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RAISING THE RETURNS TO INNOVATION: STRUCTURAL POLICIES FOR A KNOWLEDGE-BASED ECONOMY

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RAISING THE RETURNS TO INNOVATION: STRUCTURAL POLICIES FOR A KNOWLEDGE-BASED ECONOMY

Main findings

- **Investment in knowledge-based capital (KBC)** – assets that have no 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.
- **Investment in KBC differs greatly across countries**. While the available data suggests that English-speaking countries – particularly the United States – Japan and Sweden invest in the vicinity of 10% of GDP in KBC, investment in KBC in Italy, Portugal and Spain typically amounts to less than 5% of GDP.
- **Some countries are more successful than others at channeling tangible resources to firms that invest in KBC**. For example, the ease with which investment flows to firms that patent ideas in the United States and Sweden is over four times higher than for similar firms in Italy and Spain.
- **Policies that make it easier to reallocate scarce resources to firms that invest in KBC will bolster the returns to investing in KBC**.
- **Such policies include those that enhance the functioning of product, labour and risk capital markets and bankruptcy laws that do not overly penalise failure**.
- **Well-defined intellectual property rights (IPR)** provide firms with the incentive to innovate, especially in the chemicals and pharmaceutical sectors. However, such **IPR regimes need to be coupled with pro-competition policies** to ensure maximum effect while **rising litigation costs are undermining the effectiveness of the patent system in promoting innovation in the software sector**.
- **R&D tax incentives and, as a finding that contrasts with previous research, direct support measures are found to boost investment in KBC**. However, **design features are crucial** in order to minimise the fiscal cost and unintended consequences of these policies.

The emerging knowledge-based economy as a source of economic growth

1. Innovation-based growth, underpinned by investments in a broad range of knowledge-based capital (KBC), is central to raising long-term living standards. While investment in innovation has traditionally been proxied by spending on R&D, innovation-based growth relies on a much broader range of assets, such as employee skills, organisational know-how, databases, design, brands and various forms of intellectual property (Table 1). Indeed, investment in KBC has been increasing, and in some countries is larger as a share of GDP than investment in physical capital (Figure 1). This has implications for innovation and productivity growth and places heightened importance on a policy environment that promotes smooth adjustments of labour and capital inputs and entrepreneurial risk-taking.

2. Unlike investment in tangible assets such as machinery and equipment, many knowledge-based assets (*e.g.* software) are non-rival to the extent that they can be simultaneously employed by multiple users without diminishing their basic usefulness. Thus, the initial cost incurred in developing new ideas – typically through R&D – does not get re-incurred as the latter are combined with other inputs in the production process. Hence, in economies where KBC is important, growth is less likely to be constrained by scarcity than in an economy dominated by tangible capital. Furthermore, privately created knowledge often diffuses beyond its place of creation, thus providing wider social benefits.

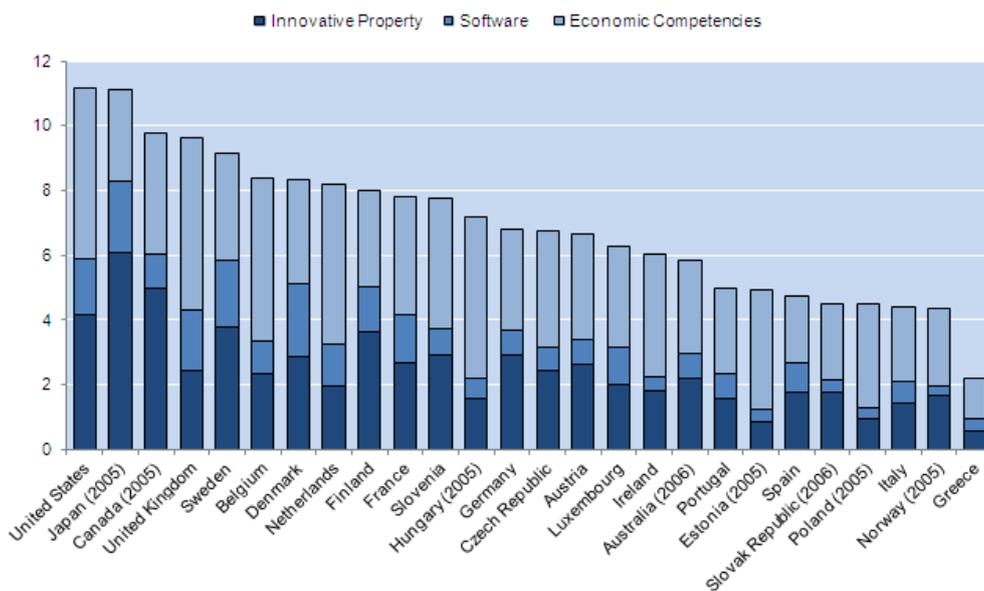
Table 1. The classification of KBC assets and their possible effects

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.
Managerial ability	Faster and better decision making. Improved production processes.
Organisational capital	Faster and better decision making. Improved production processes.

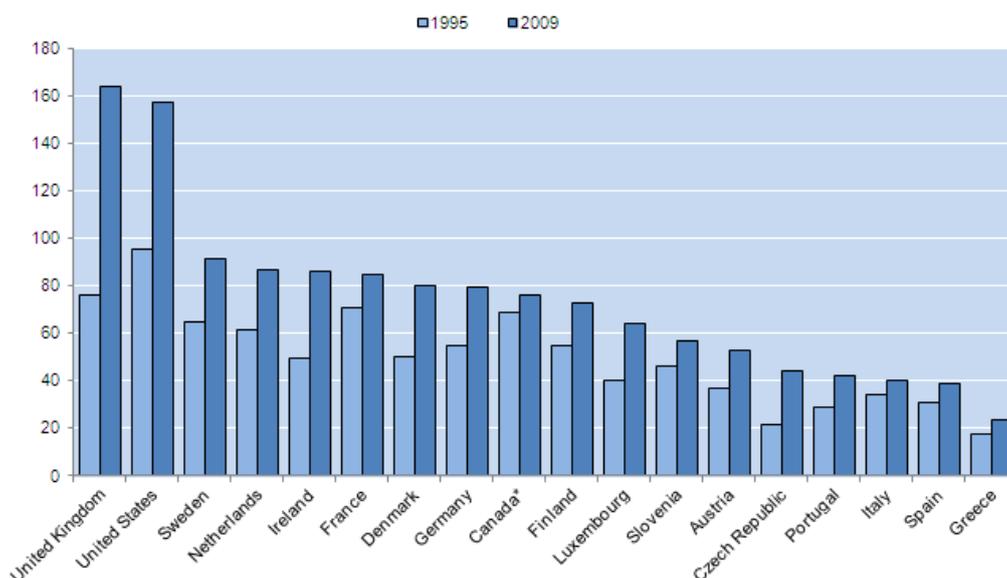
Source: OECD Secretariat based on Corrado *et al.*, (2005).

Figure 1. Investment in KBC varies significantly across countries

Panel A: Per cent of GDP; Selected OECD countries, 2009 or latest data available



Panel B: The evolution of investment in KBC relative to tangible capital; 1995 and 2009 (unless otherwise noted)



Notes: The estimates refer to the market sector and include each type of KBC outlined in Table 1 and mineral exploration. *Data for Canada in Panel B refer to 1998 and 2005.

Source: Corrado *et al.*, (2012).

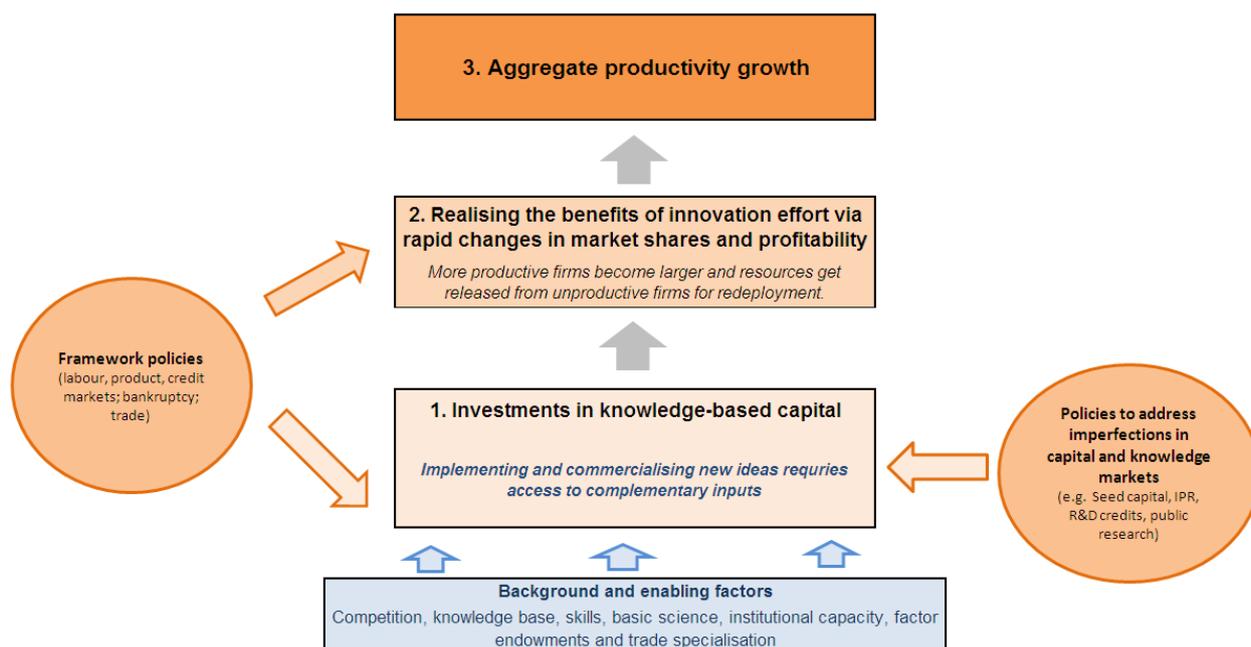
3. Given the close links between KBC and growth, cross-country differences in investment in KBC take on heightened significance. For example, the available data suggests that the United States and Sweden invest more than twice as much in KBC as a share of GDP, compared with Italy and Spain (Figure 1, Panel A). Moreover, these outcomes cannot be solely explained by differences in patterns of industrial specialisation.

Why do some countries invest more in KBC than others?

4. From the firms' perspective, investing in KBC is a multi-stage process and much can go wrong along the way (Figure 2). Clearly, the ability to create new ideas is crucial. This underscores the need for an educated workforce and basic scientific research but also a business environment that fosters the entry of innovative start-up firms, as history shows that firms that ride one technological wave often fail to continue to do so in the subsequent one.

5. However, good ideas alone are not sufficient and firms must acquire complementary capital and workers to underpin their implementation and commercialisation. This requires a policy environment that promotes the reallocation of resources to their most effective use, which is particularly important given that the uncertain nature of KBC leads firms to scale-up innovative production methods only after they have shown success in smaller-scale experiments. Similarly, in the event of failure, policies that provide the ability to rapidly and cheaply scale down operations or facilitate exit are crucial, in order to motivate risk taking activity by the firm in the first place and to release resources to be used by more successful firms.

Figure 2. Investing in KBC is a multi-stage process and is influenced by public policies



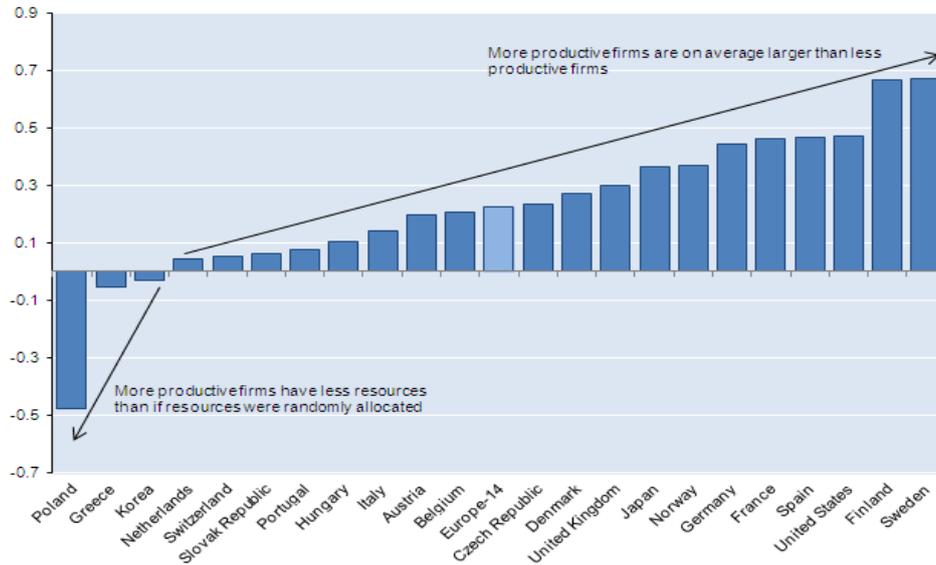
6. From the perspective of the economy as a whole, the gains from any firms' innovative efforts will be magnified when innovative firms can rapidly gain market share at the expense of unsuccessful competitors thereby boosting aggregate productivity. However, OECD economies vary significantly in their capacity to reallocate resources to underpin the expansion of the most successful firms.

7. One indicator of the efficiency of reallocation is the extent to which, all else equal, it is the most productive firms that hold the largest market shares (Figure 3). This again reflects the extent to which labour and capital resources are reallocated away from less productive toward more productive firms over time. According to this metric, the United States and some Nordic countries are more effective at channelling resources to high productivity firms than some Continental and Southern European countries (e.g. see Europe-14 in Figure 3). Similarly, the ease with which firms that patent (one indicator of innovative capacity) can attract tangible capital – which is required to implement and commercialise new ideas – is over four times higher in the United States and Sweden than for similar firms in Italy and Spain. These gaps are even larger for young firms, which are more likely to experiment with radical innovations that tend to have a larger productivity pay-off than incremental innovations.

8. Since difficulties in reallocation make it more difficult for firms to fully realise the fruits of their innovative effort, they may also reduce the incentive for firms to invest in KBC in the first place. Indeed, the countries that allocate resources more efficiently also tend to invest more in KBC (Figure 4), suggesting that policies which support reallocation also encourage innovative activity.

Figure 3. 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; manufacturing sector in selected OECD countries in 2005

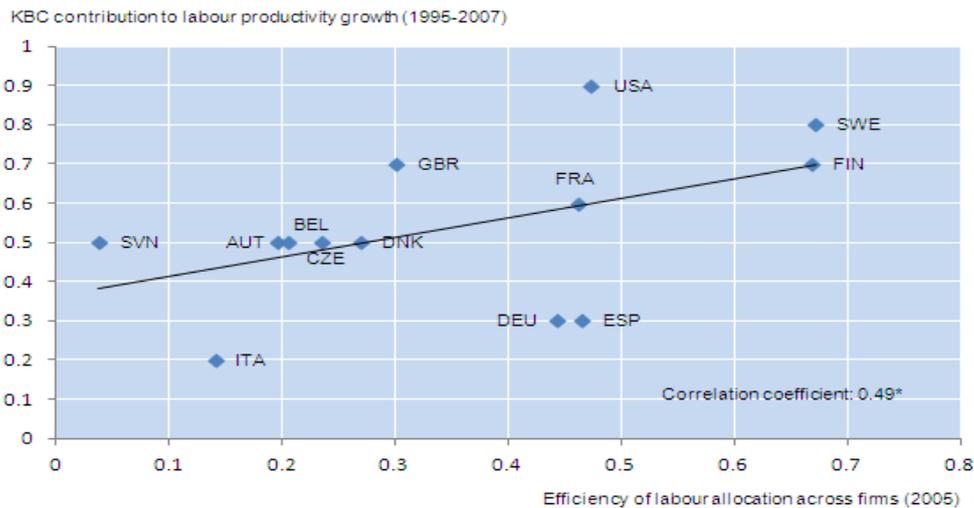


Notes: the estimates show the extent to which the firms with higher than average labour productivity have larger employment shares. In most countries, the covariance between productivity and employment share is positive, suggesting that the actual allocation of employment boosts manufacturing labour productivity, compared to a situation where resources were 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, and is obtained by aggregating the respective allocative efficiency indicators by each country's share in manufacturing sector employment.

Source: Andrews and Cingano (2012).

Figure 4. Better allocation of resources makes KBC contribute more to productivity growth

Log points; selected OECD countries

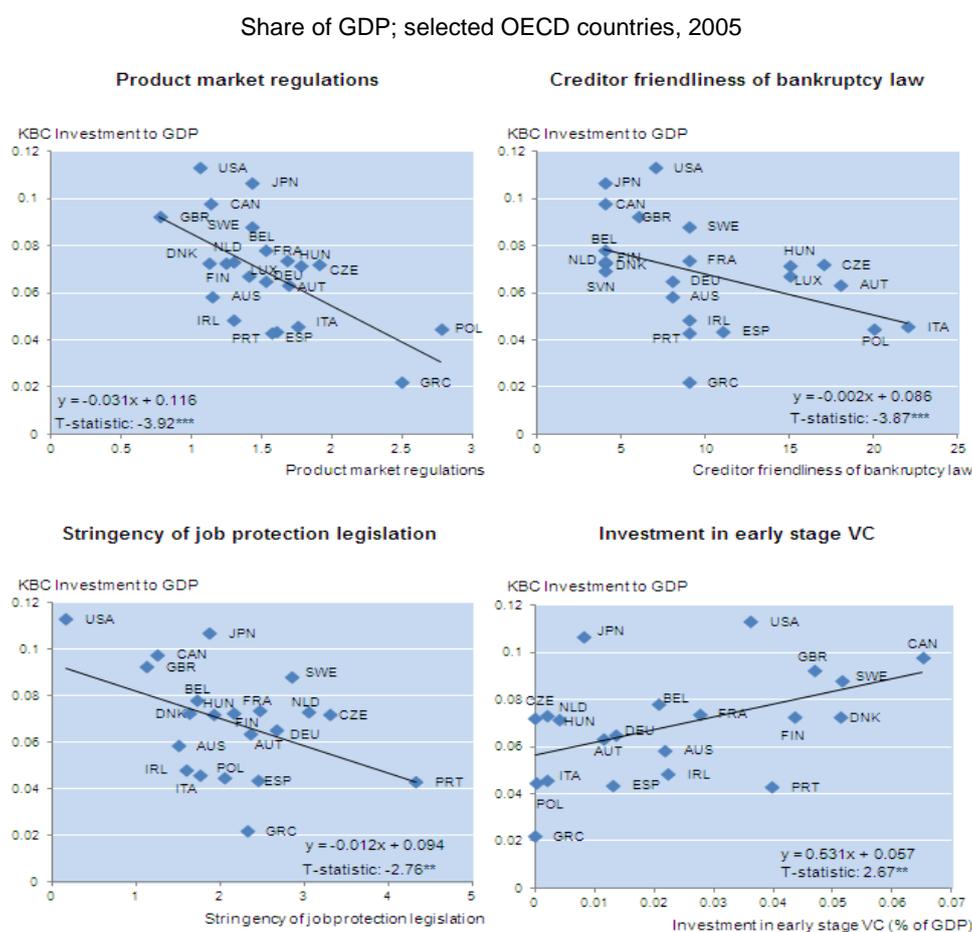


Notes: The chart plots the contribution of knowledge based capital deepening to labour productivity growth (sourced from Corrado *et al.*, 2012) against the efficiency of labour allocation based on the same estimates as in Figure 3. The correlation coefficient is statistically significant at the 10% level.

Well-designed framework policies can raise incentives to invest in KBC

9. Regulatory policies in product, labour and capital markets have a pervasive impact on KBC given their potential to affect each stage of the innovation process (Figure 2). Furthermore, reforms to these policies are an attractive way to enhance KBC-driven growth from a public finance perspective since they do not imply a direct cost to public budgets. Indeed, well-functioning product, labour and (early stage) venture capital markets and bankruptcy laws that do not overly penalise failure are associated with greater investment in KBC (Figure 5) – a link that is corroborated by more detailed empirical analysis (see Andrews and Criscuolo, 2013). These benefits are partly realised through stronger competitive pressures and more efficient reallocation, which make it easier for successful firms to implement and commercialise new ideas and, by lowering the costs of failure, encourage firms to experiment with uncertain growth opportunities.

Figure 5. Growth-friendly structural policies are associated with more investment in KBC



Notes: Investment in KBC to GDP is measured in 2005, while the policy indicators refer to either 2003 (Product Market Regulations, Job Protection Legislation, Bankruptcy Law) or 2005 (Early Stage VC). The correlations are robust to the exclusion of outliers, such as Greece and Poland in the Product Market Regulations panel.

Source: OECD calculation based on intangible capital estimates from Corrado *et al.*, (2012), and policy indicators from: the OECD (Product Market Regulations, Job Protection Legislation and Early Stage VC) and the World Bank (Bankruptcy Law).

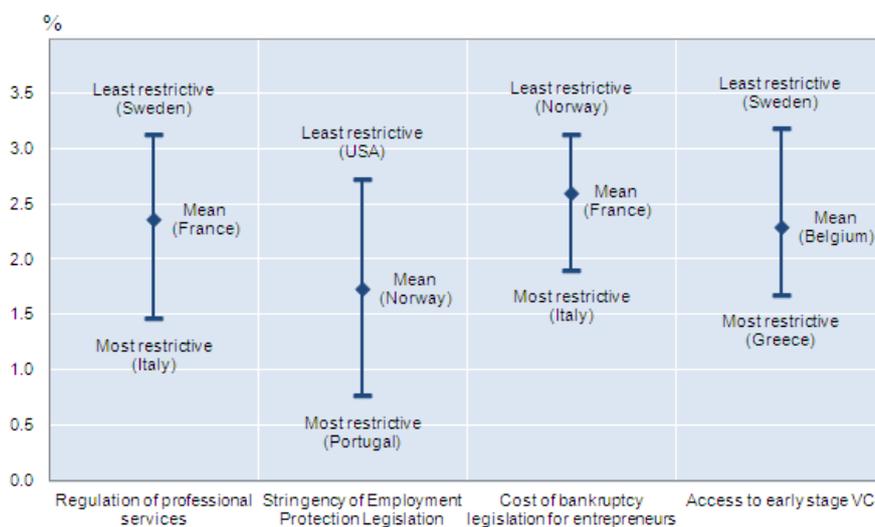
Product market liberalisation has pervasive impacts on KBC

10. Reforms to anti-competitive product market regulations – such as the removal of administrative burdens on start-up firms as well as broader barriers to competition – can increase investment in KBC via:

- More entry of entrepreneurial start-ups, which in turn increases pressure on incumbent firms to invest in R&D and incorporate foreign technologies.
- Improved management performance as a result of greater market discipline, which enhances the ability of firms to implement new technologies and sustain the innovation process. See Bloom and Van Reenen (2010) for a discussion.
- Easier and cheaper access to labour and capital inputs, which – because of easier reallocation – raises the returns to investing in KBC. For example, a policy reform that would alleviate regulatory barriers in business services from the OECD average (*i.e.* France) to the low level in Sweden is associated with a 30% increase in investment in innovative firms (Figure 6).
- Lower barriers to international trade and investment, which increase access to international technological transfer and raise the returns to innovation by expanding potential market size and facilitating the growth of the most productive firms.

Figure 6. How do specific policies affect investment in innovative firms?

Additional capital attracted by a firm that increases its patent stock by 10%; 2002-2010



The estimated impact of different framework policies on the responsiveness of the firm capital stock to patenting

Note: The chart shows that the sensitivity of firm capital to changes in the patent stock varies according to the policy environment. All policy terms are statistically significant at at least the 10% level. For example, the sensitivity of firm capital to patenting is about three times larger when EPL is at the sample minimum (*i.e.* the US), compared with when EPL is at the sample maximum (*i.e.* Portugal).

Source: OECD calculations based on matched ORBIS-PATSTAT data. EPL is the OECD Employment Protection Legislation (EPL) sub-index of restrictions on individual dismissal of workers with regular contracts; Regulation of professional services is sourced from the OECD Product Market Regulation (PMR) Index; See Figure 5 for details on Early Stage VC and Bankruptcy Legislation.

Labour market reforms encourage experimentation with uncertain technologies

11. Employment protection legislation (EPL) that imposes heavy or unpredictable costs on hiring and firing slows down the reallocation process – which reduces the returns to investing in KBC – and by raising the costs of exit in case of business failure, makes it less attractive for firms to experiment with highly uncertain technologies.

- Reforming EPL significantly increases the ability of innovative firms to attract resources that are required to implement and commercialise new ideas (Figure 6). For example, for firms in the United States where EPL is relatively lax, a 10% in the firm patent stock is associated with a 2.7% increase in investment, but this effect is round three times smaller for firms in Portugal where EPL is very rigid.
- High and unpredictable job protection costs particularly handicap dynamic firms that operate in an environment subject to greater technological change and that place therefore a high option value on flexibility, given their tendency to experiment with uncertain technologies.

12. While labour market reforms are desirable in order to boost KBC, the recent experience of some European countries highlights that such reforms should be designed and implemented in a broad-based fashion. For instance, the asymmetric liberalisation of employment protection for temporary contracts, while leaving in place stringent regulations on permanent contracts may have adverse effects on the accumulation of firm-specific human capital (one form of KBC), to the extent that firms replace permanent workers with temporary workers, who are less likely to participate in job-related training.

Debtor-friendly bankruptcy laws can promote risk-taking but trade-offs emerge

13. Bankruptcy regimes can foster experimentation with risky technologies if they do not sanction business failure too severely. If the cost of winding-down a business is particularly high, risky entrepreneurial ventures might not be brought to the market to avoid incurring high exit costs in case of failure. Reforms to bankruptcy legislation that lower the cost to close a business can promote investment in more innovative business ventures (Figure 6), by reducing the expectation of entrepreneurs that they will be heavily penalised in case of failure. Such arrangements could, however, also discourage investment in KBC if credit supply is tightened as a result of reduced loss recovery in case of bankruptcy. Striking the right balance between these two forces makes the design of bankruptcy provisions complicated.

14. The swift reallocation of resources from failed ventures to other more effective uses will also be affected by the time required for the full completion of all legal procedures to wind up a business and the incentives to the use of out-of-court arrangements. In extreme cases, these legal procedures might take years to complete, thus undermining reallocation and the accumulation of entrepreneurial capital. Thus, by easing reallocation constraints, measures aimed at streamlining and quickening bankruptcy procedures can create conditions for increased investment in KBC. For more details on impact of legal systems on economic performance, see Palumbo *et al.*, (2013).

Financing KBC by nurturing the market for risk capital

15. Countries with more developed seed and early stage venture capital markets are more effective at channelling investment to young, innovative firms (Figure 6). The importance of risk capital markets stems from the fact that knowledge-based assets are difficult to collateralise – partly because they are less easy to define and transfer than tangible assets – which makes them less conducive to traditional debt and equity financing. Cross-country differences in the size of risk capital markets are significant (Figure 5), and reflect a number of policy-related factors:

- Appropriate labour market regulations and bankruptcy legislation (see above) and lower rates of taxation on corporate incomes and capital gains can foster risk capital markets.
- The existence of exit possibilities for risk capital investments (*e.g.* secondary stock markets such as the NASDAQ) increases the expected return to investors and entrepreneurs. Rules affecting initial public offerings and portfolio restrictions that bar, or limit institutional investors (*e.g.* pension funds) from investing in risk capital also loom large.

16. While government risk capital funds and favourable tax treatment of risk capital investments and returns are becoming increasingly common in OECD countries, evidence on their effectiveness is scarce.

Innovation policies

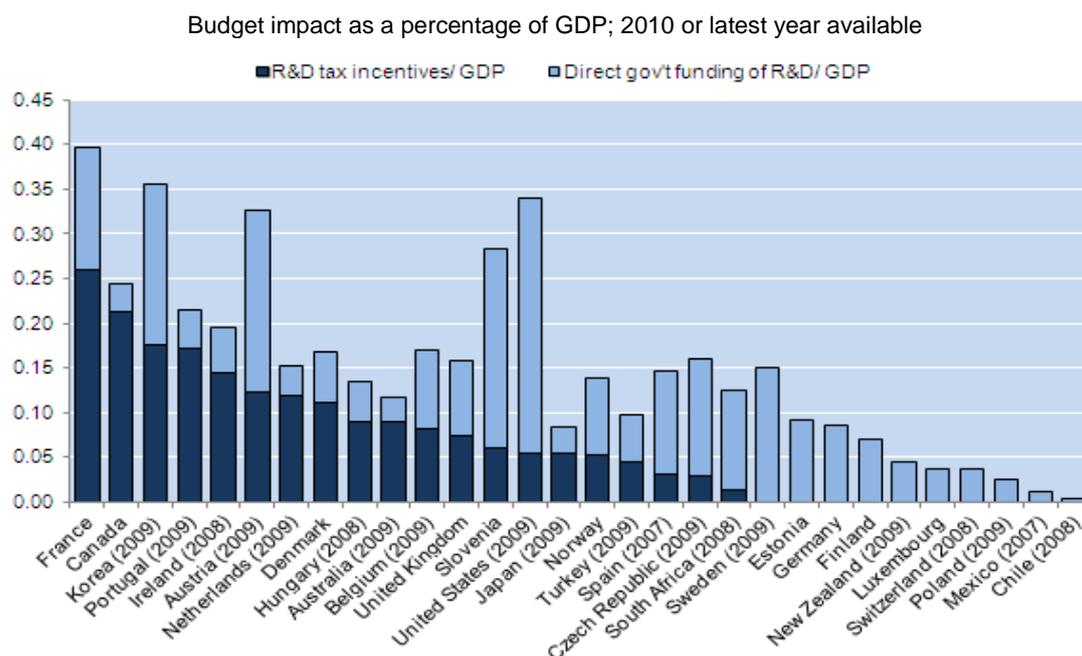
17. There is also scope for policies that raise private incentives to invest in KBC towards more socially desirable levels since knowledge spillovers across firms prevent firms from fully appropriating the returns from their innovative investments in absence of policy intervention.

18. Intellectual property rights (IPR) provide firms with the incentive to innovate, but maximum effects are obtained when they are coupled with pro-competition policies. However, in some emerging KBC sectors where the innovation process is typically fragmented (*e.g.* software), the patent system may unduly favour incumbents at the expense of young firms, thus undermining incentives to invest in KBC. Empirical evidence from the United States suggests that the cost of litigation exceeded the profit from patents in the late 1990s in industries outside pharmaceuticals and chemicals. Indeed, the increasing emergence of “patent aggregators” that accumulate software patents with the sole objective of extracting rents from innovators may challenge innovation activities. While the patent system remains effective at promoting innovation in sectors such as pharmaceuticals and chemicals, the rising importance of the digital economy raises an important policy dilemma for governments, which is yet to be resolved in academic and policy circles.

19. Aside from setting appropriate intellectual property rights, there is scope for public finance policies that subsidise innovation-related KBC. The most frequent policies are tax incentives and direct support (*i.e.* loans, grants) for R&D (Figure 7), with reliance on the former increasing dramatically over recent decades in many economies. While both policies can be effective, their design features are crucial in order to minimise the cost to the tax payer and unintended consequences:

- It is important that R&D tax incentives are refundable or contain carry-over provisions so as to avoid overly favouring less dynamic incumbents at the expense of dynamic young firms. Many young innovative firms are typically in a loss position in the early years of an R&D project and thus will not benefit from the program unless it contains provisions for immediate cash refunds for R&D expenditure or allows such firms to carry associated losses forward to deduct against future tax burdens (see Table A1 for how the design of R&D tax incentive schemes varies across countries).
- Recent improvements in the design of schemes that provide direct government support to R&D may explain why, in contrast with earlier empirical research, there is now clearer evidence of a positive impact on innovation (Westmore, 2013). For example, the structure of public support has become more focused on subsidies for commercial R&D activities and with matching grants (for private sector investments) being a more common feature of government funding programmes.

Figure 7. Direct government funding of business R&D (BERD) and tax incentives for R&D



Notes: Countries ranked from highest to lowest R&D tax incentives/GDP. R&D tax incentives do not cover 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 (2011) and national sources.

Suggested further reading

The main paper summarising the project is:

Andrews, D. and C. Criscuolo (2013), “Knowledge Based Capital, Innovation and Resource Allocation”, *OECD Economic Policy Papers*, No.4, OECD, Paris.

Supporting papers and other relevant research include:

Andrews, D. and F. Cingano (2012), “Public Policy and Resource Allocation: Evidence from Firms in OECD countries”, *OECD Economics Department Working Papers*, No.996, OECD, Paris.

Bloom, N. and J. Van Reenen (2010), “Why Do Management Practices Differ across Firms and Countries?”, *Journal of Economic Perspectives* 24(1), pp. 203–224.

Corrado C., C. Hulten and D. Sichel (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, Chicago: The University of Chicago Press.

Corrado, C., J. Haskel., C. Jona-Lasinio and M. Iommi (2012), “Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results”, *INTAN-Invest Mimeo*.

OECD (2010), *Innovation Strategy*, OECD, Paris.

OECD (2011), *OECD Science, Technology and Industry Scoreboard 2011*, OECD, Paris.

Palumbo G., G. Giupponi, G., L. Nunziata, and J. Mora-Sanguinetti (2013), “The Effectiveness of Civil Justice: A Cross-country Economic Analysis”, *OECD Economic Policy Papers*, No. 5, OECD, Paris.

Westmore, B. (2013), “R&D, Patenting and Productivity: The Role of Public Policy”, *OECD Economics Department Working Papers*, No. 1047, OECD, Paris.

ANNEX TABLE

Table A1: Details of differences in R&D tax incentives schemes across selected countries (2013)

Design of the R&D tax incentive scheme	<i>Volume base R&D tax credit</i>	Australia*, Austria, Belgium (capital), Canada, Chile, Denmark, France, Norway.
	<i>Incremental R&D tax credit</i>	United States (mostly)**.
	<i>Hybrid system of a volume and an incremental credit</i>	Ireland, Italy, Japan, Korea, Portugal, Spain.
	<i>R&D tax allowance</i>	Belgium (capital), 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 <u>not</u> 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 <u>not</u> 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	<i>Special for energy</i>	United States (volume-based).
	<i>Special for collaboration</i>	Hungary, Italy, Japan, Norway.
	<i>Special for new claimants</i>	France.
	<i>Special for young firms and start-ups</i>	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, 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, Switzerland.

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 \$20 billion (about US\$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 and refundable tax credits.

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

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