

Uppenberg, Kristian

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The knowledge economy in Europe

A review of the 2009 EIB Conference
in Economics and Finance

by Kristian Uppenberg





About the author

Kristian Uppenberg is a Senior Economist in the Economic and Financial Studies division of the EIB, specialising in issues related to innovation and economic growth.

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1. Preface

by EIB President Philippe Maystadt



Founded by the Treaty of Rome in 1958, the European Investment Bank (EIB) is a major financial institution supporting the European Union's public policy objectives. Among such objectives, economic integration, convergence and regional cohesion have featured most prominently over the years in the EIB's operations. In concrete terms, this has meant the EIB providing financial and advisory support to countless infrastructure and other projects connecting European countries, regions and people.

But as the European economy has evolved over time, so has the EIB. Specifically, in the decades following World War II, the European economy was dominated by the expansion of traditional manufacturing. In this context, investment for the most part meant infrastructure, buildings, machinery and equipment. These remain substantial components in overall investment, but the European economy has over time become a predominantly post-industrial society. Today, services account for around 70 percent of value added and employment in the EU. Investment in this economy does not mean quite the same as it meant in the manufacturing-dominated societies of the post-war era. A large portion of business sector investment today consists of investment in "knowledge".

This is reflected in the operations of the EIB. Today, a non-negligible portion of the EIB Group's activities is directed at the knowledge economy. To illustrate, in 2009, the EIB provided about €18 billion in support of (i) research and development, (ii) innovation, and (iii) education and training. This accounts for around one-third of the EIB's total lending.

 Plutarchos Sakellaris (EIB Vice President) and Philippe Maystadt (EIB President)



Against this background, for the EIB a sound understanding of the knowledge economy is crucial. What drives investment in the knowledge economy? What hinders it, and how could possible roadblocks be removed? How does investment in knowledge affect aggregate economic performance? These questions were addressed at the 2009 EIB Conference in Economic and Finance¹, titled “R&D and the Financing of Innovation in Europe” (henceforth referred to simply as the “2009 EIB Conference”). The conference papers were published in volume 14 of the *EIB Papers*².


This overview discusses some key findings of the papers presented at the conference and draws some policy conclusions from them in the context of the broader literature. The papers and the wider academic discussion are sorted into three broad groups. The first looks at macroeconomic issues: The measurement of intangible capital and how this affects economic growth (Sections 2-4). The second group analyses the motivations of firms to invest in R&D and the role of public policy in spurring innovation (Section 5). The third group focuses on the financing of innovation (Section 6). Section 7 concludes.

2. R&D investment and capital stocks

One of the key findings of the empirical growth literature of the past half-century is that the increased supply of labour and fixed and human capital can only account for between half and two-thirds of economic growth in most countries. The remainder is driven by something else. Over time the empirical literature has shown that this residual can be broadly defined as the stock of “knowledge”. It is also commonly referred to as Total Factor Productivity (TFP), since it entails an expansion in output for a given set of inputs.

1 The Conference was held in Luxembourg on 22 October 2009

2 Hard copies are available on request from the EIB (infoeifs@eib.org). Electronic versions are available from the EIB web site: <http://www.eib.org/infocentre/efs/publications/eib-papers/index.htm>



Another finding of the empirical literature is that investment in research and development (R&D) is a key input into the process of innovation and in the expansion of the knowledge stock. Other things being equal, countries and sectors devoting a larger share of their resources to R&D also tend to enjoy higher productivity growth. In this sense, the inclusion of explicit R&D targets in the Lisbon strategy was supported by empirical evidence. The complexity of the innovative process blurs, however, the relationship between R&D and productivity growth.



Setting the stage at the 2009 EIB Conference, EIB Economist **Hubert Strauss** (presenting a paper written together with Christian Helmers and Christian Schulte, published as Helmers *et al.* 2009 in the EIB Papers) provided some key figures on R&D expenditures and R&D capital stocks in Europe.

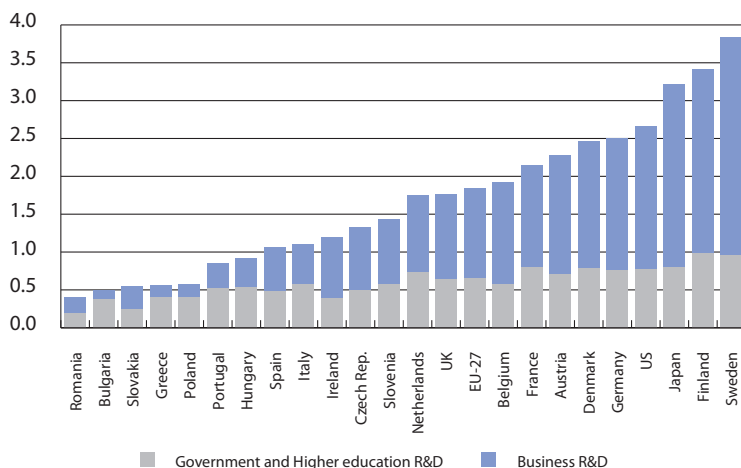
As illustrated by Figure 1, Europe continues to spend notably less on R&D than either the US or Japan. The bulk of this spending gap is accounted for by lower R&D spending in the European business sector. The fact that this gap has been remarkably stable over a long period of time suggests that it has structural causes. Despite their stated commitment to the Lisbon Strategy, European countries have made little progress in closing this gap in the past decade. There are also large and persistent differences across individual European countries. While R&D intensity in Sweden and Finland exceeds that of Japan, a number of European countries spend less than half the EU average.

While much of the public discourse on R&D has concentrated on the resources that countries invest in R&D on an annual basis, what actually matters for economic growth is the *stock* of knowledge, as represented by the R&D capital stock. The R&D capital stock accumulates gradually as

 Hubert Strauss

a result of many years of investment in R&D, but it also depreciates as older knowledge becomes obsolete. If Europe would suddenly raise its level of R&D investment to meet the Lisbon target of 3 percent of GDP, this alone would not have an immediate impact on its economic performance. What is needed is a sustained increase in the level of investment that would over time expand Europe's R&D capital stock.

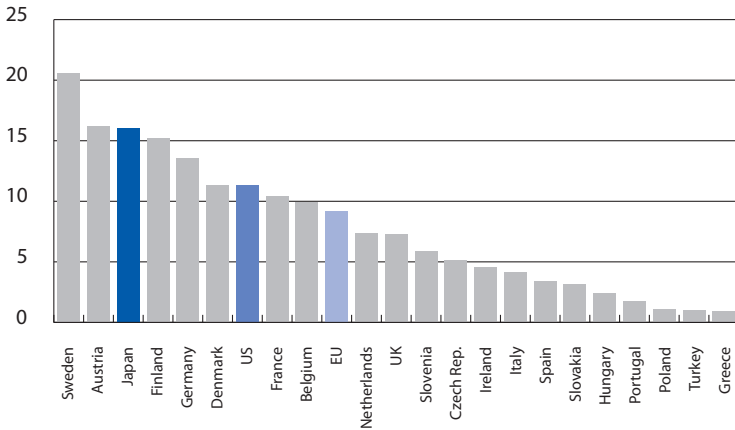
Figure 1: R&D expenditures in 2006, percent of GDP



Source: Eurostat

Helmerts *et al.* produced business sector R&D capital stock estimates for 22 countries, including new estimates for seven additional countries (Figure 2). Mirroring the distribution of annual investment in R&D, Japan and the US have notably larger business sector R&D capital stocks than the EU, relative to business sector gross value added (the sectoral equivalent of GDP). Furthermore, the dispersion across European countries is much larger in terms of R&D capital stocks than for other factors of production. Finally, the authors find little evidence of convergence in these R&D capital stocks over time.

Figure 2: Business sector R&D capital stocks in 2005, percent of value added



Source: Helmers *et al.* (2009)

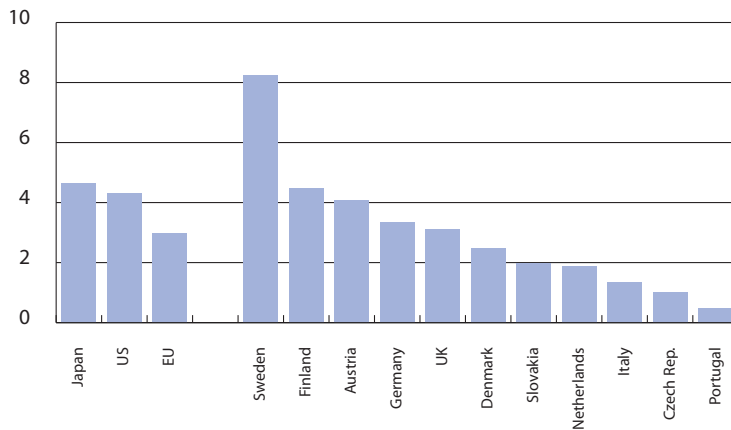
Helmers *et al.* also point to evidence of complementarities between R&D capital and the ICT capital stock (information and communications technology). As suggested by the growth literature, new inventions resulting from investing in R&D affects the wider economy only when they are commercially applied on a large scale. This suggests that there are positive complementary effects between the stock of R&D and the stock of tangible fixed capital. These positive interaction effects are believed to be particularly strong between R&D and ICT capital. Helmers *et al.* find some evidence in support of this conjecture. In high technology manufacturing in Europe, industries with a high R&D intensity also tend to have a larger stock of ICT capital. This result is particularly striking since such positive correlation cannot be detected between R&D capital and other types of fixed capital.

The ratio of R&D capital to fixed tangible capital gives an indication of the “knowledge intensity” of the economy relative to its fixed capital stock (Figure 3). It should be stressed here that the R&D stock is of a

different order of magnitude than tangible fixed capital. In no country included in the study does the R&D stock exceed one-tenth of the fixed capital stock. As shown in the figure below, Japan and the US do not differ significantly on this measure of knowledge intensity. Even though Japan's R&D intensity is higher than that of the US, so is its stock of tangible fixed capital, relative to the size of the economy. As a result, Japan's knowledge intensity is not substantially higher than that of the US when scaled against the stock of fixed capital. Europe, on the other hand, has a knowledge-intensity relative to fixed capital that is around one-quarter lower than that of both the US and Japan. Again, there are notable differences across individual European countries.



Figure 3. R&D capital stocks as a ratio of total-economy capital stock, 2005 (percent)



Source: Helmers *et al.* (2009)



3. Intangible capital and economic growth

The traditional concept of productive fixed capital includes tangible assets such as non-residential buildings and machinery and equipment. But from an economic point of view, this is a rather too narrow definition of productive fixed capital. In principle, capital expenditure should include any outlay that increases future output and income at the expense of current consumption. As we have already suggested, investment in R&D for example gives rise to a productive capital stock similar to tangible fixed capital. The same argument can be made for investment in human capital, in the form of education and training. Human capital and R&D capital are key components of the economy's "intangible capital", but this concept can be broadened even further.

The exclusion of intangible capital from traditional measures of the fixed capital stock was to a large extent caused by a lack of reliable data. Intangible investment and capital tends to be more difficult to measure than tangible fixed capital. For much of the post-war period, this exclusion was not a great concern. Most advanced economies were manufacturing-based and tangible capital accounted for the bulk of the total productive capital stock. Over time, however, the exclusion of intangible capital from official statistics has led to a growing misrepresentation of the economic growth process. The reason is that many advanced economies have shifted away from traditional manufacturing towards services and towards economic activity that is increasingly knowledge-based. Growth in modern post-industrial countries has become increasingly dependent on investment in human capital, knowledge and other forms of intangible capital. It is estimated that intangible assets now account for between one third to half the market value of the US corporate sector. In Europe the share of intangible assets in the total assets of publicly-listed firms has more than tripled since the early 1990s, to around 30 percent. Even this figure understates

the true share of intangible assets, however, because accounting standards do not allow for treating R&D as capital, and because only intangible assets which are actually on the balance sheet are measured. Hall *et al.* (2007) show, on the basis of just over 1000 publicly-listed European firms, that investment in R&D is a fundamental determinant of corporate financial value and competitive advantage. These findings are in line with other studies on US firms showing that investors view R&D as an asset rather than as an expense.

The shift towards a growing role for intangibles is visible also at the macroeconomic level, which suggests that their exclusion from national accounts entails a growing misrepresentation of economic activity. Neither the system of national accounts (SNA) nor the financial accounting of firms have traditionally allowed for the capitalisation of intangibles, for both measurement and methodological reasons. Intangible capital such as the stock of R&D or human capital is often tacit, i.e. embedded in the skilled staff and researchers of firms. Also, such expenditures often contain a mix of genuine capital investment (which should be capitalised) and intermediate consumption (which should not be). Some fear that companies might be tempted to label almost any kind of expenditure a “capital expenditure” in order to improve their standing with investors. In contrast, conventional fixed investment and the capital stock it generates is relatively easy to distinguish.

Some steps have been taken towards the capitalisation of intangible investment in the SNA. Expenditures on computer software, for example, have already been counted as capital expenditure for a decade. Software benefits from relatively easy measurement and is relatively distinguishable as pure capital expenditure. It was also decided in 2008 to start counting R&D as investment, to be implemented in a few years time.

Given the limited coverage of intangibles in official SNA statistics, economic researchers have relied on a combination of private and public information sources to estimate such investment. Most have chosen the





template created by Corrado, Hulten, and Sichel (2005, 2009), henceforth referred to as CHS. They include three types of intangible assets for the US economy:

- **Computerised information** (software and databases);
- **Scientific and creative property** (R&D, mineral exploration, copyright and license costs, other product development, design, and other research expenses);
- **Economic competencies** (brand equity, firm-specific human capital and organisational structure).

On this basis, they estimate total annual investment in intangible assets by US businesses in the late 1990s to have amounted to some USD 1.1 trillion, or 12 percent of GDP. This is a substantial figure, a similar order of magnitude as tangible investment. This is perhaps the single most important result of their exercise: Once the definition of capital is broadened to include all forms of expenditure that raise the future output potential of the economy, business sector investment is actually twice as large as that traditionally reported.

The data collected by CHS also suggest that US investment in intangibles has risen markedly over time. This gradual rise in intangible investment has been of the same order of magnitude as the decline in tangible investment, thus keeping the ratio of total investment to GDP relatively stable over time. Not all segments of intangible investment have contributed equally to this expansion however. Comparing the time period 1973–1995 with 1995–2003, CHS find that overall intangible investment grew from 9.4 percent of total national income to 13.9 percent. Computerised information rose the most, from 0.8 to 2.3 percent. Interestingly, while traditional scientific R&D remained flat at around 2½ percent, “non-scientific R&D” rose from 1 to 2.2 percent. Non-scientific R&D includes innovative and artistic content in the form of commercial

copyrights, licenses, and designs, which are not counted in traditional R&D statistics. Investment in brand equity rose from 1.7 to 2 percent, while that in firm-specific resources increased from 3.5 to 5 percent. In other words, while scientific R&D is traditionally seen as the key element in knowledge creation, it has made a negligible contribution to the ascent of US intangible capital investment in recent decades.




Box 1: The neo-classical growth model and growth accounting

The most common method used to empirically investigate the composition of economic growth is called growth accounting, drawing on the neo-classical model of the economy developed simultaneously by Solow (1956) and Swan (1956). In the neo-classical production function gross output is a simple function of only two factors of production: capital and labour. These two are smoothly but imperfectly substitutable, as can be exemplified by the standard Cobb-Douglas production function:

$$(1) \quad Y = AK^\alpha L^{1-\alpha}$$

What this function says is that aggregate output can be expanded either by increasing the amount of labour (L) or fixed capital (K) used in production, or through an expansion of the stock of knowledge (A). The function above has constant returns to scale. This means that a doubling of both capital and labour also leads to a doubling of output. At the same time there are diminishing returns to individual inputs (i.e. $\alpha < 1$). Because of diminishing marginal returns to capital, the marginal contribution to growth from steadily increasing the capital stock for each worker will be smaller and smaller. Consequently, the only way for the neo-classical economy to keep growing on a *per capita* basis is by continuously expanding the stock of knowledge.



The seminal contribution of Solow was his pioneering empirical work on growth accounting. Applying his model to US data from the first half of the 20th century, Solow (1957) could calculate the shares of growth that stemmed directly from the expansion of labour and fixed capital³. Whatever portion of growth that cannot be directly explained as the result of increased factor inputs must, according to the neo-classical model, be the result of an expanding stock of knowledge. Solow's startling discovery was that, indeed, some nine-tenths of US growth could *not* be explained by the expansion of labour and capital, but was captured by the residual A. While knowledge is certainly one key element of this residual, this interpretation may in fact be a bit too narrow, since empirically the residual captures all efficiency gains in the use of factors of production. The residual captures all increases in output for a given combination of factor inputs. Hence it is nowadays often referred to simply as "total factor productivity", or TFP.

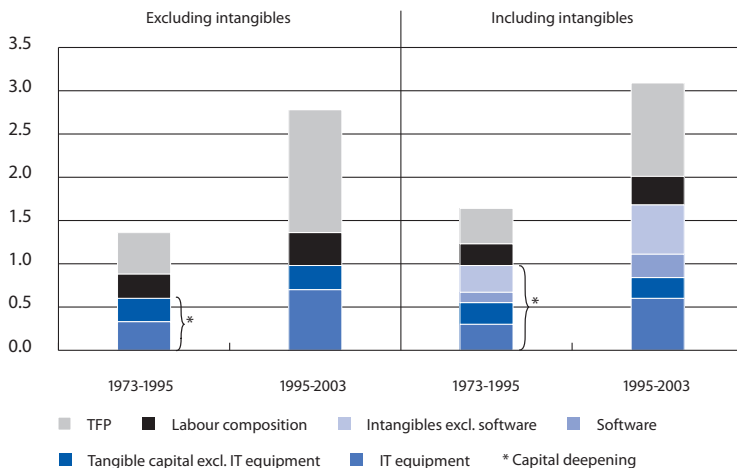
Modern growth research has found that one reason the TFP residual accounted for such a large portion of growth in Solow's calculations was that early measures of fixed capital were rather too narrow. By broadening the concept and measurement of capital, the unexplained TFP residual can be reduced.*

3 In order to do this using the relatively simple neo-classical production function and the limited set of data at his disposal, Solow had to make a few simplifying assumptions. First, he assumed that the US economy was on its equilibrium growth path, not unreasonably given its long history of having a relatively free market economy. This allowed him to draw on some generalised properties of the production function that are only true in equilibrium and under the additional assumption of perfect competition. Under these circumstances, the wage rate equals the marginal productivity of labour and the rate of return on capital equals the marginal productivity of capital. The income shares reflect the output elasticity of each input. Assuming constant returns to scale, they add up to one. These are the α and $1-\alpha$ shown in equation (1). Consequently, while the output elasticities are not directly observable, one can simply calculate the contribution of an input to output growth as the growth rate of each input (capital and labour) multiplied by its own income share, which is observable.

*A more comprehensive review of the modern growth literature is provided in Uppenberg (2009).


Based on their estimates of intangible investment, CHS estimate the size of the intangible capital stock, which is then incorporated into the standard growth accounting framework first developed by Solow (see Box 1). As illustrated by Figure 4, productivity growth is higher in the presence of intangible capital. The reason is that spending on intangibles, which grew faster than other segments of the economy, is now included in measured output. It was not when viewed merely as intermediate consumption. Another consequence of treating intangibles as capital expenditure is that it dramatically changes the observed sources of economic growth. Capital deepening – increases in the stock of capital per hour worked – now becomes the dominant source of growth. For the period 1995-2003, intangible and tangible capital investment account for broadly equal shares of growth in US output per worker.

Figure 4: Contributions to US output growth per hour worked (percentage points)



Source: Corrado *et al.* (2009)

With capital deepening explaining a larger share of growth, the contribution from the TFP residual becomes correspondingly smaller,



falling from around half to one-third for the post-1995 period when intangibles are included. The Solow residual also accounts for a smaller portion of the post-1995 *acceleration* in US growth. When intangibles are excluded, some two-thirds of the increase in growth is accounted for by TFP. Its share drops to just over one-third when intangibles are included. On balance, this research is suggestive of the very substantial role that investment in intangibles has played in US economic growth.

The CHS methodology was consequently applied by Giorgio Marrano and Haskel (2007) for the UK, by Fukao *et al.* (2009) for Japan, by Jalava *et al.* (2007) for Finland and by Edquist (2009) for Sweden. In all of these cases, total investment in intangible capital stood at around 10 percent of GDP, *i.e.* a similar order of magnitude as in the US. However, when this methodology has been applied to a larger number of continental European countries, a wider range of results has emerged.

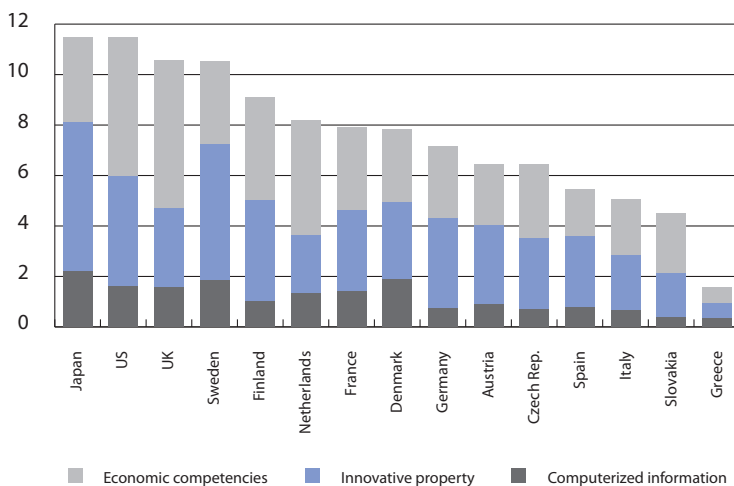


In Europe, with the exception of the countries mentioned above, both the resources devoted to intangible investment and their contribution to productivity growth have typically been of a smaller magnitude. This is one of the key findings by **Bart van Ark** (The Conference Board and University of Groningen) in his contribution to the 2009 EIB Conference (see van Ark *et al.* 2009).

Building on existing estimates of intangible capital for the US and several European countries, van Ark and his co-authors extended the estimates of intangible investment and capital to five additional European countries: Austria, the Czech Republic, Denmark, Greece and Slovakia. The concept of intangible capital follows the template of CHS for the US. Figure 5 provides a comparison of intangible investment in the US, Japan and a number of European countries, drawing on the results of van Ark *et al.* and other studies using the CHS methodology.

 Bart van Ark

Figure 5: Intangible investment in the market sector (percent of GDP, 2006 or latest)



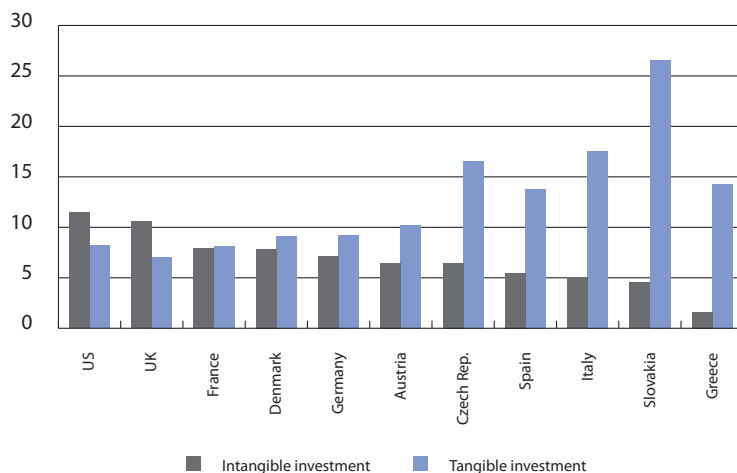
Source: van Ark *et al.* (2009); Edquist (2009); Fukao *et al.* (2009); Jalava *et al.* (2007); Van Rooijen-Horsten *et al.* (2008)

We see here that the ratio of intangible investment to GDP varies markedly across countries, not least within Europe. Also the composition of intangible investment varies across countries. Economic competencies (which include investment in human capital) account for as much as half of total intangible investment in the US, UK and the Netherlands, while innovative property such as copyrights and licenses tend to dominate in Japan and a large number of continental European countries.

Figure 6 below compares the size of intangible investment with tangible investment across a selection of countries. As seen earlier for the US, intangible investment is of a similar order of magnitude as tangible investment in the Nordic countries and in the three biggest EU economies. In many other European economies, however, investment in intangibles remains far below tangible investment.



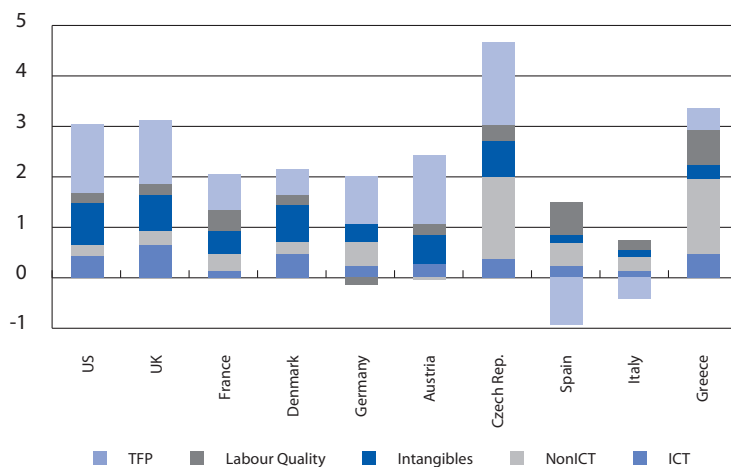
Figure 6: Intangible and tangible investment in the market sector, percent of GDP, 2006



Source: van Ark *et al.* (2009)

Just as the level of intangible investment varies across countries, so does its impact on economic growth. As shown in Figure 7, intangible capital deepening (i.e. more intangible capital per unit of labour) contributed 0.7-0.8 percentage points to labour productivity growth in the US, UK, Denmark and the Czech Republic in 1995-2006. In Germany, France and Austria the growth contribution was slightly smaller, ranging between 0.4 and 0.6 percentage points. The smallest contributions to productivity growth were found in Italy, Spain and Greece, where it averaged only 0.1-0.2 percentage points during this period. The figure also illustrates how non-ICT capital deepening has been delegated to a minor role in growth during this period, with the notable exceptions of the Czech Republic and Greece.

Figure 7: Contribution of inputs to labour productivity growth, annual average in percent, 1995-2006



Source: van Ark *et al.* (2009)

To sum up, this literature shows that the exclusion of intangible investment has tended to generate a growing misrepresentation of growth in economies that have become increasingly specialised in knowledge-intensive production. A more complete accounting of intangibles demonstrates that the business sector in fact sets aside a much larger share of their total resources to investment than conventional capital measures would have us believe. This modification, in turn, has substantially affected our perception of the composition of economic growth. Most importantly perhaps, this literature points to the large and indeed growing role that investment in intangibles has in economic growth in post-industrial societies. This is an important observation to consider if Europe is to succeed in catching up with US productivity growth in coming years.



4. Can the EU close its productivity gap with the US?

The growth accounting literature provides an indication of how different forms of investment have contributed to economic growth. This literature has its limitations, however, especially in terms of policy conclusions. Growth accounting rests on simplifying assumptions regarding the rates of return on investment. The parameters determining the impact of investment on growth are imposed *ex ante*, rather than estimated. This implies that the estimated growth contribution of a factor of production is always strictly proportional to the growth of the factor itself, even if in reality there is too much of the factor to begin with, so that increasing it further has a minimal impact on growth.

Neo-classical growth accounting also cannot provide an explanation of what causes TFP to grow. TFP is simply the residual that is left after the growth contributions from capital and labour have been accounted for. Since TFP remains a substantial component in economic growth even after the inclusion of intangible capital, the underlying drivers of long-term economic growth in part remain a mystery.

4.1 Cross-country evidence from the broader empirical growth literature

There are several alternative methods of assessing the economic growth process, which are valuable complements to growth accounting in light of its limitations. Rather than imposing the parameter values *ex ante*, growth regressions estimate these on the basis of cross-sectional data and sometimes also on time series data. Cross-sectional regressions can be based on country-, sector-, or firm-level data. These methods allow for extracting the productivity effects of investment without a priori assumptions. They offer a way of estimating the importance for growth not only of investment, but also of different institutional arrangements

such as trade openness and the flexibility of labour and product markets. This literature can be used to answer questions such as: How can Europe close its growth gap vis-à-vis the United States?⁴



One key conclusion of the cross-sectional literature is that a large portion of income differences across countries stems from different knowledge stocks (i.e. different levels of TFP), rather than differences in factor input levels. In order for poor countries to catch up with richer ones it is thus not enough to just boost fixed investment. They have to address the underlying impediments to convergence in TFP levels. This result is consistent with the observations made in the growth accounting literature, which also identified TFP as a key driver of growth. This is true for both developed and developing countries, although there are also important differences in the make-up of growth between these two groups.

An illustration of this is provided by the experience of the EU's New Member States in Central and Eastern Europe (NMS). Over the course of the past two decades, these countries have achieved an impressive convergence in income levels towards the rest of the EU, mostly on account of a convergence in TFP levels. For inefficient economies, which is a fair characterisation of the NMS at the outset of the transition process, large TFP-driven gains can arise from removing product and labour

4 While cross-sectional data have tended to dominate this literature historically, there is also growing use of time series evidence. Panel data analysis has emerged as an alternative to pure cross-sectional analysis, combining time series and cross-sectional data. The different approaches have their respective strengths and weaknesses. A lack of variability across time in many structural variables sometimes makes pure time series analysis of growth unreliable. But cross-country growth regressions have their own weaknesses. Some argue that the fundamental drivers of growth are so different across countries that single-country regressions may be the only reliable way to go. See Brock and Durlauf (2001) and Temple (1999) for further discussion on these issues. While it is important to have these caveats in mind, cross-country growth regressions have nevertheless been used extensively and often productively to sort out the relative importance of different elements as fundamental drivers of long-term economic growth. One advantage of this approach is also that it can assess the impact of a given institution or policy regardless of whether it affects growth through capital deepening or TFP. For policy makers, what matters is that a certain policy or institutional framework has a positive impact on growth. Exactly through what channels it operates is often of secondary importance.



market inefficiencies, from liberalising foreign trade and from macroeconomic stabilisation. High TFP growth in transition economies and other fast-converging middle income countries have thus not stemmed primarily from investing in R&D, but from the adoption of best practice and technologies already developed elsewhere. While improvements in the quantity and quality of tangible fixed capital have played a large role as well, more important has been the massive improvement in the efficiency with which factor inputs are being used.

For advanced economies, there is less scope of achieving high growth through efficiency gains and the adoption of best practice and knowledge from abroad. Advanced countries are more dependent on indigenous R&D and knowledge creation, although they too benefit from cross-border knowledge spillovers. What developing and developed countries all have in common is that the ability to benefit from knowledge spillovers is highly dependent on domestic conditions and institutions. Specifically, empirical evidence shows that countries are on average more receptive to foreign knowledge spillovers if they: are more open to foreign trade (Coe and Helpman 1995); invest in R&D and human capital (Cohen and Levinthal 1989; Griffith *et al.* 2004; Guellec and Van Pottelsberghe 2004; Khan and Luintel 2006) and; have more flexible product markets (Parente and Prescott 2000). This literature also shows that the importance of investing in R&D tends to increase as countries close in on the global technological frontier (Benhabib and Spiegel 1994; Engelbrecht 1997, 2000).

4.2 What should Europe do to close its productivity gap vis-à-vis the US?


Simulations offer an instructive alternative to growth accounting and growth regressions in their ability to demonstrate how changes in different key variables may affect the final outcome. An example of this was provided at the 2009 EIB Conference by **Werner Röger** (European Commission). His papers (written together with Kieran Mc Morrow and available in the 2009 volume of the EIB Papers as Mc Morrow and Röger 2009) draws on empirical estimates for the rate of return on R&D to calibrate their growth model, which is an extension of the QUEST III model employed by the European Commission for quantitative policy analysis.



Opting for a reasonable mid-range approximation consistent with the empirical literature, Mc Morrow and Röger assume a rate of return of 30 percent, which they then plug into their calibrated growth model, which is then used to analyse how the productivity gap between the EU and the US could be closed. In this semi-endogenous model, research output is a function of both current research inputs in the form of high skilled labour and the knowledge capital accumulated in the past. The model accounts for the interaction between several different key variables and accounts specifically for transatlantic differences in several innovation parameters, including fixed entry costs for startups, the share of skilled labour, and the financial market risk premium. The model thus allows the authors to assess the macroeconomic impact of several concrete policy measures, either in isolation or in conjunction with each other.

On the basis of this exercise, Mc Morrow and Röger conclude that stimulating R&D investment directly through subsidies is not nearly enough to close the EU-US productivity gap, due to crowding out effects

 Werner Röger



and decreasing returns in the production of knowledge. A key finding is that additional ‘framework policies’ are needed for Europe to reach its productivity goals. More effective would be to combine R&D subsidies with increases in the supply of scientists and engineers, while substantially lowering entry barriers for start-ups. If all these variables were on par with the US, this would reduce the EU-US productivity gap by around half. Additional measures to further narrow the transatlantic productivity gap would include improvements in the quality of higher education and liberalisation of Europe’s non-manufacturing sectors, such as services and agriculture.

5. The microeconomics of R&D

Most of the literature discussed up to this point has adopted a macroeconomic perspective, shedding light on the growth impact of R&D and the broad policy frameworks needed to foster R&D and innovation. In order to design effective public support mechanisms it is also important, however, to understand the motivations of individual firms to invest in R&D and to innovate. This section zooms in on the microeconomics of innovation and specific policies and institutions that aim to boost business sector investment in R&D.

5.1 Market failure and the case for public support for R&D

Before going into the specifics of these support mechanisms, it is important to recognise that public support of R&D is motivated by the presence of market failure. Specifically, in the absence of public support, there is good reason to expect that the business sector underinvests in R&D from the perspective of what is socially optimal. This perception draws support from both theoretical and empirical research.

The theoretical argument for why there may be collective underinvestment in R&D is linked to the inherent nature of knowledge, which is the main



output of R&D. As we argued in section 3, knowledge can be viewed as a form of productive capital, similar to machinery and equipment. Investing in the creation of new knowledge is thus motivated by its ability to increase future output and income. But knowledge differs from conventional fixed capital in two important respects. The first is that it is non-rival, which means that its use by one firm in no way diminishes the ability of other firms to use the same knowledge simultaneously. Non-rivalness gives rise to positive externalities, yielding additional benefits to society beyond those accruing to the investing firm. Second, knowledge is also often non-excludable. The firm investing in the creation of new knowledge may not be able to prevent others from using it, nor can it be sure to get compensated by the firms that use this knowledge.

To the extent that knowledge is both non-rival and non-excludable, it has the properties of a pure public good. Private firms have no incentive to invest in a pure public good since doing so gives them no advantage over free-riding competitors. Knowledge that has these properties may have to be financed by the government if it is to be created at all. This is indeed the case with a lot of basic scientific research conducted in universities.

Not all knowledge has the properties of a public good, however, and the private business sector does invest substantial amounts in R&D. The reason is that quite a lot of knowledge is at least partially excludable. It may be difficult or costly for other firms to acquire second-hand knowledge, for instance because of secrecy or costly learning. Some knowledge is tacit, which means that it is embedded in the minds of individual researchers or in the organisational structure of the investing firm. But even tacit knowledge can migrate when a researcher moves to a competing firm, and competitors can learn about new innovative products through reverse engineering and trade links. Hence, even though the investing firm may be able to appropriate at least some of the profits from its inventions, some unremunerated knowledge



spillovers are bound to occur. Such knowledge spillovers insert a wedge between the private and social rates of return, as the investing firm does not take into consideration the benefits accruing to others when making its investment decisions. This in turn may cause the level of investment in R&D to be below what would be socially optimal. Romer (1986) provides a theoretical illustration of how this may occur.

As discussed by Mc Morrow and Röger (2009), empirical evidence points in a similar direction. For instance, the rate of return of investing in R&D tends to be higher in country level studies than in firm level studies, which is consistent with the inability of firms to appropriate all the returns from their investments.

The theoretical and empirical case for underinvestment in R&D has spurred many governments to provide public support for R&D through several channels. As discussed in three different presentations at the 2009 EIB Conference, policymakers can for instance use a tax credit to lower the cost of R&D and thus lift the private rate of return towards a level that is optimal from society's point of view. Alternatively, they can encourage R&D cooperation between firms in the same area of research, thus allowing for the internalisation of knowledge spillovers, again bringing the private and social rates of return closer to each other. Alternatively, governments can resort to property rights protection to compensate the investing firms for the use of knowledge by others.

Since knowledge spillovers have a positive impact on the wider economy, it would be counterproductive to prevent them outright. Doing so could for instance trigger several simultaneous research efforts aiming at creating the same knowledge. Given the non-rivalness of knowledge, this would be wasteful. Policies that allow investors to appropriate more of the rents from their investment therefore tend to be socially preferable. These issues are complex, however, and all policy options have advantages and disadvantages. The three papers presented at the 2009 EIB Conference should only be seen as a sample of this debate.

5.2 Public support for inter-firm and science-industry cooperation in R&D



Collusion between competing firms is generally prohibited by competition law when it comes to the products and services they provide to consumers. If it were not, small groups of market leading firms in many industries would soon team up to form a cartel. Yet, in R&D there is a strong case for permitting cooperation between firms, even when they are competitors in their final products. In his contribution to the 2009 EIB Conference (published in the 2009 volume of the EIB Papers), **Dirk Czarnitzki** (Catholic University of Leuven and Centre for European Economic Research, Mannheim) shows how cooperative R&D agreements can help foster more investment in R&D in the presence of knowledge spillovers. Cooperation in R&D allows the investing firms to internalise such spillovers, while also exploiting the economies of scale and scope of R&D. A pooling of risk and fixed costs can also broaden the research horizon of cooperating firms. This is particularly true for research that is closer to basic science, where the rents are typically harder to appropriate. On the basis of data from Belgium and Germany, Czarnitzki finds that private firms collaborating with academia invest more in R&D than firms collaborating with other firms – even in the absence of subsidies – and that subsidies of such science-industry collaborations would boost R&D investment even further. However, Czarnitzki also points to the opportunity cost of these vertical collaborations and the subsidies that are used to foster them. To the extent that government funding is reallocated from basic research to subsidising science-industry collaborations, this could steer academic research in a more applied direction, thus undermining the complementarity between science and industry that made such collaboration valuable in the first place.



 Dirk Czarnitzki



5.3 Public support for R&D by means of a tax credit

The most common policy tool used to compensate for underinvestment in R&D is a public subsidy, typically in the form of a tax credit that allows a company to deduct part of its R&D expenditure from its tax bill. At the 2009 EIB Conference, **Jacques Mairesse** (CREST, ENSAE, Paris; NBER), presented a paper co-authored with Damien Lentile (published in the 2009 EIB Papers as Lentile and Mairesse 2009) reviewing the effectiveness of such R&D tax credits. The paper surveys a number of studies estimating the direct effects of the tax credit on R&D investment. These suggest mixed effects of such policies. While business R&D investment increases in all cases reviewed, one euro of taxpayer money sometimes leads to less than one euro of additional R&D. Specifically, there is notable variability across countries. The survey article also shows that the R&D tax credit increases the likelihood of firms starting own R&D activities and that it is conducive to higher innovation output such as the number of new products or their share in a beneficiary firm's total sales. They point out that the best evaluation of the R&D tax credit would take into account the additional GDP generated by the additional R&D as well as all direct and opportunity costs of the measure.



 Jacques Mairesse

5.4 Intellectual property rights and patent applications

The third type of policy support for R&D is through intellectual property rights. Patents have for a long time been used to strengthen the ability of innovative firms to appropriate the rents from their R&D investments. Since patents aim at the protection of existing scientific discoveries, they can be used as a proxy for the output of R&D.

Drawing on a paper co-written with Jérôme Danguy and Gaetan de Rassenfosse (published in the 2009 EIB Papers as Danguy *et al.* 2009), **Bruno van Pottelsberghe** (Free University of Brussels) presented at the 2009 EIB Conference an investigation of the relationship between R&D expenditures and patent applications at the industry level. This relationship reflects both a productivity channel – i.e. R&D leads to inventions – and a ‘propensity-to-patent’ channel, whereby firms in different countries and industries differ in their eagerness to patent-protect their inventions. Firms seek patent protection either as a means (among others) to appropriate income from their intellectual property (IP) or to make life difficult for competitors (‘strategic propensity’). The study finds that more R&D does lead to more patents, but this relationship is not very strong. This suggests that the propensity to file for patent protection, as expressed by the stringency of IP rights protection and exposure to international markets, matters more than the productivity of R&D as the key determinant of patenting. Countries with strong IP rights rely more on the patent system, as do industries with high international exposure. Yet, a significant part of the dramatic increase in patent filings worldwide remains unaccounted for. The authors disentangle which countries and industries contribute most to this surge. They also demonstrate that the ‘global patent warming’ reflects firms’ growing desire to extend national patents to the world market rather than an increase in national patent filings.



 Bruno van Pottelsberghe



6. Financing innovation

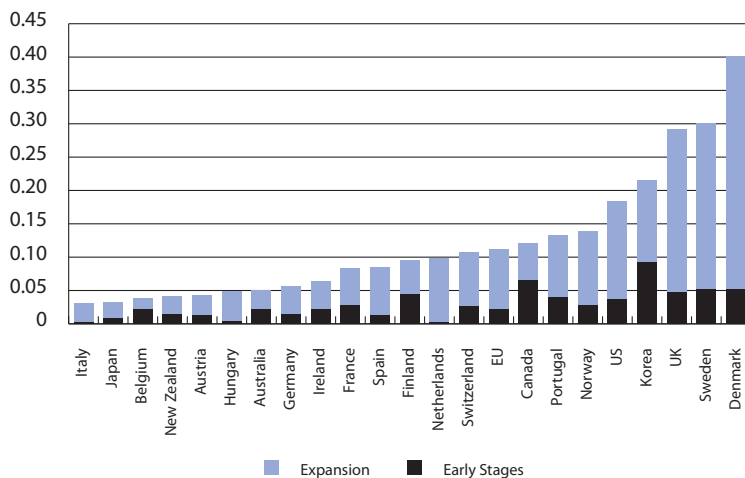
In addition to knowledge spillovers, public intervention to support R&D may also be justified by market failure in finance. At the 2009 EIB Conference, **Bronwyn Hall** (University of California at Berkeley and University of Maastricht) discussed a paper (subsequently published in the 2009 volume of the EIB Papers) reviewing the main theories and empirical evidence regarding the financing of innovation. Key questions addressed are whether new and/or innovative firms are fundamentally different from established firms and whether they therefore require a different form of financing. She points to a large literature suggesting that this is indeed the case. First, intangible assets typically account for a larger portion of total assets in innovative firms. Such assets are less easily used as collateral when seeking external finance. Second, in the case of young innovative firms, these tend to be inherently riskier and have less of a track record. The particularly severe asymmetric information and agency problems that characterise such firms tend to make external finance costlier and more difficult to obtain. By addressing the information and incentive issues directly through better monitoring and risk sharing, equity financing in general – and venture capital in particular – tends to be the preferred form of external financing for such firms.



The market for venture capital (VC) developed later in Europe than in the US. As shown in Figure 8, VC investment in the EU stands at just over 0.1 percent of GDP, which is around two-thirds the US level. There are also substantial differences across EU countries. In the three largest euro area economies the level of VC investment is low. In contrast, in the UK, Sweden and Denmark it exceeds that of the US, relative to the size of their economies. The figure also illustrates how a large portion of VC funding is aimed at the expansion phase of new ventures rather than early stage financing.

 Bronwyn Hall

Figure 8: Venture capital investment, percent of GDP, 2005 or latest



Source: OECD (2007)

At the 2009 EIB Conference, **Laura Bottazzi** (Bologna University) reviewed the role of venture capital in financing new dynamic firms in Europe. On the basis of her own research, Bottazzi finds that venture capital in Europe is not associated with particularly dynamic or successful companies, whether one looks at sales growth or employment. This stands in contrast to US experience, where venture capital has tended to accompany the formation and growth of dynamic companies. A key factor in the effectiveness of venture capital appears to be its own human capital. Human capital affects the level of activism of venture capitalists and thus the value added that they bring to the firms they invest in. This points to the importance of postgraduate education for the level of professionalism in the European venture capital industry. In the last decade, however, Europe has experienced new entrants in the industry, which seem to operate in a manner closer to the US investment style.



 Laura Bottazzi



It is only through commercial application that most technological discoveries can affect the productivity of the wider economy. To the extent that scientific research is conducted in universities and specialised research institutions, successful commercialisation of technological discoveries requires linking scientific research to the wider business sector. This is what is commonly known as technology transfer. In his presentation to the 2009 EIB Conference, **Jacques Darcy** (European Investment Fund, presenting a paper written together with Helmut Krämer-Eis, Dominique Guellec and Olivier Debande) provided a mapping of the specific financial constraints, risks and asymmetric information problems that may impede such technology transfer. The scaling up of scientific research for commercial application requires large amounts of capital typically not available in the research community itself. But similar to venture capital, the financing of technology transfer entails more than just the provision of funds. If technology transfer is to take off in Europe, there is a need to tailor both intellectual property rights and financial instruments in such a way that the incentives, risks and rewards are optimally aligned between universities, inventors, entrepreneurs and investors.



 Jacques Darcy

The commercialisation of new technological discoveries in part suffers from a shortage of financing because intangible capital is more difficult to use as collateral. These problems would be alleviated with the development of a better market for technology. If patented knowledge could be bought and sold in a marketplace, then it would also become more attractive as collateral when seeking external finance. **Dietmar Harhoff** (Institute for Innovation Research, Technology Management and Entrepreneurship, Ludwig-Maximilians University Munich) focused on this issue in his presentation at the 2009 EIB Conference. A key condition



for patents to serve not only as intellectual property protection, but also as collateral, is that they have a residual market value outside the investing firm. European experience in this area has so far been mixed. Some intermediaries have attempted to provide external finance to innovative firms based on their patent portfolios. Patents have been used either as collateral, or as assets in patent funds seeking to commercialize the patent rights. Patent auctions are indicative of a nascent market for patented technology. Supported by changes in valuation techniques and accounting regulation, it seems likely that patent rights will increasingly be used as collateral in debt finance. The development of a liquid market for technology and the use of patents as collateral are complementary, but they depend crucially on an appropriate design of patent systems. Uncertain and questionable patent rights tend to hamper the development of markets for technology and the use of patents as collateral, which in turn drives up the cost of innovation finance.

 Dietmar Harhoff

In his concluding comments to the 2009 EIB Conference, **Plutarchos Sakellaris** (Vice President of the EIB) reminded the audience that a proper understanding of knowledge creation and innovation is paramount to ensure high standards of living in the long run. Large players like the EU need to take the lead in addressing the policy challenges and the EIB Group has a role to play in alleviating financing constraints.

 Plutarchos Sakellaris (Vice President of the EIB)





7. Concluding remarks

The empirical growth literature has confirmed that growth of the knowledge stock accounts for a large portion of growth in output per worker. Treating some of the knowledge stock as intangible capital that is proprietary to the investing firms does not fundamentally change this conclusion, but it makes it easier to account for the relative importance of the different types of tangible and intangible capital in economic growth. These expanded growth accounting efforts have shown that investment in R&D and other intangible capital has over time become increasingly important drivers of growth. This is particularly the case in countries that have made the most complete transition from traditional manufacturing to knowledge-based economic activity.

Given the large role that knowledge plays in economic growth, it is crucial for policymakers to obtain a better understanding of the complex mechanisms that underpin knowledge creation and business innovation. European policymakers have also recognised that sustained growth is increasingly dependent on innovation as the economy has converged towards the global technological frontier. But efforts to boost Europe's R&D have so far met with limited success and a substantial investment gap remains vis-à-vis Japan and the US. This is also mirrored by a persistent transatlantic productivity gap.

Even though the economic literature has acknowledged that R&D subsidies are justified to compensate for knowledge externalities, such incentives are likely of second order importance for the innovative business sector. It is becoming increasingly clear that the pace of innovation and the rate of productivity growth in Europe are unlikely to budge unless policymakers continue to improve the wider economic framework that create the incentives for firms to innovate. These conditions affect not only the propensity of firms to invest in R&D, but also their willingness and ability to apply this new knowledge in the form of product and process innovation. Innovation generates productivity

gains primarily by allowing for a more efficient organisation of the economy, often combined with a reallocation of resources towards new industries with higher growth prospects. Crucial elements in this process are competition and product and labour market flexibility, the exit and entry of firms, and the provision of financial and other means allowing new innovative companies to expand quickly when successful. There is also a strong case for improving European patent laws and policies and for further developing markets for patented technology. This would both encourage firms to invest in intangible capital and make it easier for them to then use these assets as collateral when seeking finance.





References

Benhabib, J. and Spiegel, M.M. (1994). "The role of human capital in economic development. Evidence from aggregate cross-country data". *Journal of Monetary Economics* (34), pp. 143–173.

Bottazzi, L. (2009). "The role of venture capital in alleviating financial constraints of innovative firms". *EIB Papers*, (14:2), pp. 30-53.

Brock, W.A. and Durlauf, S.N. (2001). "Growth empirics and reality". *World Bank Economic Review*, (15:2), pp. 229-272.

Coe, D. and Helpman, E. (1995). "International R&D spillovers". *European Economic Review*, (39), pp. 859–887.

Cohen, W. and Levinthal, D. (1989). "Innovation and learning: The two faces of R&D". *Economic Journal*, (99), pp. 569–596.

Corrado, C.A., Hulten, C.R. and Sichel, D.E. (2005). "Measuring capital and technology: An expanded framework", in Corrado, C.A., Haltiwanger, J. and Sichel, D.E. (eds.), *Measuring capital in the new economy*. NBER Studies in Income and Wealth, (65), University of Chicago Press, Chicago, USA.

Corrado, C.A., Hulten, C.R. and Sichel, D.E. (2009). "Intangible capital and US economic growth". *The Review of Income and Wealth*, (55:3), pp. 661-685.

Czarnitzki, D. (2009). "The virtue of industry-science collaborations". *EIB Papers*, (14:1), pp. 120-143.

Danguy, J., de Rassenfosse, G., and van Pottelsberghe de la Potterie, B. (2009). "The R&D-patent relationship: An industry perspective". *EIB Papers*, (14:1), pp. 170-195.

Darcy, J., Krämer-Eis, H., Guellec, D. and Debande, O. (2009). "Financing technology transfer". *EIB Papers*, (14:2), pp. 54-73.



Edquist, H. (2009). "How much does Sweden invest in intangible assets?" Research Institute of Industrial Economics Working Paper No. 785.

Engelbrecht, H.J. (1997). "International R&D spillovers, human capital and productivity in OECD economies: an empirical investigation". *European Economic Review*, (41), pp. 1479–1488.

Engelbrecht, H.J. (2000). "Human capital and international knowledge spillovers in TFP growth of a sample of developing countries: An exploration of alternative approaches". *Applied Economics*, (34), pp. 831–841.

Fukao, K., Hamagata, S., Miyagawa, T. and Tonogi, K. (2009). "Intangible investment in Japan: Measurement and contribution to economic growth". *The Review of Income and Wealth*, (55:3), pp. 717-736.

Giorgio Marrano, M. and Haskel, J., (2007). "How much does the UK invest in intangible assets?". CEPR Discussion Paper No. 6287.

Griffith, R., Redding, S. and van Reenen, J. (2004). "Mapping the two faces of R&D: productivity growth in a panel of OECD industries". *Review of Economics and Statistics*, (86:4), pp.883-895..

Guellec, D. and van Pottelsberghe de la Potterie, B. (2004). "From R&D to productivity growth: do the institutional settings and the source of funds of R&D matter?". *Oxford Bulletin of Economics and Statistics*, (66:3), pp. 353-378.

Hall, B.H. (2009). "The financing of innovative firms". *EIB Papers*, (14:2), pp. 8-29.

Hall, B.H., Thoma, G. and Torrisi, S. (2007). "The market value of patents and R&D: Evidence from European firms". NBER Working Paper No. 13426.

Harhoff, D. (2009). "The role of patents and licenses in securing external finance for innovation". *EIB Papers*, (14:2), pp. 74-97.



Helmers, C., Schulte, C., and Strauss, H. (2009). "R&D expenditure and capital in Europe". *EIB Papers*, (14:1), pp. 36-61.

Ientile, D. and Mairesse, J. (2009). "A policy to boost R&D: Does the R&D tax credit work?". *EIB Papers*, (14:1), pp. 144-169.

Jalava, J., Aulin-Ahmavaara, P. and Alanen, A. (2007). "Intangible capital in the Finnish business sector 1975-2005". Discussion Papers 1103, The Research Institute of the Finnish Economy.

Khan, M. and Luintel, K.B. (2006). "Sources of knowledge and productivity: how robust is the relationship?". OECD Science, Technology and Industry Working Papers 2006/6, OECD, Paris, France.

Mc Morrow, K., and Röger, W. (2009). "R&D capital and economic growth: The empirical evidence". *EIB Papers*, (14:1), pp. 94-119.

OECD (2007). *Science, Technology and Industry Scoreboard 2007*. OECD, Paris, France.

Parente, S.L. and Prescott, E.C. (2000). *Barriers to Riches*, MIT Press: Cambridge, Massachusetts.

Romer, P. (1986). "Increasing returns and long-run growth". *Journal of Political Economy*, (94:5), pp. 1002-1037.

Solow, R.M. (1956). "A contribution to the theory of economic growth". *Quarterly Journal of Economics*, (70), pp. 65-94.

Solow, R.M. (1957). "Technical change and the aggregate production function". *Review of Economics and Statistics*, (39), pp. 312-320.

Swan, T.W. (1956). "Economic growth and capital accumulation". *Economic Record*, (32:2), p.334-61.



Temple, J. (1999) "The new growth evidence". *Journal of Economic Literature*, (37), pp. 112–156.

Uppenberg, K. (2009) "Innovation and economic growth". *EIB Papers*, (14:1), pp. 10-35.

van Ark, B., Hao, J.X., Corrado, C., and Hulten, C. (2009). "Measuring intangible capital and its contribution to economic growth in Europe". *EIB Papers*, (14:1), pp. 62-93.

van Rooijen-Horsten, M., van den Bergen, D., de Haan, M., Klinkers, A. and Tanriseven, M. (2008). "Intangible capital in the Netherlands: Measurement and contribution to economic growth", Discussion Paper No. 08016, Statistics Netherlands, The Hague.



EIB and the financing of innovation in Europe*

By EIB Vice President Eva Srejber

As the long term financing arm of the European Union, the European Investment Bank is committed to support innovative projects undertaken by the public and private sectors in Europe.

Since the European Council in Lisbon in 2000, the EIB has had a specific lending objective for innovation, or - as it was decided to call it in 2008 - the Knowledge Economy. This covers not only research and development but also investments in information and communication technology (ICT) and support for higher education institutions, all of which are important and interactive ingredients in helping improve European competitiveness.

Our aim is to support all areas of the “Knowledge Triangle”: innovation, research and education. All three components are important in improving the productivity of the EU. Research and innovation drive the knowledge frontier and create applications and enabling infrastructures, while education enhances the skills to innovate. Also, enabling certain types of education, such as full-day schools, where school meals are served also increases labour productivity as parents can spend more time at work.

Between 2000 and 2009, out of total lending to support the Knowledge Economy of 87 billion euro, R&D projects accounted for some 46 bn, more or less evenly split between the business sector and public-sector research facilities, universities, and science and technology parks. Examples include the financing of the Large Hadron Collider at CERN in

* An earlier version of his article first appeared in “Innovation Europe” in October 2009

 Eva Srejber (Vice President of the EIB)

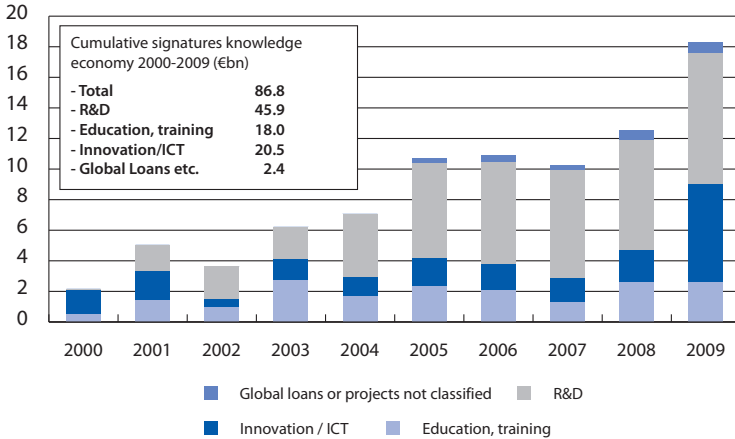
Geneva and the laser synchrotron in Trieste. The Bank follows closely projects identified by the European Strategy Forum on Research Infrastructures, such as the planned European Spallation Source in Lund.

18 bn euros – or one fifth of total signatures over the 10-year period – were allocated to education and training, which mostly meant education infrastructure. In 2008, for example, EIB lent 75 million euro for new biomedical research and training facilities at Trinity College in Dublin.

20 bn euros went to projects in ICT, including advanced telecommunications networks and state of the art ICT production facilities such as semiconductor production plants. Around two-thirds of this was to private sector projects. One of the chief aims of this lending has been to facilitate a modern and interconnected ICT infrastructure so as to expand the environment necessary for developing further the knowledge-based economy in Europe, including for example widespread availability of fixed and mobile broadband networks in order to improve ICT-based productivity.

Demand for EIB loans was notably higher in 2009 as the financial crisis has made it harder for companies to obtain other sources of finance. Responding to these circumstances, the Bank increased its total lending under the knowledge economy objective by 46 percent in 2009 relative to the year before.

EIB lending under the Knowledge Economy objective



The EIB raises finance by issuing bonds on capital markets. Thanks to its owners – the EU’s 27 member states – and its own solid capital base it can raise this money on favourable terms. It aims to pass on this financial benefit to project promoters, its customers, either directly, in the case of larger loans, or indirectly via partner banks and financial intermediaries.

The Bank offers a wide range of financial instruments to accommodate everything from small start-up companies to large investment grade companies and the public sector. One of EIB’s instruments that support the Knowledge Economy is a special window for more risky RDI loans created together with the European Commission, where one billion euro from the 7th Research Framework Program of the EU together with one billion euro from the EIB is the capital cushion for possible losses on these loans. EIB and the Commission are sharing the risk of losses. Using this one billion euro from the EU budget as a buffer together with a one billion euro buffer from EIB will enable loans of several billions over the years for the benefit of RDI .

Since the start of operations in June 2007, cumulative signatures under this risk sharing facility (named RSFF) amount to 4.5 billion euro.



Part of the indirect lending of the EIB is directed at SMEs and Mid-Caps, acknowledging their importance as early adopters of more innovative processes as well as innovators. Total lending under this heading stood at 2.4 bn euro for the 2005-2009 period.

In early start-up operations in the field of Innovation, the high risk profile of the companies may demand an equity-type of financing rather than a loan. The EIB can accommodate this through the European Investment Fund (EIF), whose shareholders are the EIB (with 62% of the capital), the European Commission (29%) and several European banks (9%). The EIF operates in support of SMEs, not through direct investments, but through equity investments in venture capital and growth funds that support in particular early-stage and technology-oriented SMEs.

For venture capital investments, EIF uses its own resources, as well as resources from the European Investment Bank, from the European Commission's Competitiveness and Innovation Programme (CIP), from Member States and regions through the Joint European Resources for Micro to Medium Enterprises (JEREMIE) initiative and other third parties.

EIF's total net equity investment commitments amounted to EUR 3.9bn by the end of 2009, invested in over 300 funds. EIF's portfolio still remains largely focused on the early stage sector with over 45% of its portfolio in seed and start-up funds, although growth and mezzanine funds are being included to balance the portfolio by offsetting the higher risks inherent in early stage investing. Within the early stage technology portfolio, information and communications technologies and life sciences figure strongly.

The EIB's support to the Knowledge Economy covers all areas in the Knowledge Triangle; Innovation, Research and Education. Developments in these areas lead to subsequent productivity gains and market-related competitiveness, growth and jobs.



The EU has made progress in certain areas of the Knowledge Economy in the last years - the EU is world-leading in terms of clusters (automotive and telecommunications) – and the EIB aims to help the EU reinforce its leadership in this area. The Bank recognises that R&D and innovation are conducted in very different types of organisations and has adapted its financial instruments accordingly. Our aim is to offer continued support and attractive financing solutions for all parts of the Knowledge Economy enabling the narrowing of the current R&D gap that Europe has vis-à-vis the United States and Japan.

About the author:

Eva Srejber is EIB vice president responsible for knowledge economy lending.

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Economic and Financial Studies
98-100, boulevard Konrad Adenauer
L-2950 Luxembourg

 infoefs@eib.org

 (+352) 43 79-82154

 (+352) 43 79-68895

www.eib.org/efs

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