific human capital, and operating synergies, the value of which depends on keeping the firm's assets together; Hotchkiss et al.*,* 2008; Gilson et al.*,* 1990).

42. There is also a tension between the limited appropriability and inherent uncertainty of intangibles, on the one hand, and, on the other, the capacity to control the asset and the probability of future benefits required for accounting purposes: attributes (b) and (d) in Box 1.5.

43. Likewise, intangibles that are acquired through mergers and acquisitions are recorded as assets since they are valued in a "market" transaction (von Hippel, 1988), based on a negotiated acquisition cost which is often quite arbitrary

44. Lenders also used soft information (e.g. prior lending relationships) to alleviate moral hazard and contain monitoring costs. This analysis is based on a sample of large firms as opposed to start-up firms.

45. The impact of seed and early-stage capital on resource flows to patenting firms is only statistically significant for young firms (Andrews et al.*,* 2013).

46. For example, business angel groups in Mexico cannot organise themselves as limited liability entities (OECD, 2013b). This has important consequences both for the legal standing of minority shareholders and for issues related to management of trusts and execution of guarantees, which must be carried out by the courts. In order to protect their minority shareholders and be able to apply trusts decisions directly, Mexican business angel networks register as limited liability companies abroad, mainly in Canada and in the United States.

47. This likely reflects the frequent changes in the availability and generosity of such measures, further underscoring the importance of a predictable policy environment for the financing of innovative ventures.

48. Due to data constraints, it was only possible to measure generosity in terms of the number of policy instruments (fiscal incentives and government equity finance programmes; see Da Rin et al.*,* 2013). Note that government equity finance programmes also include some business angel policies.

49. Secondary stock markets specialised in high-technology firms have traditionally constituted a popular exit route, owing to their lower costs and less stringent admission requirements relative to first-tier markets.

50. In the software industry, products are often made of multiple components, each covered by numerous patents.

51. See Table 1.2 for a list of countries included in the analysis.

52. The distribution of firm productivity and size is typically not clustered around the mean (as would be the case with a normal distribution) but is characterised by many below-average performers and a smaller number of star performers, captured in the long right tail of the distribution (Haltiwanger, 2011).

53. For example, if SDBS employment is 30% higher than ORBIS employment in a given cell, then the 30% "extra" employment is obtained by drawing firms randomly from the pool of ORBIS firms, such that the "extra" firms will make up for the missing 30%. See Gal (2013) for more details.

54. This analysis is still informative, however, since cross-country differences in the post-entry performance of firms tend to be more marked than differences in entry and exit patterns (Bartelsman et al., 2003).

55. Similarly, the adoption of new ICT often requires internal reorganisation (e.g. Brynjolfsson, 2011). This is likely to be easier to accommodate in environments where EPL is less stringent.

56. Note that countries with small venture markets (e.g. Chile, Greece, Mexico, Slovenia, Turkey) may have few venture firms reporting deals and therefore appear even smaller than they actually are.

57. The capital gains tax rate was also interacted with the dummies for high and low regulation to test if the effect of taxes on the number of venture capital deals differs depending on regulations. This turned out not to be the case.

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