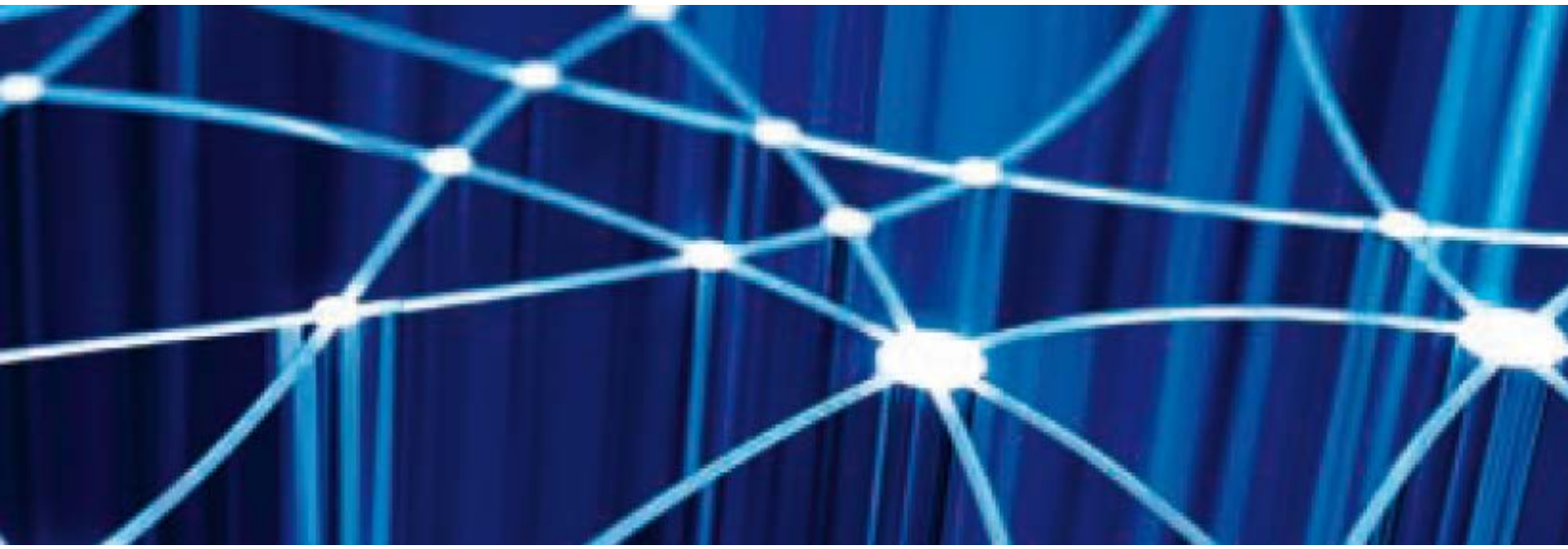
New Sources of Growth: Knowledge-Based Capital

Key Analyses and Policy Conclusions

SYNTHESIS REPORT



OECD

FOREWORD

At the start of 2011 the OECD began work on a two-year project entitled **New Sources of Growth: Knowledge-based Capital**. For OECD member countries and key non-members it had two aims: to provide evidence of the economic value of knowledge-based capital as a new source of growth; and to improve understanding of current and emerging policy challenges. It was born out of insights from the OECD's Innovation Strategy, which was released in 2010. The project has drawn on expertise from across the OECD and from streams of work on "big data", competition, corporate reporting, the efficiency of resource allocation, global value chains, innovation, knowledge networks and markets, measurement and taxation. This synthesis presents the project's main analyses and policy findings.

The Directorate for Science, Technology and Industry, the Economics Department, the Centre for Tax Policy and Administration, the Directorate for Financial and Enterprise Affairs and the Statistics Directorate have contributed to this report. Reflecting the cross-directorate character of the OECD work on knowledge-based capital, the work was discussed and declassified by various OECD Committees including the Committee on Industry, Innovation and Entrepreneurship (CIIE), which took the lead for this work, the Committee for Scientific and Technological Policy, the Committee for Information, Computer and Communications Policy, Working Party 1 of the Economic Policy Committee, the Committee on Fiscal Affairs, the Competition Committee, the Corporate Governance Committee and the Committee on Statistics. The comments and inputs formulated by national delegates to these OECD bodies are greatly acknowledged. This synthesis report was discussed by the OECD Executive Committee and OECD Council and was presented at the Ministerial Meeting of May 2013.

Further information about the project is available at **http://oe.cd/kbc**.

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EXECUTIVE SUMMARY

At the start of 2011 the OECD began work on a two-year project entitled **New Sources of Growth: Knowledge-based Capital**. The motivation for the project was two-fold. The first was to examine in depth a finding highlighted by the OECD's 2010 **Innovation Strategy**, namely that many firms that innovate do not invest in R&D. Instead, innovation in such firms is based on investments in a wider range of intangible assets – knowledge-based capital (KBC). Secondly, the NSG-KBC project aims to help governments and policy analysts better understand the determinants of growth. Today, the importance of growth can barely be overstated. The drawn-out nature of the global crisis, sluggish macro-economic conditions in many OECD economies, weak labour markets and burgeoning public debt have all added urgency to the search for new sources of growth. Furthermore, rapidly ageing populations, combined with natural resource constraints, mean that the future of growth in advanced economies will increasingly depend on productivity-raising innovation. Drawing on inputs from across the OECD Secretariat, the work summarised in this synthesis report aims to provide evidence of the economic value of knowledge-based capital as a new source of growth and to improve understanding of current and emerging policy challenges.

KBC results from business investment in non-physical assets such as research and development (R&D), data, software, patents, new organisational processes, firm-specific skills and designs. In many OECD countries, business investment in KBC has increased faster than investment in physical capital (machinery, equipment, buildings). In some countries, business investment in KBC significantly exceeds investment in physical capital.

KBC and growth

Inherent features of KBC are growth-promoting, and various forms of evidence link business investment in KBC to growth and productivity change. Unlike physical capital, KBC can foster growth because the initial cost incurred in developing certain types of knowledge is not re-incurred when that knowledge is used again. This can lead to increasing returns to scale in production. Investments in many forms of KBC – such as R&D, design and new business processes – also create knowledge that spills over into other parts of the economy, again spurring growth. Growth accounting studies for the European Union and the United States show that business investment in KBC contributes 20% to 27% of average labour productivity growth. And during the global crisis, investment in KBC has been relatively resilient. KBC is also transforming the determinants of competitive success for firms. For instance, in the automotive sector, the cost of developing new vehicles is increasingly dominated by software, with high-end vehicles relying on millions of lines of computer code.

As overall business investment in KBC increases – and because of KBC's particular economic features, especially its intangible nature – certain key policy settings need to be updated. Ensuring that policies are up to date and conform to good practice is

essential in the fields of taxation, innovation, entrepreneurship, competition, corporate reporting and intellectual property. This also holds for policies that enable the exploitation of data as an economic asset. The rising importance of KBC also amplifies the importance of some framework policies already understood to be essential, such as education. Getting the key framework conditions right, while a challenge, is in fact a low-cost step for policy makers in fiscal terms.

Innovation

The breadth of the assets that make up KBC points to the need for policy makers to adopt an enlarged concept of innovation, beyond the conventional view in which R&D is pre-eminent. Other assets such as organisational capital and design, and the ability to create value from data, are important arenas of innovation and productivity growth that often require specific policy action. Well-designed support measures – such as those that facilitate access to finance for innovative firms – along with frameworks that foster collaboration to innovate, supply-side measures that support KBC investments in areas of highest social return, and the redesign of some long-standing innovation programmes, are all important. And demand-side policy – particularly innovation-oriented competitive public procurement – could help support KBC investments that also meet public needs. Policy stability – keeping policy uncertainty to a minimum – is also important.

Entrepreneurship and business development

The accumulation and optimal use of KBC requires experimentation (for instance with new business models and organisational forms) in firms of all sizes. Evidence from thirteen OECD countries for 2001-11 shows that young firms (*i.e.* below five years of age), many of which use KBC intensively, accounted for 18% of total employment but generated 47% of all new jobs created. Policy should make it easier for firms to develop and commercialise new ideas by lowering the costs of failure and encouraging firms to take risks and experiment with potential growth opportunities. All this requires well-functioning product and labour markets. Also essential are bankruptcy laws that do not overly penalise failure (reducing the stringency of bankruptcy legislation from the highest to the average level in the OECD could raise capital flows to patenting firms by around 35%) and well-functioning systems of debt and early-stage equity finance. Indeed, the countries that invest more in KBC are those that reallocate resources to innovative firms more effectively. As a share of gross domestic product (GDP), the United States and Sweden invest about twice as much in KBC as Italy and Spain, and patenting firms in the United States and Sweden attract four times as much capital as similar firms in Italy and Spain. Macroeconomic and political uncertainties are also likely to hinder business investment in KBC.

Taxation

A wide variety of tax policies affect innovation and growth, as examined in previous OECD publications such as *Tax Policy Reform and Economic Growth* (2010). Work reported here focuses on effects on KBC investment by multinational enterprises (MNEs) of limited corporate income tax on returns on investment. R&D tax incentives play a central role in many countries in encouraging investment in KBC. However, the effective tax rate on such investments depends also on other aspects of the tax regime,

including not only explicit government policies (such as 'patent boxes') but also the cross-border tax planning strategies now widely used by MNEs. New analysis is provided that finds that overall tax relief for R&D by MNEs, when factoring in relief resulting from cross-border tax planning by MNEs, could well be greater than governments foresaw when their R&D tax incentives were designed. The study considers how MNEs are able to transfer KBC to offshore holding companies, and how interactions of tax systems may encourage the use of KBC in foreign rather than domestic production. Consequently, countries may be losing tax revenue from the commercialisation of subsidised R&D and foregoing some potential domestic knowledge spillovers associated with production (while still gaining the benefits of knowledge spillovers from the subsidised R&D performed locally). Furthermore, 'stand-alone' firms that are not part of a multinational group of companies, and thus are unable to adopt cross-border tax-planning strategies, may be placed at a competitive disadvantage, relative to MNEs, in undertaking and exploiting R&D. The findings add to arguments for:

- *Targeting R&D tax credits on 'stand-alone' firms without cross-border tax planning opportunities.* This message is further supported by other OECD analysis showing that fiscal incentives may favour less dynamic incumbents at the expense of dynamic young firms.
- *Reducing unintended tax relief for MNEs on the exploitation of KBC through international cooperation.* New work to address base erosion and profit shifting (BEPS) should take into account growth in the importance of KBC and intra-group trade in intangibles.
- *Recognition of the risk that the increasing reliance of countries on tax incentives for R&D could, in some cases, increase foregone tax revenue without resulting in 'incremental' R&D (i.e. additional R&D spurred by the incentive) and without increasing income from R&D commercialisation. In this environment, it is essential to pay careful attention to the design of R&D tax credits to reduce these risks.*
- *Gathering more data to estimate the amounts of income being shifted to no-/low-tax countries through MNE tax planning involving KBC, given potentially significant implications of this planning for countries' public finances.*

Competition policy

Industries founded on KBC raise new issues for competition policy. This is particularly true for the digital economy. Never before have leading firms grown so large so quickly, and the nature of competition also differs in some respects from other sectors. Some experts have observed, for example, that unlike traditional manufacturing sectors, the digital economy's most meaningful competition takes place among platforms created by companies that use very different business models, rather than among companies that all follow more or less the same model. Apple, Google and Microsoft illustrate that point, as they all compete in the market for mobile phone operating systems but each has a different business model. Competition *among* platform providers may therefore be more important to innovation and consumer welfare than competition *within* platforms (such as rivalry among companies that create apps for the iPhone). Competition policy should: properly account for inter-platform competition; promote the elimination of unnecessarily anti-competitive product market regulation; and include the effective enforcement of competition law, which will protect and encourage innovation.

Intellectual property rights

High-quality intellectual property rights (IPR) are an increasingly important framework condition. The rise of KBC is shifting IPRs from a largely technical area that is important to a few sectors to an area with economy-wide prominence. Concerns are growing that not all facets of IPR are well suited to this more pervasive role and that some intellectual property regimes have not kept pace with technological change (many copyright systems were designed for a world of paper and print and may inhibit new digital services). In a world increasingly based on knowledge assets:

- IPR systems must be coupled with pro-competition policies and efficient judicial systems.
- Steps should be taken to address the erosion of patent quality (i.e. the accuracy of patent claims and whether patents reflect genuinely novel innovations). OECD data suggest that patent quality across the OECD area has eroded steadily over the last decade.
- There is a need for greater mutual recognition and compatibility across IPR systems internationally (for instance to permit cross-border copyright licensing). Better understanding is needed of how firms combine different IPRs (not only patents, but also trademarks, design rights and copyrights) in their overall innovation strategies.

Capturing value in global value chains

The geographic fragmentation of production chains is a salient feature of the global economy. Investment in KBC plays an important role in global value chains (GVCs) and international competitiveness. The highest level of value creation in a GVC is often found in upstream activities such as concept development, R&D or the manufacture of key parts and components and in certain downstream activities such as marketing, branding or customer service. These activities all involve KBC and define the extent to which firms generate the value available through GVCs. *Getting policies and framework conditions right is important to ensure that high-value jobs are created and maintained in GVCs.* China, Brazil and other emerging economies are also making concerted efforts to help their businesses develop KBC.

Financial markets

In traditional debt markets, tangibles (assets such as equipment and structures) have well-defined market prices and readily serve as collateral. While there are innovations in the securitisation of debt using KBC, more could be done (for instance by facilitating robust markets for intellectual property). The increasing importance of KBC underscores the need for market-enhancing policy instruments to address shortfalls of early-stage risk capital that affect young KBC-intensive firms and the need for better ways for firms to communicate the value of KBC in their business models.

Corporate reporting

The value of many of the world's most successful companies resides almost entirely in their KBC. In 2011, for example, physical assets accounted for only about 13% of the value of Nestlé, the world's largest food company. Across countries, there is a positive correlation between the market value of firms and investment in KBC. Nevertheless,

corporate financial reports provide limited information on companies' investments in KBC. This may hinder corporate finance and governance. Governments might: *i)* support better corporate disclosure by establishing voluntary recommendations and guidelines or by backing private-sector reporting initiatives; *ii)* create mechanisms to facilitate companies' reporting of investments in KBC; *iii)* introduce frameworks for auditors; *iv)* engage in international co-ordination to improve international comparability of data and information supplied by companies; and *v)* promote the establishment of asset classifications that would increase consistency in data collection and reporting.

Measurement

A fuller understanding of innovation and growth, and the design of better policy, require governments to do more to measure investments in KBC and to agree on common measurement guidelines. Current international accounting standards, such as the System of National Accounts, capture a number of KBC investments, such as software and R&D, but efforts to develop guidelines for robust and comparable measurement should continue. This will require significant investment in the statistics needed to measure reliably all the forms of KBC referred to in this report. In the short to medium term countries are encouraged to develop additional measures via satellite accounts to maintain the international comparability of GDP. This will help to improve understanding of growth and productivity. As an indication of the potential impact of better measurement, accumulated investments in KBC (not measured in GDP) amounted to around USD 4.1 trillion in the United States in 2007. In fact, around 40% of growth is still an unexplained "residual", and better measurement of KBC can help fill a part of this gap.

Using data as an economic asset

Creating economic value from large data sets is at the leading edge of business innovation, while companies that base key decisions on data analytics outperform other firms. While there is no clearly optimal policy in this fast-evolving field, it is evident that to unlock major economic benefits all OECD governments must do more to implement coherent policies in the fields of privacy protection, open data access, information and communications technology (ICT) infrastructure and ICT-related skills.

Education and training

Growing business investment in KBC amplifies the importance of getting human capital policies right. Human capital is the foundation of KBC: software, for example, is essentially an expression of human expertise translated into code. The rapid evolution of different parts of the KBC-intensive economy inevitably generates skills shortages. Research in the United States suggests a shortfall of some 1.5 million managers and analysts with adequate understanding of the business benefits of data. The NSG-KBC project highlights the importance of policies to balance skills supply and demand efficiently (as elaborated in the OECD Skills Strategy). Public-private partnerships can also help to better align curricula and programmes with the needs of business. And given highly constrained public finances, in countries where educational attainment is already high, efforts to improve the quality of education will often be a priority.

The rise of KBC has profound implications for employment and earnings inequality. A KBC-based economy rewards skills and those who perform non-routine manual and cognitive tasks, but may also reward investors (who ultimately own much of the KBC) over workers (in the United States, for instance, wages as a share of GDP are at an all-time low). Rising investment in KBC can create winner-takes-all opportunities for a few, while entire occupational categories can be replaced by machines and software. KBC changes the demand for skills, and to the extent that workforce skills can adjust rapidly to new technologies, aggregate growth will be enhanced without greatly exacerbating income inequality. Major societal challenges will certainly arise as driverless vehicles, machine-based X-ray diagnostics, automated report-writing, and many similar advances in digital technology become widespread.

THE RISE OF KNOWLEDGE-BASED CAPITAL

Knowledge-based capital is composed of various types of assets and is increasingly the foundation of modern economies.

Knowledge-based capital (KBC) comprises a range of assets. These assets create future benefits for firms but, unlike machines, equipment, vehicles and structures, they are not physical. This non-tangible form of capital is, increasingly, the largest form of business investment and a key contributor to growth in advanced economies. One widely accepted classification groups KBC into three types: computerised information (software and databases); innovative property (patents, copyrights, designs, trademarks); and economic competencies (including brand equity, firm-specific human capital, networks of people and institutions, and organisational know-how that increases enterprise efficiency). Table 1 sets out the different forms of knowledge capital and how they affect output growth.

Table 1. Classification of the forms of KBC and their effects on output growth

Type of KBC asset	Mechanisms of output growth for the investor in the asset
Compterised information	
Software	Improved process efficiency, ability to spread process innovation more quickly, and improved vertical and horizontal integration.
Databases	Better understanding of consumer needs and increased ability to tailor products and services to meet them. Optimised vertical and horizontal integration.
Innovative property	
Research & Development	New products, services and processes, and quality improvements to existing ones. New technologies.
Mineral explorations	Information to locate and access new resource inputs - possibly at lower cost - for future exploitation.
Copyright and creative assets	Artistic originals, designs and other creative assets for future licensing, reproduction or performance. Diffusion of inventions and innovative methods.
New product development in financial services	More accessible capital markets. Reduced information asymmetry and monitoring costs.
New architectural and engineering designs	New designs leading to output in future periods. Product and service quality improvements, novel designs and enhanced processes.
Economic competencies	
Brand-building advertisement	Improved consumer trust, enabling innovation, price premia, increased market share and communication of quality.
Market research	Better understanding of specific consumer needs and ability to tailor products and services.
Worker training	Improved production capability and skill levels.
Management consulting	Externally acquired improvement in decision making and business processes.
Own organisational investment	Internal improvement in decision making and business processes.

Source: left column, C.A Corrado, C.R. Hulten and D. Sichel (2005), *Measuring Capital and Technology: An Expanded Framework.* in C. Corrado, J. Haltiwanger and D. Sichel (eds), *Measuring Capital in a New Economy*, National Bureau of Economic Research and University of Chicago Press.

Knowledge-based capital is essential to investment and growth

Aggregate business investment in KBC has now begun to be measured.

Historically, business investment in KBC was not accurately measured in national income or corporate accounts (Box 1). However, efforts to measure overall business investment in KBC have recently started. Beginning in the early 2000s, and focusing initially on the United States, researchers have applied direct expenditure methods to assess business investment in KBC, and then used these measures in growth accounting studies (growth accounting ascribes an economy's growth to increases in the volume of factors used – usually capital and labour – and the increase in the productivity of those factors). A significant research effort has expanded the number of countries covered by growth accounting analyses. Important findings of this research are summarised below.

Business investment in KBC is increasing in many OECD economies... and often outpaces investment in tangible capital.

Most advanced economies have become progressively intensive users of KBC. In the United Kingdom, business investment in KBC is estimated to have more than doubled as a share of market sector gross value added between 1970 and 2004. In Australia, since 1974-75, average annual growth of investment in KBC has been around 1.3 times that of investments in physical assets such as machinery, equipment and buildings. In Japan, the ratio of investment in KBC to GDP has risen throughout the past 20 years. In Canada, between 1976 and 2008, real investment in KBC increased at 6.4% a year, compared to 4.1% a year for investment in tangible assets. In the United States, the country with the longest time series, research shows business investment in KBC rising almost continuously for at least 40 years (Figure 1) to reach around 15% of value added by 2011.

KBC is not just about R&D.

The growth of business investment in KBC concerns more than research and development (R&D). For example, between 1995 and 2010, in the United States, business spending on R&D rose from 2.3% to 2.4% of value added. But over the same period, business spending on non-R&D forms of KBC increased from 8.5% to 11.2% of value added. Many other countries present a similar pattern. In France, again between 1995 and 2010, business spending on R&D remained unchanged at 1.9% of value added. But spending on non-R&D-related KBC increased from 7.4% to 10.6% of value added. Overall, private R&D stocks generally represent no more than 20-25% of total private stocks of KBC.

Investment in KBC remained relatively resilient during the global crisis.

Recently gathered data suggest that, at least in the early phase of the global economic crisis, business investment in KBC either grew faster than, or did not decline to the same extent as, investment in physical capital (Figure 2). This apparent degree of counter-cyclicality in aggregate investment in KBC suggests that mis-measurement of the economy may be more of a problem now than during periods of robust growth.

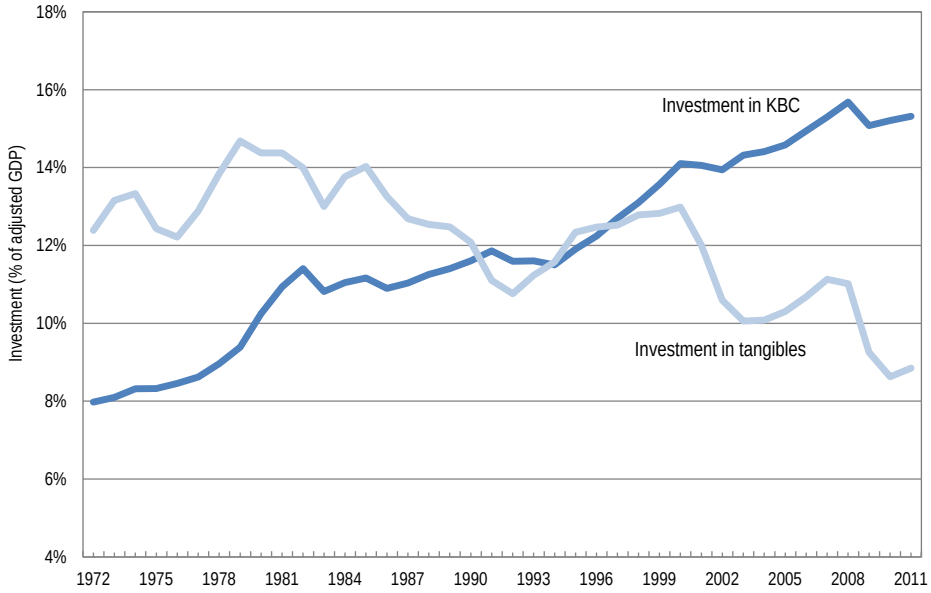
Box 1. Treating spending on knowledge-based capital as investment

When businesses invest to integrate databases and organisational processes, spending on hardware typically only represents some 20% of total costs. The remaining costs are for organisational changes such as new skills and incentive systems. Most of these costs are not counted as investment, even if they are as essential as the hardware. Treating spending on different forms of KBC as investment accords with the views of many in the business community who attribute fundamental aspects of corporate success to spending on such things as marketing, data, design and business process re-organisation.

Both firm and national income accounting have historically treated outlays on KBC as intermediate expenditure and not as investment. By accounting convention, if an acquired intermediate good contributes to production for longer than the taxable year, the cost of the good is treated as investment. Evidence suggests that the different forms of KBC should be treated as investment from an economic viewpoint. Research from the United Kingdom has estimated the productive lives of specific types of KBC as follows: firm-specific training (2.7 years); software (3.2); branding (2.8); R&D (4.6); design (4); and business process improvement (4.2) (Haskel, www.coinvest.org.uk). New OECD research shows that firms expect investments in organisational capital to last on average 4 to 6 years in services, and between 7 and 10 years in manufacturing.

Spending on software and mineral exploration is currently treated as investment in the national accounts, and a number of countries have capitalised, or are in the process of capitalising, R&D. However, the growing literature on KBC suggests that, conceptually, other types of KBC could be treated as investment.

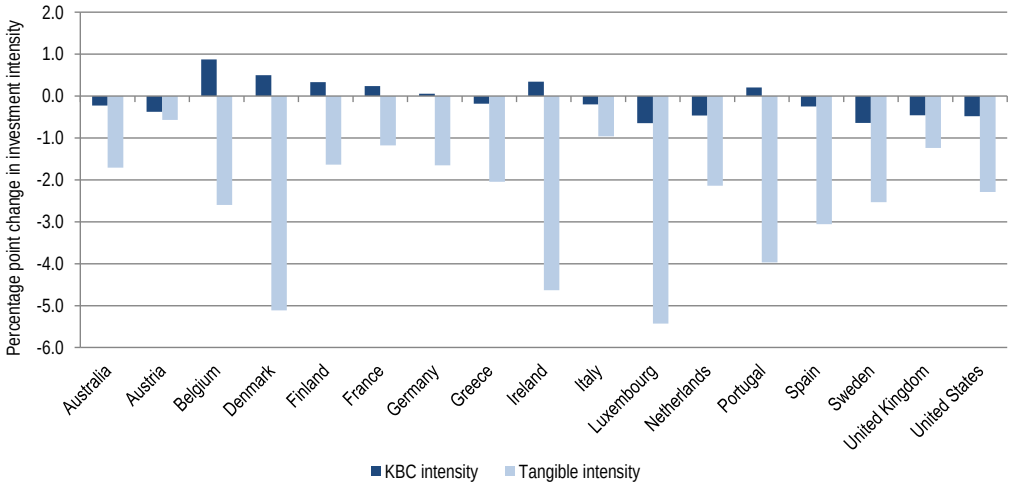
Figure 1. Business investment in KBC and tangible capital, United States, 1972-2011 (% of adjusted GDP)



Note: Estimates are for private industries excluding real estate, health and education.

Source: Unpublished update on Corrado, C.A. and Hulten, C.R. (2010), How do you Measure a 'Technological Revolution?, *American Economic Review: Papers & Proceedings* 100 (May 2010): 99–104.

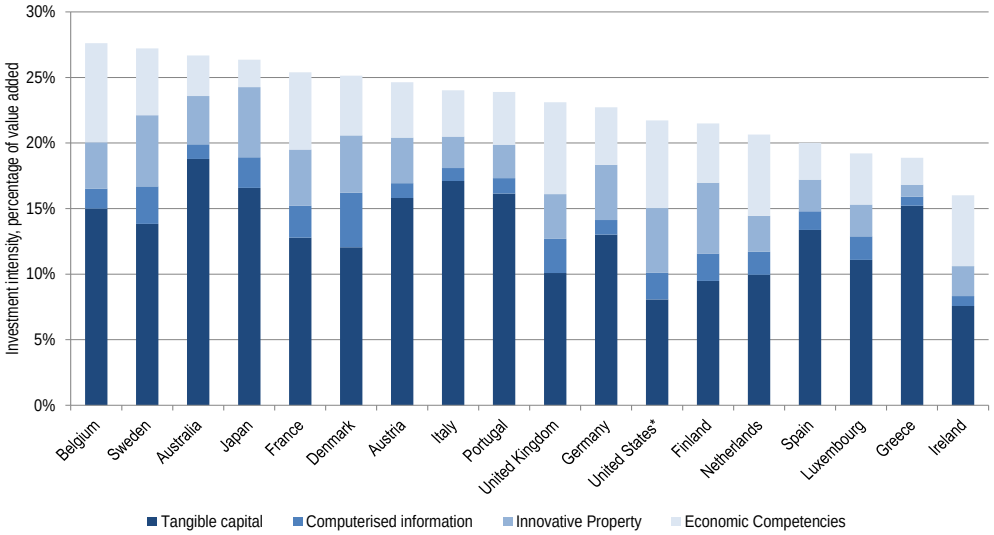
Figure 2. Change by type of business investment from 2008 to 2010 (percentage points of value added)



Note: Between 2008 and 2010, in most of the countries shown in Figure 2, business investment in KBC rose further as a share of GDP, or declined less, than investment in physical capital. For instance, in Denmark, investment in KBC rose from 12.6% of value added to 13.0%, an increase of 0.4 percentage points. Investment in tangible capital in Denmark fell from 17.1 % to 12.0% of GDP over the same period.

Source: INTAN-Invest (www.intant-invest.net), with additional information from the OECD Main Science and Technology Indicators, from Eurostat for EU countries' tangible investments and market sector value-added, from the United States Bureau of Economic Analysis for US tangible investments and private sector value-added, and from the Australian Innovation System Report (2012) and Australian Bureau of Statistics.

Figure 3. Business investment in KBC and tangible capital, 2010 (% of value added)



Note: Figures refer to the market economy, which excludes real estate, public administration, health and education.

*Figures correspond to the definition of the private sector in the National Industry and Production Accounts (NIPA).

Source: INTAN-Invest (www.intan-invest.net), with additional information from the OECD Main Science and Technology Indicators, from Eurostat for EU countries' tangible investments and market sector value-added, from the United States Bureau of Economic Analysis for tangible investments and private sector value-added, from the Australian Innovation System Report (2012), Australian Bureau of Statistics, and from the Japanese Industrial Productivity database.

Studies suggest that business investment in KBC is large...

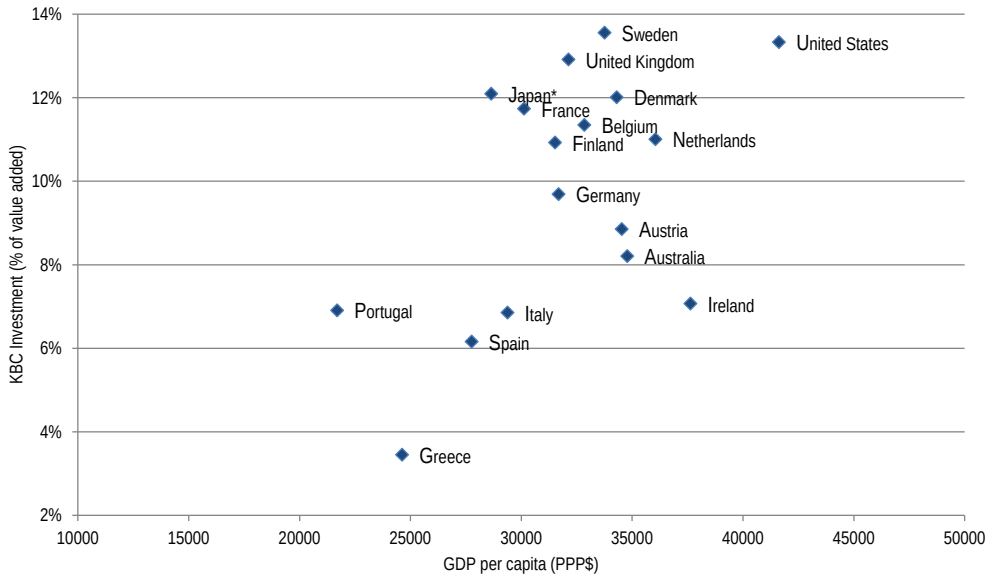
Research also indicates that business invests significantly in KBC. This again underscores the need for better measurement so as to understand the dynamics of the modern economy. For example:

- In Sweden, the United Kingdom and the United States investment in KBC matches or exceeds investment in physical capital (Figure 3). By 2009, KBC investment in the United Kingdom was 34% higher than investment in tangible capital.
- In the United States, total investment in KBC in 2009 is estimated at USD 1.17 trillion, some 11.4% of gross domestic product (GDP). By omitting accumulated investments in KBC, around USD 4.1 trillion appears to have been excluded from published national accounts data in 2007.

...and sometimes exceeds business investment in tangible capital.

- In France, KBC investments more than doubled as a share of value added, from 5% to 12%, from 1980 to 2008, with a sharp acceleration between 1995 and 2000 due to investments in software.
- For 2005-10, business investment in KBC represented an (unweighted) average of 9.7% of value added across 15 EU countries, including Germany, France, the United Kingdom and Italy (investment in tangible capital averaged 14.3% of value added).
- In Japan, business investment in KBC stood at 9.6% of gross value added in 2008 (up from 5.9% in 1985).

Figure 4. Business investment in KBC and GDP per capita, average 2000-10



Note: Data for Japan refer to 1998-2008.

Source: OECD National Accounts Main Aggregates and various sources for KBC data (see Figure 3).

National differences in the share of business investment in KBC correlate positively with income per capita.

As a share of GDP, the business sector in higher-income economies invests proportionally more in KBC. Figure 4 illustrates this positive correlation (although it does not establish a causal relationship).

Business investment in KBC is important for growth and productivity

Growth accounting exercises and macroeconomic and microeconometric studies offer evidence that business investment in KBC can promote growth and productivity. Business investment in KBC has increased for several reasons (Box 2).

Box 2. Why is business investing more in knowledge-based capital?

There are a number of possible explanations for the growing intensity of business investment in KBC:

- With rising educational attainment, OECD economies have accumulated a bigger stock of human capital. The stock of human capital in turn enables and complements the production and use of KBC. For instance, patents are a means of securing the intellectual property associated with innovations emanating from human capital, while software is essentially a translation of human expertise into code.
- Many products are themselves becoming more knowledge-intensive. In the automotive sector, it is estimated that 90% of the new features in cars have a significant software component (an innovative start-stop system, improved fuel injection, on-board camera, safety systems). Valuable trade secrets now lie in the electronic controls that regulate the operation of motors, generators and batteries. Hybrid and electric vehicles require huge volumes of computer code: the Chevrolet Volt plug-in hybrid uses about 10 million lines of computer code. A major part of the development costs for entirely new vehicles is also software-related (while manufacturers guard the exact figures closely, estimates of around 40% are not uncommon).
- In a context of global integration of markets and deregulation, sustained competitive advantage is increasingly based on innovation, which in turn is driven, in large part, by investments in different forms of KBC. For instance, levels of patenting, R&D, information technology (IT) and management quality have risen in firms more exposed to increases in Chinese imports. In sectors particularly exposed to Chinese imports, jobs and survival rates have fallen in firms with lower patenting intensity, but have been relatively protected in those with high patenting intensity.
- The fragmentation and geographic dispersion of value chains – as well as the increased sophistication of production processes in many industries – have raised the importance of KBC, in particular organisational capital (Wal-Mart's computerised supply chains, Merck's multiple R&D alliances).
- Businesses have made major investments in new information and communication technologies (ICTs). These have required complementary investments in forms of KBC such as new business process skills.
- New ICTs may make some types of KBC more valuable to firms. For example, when consumers can buy on line, rather than face to face, a brand and a reputation for reliable service gain in importance. For instance, although at least one Internet bookseller offers lower prices than Amazon 99% of the time, Amazon retains its large market share because of its reputation for customer service.

Growth accounting shows the important role played by KBC.

Growth accounting studies covering various periods show a positive relationship between business investment in KBC and macroeconomic growth and greater productivity. Treating KBC as investment, rather than intermediate expenditure, generally increases the contribution of capital deepening to overall growth (the capital represented by KBC is used more in production). Treating KBC as investment also typically reduces the contribution of multi-factor productivity (MFP) to growth. This suggests that the determinants of growth are better attributed (although changes in MFP also occur for reasons unrelated to KBC – from changing patterns of trade, to changes in economies of scale in production, to changes in the weather).

It is estimated that between 1995 and 2007 27% of labour productivity growth in the United States was due to investments in KBC. Estimates for the EU27 show that investment in KBC accounts for 20% to 25% of average labour productivity growth. In Canada GDP and annual average labour productivity growth would likely have been 0.2 percentage points higher between 1976 and 2000 if KBC had been included in the national accounts as investment.

Econometric research has examined the effects of various forms of KBC on productivity…

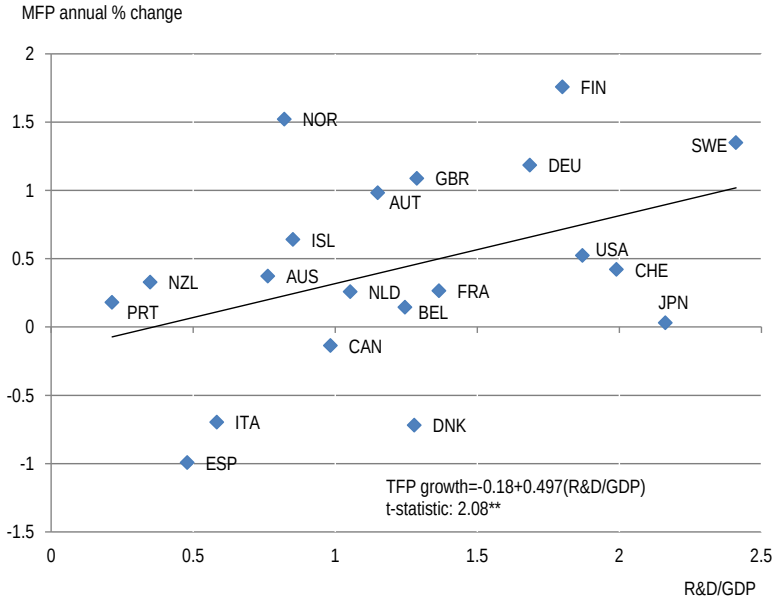
Growth accounting, however, does not explain what causes growth. Nor does it explain the complementarities between the relevant components. Econometric methods have therefore been used to reveal the positive, and significant, impacts of various forms of KBC – human capital, R&D, use of data analytics and management practices – on productivity.

For human capital, raising average educational attainment by one year has been estimated to increase macro-level productivity by at least 5%. At the firm level, research shows that firms in the United States that base significant decisions on data analytics have levels of output and productivity 5-6% higher than would be expected given their other investments and use of information technology.

…and shows that business investment in R&D relates positively to productivity growth.

Countries differ significantly in the extent to which the business sector invests in R&D. These differences are closely linked to productivity performance at the macro level (Figure 5). R&D not only enlarges the technological frontier, it also enhances firms' ability to absorb existing technologies. Microeconometric studies often find private rates of return to R&D in the range of 20-30%. This is generally higher than the returns to physical capital, which is consistent with the higher risk associated with KBC.

Figure 5. Multi-factor productivity growth and business R&D, 1986-2008 (% of GDP)



Source: *OECD Science, Technology and Industry Scoreboard 2011*, OECD Productivity Database and OECD calculations based on A. Johansson, Y. Guillemette, F. Murtin, D. Turner, G. Nicoletti, C. de la Maisonneuve, P. Bagnoli, G. Bousquet and F. Spinelli (2012), "Long-term Growth Scenarios", *OECD Economics Department Working Paper* No. 1000.

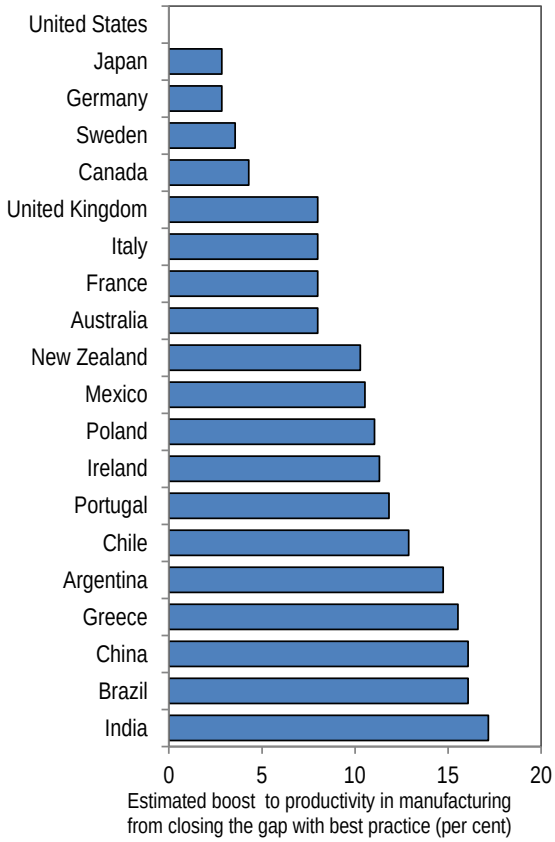
Managerial quality also affects productivity....

Managerial quality affects firm productivity and varies widely across OECD countries (Figure 6). This dispersion affords significant opportunities for productivity growth in some countries. For instance, raising managerial quality from the median level (roughly corresponding to New Zealand in Figure 6) to the level of the United States could increase average productivity in manufacturing by as much as 10%.

...and complementarities between KBC and ICT are particularly important for growth.

ICT networks within and between firms also facilitate the rollout of new business ideas and processes. There are also important complementarities between ICT capital investment and organisational capital, another form of KBC (Figure 7). This is because firms typically need to adopt ICT as part of a wider – and more costly – set of mutually reinforcing organisational changes to obtain the greatest benefit. The link between organisational capital and ICT is particularly significant because cross-country differences in aggregate growth in OECD countries largely depend on the performance of ICT-intensive sectors and because better management practices can raise the productivity of ICT capital. In fact, at least half of the US-Europe difference in labour productivity growth between 1995 and 2004 has been attributed to superior management practices in the United States.

Figure 6. Potential productivity growth in manufacturing when raising managerial quality to the level of global best practice



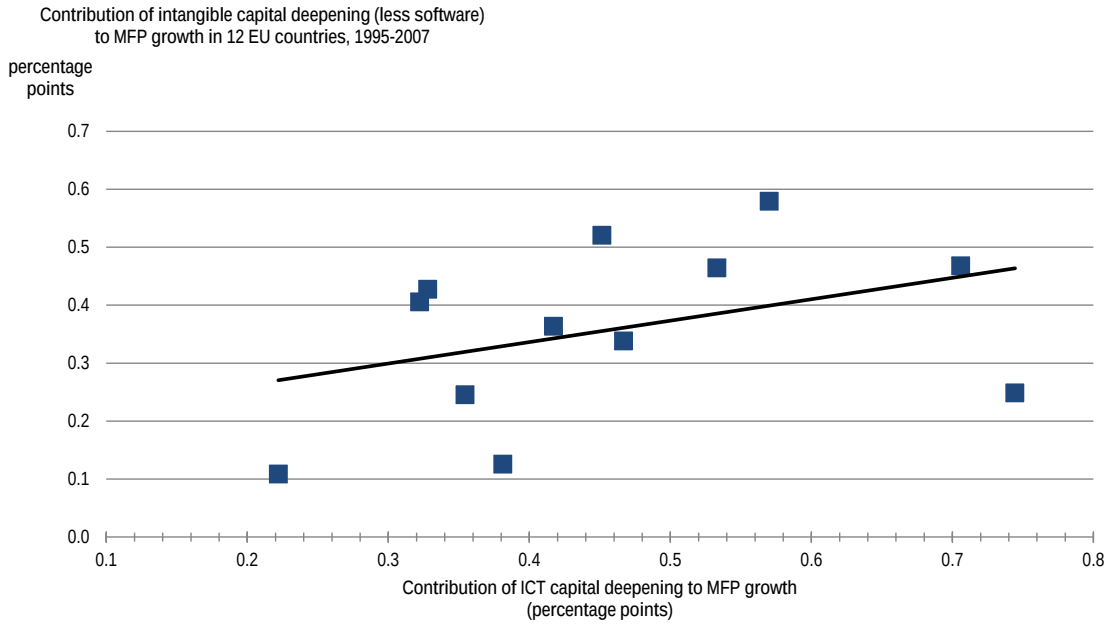
Note: The estimates are calculated from the difference in management score between each country and the United States and the estimated coefficient on the management score term in a firm-level regression of sales on management scores, capital and employment. The sample is based on medium-sized firms, ranging from 50 to 10 000 employees. The management score is an average of responses to 18 survey questions 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).

Source: OECD calculations based on management scores and estimated coefficients in Bloom, N, Genakos, C., Sadun, R., and van Reenen, J. (2012), "Management Practices across Firms and Countries", *NBER Working Paper*, no 17850.

Some features of KBC can be growth-promoting.

Two properties of KBC have particularly positive implications for growth. First, unlike physical capital, investments in many forms of KBC – R&D, organisational change, design – result in knowledge that can spill over to other parts of the economy. That is, firms that do not invest in KBC can only be partially excluded from benefits created by firms that do. For this reason, policy must provide adequate incentives for private investment in KBC.

Figure 7. ICT investment and KBC are positively correlated



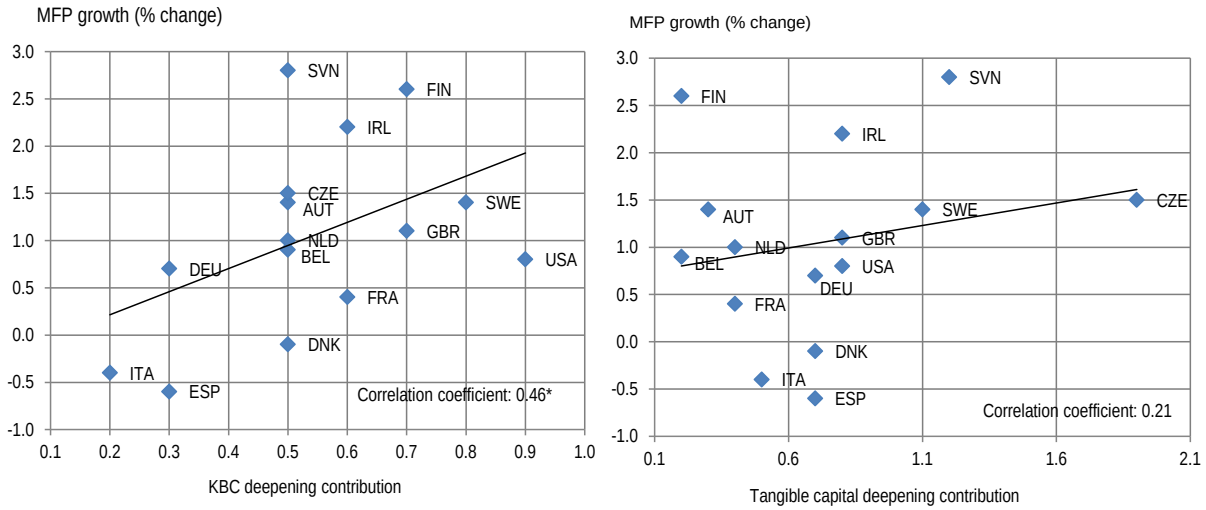
Source: Corrado, C.A., Haskel, J., Jona-Lasinio, C., (forthcoming), Knowledge Spillovers, ICT and Productivity Growth.

They include knowledge spillovers…

While it is difficult to estimate knowledge spillovers, empirical studies focused on R&D have generally found them to be quite widespread. Research at the country level has also identified spillover effects from design, brand equity, organisational capital and training (although industry-level analysis is needed to consider these findings definitive). Furthermore, new research shows a stronger positive correlation between KBC investment and MFP growth than between tangible capital investment and MFP growth (Figure 8) (the correlation is statistically significant for KBC investment but not for tangible investment). MFP rises faster when workers use more KBC than when they use more tangible capital. This points to knowledge spillover effects from KBC.

Figure 8. 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 charts plot the contributions of KBC and tangible capital deepening to labour productivity growth against the growth of MFP. The correlations are robust to individually dropping outliers, such as the Czech Republic, Finland and Slovenia. The MFP estimates differ from conventional growth accounting exercises in that they are based on a value-added series that capitalises all of the forms of KBC outlined in Table 1.

* Denotes statistical significance at the 10% level.

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

…and the fact that knowledge, once created, can be used again at no further cost.

Second, KBC can spur growth because the initial cost incurred in developing some types of knowledge – often but not exclusively through R&D – does not need to be incurred again when that knowledge is used again in production. Indeed, once created, some forms of KBC – such as software and certain types of designs – can be replicated at almost zero cost (they can also be used simultaneously by many users - this is known as "non-rivalry"). This can lead to increasing returns to scale in production, the property that makes ideas and knowledge an engine of growth. Scale economies of this sort can be reinforced by positive network externalities. These occur when the benefit from a network rises with the number of users. Such externalities are particularly prevalent in the KBC-intensive digital economy (where the value of a platform, such as Apple's Operating System, increases with the number of users of the platform). Policy must ensure that competition is maintained in contexts of increasing returns to scale.

While R&D exhibits properties of partial excludability and non-rivalry, other forms of KBC may have a smaller impact on growth (and have also been less studied). For instance, firm-specific human capital, and much of brand equity, are highly excludable and rivalrous.

Knowledge-based capital helps to capture value in global value chains

GVCs have changed the nature of production and competition...

The development of global value chains (GVCs) has changed the nature of global competition. Economies and firms no longer only compete for market share in high value-added industries. They increasingly compete for high value-added activities in GVCs.

...and KBC is a driver of success in global value chains.

Usually, the value created in a GVC is unevenly distributed among its participants. The allocation of value depends on the ability of participants to supply sophisticated, hard-to-imitate products or services. Increasingly, the supply of such products or services stems from forms of KBC such as brands, basic R&D and design, and the complex integration of software with organisational structures. Policy makers in both OECD and many emerging economies clearly understand the need to develop KBC in order to enter higher-value segments of GVCs. As the Secretary General of the China Industrial Overseas Development and Planning Association recently remarked, "Our clothes are Italian, French, German, so the profits are all leaving China…We need to create brands, and fast."

KBC affects which locations create value...

KBC can determine the geographical pattern of value creation in a global value chain as the much-studied iPhone shows. The largest share of the value created by the iPhone accrues to providers of distribution and retail services in the United States and to Apple, mainly to its innovations in design, marketing and supply-chain management. For each iPhone 4 sold, at a retail price of USD 600, Apple earns around USD 270, while Korean firms supplying core components earn USD 80, and Chinese enterprises that undertake the assembly earn USD 6.5, a mere 1% of the total value. While China has invested heavily in KBC, its investment rate is below that of the United States or Japan (Box 3).

...export specialisation...

New OECD research also shows that a country's KBC is significantly and positively correlated with its export specialisation, particularly in industries that are skill-intensive and source many inputs from abroad. In other words, the more a country invests in KBC, the more likely it is to develop a comparative advantage in international trade in such industries. Among the categories of KBC, economic competencies, which relate to competitive organisational structures and processes, seem to have the largest impact in this area.

...and the development and retention of advanced manufacturing.

Retaining capacity in (advanced) manufacturing is a major policy concern in many OECD economies. Manufacturing is a strong driver of investment in KBC. In Australia in 2005-06, spending on KBC in manufacturing stood at almost 65% of tangible investment, but in the services sector, it only reached 50%. In Germany, manufacturing accounts for nearly 50% of all investment in KBC, a share much higher than manufacturing's contribution to GDP. In the United States, manufacturing accounts for around 70% of all business R&D. An economy that facilitates business investment in KBC is likely to provide an environment supportive of advanced manufacturing. Furthermore, sustainable competitive advantage often comes from a complex, and often challenging, integration of different types of KBC. In fact, some firms integrate simulations of product designs and models of workplace organisation with the use of large computerised data sets so as to introduce products faster and more efficiently.

Economic competencies are hard to replicate...

Economic competencies are among the categories of KBC that are hardest to replicate. They include firm-specific skills such as management, brand equity and organisational structure. These forms of KBC are usually firm-specific, non-tradable and built up through in-house accumulation over time. By comparison, forms of KBC such as innovative property and computerised information can be purchased or, in some cases, reverse engineered. Toyota provides an example of hard-to-replicate organisational capital. It excels as a global car manufacturer, owing in part to a deeply entrenched process of continuous incremental innovation – or *kaizen* – rather than radical innovation. It is estimated that Toyota implements around a million new ideas a year, most of them from workers. Other car manufacturers have found this system extremely difficult to duplicate, even though they have the financial resources to do so.

...and particularly important for creating value.

More broadly, persistent productivity differentials are known to exist across plants and firms, even among those in the same location. A plausible explanation for these productivity differentials is differences in KBC. In the words of Herb Kelleher, who led Southwest Airlines to over 30 consecutive years of profitability and established it as an innovation leader, first as the company's cofounder and then as its president, "It's the intangibles that are the hardest thing for a competitor to imitate."

Many emerging economies are increasing their investments in KBC

Many emerging economies are seeking to raise their investment in KBC to compete in higher-value activities.

Emerging economies account for an increasing share of global investment in innovation. Business investment in KBC has become a priority in many emerging economies. Policies focus on education and R&D, coupled with efforts to develop linkages between multinational enterprises (MNEs) and local firms and in some cases with measures to strengthen intellectual property rights (IPRs). Examples include Thailand's establishment of an intellectual property (IP) capitalisation project, Brazilian investments in aerospace and Indian information technology.

Indian pharmaceutical firms such as Ranbaxy and Dr Reddy have also made significant efforts to move up the value chain. They have accumulated knowledge of technology and marketing through active research alliances and joint ventures with Western firms. They have upgraded from generic drug companies that supply the Indian market to suppliers of Western markets that can develop patented drugs. In Singapore, investments in knowledge and human capital in the 1990s have made the Seletar Aerospace Park a major hub of aircraft engine manufacture and assembly, with over 19 000 jobs and annual revenues exceeding USD 6.5 billion.

China is taking major steps to facilitate investment in KBC.

To achieve its goal of being an "innovation-oriented" society by 2020, the People's Republic of China must invest heavily in KBC (Box 3). It is therefore investing in IP, acquiring and developing global brands, promoting design, and investing in human capital. Chinese enterprises such as Lenovo, TLC and Huawei Technologies have introduced global brands. Once considered a low-cost vendor, Huawei's innovative products are now used by telecoms operators around the world. In 2008, Huawei topped the list of Patent Cooperation Treaty applicants reported by the World Intellectual Property Organization, a first for a Chinese company. The Chinese government actively promotes the protection of intellectual property to protect intangible economic value. Counterfeiting and piracy have long been a threat to the intellectual property of firms investing in China. China's adherence to relevant international conventions (including accession to the World Trade Organization) and the introduction of intellectual property legislation have brought some improvements. However, a change in perspective of Chinese firms, which increasingly seek protection for their own intellectual property, is a significant breakthrough.

Box 3. Estimating business investment in knowledge-based capital in China, Brazil and India

Hulten and Hao (2011) measure investment in KBC in China.[1] Recent economic reforms in China aim to raise income by capturing more value added via technology. This will require large-scale investment in KBC. Moreover, certain features of the economic transition in China require the creation of particular forms of KBC. For instance, the privatisation of state-owned enterprises requires investments in organisational capital and new business models.

Severe data constraints hamper measurement of KBC in China. Nevertheless, the authors estimate that investments in KBC were equivalent to 7.5% of GDP for the total economy in 2006, increasing from 3.8% in 1990. Spending on R&D accounts for only 18% of total investment in KBC; this suggests that narrowly focused innovation indicators will ignore much of total spending on innovation.

China's rate of investment in KBC is comparable to estimates for France and Germany, but behind those of Japan, the United Kingdom and the United States. However, it is uncertain whether this investment will translate into technological leadership. Half of KBC investment in China goes to just two categories: software and architectural and engineering design. Both are tied to investments in tangible capital (ICT and residential structures). A more focused measure of organisational and product/process innovation might exclude them. In this case, the adjusted KBC investment rate for China would only be 3.6% of GDP (2006). This is well below the corresponding adjusted rate of 8.6% for the United States, or 6.8% and 6.6% for Japan and the United Kingdom, respectively. Furthermore, in China, the ratio of investment in KBC to investment in tangible capital is around 0.3. By contrast, in Finland, France, the United Kingdom and the United States this ratio is near to, or above, 1.

A 2012 World Bank study[2] estimates that business investment in KBC in Brazil averaged around 4% of GDP between 2000 and 2008. This is not much below investment in tangible assets, which varied between 4% and 9% of GDP over the same period. Business investment in KBC has also been increasing, from 3% of GDP in 2000 to 5% in 2008, although investment in tangible assets has risen more rapidly. In India, business investment in KBC in 2007 was recently estimated at 2.7% of GDP. Around 30% was contributed by R&D.[3]

1. Hulten, C.R. and J.X. Hao (2011), The Role of Intangible Capital in the Transformation and Growth of the Chinese Economy, *NBER Working Paper* 18405, September 2012.

2. World Bank (2012), Measuring Intangible Assets in an Emerging Market Economy: An Application to Brazil, *Policy Research Working Paper* 6142.

3. Hulten, C.R, J.X. Hao and K. Jaeger (2012), The Measurement of India's Intangible Capital, paper prepared for the World Input-Output Data project, The Conference Board.

POLICY ANALYSIS AND CONCLUSIONS

This section reviews the key policy conclusions and insights from the *New Sources of Growth* project. Future analytical challenges are also considered. The policy insights described are broadly applicable to OECD countries at lower and higher income levels and to many emerging economies.

Business investment in KBC underpins modern economies and is affected by a wide range of policies…

Business investment in KBC underpins much of the knowledge economy and is therefore affected by many areas of policy. As overall business investment in KBC increases, and because of KBC's intangible nature, certain policy settings require readjustment. Framework conditions provide the fundamental economic context for investment in KBC and for the efficient reallocation of resources to new sources of growth, including those based on KBC. Indeed, the countries that invest most in KBC are the ones that are most effective in reallocating resources to innovative firms. The United States and Sweden invest about twice as much as Italy and Spain in KBC as a share of GDP, and patenting firms in the United States and Sweden attract up to four times as much capital as similar firms in Italy and Spain. Such differences are even larger for young firms that are more likely to experiment with radical innovations.

…many of which require updating…

It is essential for policies to be well suited to this new situation and conform to good practice as regards taxation, entrepreneurship and business development, competition, corporate reporting and intellectual property. The same holds for policies that enable the exploitation of data as an economic asset. The rise of KBC also amplifies the importance of essential framework policies, such as education. Attention must likewise be given to complex regulatory issues that address data privacy and security. Indeed, as new technologies based on KBC develop, new regulatory challenges are likely to arise.

…and some of which are ill-suited to a world in which intangible capital is of increasing importance.

Many current policy settings, as well as systems of accounts (both corporate reports and national statistical accounts), are best suited to a world in which physical capital is the standard. The importance of a policy context that supports business investment in KBC is reinforced as global competition increasingly takes place in segments of global value chains. This is because KBC is a source of competitiveness in knowledge-intensive activities in the upstream or downstream portions of GVCs.

Getting these framework conditions right, while a challenge, is essential for growth in the 21st century. In fiscal terms, it can be relatively inexpensive. More than new government spending, smarter and better-focused rules and incentives for businesses should be the first priority for many countries.

Policy makers should take a broader view of innovation

Work on KBC shows that innovation and value creation are driven by assets beyond R&D...

Given the range of assets that compose KBC (from databases, to patents, to brand equity and business process know-how), policy makers need to adopt a view of innovation that is broader than R&D. Forms of KBC, such as data (see sections below), new business processes (Box 4) and design (Box 5), also drive innovation and value creation and may be affected by specific barriers and policies. One implication of this broader perspective might be a renewed emphasis on programmes such as technical extension services that facilitate the diffusion of various forms of KBC to firms. Historically, such activities played a major role in diffusing new agricultural technologies. Extension programmes in manufacturing, some with a broader focus than technology, have been extensively evaluated.

...which can be supported by a variety of supply and demand-side policies...

In adopting a policy perspective that goes beyond R&D, well-designed support measures are needed, including: measures that facilitate access to finance for innovative firms; frameworks that foster collaboration to innovate, for instance between firms and public research organisations; and well-crafted direct support that facilitates KBC investments in areas of highest social return (such as through innovation prizes and competitively awarded grants). Demand-side policy, which has typically received less attention than supply-side policy, could also support KBC investments in ways that simultaneously help to meet public needs (this is particularly so for innovation-oriented competitive public procurement). Furthermore, as described in the 2010 OECD Innovation Strategy, a whole-of-government approach to policy is needed, involving multiple stakeholders in policy development, the development of platforms for co-ordinating actions, and a medium- to long-term perspective.

...but targeted public support for investment in KBC requires evidence of private under-investment.

Beyond the essential attention to framework conditions, public policies to increase business investment in KBC must of course be based on evidence that businesses would otherwise under-invest in KBC. Firms' ability to internalise fully the returns from investments in KBC varies depending on the type of asset. The strongest evidence for private under-investment exists for R&D-related spending. But there are positive externalities – which could lead to socially suboptimal investment – for design and other forms of KBC (many businesses find their designs copied, a sign that some spillover of value is occurring). There is a need for more evidence based on good data on the scale of such positive externalities. Where the evidence warrants it, direct or indirect public support might be provided for business investment in specific forms of KBC.

Box 4. Business process innovation: An example of knowledge spillovers in the airline industry

Southwest Airlines has introduced many significant innovations in the airline industry, such as boarding passengers without assigned seats and frequent-flyer programmes. For decades after the company's creation, in 1971, Southwest consistently achieved the lowest average cost per seat-mile among US airlines. Its stockmarket return has also been one of the highest of all S&P 500 companies. While these innovations were central to its success, many were not patented. Other airlines have replicated Southwest's innovations – including RyanAir, Easy Jet and Go in Europe as well as Air Asia in the Far East – often on the basis of passive or easily accessed knowledge flows (from travelling on Southwest planes to participation in "best practice" events organised by Southwest). Southwest also developed key innovations by learning from others. For instance, Southwest sent staff to the Indianapolis 500 to observe pit crews fuel and service race cars because the pit crews performed the same functions as aircraft maintenance crews, but faster. New ideas gleaned in this way and from other sources eventually contributed to a 50% reduction in Southwest's aircraft turnaround time.

Source: Criscuolo, C., Haskel, J. and Slaughter, M. (2005), Global Engagement and the Innovation Activities of Firms, NBER Working Paper 11479 (http://www.nber.org/papers/w11479).

Box 5. Design: A form of KBC that drives innovation and growth

A design is a plan or representation of the look, function or workings of a product or system. Product design affects functionality and the consumer's attachment to the product. Beyond physical appearance, design is often integral to all stages of the business process, from manufacture, brand development and marketing, and after-sales service (in a global context, design can help to differentiate products to meet the requirements of different local markets). The impacts of design are not limited to physical products. The design of graphical user interfaces is increasingly important. Design also plays a major role in services, such as online purchasing or airport check-in. There is substantial quantitative and qualitative evidence that design plays important roles in innovation and firm performance and that overall business spending on design is large. For instance:

- One study of the United Kingdom suggests that spending on design might almost equal business spending on R&D.
- A number of world-beating products owe at least part of their success to different facets of design. For tablet computers and smartphones, some of the most prominent intellectual property conflicts in recent years have focused on design.
- Research published in 2010 indicated that the iPhone had then added around USD 30 billion to the value of the Apple Corporation, only 25% of which was attributable to patentable technology stemming from R&D. Much of the rest was attributable to Apple's innovations in design, marketing and management. Incorporating design into the early stages of new product development has been shown to result in stronger corporate financial performance.
- Design can allow firms to pull away from cost-based competition (for example, design enabled Sony to charge a 25% higher price for its Walkman than competitors).
- Design competencies can help companies in traditional industries such as textiles, apparel and furniture to succeed. Italy has long had a successful furniture industry largely based on small and medium-sized firms with competitive advantages in design.
- 67% of exporters in New Zealand have identified design as central to their commercial success.
- In 2007, almost half of businesses in the United Kingdom believed that design contributes to increased market share and turnover. In 2004, among firms in the United Kingdom that saw design as integral to their business, nearly 70% had introduced a new product or service in the previous three years (compared to just 3% of companies for which design played no role).
    - Design expenditure has been shown to have a positive association with Dutch firms' sales of new products.

Industrial design filings have risen strongly in recent years. The World Intellectual Property Organization (WIPO) estimates that design filings grew by 16% worldwide in 2011, after 13.9% growth in 2010. Much of this growth reflects increased design filings in China.

The Europe 2020 Flagship Initiative – Innovation Union includes design among its ten priorities. Further afield, China, India, Korea and Singapore have all enacted design policies and consider design to have strategic economic importance.

A broader view of innovation also has implications for programme design… such as moving from STEM to STEAM.

A wider perspective on innovation's drivers may require the redesign of some long-standing innovation programmes. For example, most OECD governments operate programmes that facilitate business access to research or technology-related advice and information, often from universities and public research organisations. These schemes – such as innovation vouchers, know-how funds and technical extension services – tend to focus on technological information and typically create links to academics in science, technology, engineering and mathematics (STEM) disciplines. Work on KBC suggests that an exclusive focus on STEM disciplines is too narrow. In fact, businesses require information and advice relating to many forms of KBC and interact with academics for a variety of reasons. In the United Kingdom, for instance, nearly a third of all academics in the arts and humanities are engaged with business in some way, as are nearly half of academics in the creative arts and media. As well as knowledge related to STEM disciplines, businesses may want assistance with marketing, sales and support services, as well as human resource management, logistics and procurement. This suggests that a move from STEM to STEAM, as some researchers have proposed (the "A" refers to "Arts") would be appropriate.

Collaborative frameworks for innovation might also be broadened…

Policy frameworks might also facilitate collaboration on non-R&D-based innovation. Collaboration on R&D between private firms and public research entities is increasingly common in OECD countries and reflects the growing complexity of innovation and the need for complementary knowledge. Collaboration can help government laboratories or universities obtain funding for research activities and help ensure that their research agenda is commercially relevant, while firms gain access to the pool of knowledge accumulated by such institutions. New OECD evidence shows that more collaboration, as proxied by the share of higher education R&D financed by industry, is associated with stronger firm-level productivity growth in firms in R&D-intensive sectors. Without jeopardising the critical role of universities in fundamental research, policy might enlarge the focus of collaboration-enabling programmes.

…and innovation targets as well.

Establishing targets for innovation policy has both advantages and disadvantages, but if governments do use innovation targets – such as the Lisbon Agenda's 3% of GDP guideline for national R&D spending – these should include the wider innovation indicators provided by KBC.

In a context of globally fragmented production, innovation policy can help to upgrade in value chains.

Policies that facilitate linkages between participants in GVC and the local knowledge base, such as research and training institutions, can help forge positive feed-back loops between investment in KBC and GVC upgrading and enhance firms' ability to absorb knowledge from foreign counterparts in a GVC. For instance, Chinese IT firms based in

Beijing upgraded from the manufacture of computer peripherals to become own-brand producers of electronics products through their links to Beijing's research institutions. These firms tapped into the latest technology through participation in the GVCs of multinational companies and used this knowledge in their R&D base in Beijing to develop products for China's growing domestic market. Such a strategy enabled the rapid growth of IT giants such as Lenovo and Aigo.

Policy stability is also important.

Policy stability – keeping uncertainty to a minimum – is important. New OECD evidence shows that in countries that have often reversed R&D tax policy, the impact of R&D tax credits on private R&D expenditure is greatly diminished.Policy should facilitate efficient resource allocation, which is positively correlated with KBC use.

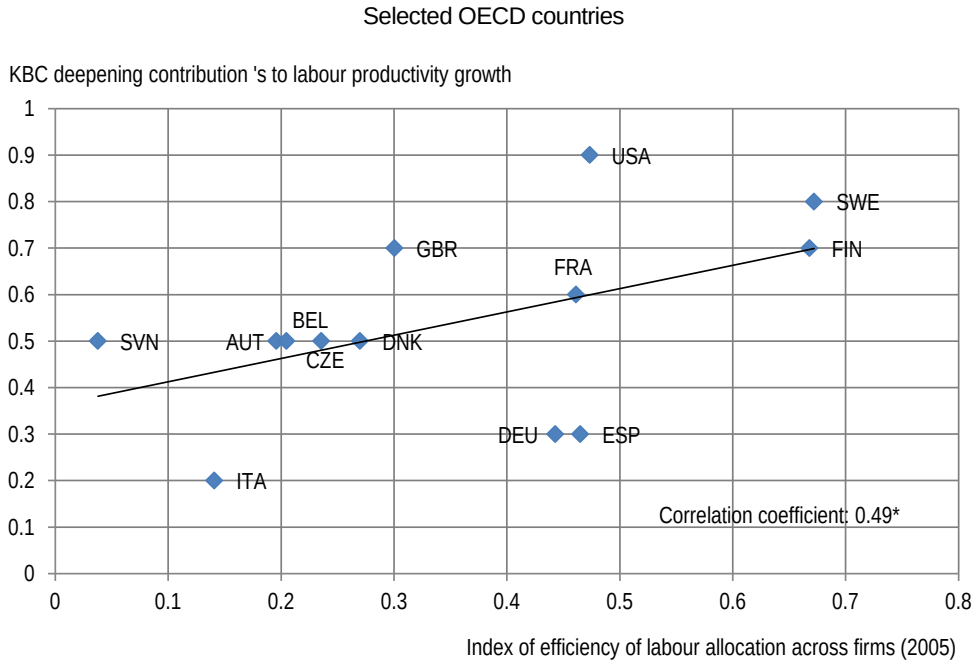
Markets that allocate resources efficiently facilitate KBC investment and innovation.

The allocation of economic resources to their most productive uses is a critical determinant of growth. The principal reallocation mechanisms are firm turnover (entry and exit), shifts in resources across firms and reallocation within firms. Reallocation is a frequent phenomenon in OECD countries: on average, about 15-20% of all firms and more than 20% of jobs are created or destroyed each year. The efficiency of resource allocation varies considerably from country to country, however. Countries that are more successful at channelling resources to the most productive firms also invest more in KBC. Figure 9 indicates the existence of a positive correlation between investment in KBC and the efficiency of resource reallocation, as captured by an index (horizontal axis) of the extent to which firms in manufacturing with higher than average labour productivity also have larger shares of employment.

Efficient reallocation of tangible resources is also crucial.

Efficient mechanisms to reallocate *tangible* resources are also essential because of tendencies to under-invest or over-invest in KBC (Box 6). To develop and commercialise new ideas, firms require a range of tangible resources to test ideas (*e.g.* to develop prototypes), develop marketing strategies and eventually produce at a commercially viable scale. New OECD evidence reveals important cross-country differences in the extent to which labour and capital flow to innovative firms. For example, the degree to which labour flows to patenting firms in the United States and Sweden is estimated to be twice as large as in Italy. Countries with more stringent regulations in product, labour and (to a lesser extent) credit markets tend to invest less in KBC; investment in KBC is also positively correlated with debtor-friendly bankruptcy codes (Figure 10).

Figure 9. Knowledge-based capital deepening and the efficiency of resource allocation



Source: Corrado et al. (2012) and D. Andrews and F. Cingano (2012), "Public Policy and Resource Allocation: Evidence from Firms in OECD Countries", *OECD Economics Department Working Papers*, No.996.

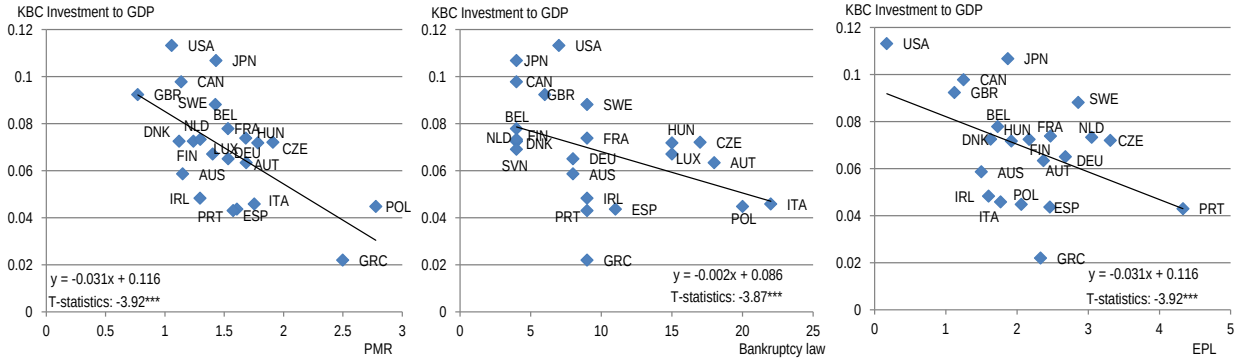
Box 6. The scope for misallocation of KBC is significant

For a variety of reasons, KBC is particularly prone to misallocation. For instance:

- Private investment in KBC may be below the socially desirable level because firms cannot fully appropriate the returns from their investments in KBC, as some knowledge can spill over to other firms, to the benefit of society.
- KBC is difficult to use as a form of collateral owing to its inherent riskiness and the accompanying information asymmetries. This can inhibit the development and commercialisation of new ideas, especially by young KBC-based firms.
- Efficient market outcomes tend to be associated with transparent environments and opportunities to trade with a wide range of actors (markets are thick). However, the amounts of transactions in the secondary market for patents are not publicly disclosed, which undermines the development of a more liquid market. Similarly, the bilateral environment in which details of a licence are negotiated lack a transparent price discovery process to reveal the "fair" price of the patent and thus risk a poor quality match.
- Mechanisms for allocating KBC based on human capital are even less efficient. Firms have two main options: corporate takeovers or selective recruitment (poaching) of specialists. However, both strategies entail risks. A company acquiring an entity in which most intangible assets are based on its human capital has to be sure to retain the employees of interest (and their teams) following the acquisition. At the same time, selective recruiting of specialists is complicated by the usual obstacles to labour mobility – e.g. binding non-compete covenants (see Box 7) and pension and health-care portability – and the need for recruiting firms to possess at least some internally generated technological knowledge to assess these external sources and absorb the acquired knowledge effectively.
- Company-based data on KBC, for managerial decision-making, are generally deficient.

Figure 10. Investment in KBC and selected public policies, 2005

% GDP, selected OECD countries



Notes: KBC investment to GDP is measured in 2005. Policy indicators refer to 2003 (PMR, Bankruptcy Law, EPL).

Source: OECD calculation based on KBC estimates from Corrado *et al.* (2012). Policy indicators are from the OECD and World Bank.

Entrepreneurial dynamics are critical and vary significantly across countries.

Entrepreneurial activity is essential to the process of reallocating labour and all forms of capital to their most productive uses. However, entrepreneurial dynamics vary. In particular, the size of entering and exiting firms tends to be smaller in the United States than in Europe. Successful young firms also tend to expand more quickly in the United States, where firm productivity within industries also tends to be more dispersed (with more productive firms likely to account for a larger share of employment). One interpretation of these findings is that entrants in the United States engage in more experimentation and "learning by doing". Cross-country differences in entrepreneurial activity tend to be largest in new and high-technology sectors, where use of KBC is likely to be most intense.

Restrictions on trade and investment curb investment in KBC…

Liberalising barriers to international trade and investment stimulates aggregate productivity by increasing knowledge diffusion and technology transfer across borders and by encouraging more efficient resource allocation (indeed, because investments in some forms of KBC are easily scalable, having a larger market size is beneficial). Recent evidence from a sample of European firms shows that the removal of product-specific quotas following China's WTO accession triggered a significant increase in R&D, patenting and productivity. Increased exposure to trading partners' R&D stocks (a proxy for the stock of foreign knowledge) from the level of Spain (around the OECD average in 2005) to the level of Canada (the 75th percentile) is estimated to boost patents per capita by around 20% in the long run.

…and inhibit productivity.

As knowledge is partly embodied in, and can spill over from, imported intermediate goods, reductions in tariffs on intermediate inputs are associated with significant productivity growth in downstream manufacturing sectors. Reductions in tariffs on foreign high-technology intermediate inputs boost the productivity of sectors closest to the technology frontier, but have no impact on sectors further from the frontier. Across the services sector in OECD countries, more stringent restrictions on foreign direct investment (FDI) are associated with lower allocative efficiency. Lowering restrictions on FDI from the relatively high levels of Poland to those of Germany could increase aggregate productivity by around 2%.

Employment protection legislation affects the KBC-innovation-reallocation nexus in complex ways…

By raising labour adjustment costs, more stringent employment protection legislation (EPL) slows the reallocation process. Conversely, employment protection raises workers' commitment and firms' incentives to accumulate firm-specific human capital. In line with this trade-off, evidence on the impact of EPL on innovation and productivity is somewhat mixed.

…but strict EPL appears to hinder certain types of innovative processes…

However, EPL has important effects on the form of the innovation process. New OECD evidence shows that in environments of greater technological change, stricter EPL lowers productivity growth by reducing firms' willingness to experiment with uncertain growth opportunities. By raising reallocation costs – particularly with respect to exit – it handicaps firms that need to be flexible because they are experimenting with uncertain technologies. Countries with stringent EPL tend to have smaller innovative sectors associated with intensive ICT use, and MNEs tend to concentrate more technologically advanced innovation in countries with weaker EPL.

…especially in sectors that require significant reallocation.

In sectors with significant reallocation needs – measured by job layoffs, firm turnover and ICT intensity – reallocation is far more efficient under less stringent EPL. Stringent EPL instead notably reduces R&D expenditure in sectors with higher rates of patenting. It also stunts the development of venture capital (VC) financing in Europe because it depends on rapid reallocation of resources from underperforming to high-performing firms.

More work is needed to assess the effects of employee non-compete agreements.

Employers have developed strategies to protect knowledge investments from the risks created by employee turnover. One of these is to require employees to agree not to compete with the employer upon departure from the firm. These are typically described as non-compete agreements (Box 7) and are widely used although not universally enforced. Rules preventing their enforcement have been linked anecdotally to entrepreneurial success in some locations and industries; when California's Silicon Valley began, key inventors set up their own companies after leaving large incumbent firms.

Box 7. Protecting trade secrets but limiting labour mobility: The role of employee non-compete agreements

Employee mobility is essential to what is arguably the most important market for knowledge, the market for highly skilled workers. New personnel are a key source of information for innovation. However, when employees are mobile, firms can lose their investment in knowledge embodied in employees and can also lose to competitors who recruit former employees. So employers have developed protective strategies, one of which requires employees not to compete with the employer upon departure from the firm. Such covenants are typically described as non-compete agreements (NCAs).

The use of NCAs is more prevalent than commonly thought. In an international comparative perspective little attention has been given to NCAs and their impacts. In fact, most policy debate and evidence have concerned the United States. To address this gap, the OECD undertook an initial investigation of legal sources to identify how countries' regulations and judicial practices differ in terms of enforcement of NCAs. The analysis captures information on the breadth of employers' protectable interest (e.g. whether it extends beyond trade secrets), the setting of time limits, industry and regional limitations, special treatment of certain "knowledge workers", compensation for preventing employees from competing, the ability of courts to modify NCAs, and the possibility of injunctions.

The results indicate that in addition to some US states (such as California), countries such as India, Israel, Luxembourg, Mexico and the Russian Federation rarely enforce NCAs. Chile and a number of "common law" countries such as Australia, New Zealand and the United Kingdom enforce NCAs but only under certain circumstances. Most European continental countries have a more permissive approach to NCAs, although their statutes often require payment of compensation to affected employees. The enforcement of NCAs is also evolving. For instance, the Slovak Republic reformed its system late in 2011 to allow the use of NCAs.

Policy decisions on NCAs can have broad ramifications. For instance, less enforcement of NCAs can increase litigation around trade secrets or encourage firms to adopt other anti-competitive practices to limit the flow of employees. There have been a number of recent prosecutions by US authorities against high-profile IT companies accused of conspiring not to poach each others' employees.

Research shows that enforcement of NCAs reduces labour mobility across firms in the relevant jurisdiction and encourages key knowledge workers to take jobs in areas where NCAs are not enforced. Companies often use NCAs for purposes other than preserving trade secrets, such as to reduce employee mobility or to lead employees to take career detours away from their area of specialisation. However, the evidence on the impacts on entrepreneurship and innovation is mixed. If NCAs are enforced, employees may be less willing to leave a firm to work for a start-up. Yet, in the absence of NCAs, incumbent firms may poach key staff from young innovating competitors. It is essential to improve the evidence base, including through questions in business innovation surveys and surveys of doctorate holders.

Overly stringent bankruptcy rules can discourage innovation-enhancing entrepreneurship.

Bankruptcy regimes that severely penalise "failed" entrepreneurs, whether by more readily forcing liquidation or by 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. Well-designed bankruptcy legislation can promote the flow of capital to more innovative firms by reducing the likelihood that valuable resources will be trapped in inefficient firms. More debtor-friendly bankruptcy codes are associated with greater intensity of patent creation, patent citations and faster growth in countries more specialised in innovative industries.

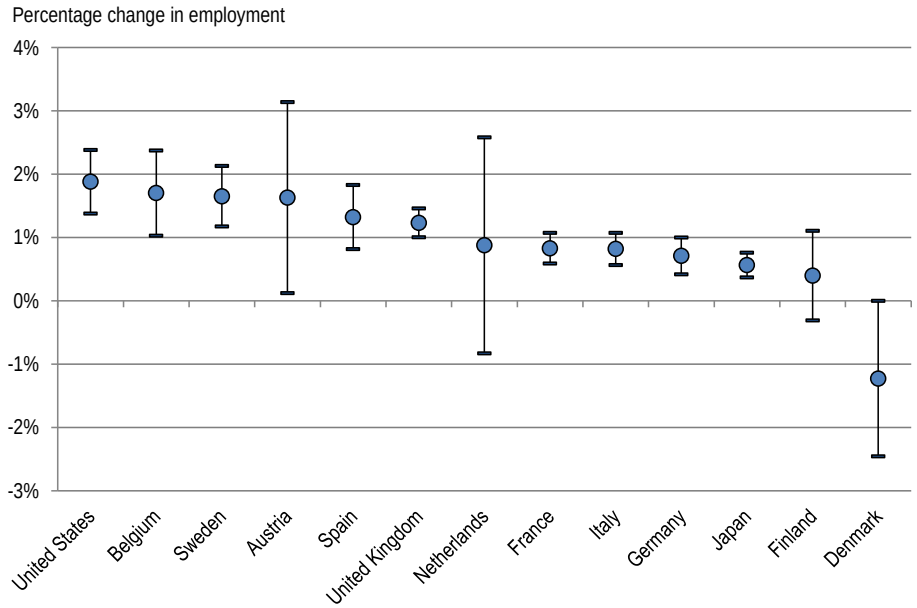
The efficiency of resource allocation affects employment outcomes from business investment in KBC

Policies that facilitate resource reallocation will help jobs move to more innovative firms.

For the average firm in a sample of OECD countries, Figure 11 shows the impact on employment of a 10% increase in the patent stock. Some important cross-country differences are apparent. For example, a 10% increase in the firm-level stock of patents – one aspect of KBC – is associated with about a 2% increase in employment in firms in the United States, but only 0.6% in Japan and 0.4% in Finland.

Figure 11. Change in employment associated with a 10% change in patent stock, 2002-10

Selected OECD countries



Note: The black dot shows the country-specific point estimate while the grey bands denote the 90% confidence interval (the confidence intervals vary across countries owing to differences in the number of observations).

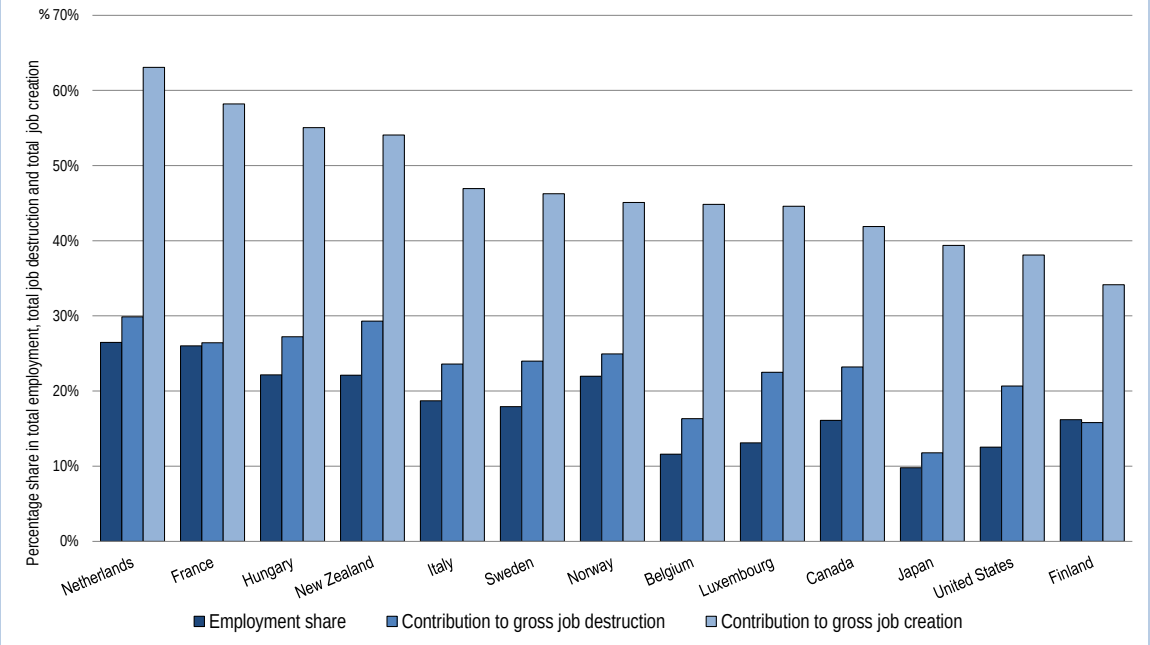
Source: OECD calculations based on firm-level data from the ORBIS-Patstat Database.

Box 8. The role of young firms in employment growth

The accumulation and optimal use of KBC requires experimentation (for instance with new business models and organisational forms) in firms of all sizes. Young firms play an important role in this experimentation process as they tend to be more dynamic than incumbents. Previous OECD work showed that such firms play an important role in the innovation process, accounting for a substantial share of radical innovation. A new OECD project demonstrates that young firms are also an important source of employment growth. The project, called DYNEMP, currently covers thirteen countries and uses countries' business registers to quantify the extent to which firms with different characteristics (in terms of age, size and sector of activity) contribute to job creation and destruction, and to assess how firm entry, firm growth and firm exit shape employment dynamics. The focus is not only on the high-growth or the average firm, but also on the patterns of employment growth over time. The resulting statistics provide insights on how the recent international financial crisis has affected business dynamics.

The importance of young firms for job creation: countries differ significantly

Young firms (less than 5 years old); average from 2001 to 2011



Notes: Preliminary results from the DYNEMP project. The participating countries are: Belgium, Canada, Finland, France, Hungary, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Sweden and the United States. The sectors of the economy considered are: manufacturing, construction and services (except for financial services). The latest available year for Canada, Japan and New Zealand is 2010, and for France is 2007. Data for Japan are based on plant-level rather than enterprise data and are limited to the manufacturing sector. Data for Canada are calculated by Statistics Canada and refer only to organic employment changes, and abstract from merger and acquisition activity. For all other countries, the data do not account for mergers and acquisitions in the determination of firm age. Owing to methodological differences, figures may deviate from officially published national statistics.

Evidence from thirteen OECD countries over 2001-11 suggests that young businesses, many of which are KBC-intensive, play a crucial role in employment creation, regardless of their size. Over this period, young firms (less than five years of age) accounted for 18% of total employment but generated 47% of all new jobs created. In most countries young firms have been crucial for job creation in the aftermath of the crisis. During the financial crisis, the majority of jobs destroyed generally reflected the downsizing of large mature businesses, while most job creation was due to young small and medium-sized enterprises (SMEs).

Countries differ significantly with respect to the employment growth (net and gross) generated by business entry and by young startups and the contraction or expansion of firms' employment. These differences point to the significant role played by framework conditions, which may or may not allow successful businesses to grow or failing businesses to exit. Conducive framework conditions are particularly important in knowledge-based economies where experimenting with new ideas and innovations is essential for firms to succeed and drive aggregate economic growth.

Young high-growth firms – often KBC-intensive – make a disproportionate contribution to job creation.

Because business investment in KBC is rising, new firms are more intensive users of KBC than in the past. At the same time, young and high-growth firms (many of which are also KBC-intensive) make a disproportionate contribution to employment growth (Box 8). Young firms account for between 34% (Finland) and 63% (Netherlands) of all jobs created, while they only represent 16% and 26%, respectively, of total employment in these two countries. While policies to foster job creation must consider the needs of firms of all sizes, these data indicate the importance of a policy context that enables (KBC-intensive) entrepreneurship.

KBC is likely to affect the distribution of high-wage jobs in global production chains.

While systematic evidence is not yet available, the environment for investment in KBC is likely to play a role in determining which countries retain or move into the high-wage segments of different industries. For example, in 2006, the iPod accounted for 41 000 jobs, of which 14 000 in the United States and 27 000 elsewhere. But US workers, largely engaged in forms of KBC such as design, R&D, software and marketing, earned a total of USD 753 million, while those abroad (almost double their number), mostly engaged in manufacturing of parts, components and their assembly, earned USD 318 million.

Industries founded on knowledge-based capital create challenges for competition policy

Competition policy has important implications for the evolution of KBC-focused industries.

Competition law and policy provide a flexible framework that can be adapted to diverse markets. Traditional competition laws and principles can and should be applied to deter anticompetitive behaviour in any setting. Nonetheless, the question has arisen of whether they are fully applicable in KBC-intensive markets and, if they are, whether they need to be adjusted to account for differences between KBC-intensive markets and other kinds of markets. Because competition is a key driver of innovation and growth, it is an important factor in the development of KBC-intensive sectors.

Competition in the digital economy is dynamic and complex.

In this connection, much recent attention has been drawn to the functioning of the "digital economy" (an umbrella term to describe markets focused on digital technologies that typically involve the trade of information goods or services via electronic commerce). The digital economy has brought new, rapidly expanding industries and business models. Indeed, never before have leading firms grown so large so quickly, and new businesses are challenging incumbents in novel ways. Claims of dominance and abusive or otherwise restrictive practices are frequent and have led to major legal

disputes. Simply understanding how competition operates in the digital economy can be difficult. Features of the digital economy that are especially significant for competition include:

- Rapid change and constant innovation.
- The *prominent role of IP in business strategies.* IP rights are often crucial and help to shape firms' competitive strategies as well as the conditions of market entry. Issues that arise for competition authorities include: mutually blocking patents, which may lead to patent pools or cross-licences; standard-essential patents; fair, reasonable and non-discriminatory licensing terms; and protection of trade secrets.
- *Economies of scale for information products.* Many information products involve large economies of scale. This can lead to substantial efficiencies, but can also help cement market power.
- *Interoperability issues*. Many high-technology products are composed of complex systems of components that need to interface with each other and, in some cases, with external networks. Consequently, firms must work together to set standards and ensure interoperability. But this might invite collusion, and the standardisation process may be vulnerable to other anticompetitive conduct such as patent "ambushes". These occur when a firm participating in a standard-setting process conceals its patents, succeeds in putting the technology covered by those patents into the standard, and then reveals its intellectual property once users have invested in the standard and demands excessive licensing fees by threatening to sue for patent infringement.
- The *importance of networks* and the effects of network economies. Networks generally become more valuable as they increase in size (in terms of nodes or users). Networks thus exhibit scale economies on the demand side. This increases the importance for competition of the terms of suppliers' access to a dominant network. Virtual networks – such as users of Microsoft Office – are also important in the digital economy. As virtual networks grow, the control of interfaces and compatibility standards increases in importance.

The global scope of the digital economy also raises jurisdictional issues.

Many markets in the digital economy are global in the scope. This can lead to jurisdictional or territorial difficulties. For example, it may be difficult to identify in a given a physical entity that is legally the representative of the party responsible for suspected anticompetitive behaviour. Moreover, an anticompetitive practice may affect several jurisdictions, thereby raising the question of which agency should take enforcement action.

Competition among platforms is a salient feature of the digital economy.

When companies in the digital economy become very successful, many, even thousands, of other businesses may depend on their products or platforms. Examples include Apple's iPhone and the thousands of software companies that have developed iPhone applications, and Facebook and the many software developers that enhance the Facebook product for users. As such companies may have huge market valuations, competition authorities may be tempted to focus on competition issues specific to

individual platforms. However, some analysts argue that, unlike other sectors of the economy, the most meaningful competition in the digital economy takes place between platforms, which may be created by companies with very different business models. For example, Apple, Google, and Microsoft all compete in the market for mobile phone operating systems. Apple does not license its Operating System (OS) to handset manufacturers but reserves it for its own brand. Google offers handset manufacturers free licences to the Android system, while Microsoft licenses its mobile OS but charges users a fee. In such contexts, competition *among* platforms may be more important to innovation and consumer welfare than competition *within* platforms.

Certain features of the digital economy may complicate the enforcement of competition law.

While competition rules remain fully applicable in digital markets, the digital context raises particular issues. For example, it can be difficult to determine the optimal timing of an intervention. While it is necessary to act before dominance is entrenched, enforcers are rightfully wary of intervening too readily in still-competitive markets. Moreover, market power may develop and appear to raise competition issues, only to fade because innovation moves the market in a new direction. The challenge is to keep digital markets open and innovative without inhibiting the process of "creative destruction" that has driven much of the technological progress to date. There is no simple rule for determining when market power in the digital economy is durable and strong enough to warrant intervention based on competition law (assuming that actual anticompetitive *conduct* has occurred). Intervention should perhaps occur only if a firm has been dominant for a number of years, has survived several challenges, and is profitable.

It is essential to eliminate anticompetitive product market regulation…

Beyond the digital economy, it is clear that competition is central to innovation, even if discussion continues on the circumstances under which it has the greatest effect. OECD studies show that one of the most effective ways to boost business R&D is to eliminate unnecessarily anticompetitive product-market regulations (PMR). Indeed, the effect on business R&D of reducing these could be greater than what has been achieved by reinforcing IPRs or by granting subsidies for private R&D. New OECD evidence shows that a modest reduction in PMR in the energy, transport and communications sectors – corresponding to Germany's reforms in 2005, or the difference in regulation between Australia and Austria in 2008 – could result in a 5% increase in the stock of business R&D and a 3% rise in patents per capita in the long run. Product-market reforms can also increase incentives for firms to incorporate foreign technologies. Product-market regulations also affect the ability of successful firms to attract the complementary tangible resources needed to implement and commercialise new ideas. For example, reducing the stringency of regulations on business services from the high level in Italy to the OECD average (i.e. France) could raise the extent to which labour and capital flow to innovative firms by around 30% and 60%, respectively.

…and the OECD has tools to assist in policy reform.

To help governments reduce unnecessary regulation, the OECD has developed the *Competition Assessment Toolkit*. The toolkit provides a methodology for identifying unnecessary state-imposed restraints and developing alternative, less restrictive policies that still achieve government objectives.

Competition law must be enforced.

While there is no clear consensus on the degree of competition that generates the most innovation, support is accumulating for the idea that the relationship is similar to an inverted "U", with moderate levels of competition stimulating more innovation than low or high levels. The great majority of enforcement activity by competition authorities occurs in relatively concentrated markets with low levels of competition that are likely to become less competitive in the absence of enforcement. The inverted-U theory implies that enforcement actions increase innovation by moving markets closer to moderate levels of competition. Effective enforcement of competition law stimulates innovation by protecting and encouraging competition in markets where there is the greatest potential for innovation to increase.

Mergers in KBC-intensive markets require careful investigation…

…and the approach may require some customisation.

Enforcement of competition in KBC-oriented markets includes the application of merger control rules. Determining whether a merger is likely to promote or prevent innovation requires a case-specific and often complex inquiry. For instance, a merger could lead to efficiencies in undertaking R&D, but could also reduce rivalry and increase market power, thereby slowing the post-merger rate of technological change. Although some mergers save costs by eliminating duplicative R&D and encouraging synergies, protecting competition in R&D is important because R&D is inherently uncertain. A special analytical framework is neither necessary nor desirable for undertaking merger reviews in innovation-intensive markets. The traditional merger review analytic framework is sufficiently flexible. However, in very innovative markets there may be a need for some customisation, in particular as regards: defining markets and assigning market shares; assessing the significance of changes in market structure; giving proper weight to the benefits that consumers reap from innovation; assessing the ability of merging parties to exclude or restrict competitors; and designing appropriate remedies.

Appropriate tax treatment of KBC can stimulate investment and growth in cost-effective ways

The OECD is reassessing tax policy and KBC/innovation in a globalisation perspective.

A wide variety of tax policies affect innovation and growth, as examined in previous OECD publications such as *Tax Policy Reform and Economic Growth* (2010). That work showed, for instance, that corporate income taxes, because of their effects on the size and composition of investment expenditure, are the most harmful type of tax for economic growth. These growth considerations have to be balanced against the contribution that the corporate income tax plays in ensuring that tax regimes are fair and have capacity to redistribute income from wealthier to poorer individuals. Work reported here focuses on the structure of corporate income tax regimes and how they affect incentives for investment in KBC and tax revenues. In particular, new effective tax rate indicators have been developed and an assessment made of effects of corporate income tax on KBC investment decisions of multinational enterprises (MNEs), considering both domestic and international tax rules.

A key message from new OECD analysis is that the tax treatment of not only R&D expenditure but also returns to R&D must be taken into account in assessments of the overall scale of tax relief for R&D and the design of R&D tax incentives. This includes consideration not only of statutory tax provisions that reduce the effective rate of tax on returns – such as 'patent boxes' which allow income from KBC (i.e. royalties) to be taxed at lower rates than other types of income – but also of how MNEs are able to use cross-border tax planning strategies to avoid corporate tax and obtain very high levels of overall tax relief for R&D.

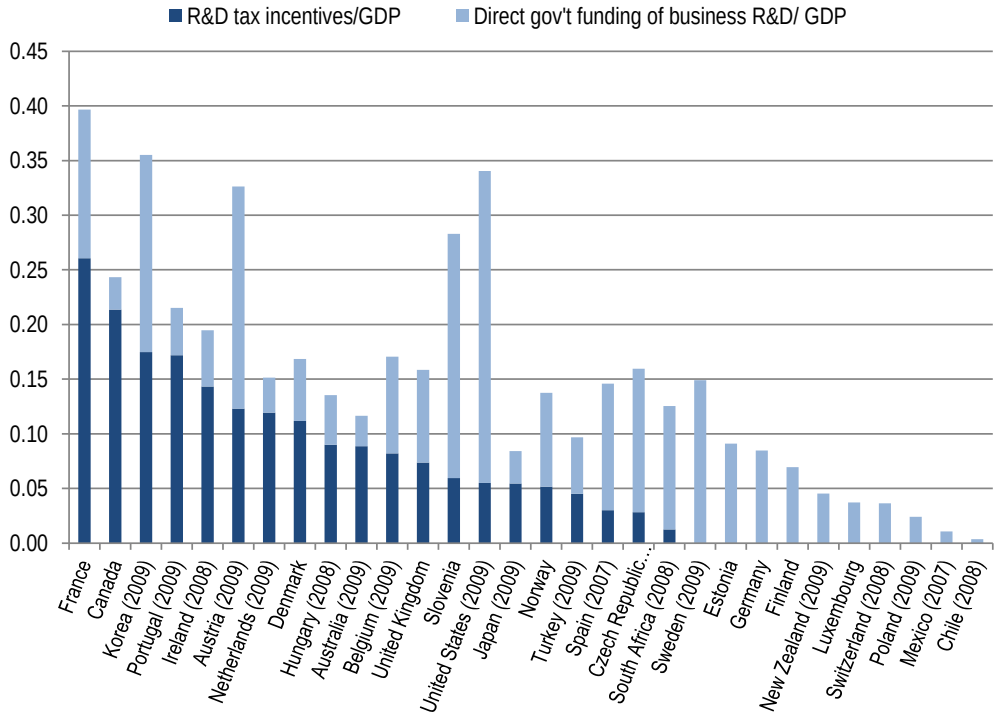
The OECD analysis of these international tax considerations suggests that some reassessment of the design of R&D tax incentives would be desirable. The analysis looks at how international tax regimes may permit the transfer of ownership of KBC to offshore holding companies and encourage the use of KBC in foreign rather than domestic production. Resulting losses of domestic tax revenues on returns to R&D and losses of domestic knowledge spillovers complicate the appropriate design of tax support for R&D expenditure. At the same time, 'stand-alone' firms that are not part of a multinational group (no foreign affiliates) and thus are unable to engage in cross-border tax planning, may be at a competitive disadvantage, relative to MNEs, in undertaking and exploiting R&D. This may inhibit the creation of KBC.

Designing cost-effective tax policies to promote innovation in a globalised economy in which MNEs and KBC play major roles has thus become more challenging. If substantial tax revenues are lost, and productivity and other spillover benefits from incorporating new KBC in production do not accrue to the country providing tax incentives for R&D, some redesign of these incentives and, indeed, of the wider tax regime may need to be considered.

Most OECD countries offer significant tax relief for business spending on R&D.

Tax policy affects business investment in KBC both directly and indirectly. Whether through R&D tax credits or special tax allowances, many OECD countries offer significant tax incentives for business spending on R&D (Figure 12). Some also offer reduced rates on income from KBC (e.g. royalty income from patents). The number of countries providing tax incentives for business spending on R&D, and the generosity of such measures, is rising. Indeed, in some countries, R&D tax incentives are the principal policy instrument used to foster innovation. For instance, in the United States, the R&D tax credit is one of the largest corporate tax credits. And in Canada in 2010, the R&D tax credit accounted for around 70% of all public support for business R&D. Ensuring that such resources are used cost-effectively is essential.

Figure 12. R&D tax incentives and direct government funding of business R&D, 2010 (% of GDP)



Note: Countries ranked from highest to lowest R&D tax incentives/GDP. R&D tax incentives do not cover sub-national incentives.

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.

Source: OECD, Main Science and Technology Indicators (MSTI) Database, June 2012; OECD R&D tax incentive questionnaires of January 2010 and July 2011; OECD Science, Technology and Industry Scoreboard, 2011 and national sources.

Tax policies in support of business R&D may not fit the realities of a globalised economy.

MNEs typically operate as integrated global businesses and are able (within the limits of the law) to plan their tax affairs to take advantage of differences in tax rates and regimes across tax jurisdictions. Notwithstanding tax rules designed to protect the tax base in many countries, MNEs are often able largely to avoid corporate income tax on returns to R&D, for example by using offshore intellectual property holding companies.

A particular difficulty for tax authorities is to establish arm's-length prices for transfers of KBC within a MNE, as the unique characteristics of KBC often mean that it is not possible to observe similar transactions or prices between unrelated parties. There are obvious risks that managers of an MNE, possibly with greater awareness of the value of the KBC to the firm, may attempt to mis-represent the value of patents transferred to an offshore company in order to minimise their global (host and home country) tax burden.

Also, owing in part to pressures to provide internationally competitive tax treatment, countries are often reluctant to impose "controlled foreign company" (CFC) rules that would tax on a current basis (rather than deferred or exempt basis) royalty income received by offshore holding companies of resident MNEs.

Some countries have introduced "patent box" rules that partly exempt from tax the income derived from the use of KBC, including royalty income on licences. This may discourage MNEs from locating economic ownership of KBC offshore, but foregone corporate tax revenues may still be significant. In most cases such "boxes" have been introduced too recently to have the data to judge their cost-effectiveness.

Profit shifting involving KBC can have significant implications for public finances.

Owing to limited data, it is very difficult to make robust estimates of the global scale of profit shifting to no-/low-tax countries through MNE tax planning involving KBC, but the magnitudes involved appear to be significant. For example, the potential annual revenue cost from income shifting by US-based MNEs may be as high as USD 60 billion, with possibly half of this due to aggressive transfer pricing of KBC-related transactions.

The OECD is developing new estimates of effective tax rates on business investment in KBC.

Conventional methods for assessing effective tax rates on investment in many forms of KBC largely ignore the international dimension of tax regimes and the tax planning behaviour of MNEs. As part of the *New Sources of Growth* project, the OECD has therefore developed a new (QETR) model for assessing the overall tax burden on R&D and for understanding how domestic and international tax policies may influence business decisions to undertake R&D, where to hold KBC (such as patents) arising from successful R&D, and where to undertake production exploiting it. The analytical model captures the impact on effective tax rates not only of R&D tax credits and allowances, but also of special domestic regimes for the taxation of the returns to R&D, such as patent boxes. The model can also analyse the effects of tax planning, including

aggressive tax avoidance strategies of MNEs to shift profits to no-/low-tax jurisdictions. As indicated above, these are important considerations given the evidence that such tax planning is now widespread in industries such as ICT and pharmaceuticals where KBC is crucial and MNEs have a major market presence.

The main empirical findings from the new model, and the preliminary policy implications, are presented below.

Total tax support for R&D may exceed governments' intentions.

First, in many countries, overall tax relief for R&D (particularly that of MNEs) may be greater than governments intended when they designed support of R&D expenditure. Analysis based on the QETR model suggests that when tax planning strategies to avoid tax on returns are taken into account, MNEs may obtain a much larger than intended tax subsidy for their investment in R&D, and the post-tax return on R&D spending may exceed the pre-tax return.

Tax planning by MNEs can have a number of important consequences…

Second, no-/low-tax rates and favourable tax regimes encourage MNEs to locate economic ownership of KBC (and receipt of income in the form of royalties) in offshore holding companies. In addition, limited taxation of foreign royalty income tends to encourage the use of KBC in foreign production and particularly in host countries with relatively low corporate tax rates. It follows that:

- Because MNEs are typically well placed to exploit cross-border tax planning strategies, countries that provide tax incentives for R&D expenditure may collect little tax on the commercialisation of the subsidised R&D. The host country will, however, benefit from the spillover of knowledge that results from the R&D performed.
- If KBC is held offshore and used in foreign production, there may be an important loss of domestic spillovers from R&D (e.g. knowledge gained from embedding KBC in production technology). There may thus be leakages of the wider benefits of R&D as well as of tax revenues.
- Domestic employment may be negatively affected by tax policies that encourage the use of KBC in foreign production. Over time, the economy is likely to adjust and other jobs may be created. While overall employment may thus change little the composition of employment may be altered and the wages paid by these jobs may be lower.

…which complicate and may weaken the logic of tax support for R&D.

- Global output may be lower than otherwise if capital is attracted away from locations where pre-tax rates of return are higher. That is, investments may be made in KBC not where they are most productive but where the tax arrangements afford the highest post-tax profitability.

These effects tend to weaken the benefits from R&D commercialisation, insofar as they diminish benefits of R&D to the domestic economy, and underline the need to re-examine international tax policies that facilitate tax planning and profit shifting. These findings have important implications for the design of R&D tax incentives. In particular, policymakers should not assume that downstream activities such as production will take place in the same country, and any cost benefit analysis should consider this.

Firms not part of a MNE group may be at a competitive disadvantage for undertaking and exploiting R&D…

Third, compared to MNEs, 'stand-alone' R&D performers (firms that are not part of a MNE group, and thus without foreign affiliates to engage in cross-border tax planning) may be placed at a competitive disadvantage. This disadvantage in terms of scope for tax planning may be more pronounced for business start-ups that are not part of a MNE group and have not yet generated taxable income to make immediate use of R&D tax credits (if they are non-refundable). The absence of a level playing field may make it more difficult for such firms to compete with MNEs, which may inhibit knowledge creation. Yet such firms may have particular strengths as R&D performers (e.g. in creating radical innovations).

…which may strengthen the case for targeting R&D tax incentives to SMEs not part of a MNE group, and/or curtailing tax planning opportunities of MNEs.

The analysis strengthens the case for targeting R&D tax credits to SMEs, in particular those that are not part of a multinational group. This approach is supported by OECD analysis performed under the *New Sources of Growth* project which shows that the productivity impacts of fiscal incentives are unclear, possibly because they may favour incumbents at the expense of more dynamic young firms (Box 9). If countries do not choose to target R&D tax credits, they may decide instead to consider scope for curtailing profit shifting by MNEs to level the playing field without significant negative impacts on innovation activity. Forthcoming OECD work on base erosion and profit shifting (BEPS) will provide a collaborative framework for developing appropriate reforms to international tax systems.

Exploring scope for international co-operation would be highly beneficial

Fourth, the academic literature suggests that while R&D tax incentives generally increase the amounts of R&D undertaken, their cost-effectiveness is less certain (dependent in part on design features). There is a risk that international competition to raise levels of tax support for R&D, to attract R&D-intensive FDI, could lower tax revenue without commensurate increases taxable income from R&D commercialisation in the amount of innovation. Scope for international co-operation could be usefully explored to limit unintended tax relief for R&D (and its use in production) from cross-border tax-planning, and possible inefficiencies arising from R&D support through tax credits and patent boxes.

Box 9. R&D tax credits: Assessing their efficacy

R&D tax incentives, a market-based tool to reduce the marginal cost to firms of R&D activities, are present in 26 of the 34 OECD member countries, and also in Brazil, China, India and the Russian Federation. R&D tax incentives have become more generous and simpler to use over the past decade.

Research indicates that a 10% reduction in the tax costs 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. However, the effectiveness of R&D tax incentives also depends on the stability of the policy regime over time. New OECD evidence shows that in countries that have experienced a large number of R&D tax policy reversals, the impact of R&D tax credits on private R&D expenditure is greatly diminished. Impacts will also depend on policy design. For example, R&D tax credit programmes that lack carry-over provisions or cash refunds may provide less assistance to young and small firms than other forms of innovation support, as such firms typically lose money in the early years of an R&D project. The use of payroll withholding tax credits for R&D-related wages, whereby firms receive an immediate refund for expenditure on the wages of R&D personnel, is another way to provide support for (young) firms in a loss position. Incremental tax credits (i.e. which only apply to R&D expenditures above some baseline amount) are also more effective in inducing business R&D spending than volume based-tax credits. However, incremental tax credits may also be more complex administratively.

Empirical evidence on whether R&D tax incentives raise the proportion of firms performing R&D is scarce. However, more generous R&D tax incentives abroad are associated with lower domestic R&D. This suggests that R&D tax incentives tilt MNEs' decisions to locate R&D activities when the locations are otherwise similar.

Direct evidence on the positive impact of R&D tax incentives on innovation output is mixed. Some evidence shows a positive effect of R&D tax incentives on incremental innovations but not on innovations new to the market. This suggests that such policies may primarily benefit incumbent firms, possibly slowing the reallocation of resources towards more innovative entrants.

For knowledge-based capital, protection of intellectual property rights is a key framework condition

Table 2. The protection of knowledge-based capital by intellectual property rights

Type of Investment	Legal Forms				
	IPR				Other (trade secrets, contracts, etc.)
	Patents	Copyright	Design rights	Trademark	
Software	X	X	X		
Databases		X			X
Research & Development	X		X		
Artistic originals		X	X		
Design	X	X	X		
Market research		X		X	X
Business process	X	X			X
Training					

IPRs have long been seen as a narrow policy area of importance to a few sectors…

Intellectual property rights afford legal protection of rights to intellectual property embedded in different types of KBC. These rights include patents (mainly new products and new processes), copyrights (mostly software, databases and artistic creation), trademarks (brand or logo) and design rights. Table 2 summarises the forms of KBC that

can be protected by different types of IPR across OECD member countries (although the scope of protection varies from country to country). For example, patents can be used to protect business methods in the United States, but nowhere else.

…but the rise of KBC brings them into the mainstream.

The exact size of the IP marketplace is difficult to estimate because most transactions are based on confidential agreements. Trade statistics suggest that growth in the value of technology royalty payments is well above the growth rate of GDP. In the United States, active corporations reported gross royalty receipts of USD 171 billion in 2008, up from USD 115 8 billion in 2002. Over 5% of income in computer manufacturing now comes from royalties and licence fees.

The increasing importance of markets for intellectual property has also given rise to companies whose main activity is the monetisation of IP, principally through licensing. US data for this sector indicate total revenues of USD 20 billion in 2010, a 4% nominal increase from 2009, a time of widespread economic contraction. Figures for individual EU countries indicate particularly high growth rates; in Germany, revenues of these businesses increased in current price terms by nearly 25% in 2010.

Well-designed IPR systems can generate significant economic benefits.

The primary aim of IP is to preserve incentives to innovate and disclose innovation-related information by granting exclusive, but time-limited and scope-limited, rights to the use of a new product, process or artistic creation. In the case of patents, inventors are granted the right to prevent others from using their invention in exchange for public disclosure of technical information about the invention. Such public disclosure can be important for further technological advances, as follow-on innovators may learn from the patented invention. More broadly, IPR systems aim to encourage the creation of knowledge-based assets, create conditions for exploiting those assets, facilitate the diffusion of knowledge and ideas, and enable markets for funding innovation (for instance when patents serve as collateral or signals/certifications for investors).

They are increasingly present in economic debate, but there are concerns about their efficiency.

A number of OECD countries have begun comprehensive reviews of their IPR regimes, and debates on IPR have assumed new prominence in the economics press, particularly following recent major corporate acquisitions of intellectual property. These include Google's purchase of IP-rich Motorola Mobility for more than USD 12 billion and Nortel Networks Corp's auctioning of its patent portfolio for USD 4.5 billion. IPR regimes have also become more complex as taxation, financing and labour market policies all affect IPRs. There are now widespread concerns about the efficiency of IPR systems (Box 10).

Box 10. Intellectual property rights - current policy concerns

There are significant differences countries' IPR regimes. Nevertheless, a number of themes recur in current policy debates:

- Fears, particularly in the United States, over the possible erosion of patent quality (notably the accuracy of the patent claim and whether the patent is genuinely novel or non-obvious). OECD data indicate that patent quality across the OECD area has eroded steadily over the last decade (with "quality" measured by indicators of patent family size, patent generality and whether the patent represents a breakthrough invention). Deterioration in quality may in part result from patent offices being overwhelmed by the growing number of patent applications. Technological advances in areas such as computer programmes and telecommunications, as well as the growth in applications from emerging economies, have driven strong growth in patenting activity.
- The rise of overlapping webs of IPRs, so-called "patent thickets". These may obstruct entry in some markets (so many parties have so many patents that it becomes too difficult and expensive to determine which licences are needed and pay for them).
- The growing problem of so-called "patent assertion entities" (PAEs). PAEs are firms that do not make, own or provide their own products or services. Instead, they purchase patents and file resource-consuming lawsuits against companies alleged to have infringed those patents. They now bring the majority of US patent lawsuits, but are much less active in Europe. Examination of the impact of litigations prompted by PAEs – which tend to be in IT industries – has found evidence of a loss of social welfare and reduced innovation incentives.
- The extension of the patentable domain into the area of business methods. Overly broad patents, it is feared, could retard follow-on innovation, limit competition and raise prices through unnecessary licensing and litigation.
- Concerns over the effects on innovation and competition of specific operational features of patent systems such as patent disclosure notice (how well a patent informs the public of what technology is protected) and patent remedies (judicially awarded damages that should replicate the market reward that the patent holder loses because of patent infringement).
- In an ever more integrated global economy, the need to move to greater mutual recognition and compatibility of intellectual property systems internationally (for instance to permit cross-border copyright licensing and to ensure that examination decisions in patent offices treat local and foreign inventors equally).
- Concerns that while appropriate protection of copyright is crucial, digital technology makes enforcement extremely difficult. There are also fears that in an era of routine copying of text, data and images, copyright law may hinder the emergence of new kinds of Internet-based firms. It may also make scientists and other researchers reluctant to use text- and data-mining techniques. In response to these concerns the United Kingdom has recently introduced changes to allow greater freedom to use copyrighted works such as computer games, films, books and music, while protecting the interests of authors and rights owners. New measures allow copying of works for individuals' personal use, parody and for the purposes of quotation. Copyright works can also be used for certain purposes without permission from the copyright owners. The United Kingdom is also enabling the development of a private-sector Digital Copyright Exchange to help rights users seeking to develop new innovative services find the content they need without excessive search and transaction costs.
- A broader concern that SMEs can face capacity constraints in their ability to negotiate intellectual property systems. Capacity-constrained SMEs may be particularly affected by cross-country differences in regimes and dispute resolution mechanisms.

Recent decades have seen a tendency to strengthen patent regimes.

Recent decades have seen a trend for countries to strengthen patenting regimes in favour of patent holders. There must, however, be a balance between granting exclusive rights to encourage innovation and maintaining competition and the diffusion of ideas. Consequently, an important question is whether the growing importance of information technology and other KBC-intensive industries has altered the nature of this trade-off and, more broadly, the costs and benefits associated with IPRs. A number of factors suggest that this may be the case, at least for patents and copyrights.

Good competition policy is necessary for strong patent regimes…

The complementarity of patent protection and competition is highlighted by new OECD evidence of a positive relationship between the strength of patent regimes and the number of patent applications per capita, but only in countries with sound competition policies. Similarly, increases in patenting have a stronger association with MFP growth when anticompetitive product market regulations are lower, as it is easier to bring new ideas to market and exploit knowledge spillovers when barriers to entry are low. In sectors with higher patenting intensity, lower barriers to firm entry are also associated with higher allocative efficiency. However, while strengthening IPR increases the number of patents, it is unclear whether this reflects increased innovation or simply more widespread use of patents.

…and competition law should also apply to complex IP licensing arrangements.

IPRs do not convey immunity from competition law. The great majority of these arrangements are efficient and pro-competitive, or at least competition-neutral. However, certain types of arrangements – while still non-problematic from a competition policy standpoint in most cases – are more likely to raise concerns than others. These include, for instance: "no challenge obligations" (obliging the licensee not to challenge the validity of IPR held by the licensor); "non-assertion clauses" (a contracting party will not assert IP rights against the other party); "grant-back agreements" (giving the licensor the right to use the licensee's improvements to the licensed technology); and "reach-through licensing agreements" (granting the owner of a patent on a research tool rights on the sales or usage of products created with that tool). While providing private benefits, such agreements can, under certain circumstances, limit competition in product and/or technology markets, discourage innovation and reduce public welfare. IPR-granting institutions and competition agencies therefore play a crucial role in designing and implementing a sound regulatory framework.

Design rights are an important part of the IPR framework…

The OECD's work on KBC also draws attention to the importance of copyright and design. Design rights protect aspects of a product's appearance (rather than its function). Differences across countries in the propensity to register design rights may reflect different legal traditions, culture and design rights systems. For instance, France and

Germany have historically had more registration of designs than the United Kingdom. Compared to the United Kingdom, Germany appears to be more aware of design-related intellectual property. The cost of enforcement also appears to be lower, and there is a general perception that courts will protect design rights. Infringement of design rights in the United Kingdom is dealt with under civil law and, in contrast to Germany, does not include criminal sanctions. With its strong and relatively inexpensive legal enforcement, Germany also has many private initiatives to protect design. France has a simplified registration process for products with short product cycles.

...but too little is known about frameworks to protect design rights and their impact on investment in design.

Internationally, little is known about the relative efficacy of different frameworks to protect design rights and provide incentives for investment in design. More analysis is needed to understand how differences among firms in terms of design registration affect differences in their economic outcomes. Much design investment is undertaken by small firms with comparatively limited capacities to enforce their design rights, a situation aggravated by the fact that the value of most individual design rights is relatively small. It would be important to understand how policy can enable designs to be monetised effectively, especially by small firms.

Better corporate reporting of KBC should be encouraged

Corporate reporting has received much policy attention in recent years....

...and reporting burdens have risen...

Corporate reporting has been a subject of vigorous debate in recent years, and views diverge on how to enhance its quality and usefulness to investors, analysts and financial institutions. While attention has focused on integrated reporting and environmental, social and governance (ESG) reporting, better reporting of corporate spending on, and benefits from, intangibles/KBC is also important to the broader debate on improving the quality of corporate reporting (the corporate governance community and literature employ the term "intangibles", which is therefore generally used to denote KBC in this section).

...but reporting of investments in KBC is widely considered deficient.

Nevertheless, in terms of practice, corporate reporting of intangibles appears not to have changed significantly in recent years. Indeed, despite the fact that the value of many of the world's most successful companies resides almost entirely in their intangibles, corporate reports provide only limited information on these. Privately held companies have no obligation to report on them, nor do publicly held companies, except when recognition is required in the context of mergers and acquisitions.

Improved corporate reporting could yield a range of significant benefits.

Wealth creation depends on achieving an efficient allocation of capital on a risk-adjusted basis. Risk assessment requires high-quality information on firms' value creation strategies and tools. A lack of reliable and relevant information on its intangibles may mean that companies have to bear a higher than necessary cost of capital or have difficulties for accessing finance.

Industrial sectors more dependent on external finance grow faster in countries with higher-quality corporate disclosure regimes. In sectors more reliant on external finance, R&D expenditure as a share of value added grows faster in countries with higher-quality corporate disclosure. In addition, enhanced disclosure of intangibles, in a manner that is consistent across companies and countries, could have a positive impact on corporate performance by improving internal controls and risk management, raising the quality of strategic decision making and increasing overall transparency for shareholders and other stakeholders.

Companies have various motivations to report intangibles/KBC.

Given that the prevailing accounting standards do not generally require recognising intangibles (except in specific cases), reporting depends almost entirely on management's interest to disclose this information, most often through narrative reporting. As a result, intangibles are often described qualitatively and generally not assigned any financial value. Reporting on intangibles is motivated by the same considerations as any other type of voluntary disclosure: the desire to increase market valuation and enhance access to finance. However, the motivation for companies to collect information on their intangibles varies considerably, depending on company size, industry and the availability of resources to implement the necessary processes.

Companies do not collect information on intangibles exclusively for external reporting. They also generate such information to improve internal management of intangibles, for example to support risk management processes and meet specific objectives such as due diligence in the context of a merger or an acquisition. Some research indicates that these internal considerations are the primary motivation for companies to collect data and information on KBC.

Approaches to the management and reporting of KBC have proliferated in recent years...

Currently, relatively few policy makers and academics advocate better recognition of KBC in national or international accounting frameworks. Better assessment of KBC using non-financial metrics, primarily through narrative reporting, is considered a priority, along with steps to promote meaningful classification and reporting of assets. A variety of approaches to the collection and disclosure of intangibles/KBC data exist. Some have been developed by governments but most by the private sector (e.g. the Intangible Assets Monitor and the World Intellectual Capital Initiative). However, implementation is voluntary and has not been widely taken up.

...but uptake is hard to measure.

Furthermore, measurement of implementation is complicated by the fact that privately held companies may report their intangibles to private investors but not externally (listed companies are required to provide the same disclosure to the entire market). In addition, neither private nor governmental standard setters generally track the adoption of their standards and therefore have little information on how, and how widely, they are used by companies and sectors.

The debate on policy measures to stimulate disclosure of intangibles/KBC continues...

While most market participants see the value of enhanced disclosure of intangibles/ KBC, the question of how this should be achieved remains contentious. Corporate reporting requirements have grown significantly in complexity and length in recent years. The overall volume of information reported needs to be reduced and presented in a manner that best reveals value-adding assets and processes. Companies should probably not be asked to provide another layer of disclosure on KBC in a format that may be too general to communicate company-specific value added.

...with the current emphasis on integrated and ESG reporting.

Specific issues include whether standards on reporting of intangibles/KBC should be voluntary and whether the reporting should be externally verified. Integrated reporting and environmental, social and governance reporting have for the moment taken centre stage in discussions of corporate reporting. Advocates of better reporting of intangibles/KBC may need to connect these not only to corporate valuations but also to better financial transparency and stability. These issues have risen on policy makers' agendas in recent years, and the OECD recommends a number of policy approaches to the reporting of corporate spending on intangibles/KBC.

Policy makers can establish guidelines for voluntary corporate reporting of intangibles/KBC.

Policy makers can support disclosure through recommendations and guidelines or by backing private-sector initiatives. To date, few OECD governments have introduced guidelines on this topic. This leaves disclosure subject to market demand and companies' perceived need and ability to do so. As a result, company reporting follows different frameworks, which limits comparability and consistency. There is some evidence of market participants' support for voluntary disclosure guidelines.

Policy can encourage greater standardisation…

A significant challenge for promoting reporting of KBC is the lack of standardisation of reporting methodologies and the variety of key performance indicators reported by companies. Although full harmonisation of reporting standards is neither feasible nor necessarily beneficial (because of sectoral idiosyncrasies), policy makers could help promote comparability and consistency.

…establish asset classifications to promote consistent data collection and reporting…

Policy makers might pronounce on the preferred format of disclosure and establish asset classifications that would promote consistency in data collecting and reporting domestically.

…help young firms understand and implement reporting…

They could also establish support mechanisms to facilitate reporting. Such measures might include support to young enterprises, for instance through coaching for data collection and reporting. Public support for academic initiatives that promote KBC reporting through pilot projects might also have a positive impact.

…and develop frameworks for auditors.

Another example of a policy that could potentially stimulate reporting on intangibles is the introduction of frameworks for auditors that would provide more assurance about disclosure of KBC. Currently, auditors lack a framework to provide an opinion on intangibles that cannot be recognised in financial statements (few forms of KBC can currently be recognised).

In a world of integrated financial markets, international policy co-ordination would be valuable.

Policy makers can also engage in international co-ordination with a view to cross-country comparisons of companies. Better co-ordination has been achieved in the area of integrated reporting, where the International Integrated Reporting Council (IIRC) has been instrumental. Initiatives such as the World Intellectual Capital Initiative or other platforms that promote global dialogue on this issue might facilitate future global co-ordination.

Better policy can help create economic value from data

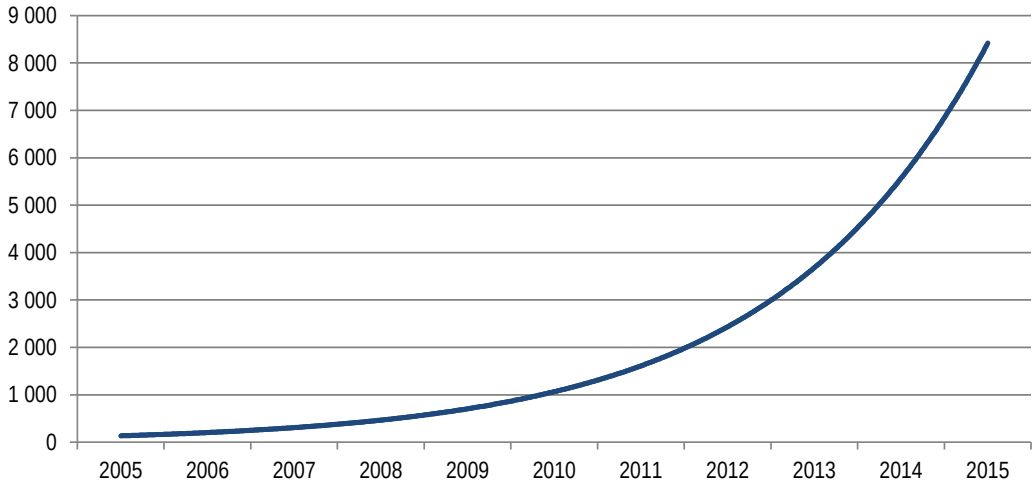
Data now constitute an economic asset…

The explosive growth of the Internet and particularly of digital technologies such as mobile networks, remote sensors and applications such as smart grids has created bodies of information, loosely referred to as "big data". The growing pervasiveness of the Internet means that personal and professional activities are increasingly conducted on line, and new capabilities emerge to capture, store and analyse data about online activity. Data are now processed, shared and transferred around the clock and across the globe. Global data creation is projected to grow by 40% a year, compared with 5% yearly growth in worldwide IT expenditure. The world's data storage capacity was estimated to have exceeded 1 000 exabytes in 2010 (an exabyte is a billion gigabytes) and is expanding exponentially (Figure 13).

…and a new frontier in productivity and competitiveness.

Combined with powerful data analytics, these data offer the prospect of significant value creation, social benefits and productivity enhancement. The McKinsey Global Institute estimates that an annual EUR 600 billion in consumer value is potentially available through business use of personal location data. Search engine data fuel automated translation services or uncover flu trends. Location data from mobile phones reveal transport flows. Financial services firms use personal data to assess credit requests and address fraud and security concerns. Loyalty programmes extract information on customer preferences. The value of data is also evident in crime statistics: reported theft of electronic data now surpasses physical property losses as the major crime problem for many global companies.

Figure 13. World data storage in exabytes (billions of gigabytes)



Source: OECD based on IDC Digital Universe research project.

Data can stimulate innovation and productivity across a range of sectors... such as online advertising...

Click-stream data are increasingly collected on line to track the browsing habits of consumers. For individual firms, the exploitation of click-stream data provides a new means to manage customer relations and allows businesses to allocate marketing budgets more effectively. Especially over the last five years, revenues generated by online advertising have grown rapidly. In the first quarter of 2012, online advertising revenues of the top 500 advertisers in the United States reached USD 8.4 billion, 15% more than in the first quarter of 2011. Retail is also changing as firms like Tesco, the UK supermarket chain, exploit the huge flows of data generated by their fidelity card programmes (the Tesco programme now counts more than 100 market baskets a second). These loyalty programmes are estimated to increase operating margins in the retail sector by more than 60% and could boost annual retail productivity by 0.5% up to 2020.

...and bring benefits in health care...

"Big data" could be used throughout health-care systems – from clinical operations to payment and pricing of services and R&D – with estimated potential total savings of more than USD 300 billion for US health care by 2020. Additional benefits could be had from innovations such as the formulation of timely public health policies using real-time data, for instance by assessing epidemiological trends based on the public's web-search behaviour (and improve on previous epidemiological models).

...in the utilities sector...

In public utilities, "smart-grid" technologies can generate large volumes of data about energy consumption patterns. "Smart meters" permit real-time collection of consumption data and the exchange of real-time price data. Information feedback loops help consumers to adjust their energy consumption, and utilities can run data analytics to adjust production capacities and pricing, as well as forecast future demand. Globally, the use of data-driven smart grid applications could cut more than 2 billion tonnes of CO_2 emissions (the equivalent of EUR 79 billion) by 2020.

...and in transport.

In the transport sector, the ability to track the location of mobile devices has been a major development. This makes it possible to monitor traffic to reduce congestion and save commuter time, and to provide new location-based services. In 2012, TomTom, a leading provider of navigation hardware and software, held more than 5 000 trillion data points in its databases. These data describe the location, direction, time and speed of travel of anonymised users. TomTom adds 5 billion measurement points a day. Overall, estimates suggest that the global pool of personal geo-location data is growing by about 20% a year. By 2020, such data could provide USD 500 billion in value worldwide in the form of time and fuel savings, or 380 million tonnes in CO_2 emissions saved. These estimates do not include value provided by other location-based services.

"Big data" could bring major benefits to the public sector.

The public sector is also an important data user, as well as a source of data that can generate benefits across the economy. By fully exploiting public-sector data, governments could significantly reduce their administrative costs. Examining Europe's 23 largest governments, one source estimates potential cost savings of 15% to 20%, with the potential to accelerate annual productivity growth by 0.5 percentage points over the next decade. Additional benefits could be achieved by improving access to public sector information (PSI) (as called for by the OECD's 2008 Council Recommendation).

Optimal policy for big data is not yet clear, but various policy areas play a role.

"Big data" is a relatively new theme on the policy agenda, and optimal policy has not yet been determined. However, it is clear that to unlock the potential of big data, OECD countries need to develop coherent policies and practices for the collection, transport, storage and use of data. These policies must address issues such as privacy protection, open data access, infrastructure and measurement. It is also clear that there are mismatches between the supply of and demand for skills in data management and analytics (data science). This may slow the adoption of big data analytics and lead to missed opportunities for job creation. New occupations require employees who combine expertise in computer science, data analytics, experimental method and other disciplines. In view of this, policy should facilitate the rapid updating of curricula.

Privacy protection is essential for innovation in the Internet economy.

New data sources, new actors and the increasing ease with which data can be linked and processed are testing the frameworks on which privacy protection is based. Using personal data in ways that were not originally intended raises fundamental privacy concerns and undermines user trust. Privacy frameworks should be reviewed to reflect the broadening scale of personal data use and the growing cross-border flows of data and to protect more effectively the fundamental value of privacy, while enabling the economic and social benefits associated with trustworthy and innovative uses of personal data.

Governments can lead by example, by opening and enhancing access to public data.

Data linkage and use across sectors drive innovation and growth. For example, firms such as Orange collect and sell anonymised mobile telephone traffic data to third parties. These parties include government agencies responsible for public road maintenance, but also private companies such as Mediamobile, a leading provider of traffic information services in Europe. However, many sources of third-party data are not yet considering sharing their data, and economic incentives may not encourage data sharing. Frameworks for the appropriate sharing of data should be reviewed, developed and adapted to this new landscape. Governments can lead by example by implementing the principles articulated in the OECD (2008) Council Recommendation on *Enhanced Access and More Effective Use of Public Sector Information*.

Infrastructure challenges are increasing.

"Big data" creates significant infrastructure needs, and current communications networks may be reaching their limits. For example, massive increases in the number of smart devices connecting to the Internet, and the data that they exchange, will strain current communication infrastructures, especially mobile networks. Issues that governments will need to address include: *i)* migration to the new Internet addressing system (IPv6); *ii)* opening access to mobile wholesale markets for firms not providing public telecommunication services (see Box 11); and *iii)* policies regulating the allocation of phone numbers and the radio frequency spectrum (for the maximum possible public benefit, given that this is a limited resource).

Box 11. Transmitting data – a regulatory barrier to the Internet of things

In the near future, the Internet will increasingly connect things as well as people. Companies will change how they design machines and devices. Tens of billions of devices are likely to be connected by 2025. A new type of user of mobile networks will emerge: the million-device user (e.g. car, consumer electronics and energy companies, as well as health providers, whose vehicles and devices connect to the Internet). Machine to Machine (M2M) communication will become standard.

Mobile networks are best geared to support geographically mobile and dispersed users who want to be connected everywhere all the time. However, a major barrier for the million-device user is a lack of competition once a mobile network provider has been chosen. The problem lies in the SIM card, which links the device to a mobile operator. By design, only the mobile network that owns the SIM card can designate which networks the device can roam on. In mobile phones the SIM card can be removed by hand and changed for that of another network. But when used in cars or other machines it is often soldered, to prevent fraud and damage from vibrations. Even if it were not soldered, changing the SIM by hand at a garage, a customer's home, or on-site, costs USD 100-USD 1 000 per device.

Consequently, once a device has a SIM card from a mobile network, the company that developed the device cannot leave the mobile network for the lifetime of the device. Effectively, therefore, the million-device user can be locked into 10-30-year contracts. It also means that when a car or e-health device crosses a border, the large-scale user is charged the operator's costly roaming rates. The million-device user cannot negotiate these contracts. It also cannot distinguish itself from other customers of the network (normal consumers) and is lumped into the same roaming contracts.

There are many technological and business model innovations that a large-scale M2M user might want to introduce. However, at present, it cannot, because this would require approval from its mobile network operator. Many innovations would allow bypassing the mobile operator and as such are resisted. The solution lies in governments allowing large-scale M2M users to take control of their own devices by owning their own SIM cards, something that is implicitly forbidden in many countries. This would make a car manufacturer equal to a mobile operator from the perspective of the network.

Removing regulatory barriers to entry in this mobile market would allow the million-device customer to be independent of the mobile network and create competition. It would also yield large savings on mobile connectivity and revenue from new services.

Measuring the value of data is important for the development of policy.

It is difficult to measure the value of data. Nonetheless, better measurement would facilitate the development of policies tailored to the scale, benefits and risks of the expanding uses of data. Not enough is known about the scale of investments in public data and the possible returns to its different uses. The value of personal data is also poorly captured in economic statistics and often under-appreciated by organisations and individuals. The direct collection of data from individuals often takes the form of a non-explicit exchange for "free" services, which adds to the valuation challenge. Measurement challenges also include the complexity of data flows and uses, including

across borders. In developing evidence on the value of data, it is important for governments to work with researchers and firms to understand the potential benefits and risks of applying big data analytics in different sectors of the economy.

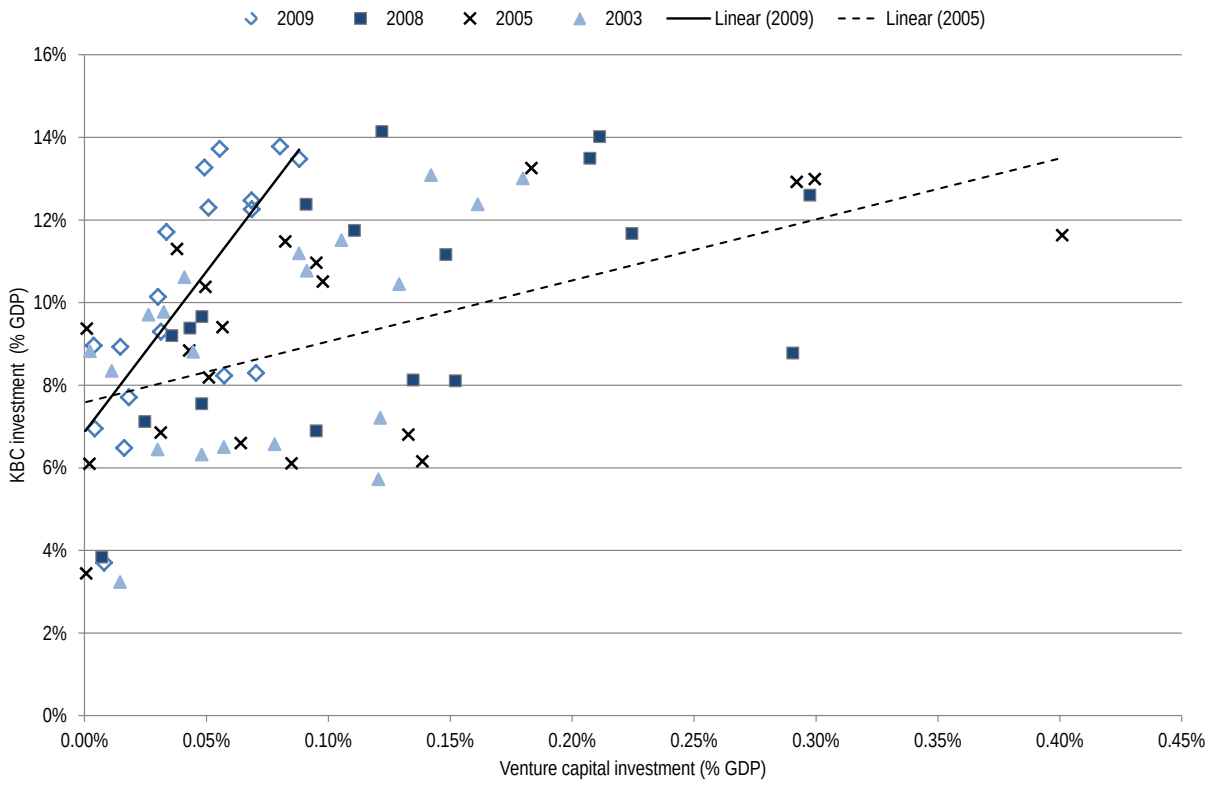
Good conditions for the financing of KBC-intensive firms will be needed

An efficient system of early-stage risk finance is important...

It is widely held that young entrepreneurial firms face a financing gap. This gap is partly bridged by specialised financial intermediaries such as venture capitalists and business angels who scrutinise firms before providing capital and monitor – and sometimes mentor – them afterwards. Many early-stage investments occur in KBC-intensive firms. Indeed, for a sample of OECD countries and over a number of years, there is a positive correlation between aggregate business investment in KBC and the size of the venture capital sector (Figure 14). Countries with more developed seed and early-stage VC are also more effective at channelling capital and labour to young innovative firms, while a number of studies show that the supply of venture capital can have a positive, sizeable and independent impact on innovation and economic growth.

Figure 14. Business investment in KBC and the size of the venture capital industry

Selected OECD countries



Source: OECD plus KBC estimates from sources in Figure 2.

…but countries' early-stage risk finance differs significantly…

Nevertheless, countries differ significantly in their supply of seed and early-stage finance (Figure 15). This raises the question of whether differences in policy settings exacerbate rigidities in the financing of investments in KBC. A number of policy areas matter here: tax arrangements (tax deductions on investments, tax relief on capital gains and special provisions concerning the rollover or carry forward of capital gains and losses); regulations governing the types of institutions that can invest in seed and early-stage venture capital, such as pension funds (venture capital activity in the United States increased significantly following the removal of restrictions on pension fund investments in 1979); the viability of exit strategies available to venture capitalists (e.g. initial public offerings); bankruptcy arrangements (regimes that provide strong exit mechanisms and do not excessively penalise business failure can foster the development of VC); and employment protection legislation.

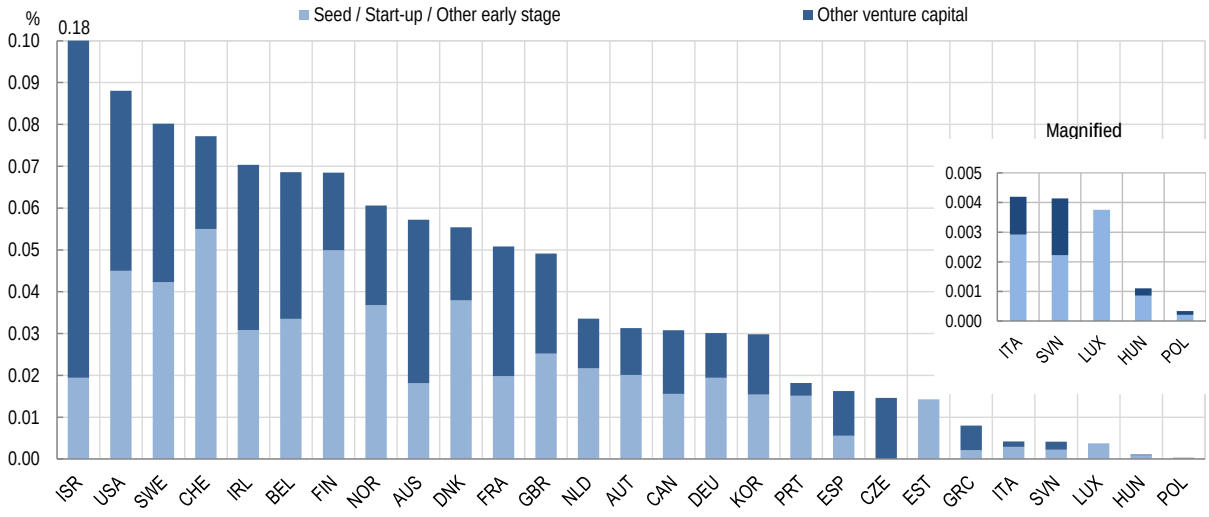
…in some cases because of demand-side policies.

New OECD evidence, which explores the determinants of VC investment in the clean technology sector, suggests that regulations that aim to create a market for these technologies are associated with a higher level of VC investment, while fiscal incentives for investment in these technologies are ineffective. This likely reflects the frequent changes in the availability and generosity of such measures and further underscores the importance of a predictable policy environment for the financing of innovative ventures.

Supply-side policies may also help… but require market discipline and careful evaluation.

Policy makers attempt to nurture the market for seed capital through a range of direct and indirect supply-side policy initiatives. Most OECD countries have some type of government equity finance programme, such as direct public VC funds, "funds of funds" and co-investment funds, whereby public funds match those of private investors. In Europe, over half of all early-stage venture capital finance is provided by publicly supported co-investment funds. Such 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 use tax incentives of some sort. Evidence on the impact of supply-side policy interventions for early-stage finance is relatively scarce, and mainly relates to the performance of public VC funds. Government-supported VC firms risk coming under pressure to consider not only financial returns, but also policy goals relating to specific sectors, regions and social groups. However, empirical evidence suggests that government funding is most effective when disciplined by private VC management and pursues commercial objectives.

Figure 15. Venture capital investment as a percentage of GDP, 2009



Source: OECD Science, Technology and Industry Scoreboard 2011.

Governments could consider fostering the innovative use of KBC as security.

While far from a mature phenomenon, there have been recent innovations in KBC-based lending and investment. For instance, royalty-based financing, particularly in pharmaceuticals and biotechnology, has been used as a source of security. Other transactions have been based on prospective revenues from products still at a pre-commercial stage of development. In the United States, royalty-based financing is estimated to have been worth some USD 3.3 billion in 2007-08. While still rare, KBC is also used as loan collateral. For instance, one major publishing company funded an expansion of its business through a deal secured by its rights to the works of composers. Governments can facilitate such developments in various ways, from monitoring the broader array of securities laws and regulations and how they affect KBC-based financing, to ensuring a robust market for IP and institutional arrangements that minimise uncertainty as to ownership claims for KBC (Box 12).

Box 12. KBC as financial security: recent developments and policy opportunities

The development of intellectual property as a source of loan collateral is part of a process of long-term economic transformation. Historically, immovable property was the most valuable type of property, and mortgage laws were developed as financial systems emerged. With the rise of manufacturing, legal systems were reformed to permit the use of machinery and inventory as security. The increasingly central role of intangible assets in modern services-based economies will require new rules governing the use of intangible property as collateral. The problem is that intellectual property has distinctive valuation risks that affect the attractiveness of its use as collateral. These risks include the fact that: some intellectual property rights have limited life spans; a patent right might be made worthless as a result of novel innovations achieved by others; an intellectual property right can be lost through failure to pay renewal fees; some intellectual property rights only have potential value (for instance, a new software that has not yet been commercialised); some intellectual property may have limited marketability beyond its current ownership because its value is contingent on being combined with other assets; trademarks cannot generally be treated as independent collateral; and there may be uncertainty about the existence of copyright, which does not require registration.

…/…

Box 12. KBC as financial security: recent developments and policy opportunities *(cont'd)*

However, while far from a mature sector, there have been innovations in recent years in intangibles-based lending and equity investment. For instance:

- Royalty financing arrangements are increasingly used as sources of securitisation. The deals take a variety of forms. Some use existing royalty streams (the so-called "Bowie Bonds", issued in 1997, were backed by the stream of royalty payments generated by the catalogue of David Bowie's music). In 2006, XOMA Corporation, a human antibody therapeutics company, obtained a loan facility with Goldman Sachs' Specialty Lending group, secured by the latter's rights to payments from sales of three of the company's brand-name drugs. Other transactions have been based on prospective revenues from products still at a pre-commercial stage of development. In the United States, royalty-based financing was estimated to have been worth some USD 3.3 billion in 2007-08.
- In 1999, Citizens & Farmers Bank in Virginia issued the first M•CAM-insured intangible asset collateralised loan to the manufacturer of specialty infant formula bottle liners (M•CAM is a financial services firm specialising in intangible assets). This transaction set the precedent for a programme that offered intangible asset collateral insurance through a partnership between Bank of America, SwissRe and M•CAM.
- In June 2004, the General Electric Corporation paid Motorola USD 50 million for certain patents and royalty payments arising from Motorola's patents licensed to the company MPEG-LA. This transaction included patent asset underwriting by M•CAM.
- Recent survey evidence showed that, in the United States, 18% of small high-technology companies in New England had used patents as collateral to obtain financing. The music publishing company Boosey and Hawkes funded an expansion of its business through a deal secured by its rights to the works of composers.
- Between 1997 and 2007, the share of secured syndicated loans collateralised by intangible assets in all secured loans rose from 11% to 24% in the United States.

Various areas of policy and institutional development could help promote an environment conducive to intangibles-based financing. These include:

- Regulations on corporate financial and accounting disclosure that help to reduce vagueness in identifying and quantifying internally generated intangible assets;
- The development of international valuation standards for intangible assets, through processes that engage the many relevant entities, from ratings agencies to large investors.
- Monitoring of the broader array of securities laws and regulations and how they affect intangible-based financing (possibly in unintended ways).
- Policies that facilitate a robust market for intangible assets, such as licensing, sales and auctions, to allow for their liquidation when necessary.
- Institutional arrangements that minimise uncertainty as to ownership of intangibles. Uncertainty can be significant and have more than one source. In the United States, with respect to patents, legal claims covered by state-level laws can lead to geographic differences in court decisions.
- Government efforts to facilitate the development of patent litigation insurance (e.g. preventing fraudulent products and promoting financially sound products). For example, the Danish Patent and Trademark Office has encouraged the creation of patent litigation insurance for SMEs.
- Government loan and loan guarantee programmes that might include provisions for purchasing intangible assets. The programmes might also be designed to explore with banks how to use facilities to finance intangibles-based firms (government loan programmes might work with commercial lenders to develop standards for the use of intangible assets as collateral). A number of experiments in this area merit further attention. For example, the Federal Development Bank (BNDES) is the main public agent for financing economic development in Brazil. In 2010 BNDES revised its credit rating procedures and adopted a methodology for basing 50% of the final rating on an evaluation of the firm's intangible assets. In China, at the end of 2008, the Beijing Intellectual Property Office created a programme to help SMEs borrow against their intellectual property.

Business investment in KBC amplifies the importance of appropriate human capital policies

Human capital underpins KBC.

Human capital is the foundation of KBC. Software, which represents a large share of R&D spending, is essentially an expression of human expertise translated into code. Over half of all R&D spending goes to wages for researchers and technicians. Patents are a legal device for securing the intellectual property associated with innovations emanating from people's ideas. Jobs producing or manipulating knowledge tend to be highly skilled – scientists, engineers, programmers, IPR lawyers, among others. The rapid evolution of different parts of the KBC-intensive economy inevitably generates skills shortages. For instance, research in the United States suggests a shortfall of some 1.5 million managers and analysts with adequate understanding of the business benefits of data. As the recovery gains momentum, skills shortages can be expected to increase. To the extent that workforce skills can rapidly adjust, so as to complement new technologies, aggregate growth will be enhanced without greatly exacerbating income inequality.

Policies that efficiently balance skills supply and demand are essential...

In a context of highly constrained public finances, and in countries where educational attainment is already high, efforts to improve the quality of education will often be a priority (the OECD's Programme for International Student Assessment shows that, for 15-year-olds, spending per student explains only around 9% of the variation in mean reading performance across countries). Particularly important are policies that balance skills supply and demand efficiently. The OECD's Skills Strategy sets out a comprehensive assessment of good practice in this area (Box 13).

...as are strong links with employers.

Partnerships between public bodies and private businesses provide an opportunity to foster and deploy KBC-related skills. A supply of skilled workers is necessary but not sufficient. Curricula must produce workers that businesses want to hire. Employers can help take responsibility for workforce development within their sectors and develop solutions that meet their rapidly evolving needs. In the United Kingdom, Jaguar Land Rover has created a network of universities to deliver targeted courses in science and engineering for their staff as part of the company's Technical Accreditation Scheme. The aim is to provide Jaguar's employees with access to "the best courses from the best sources". In Brazil, the National Industrial Apprenticeship Service (SENAI) has trained 55 million professionals since its establishment in 1942. SENAI's National Council is chaired by the president of the National Confederation of Industry (CNI) and includes representatives of industrial workers, presidents of the Regional Councils, and officials from the Federal Ministry of Education and the Ministry of Labour and Employment. Today, SENAI runs a network of 208 certified laboratories that provide technical and technological services to companies nationwide. In 2011, this network provided services to over 18 000 companies, in many cases to support technological innovation.

Institutions tasked with promoting innovation also affect skills supply.

A relatively underexplored subject is the significant role of current and former students as actors in the exploitation and commercialisation of knowledge generated in universities. Acknowledging the role of entrepreneurial students and understanding the main drivers and barriers to their activity – for instance by comparing the level and types of support and training that public research organisations provide – could have practical repercussions for policy.

Box 13. Balancing the supply and demand for skills: the OECD Skills Strategy

On the basis of a comprehensive body of research, the OECD Skills Strategy aims to help countries improve the matching of demand for and supply of skills and the use of existing skills. It also seeks to help countries decide how to prioritise investments in skills by pointing to where they produce the greatest benefits. The Skills Strategy focuses on creating a flexible "skills system" that is responsive to economic change. It identifies three related pillars for policy action, namely: developing relevant skills, activating skills supply and putting skills to effective use.

Developing relevant skills

- *By encouraging and enabling people to learn throughout life:* through gathering and using evidence about changing skills demand to guide skills development; engaging employers and other social partners in the design and delivery of skills policies; ensuring that the costs are shared and that tax systems do not discourage investments in learning; and ensuring access to, and success in, high-quality education and training programmes for children, youth and adults. The development of strong foundational skills (e.g. literacy, numeracy and problem solving in ICT-rich environments) is critical, so that specific skills can be more easily acquired later, either on the job or through retraining.
- *By fostering international mobility of skilled people to fill skills gaps:* through facilitating entry for skilled migrants and measures to support their integration; encouraging international students to remain after their studies and making it easier for skilled migrants to return to their country of origin.
- *By promoting cross-border skills policies*: through investing in skills abroad and encouraging cross-border higher education.

Activating skills supply

- *By encouraging people to offer their skills to the labour market:* through identifying inactive individuals and the reasons for their inactivity; creating financial incentives that make work pay; and dismantling non-financial barriers to participation in the labour force.
- *By retaining skilled people in the labour market*: through discouraging early retirement and staunching brain drain.

Putting skills to effective use

- *By creating a better match between people's skills and the requirements of their job*: through helping employers make better use of their employees' skills; facilitating internal mobility among local labour markets; tackling unemployment and helping young people to gain a foothold in the labour market; providing students and employers with better information about the skills needed and available in the labour market as well as the performance of education and training providers and the qualifications they deliver.
- *By increasing the demand for high-level skills:* through measures to help economies move up the value-added chain; stimulating the creation of more high-skilled and high value-added jobs; and fostering entrepreneurship.

Source: OECD (2012) *Better Skills, Better Jobs, Better Lives: A Strategic Approach to Skills Policies*, OECD Publishing.

KBC's profound implications for earnings inequality create a significant policy challenge

KBC is a factor in rising income inequality in OECD countries.

Growth driven by KBC leads to greater income inequality. A KBC-based economy rewards skills and workers who perform non-routine manual and cognitive tasks that are hard to replace, either mechanically or digitally. OECD analysis finds that skill-biased technological change is the single most important driver of rising inequalities in labour income.

Digital technologies facilitate "winner takes all" markets...

A KBC-based economy may also reward investors (who ultimately own much of the KBC) over workers (in the United States, for instance, wages as a share of GDP are at an all-time low).

...and may exacerbate the divergence between growth and employment.

Rising investment in KBC can also create winner-takes-all opportunities for a tiny few. Digital technologies allow small differences in skill, effort or quality to yield large differences in returns, in part because of the size of the market that can be served by a single person or firm. For instance, while average incomes of writers of fiction may not have changed greatly in recent decades, a select few can become multi-millionaires. J.K. Rowling is the first author to earn a billion dollars with income from books, films, video games and the fact that globalisation and digitisation mean that words, images and products can be readily obtained worldwide. A similar phenomenon is the widening of the distribution of profits across firms, particularly in sectors with heavy investments in ICT, and where an early success can be ramped up quickly and at low cost.

The increased prevalence of KBC will create major shifts in occupations...

Entire occupational categories are set to be displaced by machines and software. It is not just an occupation's skill level that determines its substitutability by technology. Whether an occupation involves routine or non-routine tasks also matters. For instance, high-skill jobs can be displaced if they involve routine tasks. And some low-skill jobs, such as those of janitors and drivers, involve non-routine tasks that have been hard to replace. However, technological change is also increasing the number of non-routine tasks that can be performed by machines. Driverless cars, for instance, will soon become widely affordable, and are already licensed in a number of states in the United States.

…and will require concerted efforts to understand and respond to the implications for society.

Technological change does not automatically lead to a loss of employment and greater cost efficiency can lead to output growth, which might create enough employment to offset the reduction in labour needed to produce a unit of output. But recent evidence from the United States indicates that productivity and employment are diverging, a trend that may accelerate as the cost of computing power continues to fall. This raises far-reaching questions about how best to respond as machine-based X-ray diagnostics, automated report-writing, systems that perform legal research, and similar advances in digital technology begin to rival or surpass human proficiency. Significant efforts will clearly be needed to understand more fully the effects of KBC on demand for skills, job characteristics and the distribution of returns to this form of capital.

Governments must invest in better measurement of innovation, investment and growth

Measurement frameworks do not fully reflect the reality of the knowledge economy. Advancing the measurement agenda is critical for policy…

Although KBC is central to growth today, the development of international comparative data is in its infancy. Measurement of investment in KBC is rife with assumptions that require further testing and empirical refinement. As part of its *New Sources of Growth* project, the OECD has worked with national statistical authorities and international experts to increase the rigour and comparability of measurement. Government support for proper measurement of KBC would help to improve understanding of the sources of employment and productivity growth and the design of evidence-based policies.

…but measuring KBC with be a lengthy endeavour.

Achieving consistent and high-quality estimates of investment for the many assets that compose KBC will require sustained effort over many years. Monitoring and co-ordinating the efforts of research groups and national statistical offices worldwide, in particular by facilitating knowledge sharing, enabling peer review and avoiding duplication, will accelerate this process. There are several key challenges, opportunities and areas of progress.

Internationally harmonised methodologies and estimates are needed…

In recent years, a number of international initiatives have estimated investment in KBC, mainly following a measurement framework conceived for, and using, data from the United States. Inevitably, this has resulted in differences in definitions, measurement parameters (such as assumed depreciation rates) and information sources (e.g. firm surveys and business registers).

Efforts to harmonise national-level estimates have led to the publication of comparable macro-level data under the INTAN-Invest umbrella for the EU27 plus Norway and the United States. At present, 34 OECD and non-OECD countries have reported estimates of aggregate investment in KBC based on a common framework.

...but industry and firm-level information is also needed to understand competitiveness and growth.

Uncovering the role of KBC in growth requires further understanding of the investment behaviour of individual firms and industries. Efforts have been made to obtain industry-level estimates of KBC for 17 countries, but there are differences in their international comparability. While these initiatives have provided important policy-relevant information, they would need to be scaled up to develop policies more targeted to firms and industries and allow for cross-country comparison. The development of international standards for company classifications of intangibles would greatly improve macro-level measurement.

New measurement guidelines are also required for assets that have so far received little attention.

A number of KBC-related assets have been overlooked in past definitional and measurement work. These forms of KBC – particularly those in the categories "economic competencies" and "innovative property" (see Table 1) – are not included in official statistics. The measurement of firm-specific training and design are cases in point. Plans exist to produce international measurement guidelines for design by 2014 to aid in the compilation of design-related data.

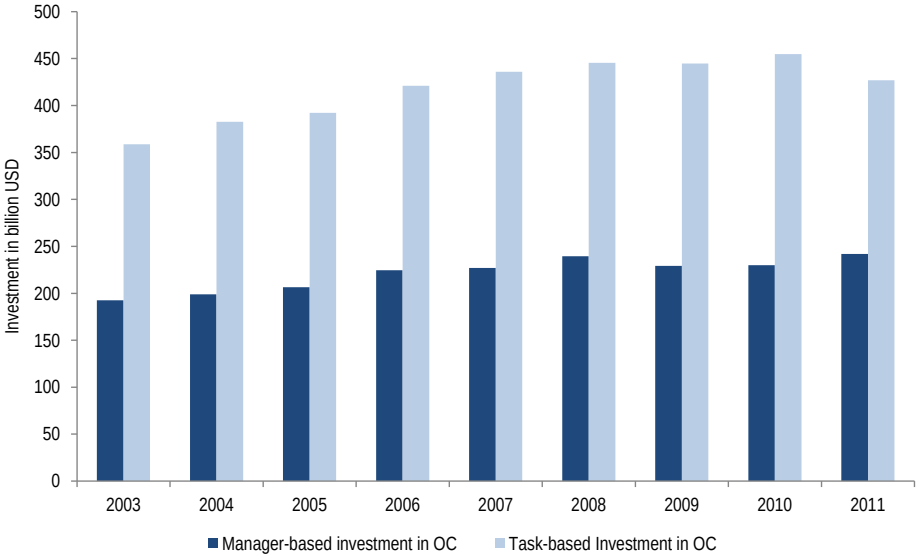
Investments in organisational capital differ across industries and are larger ....

The measurement of organisational capital involves several assumptions. A main assumption relates to the share of management time used to bring about lasting changes in a firm's productivity. In this connection, an experimental methodology proposed by the OECD has gone beyond a purely managerial focus to identify the tasks performed by any employee who contributes to the long-term functioning of a business. As indicated in Figure 16, this novel focus indicates that firms' investments in organisational capital are almost twice as large as previously thought. Moreover, there are major differences across industries in this respect.

...and remain of value longer than previously thought.

In addition to the scale of investment, the importance of organisational capital depends on the number of years over which firms can reap its benefits. Using labour mobility data related to resignations, the OECD has found that organisational capital is much longer-lived than previously thought. Firms expect such investments to last on average for 4 to 6 years in services and 7 to 10 years in manufacturing.

Figure 16. Investment in organisational capital in the United States, 2002-11



Source: OECD calculations based on the earnings data by occupation and industry from the Annual Social and Economic (ASEC) Supplement of the Current Population Survey (CPS), US Bureau of Labor Statistics, 2003-2012.

Quantifying innovative property requires reconciling the different R&D investment figures that exist…

Measurement of innovative property has progressed steadily in recent decades. However, for R&D there are a number of official data collections and distinct measurement approaches. The two main sets of guidelines focus, on the one hand, on performers and funders of R&D and, on the other hand, on producers and owners of R&D assets. Reconciling these figures has required careful assignment of ownership (as in the case of publicly funded R&D carried out by private firms). The OECD has recently provided guidelines to facilitate international harmonisation and benchmarking.

…measuring the value of innovative output and of IPRs….

Yet measuring KBC by focusing on the cost of inputs, such as R&D, ignores the value of the output of R&D. To address this, measures of the "quality" of firms' innovative property – in particular the technological and economic value of patented inventions – have been designed and constructed by the OECD using information contained in patent documents. Such indicators are generally comparable across countries and over time.

...better assessing the longevity of these investments...

Obtaining consistent industry-level depreciation rates for R&D investments has proved challenging, and there is no commonly agreed methodology. In the past, estimated R&D depreciation rates ranged between 12% and 29% for the business sector overall, and between 11% and 52% for specific industries. The OECD has used patent renewal data to estimate the length of time for which firms value the output of their R&D. Accordingly, R&D appears to be much more long-lived than previously thought, with an aggregate 8% annual depreciation figure. R&D in manufacturing appears to depreciate more slowly than in services.

...and understanding changes in the price of knowledge assets.

Assessing the way investment in KBC relates to productivity and economic growth also requires refining information on asset prices, so as to accurately capture the quantity of the assets purchased. For instance, in countries and fields where specialised researchers are in short supply, an increase in R&D expenditures may simply reflect the higher salaries that firms might have to pay to retain researchers, rather than an increase in the number of scientists hired.

Better knowledge of how different forms of KBC interact is needed.

A more comprehensive understanding of the role of KBC would require building an analytical framework able to uncover causal links and to account for interactions and spillover effects between different knowledge-based assets and between KBC and other types of investment. For example, complementarities between organisational capital and investment in ICT, and between R&D and investment in human capital, are well documented. These suggest that the effectiveness of certain support policies for R&D or investment in ICT might be diminished by framework conditions that hinder investments in complementary assets. The lack of a general model affects the ability to design more effective policies.

The risk that measurement systems will fail to keep up with rapid changes in the knowledge economy may lead to focusing policy debate on a few, easier-to-measure, indicators that do not reflect the rich variety of mechanisms for producing, exchanging and using KBC. Beyond measuring investment in KBC and its impacts there is a need for a broader system able to capture differences between knowledge production and use, partnerships and their financial dimensions, and international flows of knowledge assets.

The calibration of macroeconomic policy may need to be revised

Large and growing business investment in KBC may have implications for macroeconomic policy…

By definition, treating spending on KBC as investment rather than intermediate consumption raises the level of recorded investment and GDP as well as the savings rate. Findings suggest that capitalising R&D would have raised the recorded national savings rate in the United States by 2 percentage points in the early 2000s. Non-trivial increases in reported national savings could call into question the appropriateness of policies aimed at boosting private savings. Furthermore, to the extent that the cyclical sensitivity of firms' spending on KBC is comparable to that of physical assets, treating KBC as investment in national accounts is bound to raise the variance of measured GDP over time. More investment will be recorded during upturns in the business cycle, and investment will contract more during downturns. If spending on KBC is not treated as investment, macroeconomic policy may therefore be insufficiently counter-cyclical.

…but these have not yet been properly assessed.

The implications for macroeconomic policy of capitalising spending on KBC in national accounts requires further investigation, and has barely figured in policy analysis to date.

Opportunities exist for international collaboration

The impacts of some policy reforms and measurement initiatives will be magnified if governments work together.

The outcomes of many policies addressing KBC would certainly be greater if governments took action together. Areas in which collaboration would be valuable include:

- Co-ordination of regulations so as to permit cross-border transmission of data.
- Cross-country promotion of increased comparability and consistency in corporate reporting of investments in KBC.
- Recognition that international competition to increase levels of tax support for business R&D may be damaging and increase foregone tax revenue without commensurate increases in innovation. International co-operation could address not only unintended tax relief for R&D (and its use in production) by MNEs through profit shifting, but also statutory policies for supporting R&D through tax credits and patent boxes.
- Collaboration to agree measurement definitions and guidelines and harmonise data collection across countries.