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2nd European Conference on corporate R&D

An engine for growth, a challenge for European policy

Academic Forum – Summary Report

edited by

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TABLE OF CONTENTS

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[1] ETEPS is the European Techno-Economic Policy Support network, and the workshop was held in the context of the Industrial Research Monitoring and Analysis (IRMA) project, a joint initiative of the European Commission's JRC and DG RTD.

Preface

The European Commission collects and analyses policy relevant information on corporate R&D in the context of the '**Industrial Research Monitoring and Analysis**' [IRMA] project, a joint initiative of the Joint Research Centre's Institute for Prospective Technological Studies [JRC – IPTS] and DG Research. The *EU Industrial R&D Investment Scoreboard*, the *EU Survey on Business Trends in R&D*, as well as the *Conferences on Corporate R&D* [CONCORD] represent some of the main activities in this regard. Please consult http://iri.jrc.ec.europa.eu/ for more information.

The 2nd European Conference on Corporate R&D – "CONCORD 2010 – An engine for growth, a challenge for European policy" was organised jointly by the JRC's Institute for Prospective Technological Studies (IPTS) and the Spanish Centre for Development of Industrial Technology (CDTI) under the auspices of the Spanish Presidency of the EU Council..

The Conference was held over two days; with the first day constituting a forum for a more technical and academic discourse and the second devoted to the policy dimension of corporate R&D, based on the most policy relevant outcomes of the first day. This report, provides a compilation of the individual reports of the Conference' rapporteurs (members of the Scientific Committee of the Conference) and highlights the most important ideas resulting from the papers presented and the discussions held during the academic forum.

The Conference has had a substantial scientific and policy impact. The Editorial Board of the scientific journal *Industrial and Corporate Change* has accepted to publish a selection of papers presented in a Special issue entitled 'Globalization of Corporate R&D and Innovation', which is foreseen to be released in 2012. Moreover, the evidence and the main messages from the CONCORD Conference were presented to the Competitiveness Council and were reflected in the conclusions of their meeting of 26 May 2010 on "Creating an innovative Europe"[2].

Xabier Goenaga

HoU, Knowledge for Growth Unit, JRC.IPTS

[2] In this regard, the Council recalled "…the 3-4 March 2010 conference in Seville [CONCORD] with the aim to review the performance of corporate R&D in Europe and its policy conclusions oriented to an integrated approach of R&D&I policies by removing barriers to the restructuring of EU industry towards sectors with growth potential and to the growth of young innovative firms into tomorrow's global players;…"

Key Messages

The most relevant messages emerging from the papers presented at the Academic Forum of the CONCORD 2010 Conference are as follows:

R&D and its impact on company performance

Corporate R&D is important for firm performance as it increases productivity, particularly in high R&D intensive firms, and reduces inefficiencies in the production process. This can have a positive effect on market capitalisation, as evidence suggests.[3]

There has long been consensus in the literature that corporate R&D activity has a positive impact on most aspects of business performance and economic development. However, the magnitude of these effects varies for different types of impact (e.g. a positive relationship between R&D activity and productivity measures is generally more direct and pronounced than that between R&D and employment levels) and across different types of R&D actors (e.g. impacts on various measures of business performance are often very different for small and large firms in different industrial sectors).

Looking across the contributions to CONCORD, there is little to contradict this consensus and much to substantiate and clarify our understanding of some of the variations in these impacts. Of particular importance is the finding that the leverage of R&D investment with regard to productivity is greater for high R&D-intensive firms than for medium- and low-R&D-intensive firms. On the other hand, productivity growth in low-R&D intensive firms is driven by technological change embodied in the physical capital stock. Moreover, corporate R&D activities were found to positively affect companies' level of technical efficiency (in other words: performing R&D helps to reduce existing inefficiencies in the production process, i.e. waste); and this finding is consistent across all industries providing a general foothold for R&D policy. In addition, evidence suggests that a firm's R&D intensity can also have a positive impact on its market capitalisation performance. Finally, knowledge spillovers may help firms to improve business performance, although significant differences across sectors were found.

[3] The particular impact corporate R&D has with regard to employment still needs to be further studied.

Collaboration in corporate R&D

Evidence suggests that firms participating in collaborative R&D programmes, such as the EU R&D Framework Programme, improve their overall technological capabilities and their business performance. The formation of local clusters – and their evolution – has an important role in optimising collaboration of firms in R&D activities.

Business performance is affected by the 'how' & 'where' R&D is conducted. Moreover, collaboration in corporate R&D was shown to have a positive impact which, however, depends on the profile and the role of the partners. In this regard, excellence and involvement of demand-side partners are crucial. The formation of local clusters helps to optimise collaboration and to adapt it over time[4].

In general, support to collaboration in terms of corporate R&D has positive effects on firms' productivity and thus on competitiveness. In fact, firms participating in collaborative R&D programmes (such as the EU's Framework Programmes - FP) generally have access to the complementary knowledge assets of their public and private research partners, with consequent improvements in terms of overall technological capabilities. In this regard, an empirical analysis presented at the Conference demonstrated that those firms participating in a FP consortium deploy, on average, 40% more intangible assets per employee, which leads to an increase in labour productivity of up to 12%. Hence, participation in the FP has an indirect positive effect via intangibles, or in other words, cooperation within the FP leverages firms' capabilities and (technological) capacity.

Furthermore, evidence presented at CONCORD also indicates that there are positive related impacts on some aspects of downstream performance, such as improved productivity and market penetration. For instance, the R&D collaborations with firms located in countries close to world knowledge sources are apparently most beneficial to new technology-based firms (NTBF). Also, increasing the international profile of the consortia contributes positively to NTBFs' productivity. In sum, the findings indicate that engagement in international R&D alliances boosts performance but the extent of this positive effect crucially depends on the type and home country of the alliance partners.

[4] The importance of optimising collaboration and how this evolves over time has been demonstrated in a study of the technology super-cluster in Massachusetts (US), presented at CONCORD 2010. This cluster apparently was able to adapt to the crisis by seeking alternative funding, additional training, expanding innovation centres, and new government programs and is therefore an interesting example also for the EU.

Internationalisation of corporate R&D

Foreign R&D is complementary to, and not a substitute for, domestic R&D. In fact, firms that internationalise their R&D activities tend to receive higher returns[5], which are due to accessing complementary expertise abroad and by that means improving firms' innovative performance with a positive impact on productivity. However, evidence suggests that EU firms prefer "home" or "close to home" locations for carrying out R&D activities and that they outsource these activities worldwide on a smaller scale.

Evidence presented at the Conference demonstrated the importance of collaboration for the internationalisation of corporate R&D activities. And location matters in this regard. For instance, the internationalisation of R&D activities – involving the setting up of research facilities abroad – not only helps firms to access complementary expertise (often at cheaper rates), but also allows firms to be closer to markets where the fruits of their R&D can be exploited (possibly by foreign-based subsidiaries). In this regard, evidence from papers presented at CONCORD suggests that returns are higher in multinational than in wholly domestic firms, and (to a lesser degree) higher in services than in manufacturing. Furthermore, engaging in foreign R&D activities that are primarily driven by knowledge-oriented reasons appears to be positively correlated with innovation performance, while foreign R&D activities driven by market- or resource-oriented reasons correlate positively with productivity.

It is worth mentioning that evidence indicates that a large number of EU's multi-national companies consider their home countries to be the best location for R&D (especially for ' R') and most of them consider the US and India as the most attractive R&D locations abroad.

Financing corporate R&D

Financial constraints limit the ability of firms to invest sufficiently in R&D, particularly in SMEs. Deploying Venture Capital was shown to be a possible way out, and moreover, to have a positive effect on firms' innovative performance.

Knowing that R&D can have a positive impact on business and economic performance is not enough when it comes to designing policies seeking to maximise these impacts. A better understanding of the factors constraining and catalysing investment in R&D is also needed. The papers presented at CONCORD contributed to broadening the knowledge in this regard. Of particular importance are the financial constraints that limit the ability of firms to invest sufficiently in R&D. Empirical evidence presented during the Conference suggests that smaller firms in medium-tech sectors in the EU face es-

[5] This holds in particular for multinational companies and for firms in the services sectors.

pecially severe liquidity constraints compared to their US counterparts. On a more positive note, however, firms engaged in innovation-related activities (design, training, use of novel manufacturing systems etc.) have a higher propensity to initiate or increase R&D activities, and firms taking advantage of public support policies – larger firms in particular – tend to perform R&D that is additional to the work they would have done otherwise.

Policy supporting corporate R&D

Evidence suggests that there is a deficit in the dynamics of European enterprises and in this respect policy efforts should focus on favouring structural changes towards more research intensive activities and the growth of high innovative SMEs. Recommendations arising from the Conference papers highlight the need of tailoring policy measures according to the typology of companies, sectors and countries.

Policies aiming at improving corporate R&D performance should concentrate on the perceived **deficit in enterprise dynamics** by focusing on the removal of barriers to:

- The shift of the EU industry structure towards higher growth / knowledge-intensive sectors;
- The capacity to create and absorb new knowledge in sectors with lower-R&D intensity and less innovation activity;
- The growth of young innovative / smaller firms into tomorrow's large global players.

Policy measures should favour the creation and growth of new firms and new sectors (thus avoiding possible "deadweight effects")[6] and stimulate corporate R&D and innovation activities. In this respect, evidence presented at CONCORD showed that these measures can be proven to be more effective if expressly conceived according to the typology of companies, sectors and countries. Investigations on (especially "general-purpose") subsidy programmes confirm that they may work to incite additional R&D investments and R&D performance, but there are clear signals indicating that they result in a high dispersion of effects across firms (in particular with regards to SMEs). While evidence shows that tax instruments – rather than subsidies – should be favoured when there is low scope for public support, it is important that tax incentive schemes are selective rather than applied across the board.

However, this will require an **integrated approach to the development of policies** that calls not simply for R&D and innovation policies to be developed hand-in-hand, but for an even more radical approach that places innovation at the heart of integrated sets of supply and demand-side polices that tackle industrial restructuring, market development and regulatory frameworks. Policies geared to-

[6] Namely the risk to support new ventures which would have been started and would have grown even without receiving a subsidy.

wards strengthening the research base and educating the next generation of scientists, engineers, researchers and entrepreneurs should also be included in this agenda. This level of integration across policy spheres and instruments will in any case require a focus on specific sectors or themes. Of particular interest are those areas where research, innovation and improved industrial dynamics can lead not only to improved economic performance, but also where they can help deal with some of the major societal challenges (such as climate change, energy efficiency, aging society etc) with which we are currently confronted. Win-win situations such as this should thus be the natural focus for future policy making.

CONCORD: The Background

Research & Development (R&D) and innovation have been increasingly evoked as essential elements to foster competitiveness, economic growth, and employment during times of economic prosperity as well as in recessions.

In particular, corporate R&D has been broadly recognised as fundamental for stimulating economic growth and its contribution to firms' competitiveness. However, while the strategic role of corporate R&D is often taken for granted, there is a need to better understand the drivers of R&D investment, the dynamics of knowledge intensive sectors and the R&D impact on company performance. In fact, investments in R&D by EU companies have been increasing steadily and they are equivalent to the investments of similar companies operating in the same sectors in the rest of the world. Yet, R&D Investment by private companies in Europe stagnated in the last decade and an increasing share of the R&D investments of EU companies is located outside the EU. And, with the continuing comparative growth of the Asian economies, even more research will be carried out outside the European Union. Therefore, Europe needs to consolidate the development of the knowledge-based society, fostering the European Research Area and launching a renewed effort on innovation. These elements are also at the heart of the EU 2020 Strategy to put Europe on the path of recovery and sustainable growth.

There are around 25 million companies in Europe and for many of them corporate R&D, and thus innovation, means a continuous process of evolution. However, the bulk of European private R&D is carried out by a limited number of companies and there are also a number of technology leaders for whom research is the key of their entrepreneurial success. Through their R&D investments and innovation performance they not only improve their own productivity but also contribute to a strengthening of Europe's economy.

Following the first Conference on corporate R&D [CONCORD-2007] on *Knowledge for Growth: Role and Dynamics of Corporate R&D*, the European Commission together with the Spanish authorities decided to organise jointly a second Conference, held in March 2010, on *Corporate R&D – An engine for growth, a challenge for European policy*.

This Conference aimed at identifying policies that help to increase the positive impact of R&D on business performance and on employment. Further focus was given to the various factors that affect these relationships, including the collaboration of individual R&D actors with other private and public sector actors, the relevance of the increasing internationalisation of R&D activities, and even the influence of R&D support policies.

The main objectives of the CONCORD 2010 Conference were the following:

- To provide a platform for discussing corporate R&D (from analytical / research perspective) and a way to stimulate spending on R&D by policy initiatives
- To bring the community of researchers, policy analysts, policy makers and industry representatives together to share their specific knowledge on the subject and translate the individual insights into sound support to policy making
- To provide relevant input and sound support to the European policy making and to outline blank spots for further investigation.

The conference took place over two days; with the first being a forum for academic discourse and the practitioners' view and the second being devoted to the policy dimension of corporate R&D. Thus, the most policy relevant outcomes of the first day were the subject of the discussion in the course of the second day, by high level policy makers and CEOs from leading companies.

As a deliverable of the Industrial Research and Monitoring Analysis (IRMA) activities performed by JRC-IPTS in close cooperation with DGRTD, this summary report focuses on the Academic Forum of the CONCORD 2010 (March 3rd 2010) only. The main findings and messages of the Academic Forum of the CONCORD 2010 Conference will be synthesised in the following chapter being structured along a number of policy areas considered to be key for the economic trajectories of European businesses as well as for EU policy-making, namely profitability, productivity and market capitalisation, spillovers, competitiveness and growth, and employment.[7]

The evidence resulting form the contributed papers is referenced in detail in the annex, thus following major headings corresponding to the five thematic strands of the Conference:

- R&D and its impact on company performance
- Collaborating in corporate R&D: Empirical evidence, trajectories, and impact on innovativeness
- R&D and internationalisation: Does location matter?
- Financing corporate R&D
- Policies supporting corporate R&D

After the list of bibliographic references, further annexes list the scientific papers and posters presented at the Conference as well as name the organisers of the event.

[7] The synopsis is mainly based on unpublished internal document of European Commission, JRC-IPTS titled 'Corporate R&D: An engine for growth; a challenge for policy - Reflections on the contributions to the CONCORD-2010 conference', authored by Ken Guy, Pietro Moncada-Paternò-Castello, and Xabier Goenaga (2010).

Summary on the Academic Forum

Modern economies, especially knowledge-based economies, are powered by **innovation** and, in particular, the innovation-related activities of industrial enterprises. Policies designed to support such activities are thus an increasingly important component of public policy portfolios at regional, national, and international levels. Typically they comprise a rich mix of instruments designed both to create a favourable environment within which innovation can flourish and to provide customised support to the different types of organisation involved in innovative activities. These can include the setting of standards and regulations that encourage innovation, the development of appropriate skill sets amongst the labour force, instruments that improve access to the capital needed to set up innovative companies, mechanisms that favour the widespread diffusion and absorption of innovative technologies and practices, and even the establishment of public-private partnerships to stimulate innovation in specific spheres.

This rich array of policy instruments reflects the fact that innovation takes many forms and that many factors affect innovative behaviour. New ways of organising production capabilities and the use of novel business models in emerging market sectors, for example, both constitute radically different ways of innovating. Perhaps the most common form of innovation, however, involves the introduction of new products, processes and services that, in turn, owe much to prior investments in **research and development (R&D)** by both the public sector and, in particular, by the **private sector**. It is not surprising, therefore, that considerable attention has been paid in policy circles to the most effective ways of supporting R&D – in both the public and private sectors – and to ways of strengthening the links between R&D, innovation and, ultimately, economic performance and social prosperity.

The **CONCORD 2010**[8] Conference on *'Corporate R&D: An engine for growth, a challenge for European policy'*, provided a forum for technical and academic discussions focused specifically on the role of corporate R&D in this sphere, particularly on the most recent evidence concerning the impact of corporate R&D on various aspects of business performance and the subsequent implications for broader economic development. This was complemented by a further focus on the various factors that affect the relationships between corporate R&D and downstream impacts, including the collaboration of individual R&D actors with other private and public sector actors, the relevance of the increasing internationalisation of R&D activities, and even the influence of R&D support policies.

[8] The Conference was held under the auspices of the Spanish Presidency of the European Council in Seville, Spain, on 3-4 March 2010, being organised jointly by the Institute for Prospective Technological Studies (IPTS), one of the institutes of the European Commission's Joint Research Centre (JRC), and the Spanish Ministry of Science and Innovation's Centre for Industrial Technology, in close collaboration with the European Commission's Directorate General for Research and Directorate General for Enterprise and Industry.

Critically, the spotlight also fell on the implications that all these activities and relationships have for the formulation and introduction of new support policies designed to strengthen the impact of corporate R&D on business performance and economic development generally, expected to be a critical component of the EU's 2020 Strategy when it is announced in 2010.[9]

In turn, **the aim of this chapter is to summarise some of the main points that emerged from the papers presented in the course of the conference**, reflecting in particular on what they add to the corpus of knowledge on the relationship between corporate R&D, business performance and economic impacts, and on their **implications for future policy**. The subsequent sections thus focus on:

A. The evidence available on the impact of R&D on various aspects of the business performance of individual firms and subsequent impacts on economic development;

B. The influence that collaboration and internationalisation have on the relationship between corporate R&D and downstream impacts;

C. The factors that influence corporate investment in R&D;

D. The main implications for future policy, especially those of the EU's 2020 Strategy.

A) THE IMPACT OF CORPORATE R&D ON BUSINESS PERFORMANCE AND ECONOMIC DEVELOPMENT

Ever since the importance of R&D and innovation for business performance and economic development was suspected, there have been considerable efforts to establish the nature and scale of the links between them. These have involved micro- and macro-level studies of the relationships between measures of corporate R&D activity (e.g. R&D investment and intensity levels in different manufacturing and service sectors) and between various types and measures of both the business performance of individual firms and the overall economic performance of industrial sectors, regions and countries (patenting activity, innovation capabilities, productivity, profitability, market capitalisation, competitiveness, employment etc.).

The broad consensus in the relevant literature has long been that corporate R&D activity has a positive impact on many or most aspects of business performance and economic development. Solow (1957), for example, first pointed out that technical change is a major source of long-term productivity growth, while later authors (e.g. Romer, 1990; Guellec and van Pottelsberghe, 2001) indicated the strong link between R&D, technical change, the knowledge capabilities of firms and downstream impacts on the growth, productivity and competitiveness of economies. Subsequently, the growing body of evidence demonstrating close links between R&D levels and micro-and macro-economic perform-

[9] The **EU's 2020 strategy** is designed to lead the way towards a smarter, greener economy where knowledge is a key input and prosperity results from innovation and the better use of resources. To effect this transformation, the Commission launched a public consultation in late 2009 and is due to present a formal proposal for an EU 2020 strategy, with a view to the EU's Heads of State adopting the strategy at their spring 2010 meeting.

ance (Mitchel, 1999; Griffith, Redding and Van Reenen, 2004; Bilbao-Osorio and Rodriguez-Pose, 2004; Kafouros, 2008) has been used to justify policies aimed at increasing corporate R&D expenditure, while the work of other authors (Jones and Williams, 1998; Pessoa, 2007; Soete, 2007) has strengthened the case not only for increases in R&D expenditure, but also for policies aimed at increasing the returns to R&D investment by removing barriers to innovation and the subsequent realisation of economic and social returns.

Although the evidence linking R&D investment with downstream impacts is convincing, the nature and scale of these impacts and the strength of the relationships between R&D activities and different types of impact can vary significantly. Impacts on various aspects of business performance, for example, are often very different for small and large firms both within and across industrial sectors, and some causal relationships between R&D inputs and output performance measures are more tenuous than others. Positive relationships between R&D activity and productivity measures, for instance, are generally more direct and pronounced than those between R&D and employment levels. Some of the evidence concerning these variations is therefore reviewed below.

Profitability, Productivity and Market Capitalisation

Many factors other than R&D can affect business performance, but the impact of R&D on measures such as profitability, productivity, share value, sales and employment can still be detected. There is some evidence, for example, that investment in R&D has a positive impact on profitability (Bosworth and Rogers, 1998; Hall *et al.,* 2007), and even that the impact of investment in R&D on firm profitability can be as high or higher than the profitability increases associated with investment in physical capital (Hall and Mairesse, 2009). But perhaps the largest body of evidence concerns the strength of the relationship between R&D and productivity, for here there is an impressive empirical literature demonstrating the positive impact of R&D on productivity growth (Hall and Mairesse, 1995; Griliches, 1998; Klette and Kortum, 2004; Janz *et al.,* 2004; Rogers, 2006).

Looking across the contributions to the CONCORD 2010 conference, there is little to contradict and much to substantiate the broad consensus that **corporate R&D activity has a positive impact on business performance**, and much that clarifies our understanding of some of the variations in these impacts. **Of particular importance is the finding that the impacts of R&D investment on productivity are greater in high-tech sectors than they are in medium- and low-tech sectors** (Kumbhakar *et al.,* 2010).[10] In contrast, the same authors suggest that investment in physical capital has greater positive impacts in low-tech sectors than it does in high- (and medium-) tech sectors, but that there is no overt relationship between investment in physical capital and productivity across all sec-

[10] Industrial sectors are designated high-tech, medium-tech and low-tech on the basis of the average R&D intensity of the sectors. Each sector, therefore, can contain a mix of high-tech, medium-tech and low-tech firms (again defined in

tors. The routes to productivity increases, therefore, appear to be different for high-, medium- and low-tech sectors, though the paper also demonstrates that **R&D intensity is related positively to efficiency gains for low-, medium- and high-tech sectors**.

Another paper presented by Moreno and Huergo (2010) also focuses on the relationship between R&D, innovation and productivity. It suggests that starting positions are important, or that 'history matters', with impacts taking longer to materialise for firms starting from a low R&D intensity base. Interestingly, the paper also opens the door to further lines of enquiry by suggesting that R&D-related productivity increases are more difficult to achieve for large firms compared to small firms, and that process innovations are more positively related to productivity increases than product innovations – a finding that the authors claim is counter to those of other studies reported in the literature.

Empirical findings from econometric analyses conducted by the authors of yet another CONCORD 2010 paper suggest that a firm's R&D intensity can also have a positive impact on its market capitalisation performance (Cincera *et al.,* 2010). Top R&D-investing companies tend to outperform other companies in the stock markets, as measured by the evolution of their market capitalisation values, though the strength of this relationship varies across sectors and countries and does not hold everywhere. For example, companies in the pharmaceuticals, biotechnology, and software and computer services sectors in the UK, and firms in the chemicals sector in Germany, generally perform better than the stock market indices for their sectors. On the other hand, the top R&D-investing companies in the technology hardware and equipment sector in France underperform in comparison with their sectoral index.

Spillovers

Ideally, individual firms would like to appropriate all the benefits accruing from their own R&D investments, but invariably there are some 'leakages', 'spillovers' or 'externalities' where the resultant knowledge benefits other social actors. There are thus both private and social returns to R&D investment, with some empirical evidence suggesting that the social returns to research are more than double the private returns (Jaffe, 1988; Griliches, 1992; Cincera and van Pottelsberghe, 2001).

Spillovers of this nature can be localised or more widespread in either spatial or sectoral terms. In other words, firms in the same region and sector can benefit from the R&D investments of other companies, but so too can firms in other regions and sectors if the spillovers are not overly constrained in any way. Many studies have thus explored the nature of the spillovers produced by firms in different regions and sectors and their impact on the broader environments in which these firms operate. Malerba *et al.* (2007), for example, found that patenting activity in the electronics industry is highly re-

terms of their individual R&D intensities), with the proportions in each sector obviously varying significantly.

sponsive to inter-sectoral spillovers, whereas the patenting in the chemicals industry is highly responsive to intra-sectoral, international spillovers.

Critically, many authors have noted that **spillovers from R&D-intensive high-tech firms are often 'localised' in the sense that the spillovers are most frequently appropriated by firms in the same region** (e.g. Jaffe, 1989; Jaffe *et al.*, 1993). In turn, this leads to the phenomenon of 'clustering', i.e. the co-location of many R&D and innovation actors, with members of clusters benefiting from the spillovers produced by other members, creating localised hot-spots in terms of social benefits. As noted by Audretsch and Feldman (1996): "**Industries in which knowledge spillovers are more prevalent – that is where industry R&D, university research and skilled labour are the most important – have a greater propensity for innovative activity to cluster than industries where knowledge and externalities are less important**". Furthermore, as noted in some CONCORD 2010 papers, R&D spillover stocks have an important and positive impact on innovative behaviour (López-Garcia and Montero, 2010) and the productivity growth of firms (Aldieri and Cincera, 2010).

Interestingly, however, the latter paper also explores the relative impacts of 'spatial' and 'technological' spillover stocks on economic performance. Localised spatial spillovers are those enjoyed by firms in the same geographic region. Localised technological spillovers are those enjoyed by firms in the same sectors, whether defined by industry or by degree of technological sophistication (e.g. degree of R&D intensity). Earlier work by Jaffe (1986;1988) had suggested that the productivity-related impacts of R&D spillovers are largely technologically localised, but few studies had looked at the comparative impacts of spatial and technological spillovers. In their paper, however, Aldieri and Cincera (2010) point out that **while both types of spillover have positive impacts on productivity performance, the impacts of technological externalities are generally greater than those associated with spatial spillovers, though both are complementary**. **The benefits of co-location for R&D and innovation actors in the same and related R&D-intensive, high-tech sectors are thus clear**.

Competitiveness and Growth

The strength of the evidence linking R&D investment with technological performance and macroeconomic indicators describing the competitiveness of countries and growth in Gross Domestic Product (GDP) (see, for example, Europe Innova, 2009) has led to the incorporation of strong assumptions concerning the private and social rates of return to R&D into many macroeconomic models. In turn, many of these models have been used to estimate the impact of various levels of R&D intensity on long-term growth in GDP.[11] The study by Chevalier *et al*. (2006) using a micro-econometric model (Nemesis), for example, estimated that achieving and maintaining the Barcelona R&D intensity target

[11] The models and studies discussed here all consider the implications of raising overall R&D intensity levels to 3% of GDP. They do not discuss separately the implications of raising corporate sector R&D to 2% of GDP, the target pro-

of 3% of GDP by 2010 would lead to a 7.9% growth in GDP by 2030. Similarly, Gelauf and Lejour (2006) used the WORLDSCAN general equilibrium model[12] to predict growth in a range from 3.5% to 11.6%, depending on the assumptions concerning the scale of social returns to R&D investment, and another recent study (Bayar *et al.,* 2008) predicts a 10% increase in the GDP of the EU by 2020.

Building on this work, one of the CONCORD 2010 papers describes the study's use of three macro-economic models to assess the possible impacts of increasing R&D investment in the EU to 3% of GDP (Gardiner and Bayar, 2010). In line with other work, **the model simulations show significant and positive impacts on GDP growth in all EU Member States over a 25 year time period**. The simulations also predicted major variations across countries, however, with impacts on GDP growth much higher in the new Member States, largely because of their lower R&D base levels. The impact on real GDP in countries such as Cyprus, Estonia, Latvia, Lithuania, Malta, Poland and Slovakia, for example, was greater than 30%.

Employment

In theory, investment in R&D can have both positive and negative impacts on employment. Improved innovative performance and enhanced productivity can lead to a lowering of employment levels, while improvements in competitiveness and increased output can counter these effects in the longer term and result in job creation. Variations in the relationship between R&D investment and employment levels over time and across different settings are thus not unexpected. Positive impacts on employment have been found, for example, in Norway (Blechinger *et al.,* 1998); in seven EU Member States plus Norway (Klette and Forre, 1998; Bogliacino and Pianta, 2010); in four European countries (Harrison *et al.,* 2008); and in Italy (Evangelista and Savona, 2002). In contrast, clear relationships were not established in Denmark by Brouwer *et al* (1993).

Amongst the CONCORD 2010 papers, Falk (2010) investigated the relationship between corporate R&D intensity and firm growth in Austria between 1995 and 2006, a period when R&D intensity grew rapidly in the country. **Positive and significant relationships were established between corporate R&D intensity and both employment and sales growth in the two years subsequent to the R&D investment**, though Falk also found that the strength of these relationships was greater during the first part of Austria's R&D intensity growth phase (pre-2000) than it was subsequently (post-2000).

Turning now to modelling exercises, **the results of many model simulations suggest that increases in R&D spending frequently lead to higher employment levels in the long-term**. Gardiner and Bayar (2010), for example, report the results of simulations with three models (QUEST,

posed for 2010 at Barcelona in 2002.

[12] Developed by the Netherlands Bureau for Economic and Policy Analysis.

GreenMOD and E3ME).[13] One model (E3ME) indicated that a 10% increase in R&D spending would lead to a 0.8% increase in employment in the EU15 countries over a 25 year period, with a 0.3% increase in the EU 10 countries. In the QUEST simulation, employment increases were predicted for the EU overall, though predicted increase in some of the new Member States were small and even negative in some instances. In the GreenMod simulation, however, there were significant positive effects on the labour market in all the new Member States.[14]

B) COLLABORATION AND INTERNATIONALISATION

How and where R&D is performed also affects business performance. It has long been known, for example, that firms participating in collaborative R&D programmes (e.g. the EU's Framework Programmes) generally allow firms to access the complementary knowledge assets of their public and private research partners, with consequent improvements in terms of overall technological capabilities (Guy and Georghiou *et al.,* 1991). Evidence presented at the CONCORD 2010 Conference, however, indicates that **there are also positive associated impacts on aspects of downstream performance such as improved productivity** (Barajas *et al.*, 2010) **and market penetration** (Piva *et al.*, 2010)**, especially for New Technology-Based Firms** (NTBFs).

Collaborating with external partners thus has many attractions, and other evidence presented at the Conference additionally demonstrates the importance of location. For example, the internationalisation of R&D activities – involving the setting up of research facilities abroad – also helps firms to access complementary expertise (often at cheaper rates) and further allows firms to be closer to markets where the fruits of their R&D can be exploited by foreign-based subsidiaries. While the drivers for increased investment in R&D are market-pull and the potential to grasp technological opportunities, Cincera *et al* (2010) demonstrate that **the main drivers for locating R&D activities abroad are the availability of researchers and access to specialised knowledge**. Despite the attractions of internationalisation, however, and in line with the earlier findings of Patel and Pavitt (1991), the same authors also report that half of EU multinational companies (MNCs) still consider their home countries to be the best locations for R&D (with the other half considering Germany, the US and India to be attractive locations), while Kampik (2010) provides evidence which suggests that firm-specific characteristics of German MNEs have a greater impact on innovative behaviour than country-specific characteristics.

C) FACTORS AFFECTING R&D INVESTMENT

[13] QUEST is a model developed by the Econometric Modelling Unit of DG ECFIN; GreenMod is a model developed by the Université Libre de Bruxelles and the EcoMod Network; E3ME is a model developed by an international team including Cambridge Econometrics.

[14] The differences in the labour market outcomes stem from the differences in the modelling of the labour market in

Knowing that R&D can have a positive impact on business and economic performance is not enough when it comes to designing policies likely to maximise these impacts. A greater understanding of the factors constraining and catalysing investment in R&D is also needed. Again, the papers presented at the CONCORD 2010 Conference shed light on these issues. **Of particular importance are financial constraints limiting the ability of firms to invest sufficiently in R&D** (Mancusi and Vezulli, 2010). In particular, smaller firms in medium-tech sectors in the EU face especially severe liquidity constraints compared to their US counterparts (see Cincera and Ravet, 2010). This result runs counter to the findings of some earlier studies,[15] but it is based on a more up-to-date data set and may reflect a more recent phenomenon.

On a more positive note, however, firms engaged in innovation-related activities (design, training, forecasting, the use of novel manufacturing systems etc.) have a higher propensity to initiate or increase R&D activities (Santamaria Sánchez, forthcoming)[16], and firms taking advantage of public support policies – larger firms in particular – tend to perform R&D that is additional to the work they would have done otherwise (Cerulli *et al.,* 2010). **Public policy efforts to promote both R&D and innovation activities in the corporate sector thus appear attractive ways of helping to increase R&D investment levels**.

D) POLICY IMPLICATIONS

Many factors affect business and economic performance other than R&D, and policies supporting businesses to improve overall performance cover a very broad span. But policies specifically aimed at improving business performance via the promotion of R&D activities constitute an important sub-set of these given that there is now a critical mass of evidence suggesting, firstly, that **investment in corporate R&D does have beneficial impacts on business performance and economic development**, and secondly that **public R&D and innovation-related policies can have positive influences on both corporate R&D activity levels and many aspects of downstream performance**.

The first implication for the EU's 2020 strategy, therefore, is that it should have **a strong focus on continued efforts to raise corporate R&D intensity levels across the board, complemented by determined efforts to improve the links between R&D, innovation and economic performance**.

The evidence also suggests that **there are lessons to be learnt concerning the targeting of support policies**. Attempts to stimulate R&D across the board via generic policy instruments that are

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the three models.

15 See Hall and Lerner (2010) for a comprehensive review.

16 These results were reported in an abstract accepted by the CONCORD 2010 selection committee but not formally presented as a paper at the conference.

open to all R&D performing firms irrespective of size, industrial sector or technological capability (low, medium or high-tech) are certainly capable of raising overall R&D intensity levels and hence overall business performance, but **the greater impacts of investment in R&D on the downstream business performance of innovative, high-tech firms, combined especially with the high spillover effects associated with the R&D activities of these firms, argue strongly for complementary targeted policies that offer additional support to R&D intensive 'high-flyers' of this nature**.

Strengthening the position of R&D intensive companies could also have important long-term consequences for the industrial structure of the EU, especially if support is targeted towards R&D intensive firms in new potential growth areas. **Currently, much of the difference between the R&D intensity levels of the EU and the US can be attributed to the larger comparative size of the high-tech sector in the US and the more prominent position of the medium-tech sector in the EU** (Veugelers, 2006; Ciupagea and Moncada-Paternò-Castello, 2006; GFII, 2007; Moncada-Paternò-Castello *et al.*, 2010). Analyses of the EU Industrial R&D Investment Scoreboard (European Commission, 2009) show that the aggregate R&D intensity level for EU firms is higher than that for US firms within all R&D intensity groupings, i.e. within the four groupings defined as high R&D intensity; medium-high R&D intensity; medium-low R&D intensity; and low R&D intensity. Over all groupings, however, the US level of R&D intensity is greater than that for the EU, which suggests that the gap can only be explained by structural differences, i.e. by the larger relative size of the high-tech, high R&D intensity sector in the US, particularly the IT sector (Lindmark *et al.*, 2010).[17]

Targeted policies that complement generic policies by deliberately focusing support on high-tech, high R&D intensity sectors can help rectify this structural deficiency, which has been exacerbated over the last twenty years or so by the slow pace of structural change in the EU (Gambardella *et al*., 2007) and the relative ease with which the US has been able to nurture the growth of new, high-tech sectors and adapt its specialisation patterns (Foray and Lhuillery, 2010). **Increasing R&D intensity levels across the board, i.e. across low-, medium- and high-tech sectors will be necessary, but it will not be enough to reduce the gap significantly**. Increasing the proportion of high-tech, R&D intensive firms within industrial sectors that are typically classified as medium-tech will gradually lead to increases in overall R&D intensity, but this will not transform these sectors into high-tech sectors in either the short- or longer term since the average R&D intensities of the high-tech and medium high-tech sectors are so different (12.7% and 4.2% in the EU in 2009) (see European Commission, 2009). **Only policies that deliberately set out to catalyse structural change via the long-term growth of new and expanding high-tech sectors are therefore likely to narrow the R&D**

[17] Similar results for the manufacturing sector have been noted by other authors (e.g. Van Ark *et al.,* 2003; Erken and van Es, 2007), though these authors also note that the role of structural differences is much harder to detect when service sector firms are included. See Moncada-Paternò-Castello *et al.* (2010) for a discussion of these contrasting results.

investment deficit and lead to improvements in productivity and overall economic performance similar to those witnessed in the US over the two decades prior to the financial crisis.

However, as the rise of the R&D intensity, to **narrow the R&D investment deficit** is not *per se* the ultimate objective, it should be underlined that the competitiveness in new, high R&D-intensive sectors will not be enough to raise the employment and growth in the EU. **There is a great opportunity to improve the competitiveness of the EU economy through increasing the absorption of innovation in present medium- and low- R&D intensive sectors** (Moncada-Paternò-Castello , 2010). In fact, investment in physical capital stock results in higher periodicity returns in low-tech and service sectors than in the high-tech industries. (Ortega-Argiles *et al.*, 2010)

Furthermore, **smaller and young EU companies are less represented among the leading innovators than similar companies in competing economies, notably the US.** (Moncada-Paternò-Castello *et al.*, 2010; Cincera and Veugelers, 2010). **There is a need to favour a positive dynamism of the demographics of such firms to eventually become large global players which are certainly determinant for the success of the future European economy and society.**

Sticking to an old growth model for another decade is not an option. Doing so would almost certainly condemn Europe to relative competitiveness and economic decline on a world stage. A new growth paradigm is needed that will usher Europe out of the current crisis and set it on a path towards the type of society envisaged in the EU 2020 discussions – smarter, innovative, greener and more prosperous. Such a course demands the realization of the following **main targets**:

- The growth of new and expanding high-tech, high R&D intensive sectors capable of satisfying the huge market potential for the innovative products, processes and services needed to cope with or remedy many of the 'grand challenges' confronting Europe and the world.[18]
- **The enhancement of the absorption capacity of innovative products and services of firms operating in traditional EU medium- and low- R&D intensive sectors** to attain a greater competitiveness of the EU economy.
- The **rise of the dynamism of EU companies though the improvement of the EU ability to create, sustain and growth of young, small/mid-size companies** in high R&D and innovation-intensive and also in less high R&D and innovation intensive sectors.

The achievement of these main targets is likely to extend well beyond the only sphere of Research and Innovation policy instruments.

[18] Energy security and supply, climate change, the general health of the population, ageing, and sustainable development are just some of the more obvious 'grand challenges'.

Perhaps the most important point to be made about policy instruments concerns the coordination of the many instruments needed to stimulate the growth of new and/or expanding sectors with a high social (i.e. relevant to the 'grand challenges') and economic return thanks to the investment in R&D or use of R&D output/innovation. In fact, coordination and simplification of instruments is crucial and should take place in a way that instruments and policies reinforce / mutually intensify the probability of achieving the expected results. It should appear across different levels of implementation – EU, national, local as well as between different instruments / policies. If thus the win-win opportunity to stimulate growth by tackling major societal problems is to be grasped, it will call for a remarkable degree of coordination between the Member States of the EU not only in order to establish the coherent strategies needed to formulate and implement the necessary research agendas, but also on the demand side to create lead markets and launch the complementary innovation-friendly procurement strategies needed to ensure that market potential is tapped at an EU scale rather than solely at a national level. It will also require a considerable focus on attempts to mobilise resources and stimulate markets on a scale greater even than that of the EU, since some of the most important societal challenges we face are global in nature and will require global efforts to resolve them.

The nature and scale of the efforts needed to tackle major societal challenges are daunting, but the potential rewards and societal benefits of pooling resources to deal with them are huge. The imperative to act now to counter the most critical societal challenges is also growing day by day, since the threat many of them pose is also considerable and, in some instances, irreversible unless action is taken quickly. There is an immediate need, therefore, to devise and implement policies which take into consideration the typology of companies and sectors and which are designed to tackle the weakness and exploit the opportunities of the EU economic as well as the research & innovation system and take advantage of the opportunities relevant to the 'grand challenges' confronting Europe and the world.

In sum, these policies should be tailored to i) raise the overall corporate R&D intensity levels; ii) nurture the growth of new and expanding high-tech, high R&D intensive sectors; iii) attain a greater competitiveness of the EU economy through the enhancement of the absorption capacity of innovative products and services of firms operating in traditional EU medium- and low- R&D intensive manufacturing and service sectors; iv) favour a positive dynamism of EU firms' demographics; v) maximise the downstream impacts of corporate R&D on business performance and economic development.

Annex 1 Evidence from the Conference papers

1.1 R&D and its impact on company performance

The first thematic strand of the 2010 CONCORD conference was devoted to the investigation of the relationship between R&D and company performance. Eight papers were presented and discussed and they provided both theoretical and empirical insight towards two main directions of research. On the one hand, further evidence was put forward in supporting an evolutionary framework able to represent the innovative activity within firms and sectors; on the other hand, new results were proposed, focusing on the crucial role of R&D investment and implying possible suggestions for European R&D and innovation policies.

Starting from the first perspective, the presented papers highlighted the fact that the link between R&D and firm performance is mediated by crucial factors that - consistently with the previous literature – can be grouped together into the following four main issues.

(1) All presented papers dealing with the R&D/productivity link provided further support for the existence of a positive relationship between R&D investment and firms' productivity (either through a direct estimate (see Huergo-Moreno [HM]; Kumbhakar, Ortega-Argilés, Potters, Vivarelli, and Voigt [KOPVV]) or through a simultaneous estimation of different equations based on the Crépon et al. (1998) model (see Hall-Lotti-Mairesse [HLM]; Criscuolo, Squicciarini, and Lehtoranta [CSL]). These results are consistent both with a well established micro-econometric literature (Griliches, 1995 and 2000; Hall and Mairesse, 1995; Ortega-Argilés et al. 2009a) and with a general outcome arising from most of the papers presented during the 1st European Conference on corporate R&D [CONCORD 2007]: Role and Dynamics of Corporate R&D (for details see the corresponding Summary Report).[19]

(2) R&D activities, and innovation in general, exhibit a high degree of persistence and path dependence (see Nelson and Winter, 1982; David, 1985; Dosi, 1988). For instance, HM found state dependence both in the decision of R&D investment and in the production of innovations. This means that the so-called technology-push (Dosi, 1982 and 1988; Vivarelli 1995) is still underway: innovation at the firm level is characterised by cumulativeness and irreversibility. Indeed, HM show that the omission of this persistence leads to an overestimation of the current impact of R&D and innovation on productivity growth.

[19] van Bavel, Voigt, and Rodriguez (eds., 2008): Knowledge for Growth - Role and Dynamics of Corporate R&D. Summary Report of the First European Conference on Corporate R&D, Seville 8th–9th Oct. 2007.

However, in the long run – even taking into account the presence of persistence in technological inputs and outputs – R&D activities do have significant effects on firms' productivity. By the same token, in providing evidence on the positive effect of sectoral and regional spillovers on the innovative behaviour of companies, LM found that firm innovation performance exhibits a high degree of state dependence.

(3) However, while technology-push is still underway, demand evolution – both domestic and from export – increases R&D intensity, meaning that the "demand-pull" forces are equally important (see Schmookler, 1966; Scherer, 1982; Kleinknecht, and Verspagen, 1990; Piva and Vivarelli, 2007). For an innovative firm, sales evolution is still a crucial driver of R&D investments both in terms of available cash-flow and as a proxy of the expectations concerning future demand for innovative products. For instance, HM found that the evolution of markets plays a relevant role not only for the probability of engaging in R&D expenditures but also for the effectiveness in obtaining process innovations: both of them significantly rise when firms perceive their own markets as expansive. By the same token, HLM found that engaging in an exporting activity implies being more specialized in the innovative products and investing more in R&D.

(4) Finally, intra-sectoral, inter-sectoral and regional spillovers (Jaffe, 1986) are as much important as internal R&D. However, internal R&D is also crucial in building that absorptive capacity (Cohen-Levinthal, 1989 and 1990), which makes the recipient firms able to create value from the knowledge spillovers coming from other companies and research institutions. Moreover, spillovers are not simply positive company externalities but are embedded in particular sectoral, regional, and institutional contexts (Breschi and Lissoni, 2001). For example, LM found a positive and significant effect of spillovers on firms' innovative behaviour; more interestingly, the spillover effects arise not only from the knowledge generated in the same industry, but also from that generated in the same region and in different industries throughout the country (Spain, as the given example). Consistently with the previous literature mentioned above, the spillover effect is enhanced by a higher absorptive capacity, while the latter is not only a function of firms' R&D capabilities – as traditionally envisaged – but of such factors as the quality of the labour force and of the HR management.

The papers presented in the Conference strand on 'R&D and its impact on company performance' indeed put forward new perspectives and provide new empirical evidence on at least three important and relatively new research issues.

(1) COMPLEMENTARITY

Generally, it is well known that R&D is more related to product innovation and more intense in large firms and high-tech sectors, while "embodied technical change" (incorporated in innovative invest-

ment, particularly machinery, see Salter 1960; Solow, 1960) is more related to process innovation in small firms and low tech sectors. However, the presented evidence suggested that complementarities between the two sources of innovation are crucial.

For instance, KOPVV clearly shows that for the low-tech industries capital is essential in fostering innovation, while for high-tech industries R&D activities are the key driver. However, over-proportional R&D intensity was found to have a positive effect on companies' efficiency, no matter whether low-, medium- or high-tech industries were considered. This result points to the emergence of complementarities in between the various innovative inputs with R&D assuming a sort of a synergic leading role (see Catozzella and Vivarelli, 2007).

In more detail, three main sources of innovative complementarities are detectable on the basis of the results presented and discussed in the course of the Conference. The first one concerns the complementarity **between R&D expenditures and embodied technological change** in generating innovative output (either product or process innovation; patents or innovative sales); this is an indirect outcome from the paper by KOPVV and a direct result found in the paper by Santarelli-Piergiovanni [SP]. These authors – studying patent activity in a high-tech sector such as biotechnology – find that expenditures in improved machinery and capital equipment may play a crucial role in the development of new patentable items, a role not necessarily less important than that played by R&D expenditures.

The second important source of complementarity **concerns the innovative outputs and particularly the inter-relationship between product and process innovation** in affecting firm performance. In particular, CSL found a positive relationship between product and process innovations: process innovation appeared to be complement with product innovation and positively correlated to higher innovative sales.

The third important source of complementarity is based on the triangle: **R&D-skills-organization** (see Brynjolfsson and Hitt, 2000; Bresnahan *et al.*, 2002; Piva *et al.*, 2005). In affecting firm performance, the role of R&D is magnified by the availability of adequate skills and by the emergence of an adequate organisational firm structure. The crucial role played by the quality of the labour force was highlighted by the already discussed contributions of LM and HM, while the tripartite links between R&D, skills, and organisational change were highlighted by HLM who showed that R&D expenditures and ICT investments have a positive impact on the likelihood of introducing organisational change.

(2) R&D IS CRUCIAL, BUT IT IS NOT ENOUGH…

R&D is presumably characterised by decreasing returns. In turn, R&D alone cannot guarantee an above-average firm performance, especially as far as SMEs and low-tech sectors are concerned. For

instance, as already mentioned, KOPVV showed that for low-tech sectors the crucial input in fostering innovation is not R&D, but the acquisition of external knowledge (mainly incorporated in new capital goods; see Conte and Vivarelli, 2005).

Moreover, R&D investment made by an isolated and small firm is even more likely to be deadweight in terms of its final impact on firm performance (see Ortega-Argilés *et al.* 2009b). In fact, many of the presented papers supported the so-called "Schumpeterian hypothesis": larger firms, firms cooperating with others and those belonging to a business group are more likely to engage in innovative activities and to obtain innovative output and productivity gains. For instance, SP found that the number of patents is always increasing along with firm size; LM found that firm size has a positive impact on innovation and CSL found that being larger (in terms of number of employees) and having intense collaborations are strongly and significantly correlated with a higher probability of engaging in R&D activities. HLM found that size has a positive effect on the probability of having both process and product innovation.

All in all, scale and scope economies in R&D and innovation activities reveal that R&D is crucial but it is not enough, especially in the low-tech sectors, in SMEs and in those firms that are at the beginning of their life cycle.

The fact that R&D is not the only essential indicator of innovative activity can be one of the possible explanations of the somewhat controversial results about the correlation between R&D investments and stock market performance found by Cincera, Ortega-Argilés, Moncada-Paternò-Castello [COM].[20] Indeed, the authors found some R&D intensive companies to outperform the respective sectoral stock market indices, while others showing an underperforming behaviour. Although, on average, their empirical findings seem to suggest a positive impact of firm's R&D intensity on market capitalisation, the authors conclude that R&D investment is an important strategic element for companies' innovative, economic, and financial performance, but it is not the only one.

(3) THE R&D IMPACT IS NOT HOMOGENEOUS ACROSS FIRMS

On the basis of what has been discussed above, it is straightforward to conclude that firms' size and sectoral belonging do matter both in terms of R&D intensity and in terms of the role played by R&D expenditures in fostering firms' innovative activities and ultimately their economic and financial performance. In addition, Falck showed in his paper that the R&D impact on firms' growth (either in terms of sales or employment) is evident only for growing firms, while R&D has no effect in mitigating the

[20] The paper provides evidence of positive impact of firms' market capitalisation performance on its R&D intensity (to some extent for the other way around, too). However, there are several other factors obviously relevant for market capitalisation which may overwhelm the effect the amount of R&D investment can have.

decline of shrinking firms. Together with the results consistent with the Schumpeterian hypothesis, this outcome seems to further confirm that R&D is a crucial competitive asset only for firms above a certain threshold in terms of size, competences and perspectives of growth.

SUMMARY OF POLICY RELEVANT MESSAGES

To synthesise the empirical evidence and the main messages arising from the contributed papers (as discussed above), below the main policy relevant messages and resulting policy implications will be highlighted.

- In general, public (support to) and private R&D activities seem to be complementary rather than substitutes!

- Supporting corporate R&D has a positive impact on firms' productivity, although it is not homogeneous across firms of different size and belonging to different sectors. In general, supporting corporate R&D has a direct effect in terms of the innovative and absorptive capacity of the beneficiary firm and an indirect effect in terms of possible spillovers in favouring other firms' innovative capacity.

- R&D is an important driver for firms' efficiency, regardless of its R&D intensity or the sector the company is operating in (unlike capital intensity).[21] Hence, higher R&D spending corresponds to higher efficiency (lower inefficiency, i.e. less waste), which provides a general toehold for policy measures supporting corporate R&D.

- Innovation policy is not only R&D policy; embodied technological change should be targeted, as well. In this regard, investment subsidies might be particularly important for fostering innovation in SMEs belonging to 'traditional' sectors. In general, supply side policies should be accompanied by demand side ones; involving users and supporting demand for new products should be considered policy priorities.

- Education policy and support to Human Resources Management and firms' organisational change may be seen as indirect innovation incentives, fostering the complementarity between innovation, skill-enhancing and organisational change.

[21] Nevertheless, according to PS, there is rather complementarity than substitutability between R&D and capital expenditures (also in knowledge-based industries) suggesting a well balanced mix of supportive measures targeting capital formation (with embodied technological progress), R&D, absorptive capacity building, etc.

- R&D cooperation and business groups should be encouraged by innovation policy since scale and scope economies as well as network externalities are obvious within the innovation activities.

- Policy support should not stop once an innovation output is obtained (triggered e.g. by support to corporate R&D); it may well continue to enable firms to transform innovative output into market success. Thus, product and process innovations are complementary which questions those programmes that support only one of the two

- 'Erga omnes' policies are misplaced; policies should be distinguished according to sector and firm size:[22] R&D subsidies alone are particularly effective only for (rather large) firms in the high-tech sectors.

- In general, R&D policy should be targeted to growing firms. In fact, R&D cannot be considered a safety net for shrinking firms and subsidies can hamper the Schumpeterian “creative destruction” which is necessary for the renewal of the economy.

[22] KOPVV have shown that the way R&D affects efficiency/productivity differs among high-, medium-, and low-tech sectors, but was also found to vary significantly among industries within each of these three clusters. This calls for a targeted policy approach to be sector- and even industry-specific.

1.2 Collaborating in corporate R&D: Empirical evidence, trajectories, and impact on innovativeness

The second thematic strand of the 2010 CONCORD conference was devoted to 'collaboration in terms of corporate R&D'. Thematically this is a fairly wide spectrum ranging from incentives for companies to collaborate (pro & contra), to the organisation and actual execution of cooperative R&D activities (thus comprising learning and adjustment processes, questions concerning the ownership of any outcome of the R&D activities and joint reaping of its benefits, etc.), up to possible risks and opportunity costs that come along with cooperating in a sensitive business field such as R&D and innovation activities. In this regard, the Conference organizers purposely did not restrict the thematic focus to any of these dimensions in order to allow all relevant issues to get presented. Consequently, each of the contributed papers investigates a fairly different aspect of cooperation in terms of corporate R&D and, therefore, the main evidence and policy relevant messages will be highlighted hereinafter by considering them paper by paper.

THE EFFECTS OF INTERNATIONAL R&D ALLIANCES ON GROWTH OF HIGH-TECH START-UPS: A LONGITUDINAL ANALYSIS

Evila Piva, Massimo Colombo, Luca Grilli, Samuele Murtinu, Lucia Piscitello

The authors of this article investigate the treatment effect of the formation of a particular type of international R&D alliance – R&D collaborations funded by the EU – on the performance of new technology-based firms (NTBFs) and whether this effect is contingent on the type and country of partner firms. In particular the paper aims at testing the following four hypotheses: 1) there is an inverse-U relationship between the number of international R&D alliances in which NTBFs participate and TFP growth; 2) there is an inverse U-shaped relation between the international heterogeneity in the portfolio of industrial partners in international alliances in which NBTFs participate and their TFP performance; 3) there is a negative relationship of TFP performance with the presence of academic partners in international R&D alliances; 4) the effect of international R&D alliances in which NBTFs participate increases with the proximity to the world technological frontier in the home countries of the industrial partners.

A large sample of Italian high-tech start-ups over the period from 1994 to 2003 is employed. The sample composed of 265 Italian NTBFs, which operate in high-tech sectors in manufacturing and services and of which 24 participated in one or more EU R&D joint ventures supported by the Framework Programs or other EU support schemes between 1994 and 2003. The sample firms were extracted from the Research on Entrepreneurship in Advanced Technologies (RITA) database, which consti-

tutes the most complete source of information presently available on Italian NTBFs. TFP is estimated using the Olley and Pakes (1996) semi-parametric procedure to handle simultaneity of input choices. The estimation is based on generalized method of moments (GMM) system which is estimated to detect the treatment effect of alliance formation according to type and home country of the partners. In the econometric analysis, the authors use NTBFs' TFP as approximation for firms' economic performance. Overall, the authors construct five models to test their hypothesis. The estimates show that NTBF age has a significant positive impact on TFP. Further, the international heterogeneity of NTBFs' portfolio of the academic partners is found to exert a negative effect on NTBF productivity; R&D collaborations with firms located in countries close to world knowledge sources are most beneficial to NTBFs; and the addition of a new partner contributes positively to NTBF's productivity only to the extent that it increases the international heterogeneity of the portfolio.

In summary, the findings of the study indicate that engagement in international R&D alliances boosts NTBF performance, but the extent of this positive effect crucially depends on the type and home country of the alliance partners. Namely, the TFP of NTBFs increases with the international heterogeneity of the portfolio of industrial partners. Alliances with a plurality of industrial partners, which might be able to create a bridge between the NTBF and globally dispersed sources of technological knowledge, are the most beneficial ones. Moreover, firms incubated in science parks and business innovation centres have been found to participate in EURJVs more often than off-incubator firms and, interestingly, collaborations with research organisations were found to have a negative effect in the short run. In short, Hypotheses (1) and (2) are revoked, Hypothesis (3) is allegedly accepted, and Hypothesis (4) is accepted.

For NTBFs international alliances are important but also the choice of partner countries matters. In this regard evidence suggests favouring those from countries closer to the world technological frontier. Hence, policy schemes helping NTBFs in finding suitably located alliance partners, for instance, through business innovation centres, science parks, and incubators could be very beneficial for these firms. Moreover, initiating a certification mechanism could be useful too as it may relieve the information asymmetry problem and make it easier for NTBFs to find appropriate partners.

The R&D collaborations funded by the EU have improved the efficiency of NTBFs, and especially small-scale actions such as the Specific Targeted Research Projects (STREPs) have encouraged small- and medium sized enterprises (SMEs) to initiate their own projects.

In countries where the Venture Capital sector is still underdeveloped, policy measures may further push for improvement and thus facilitate the access to finance for NTBFs. This may have the indirect beneficial side effect of supporting the formation of international alliances. In this regard, direct support – provided in form of grants to innovative NTBFs (possibly in its very early stages of their lifecy-

cle) – appear also to be an appropriate instrument for leveraging TFP in general and the performance of NTBFs in particular.

LEARNING TO COLLABORATE FOR TECHNOLOGY DEVELOPMENT: FIRM-LEVEL EVIDENCE FOR DENMARK

Christoph Grimpe, Ulrich Kaiser

This study analyses how companies learn to collaborate in technology development over time by examining the determinants of different kinds of collaborations. The authors argue that collaborative experience with domestic and international research alliances creates an increasing knowledge with regard to 'how to collaborate'. Further, collaborative experience is laden with path-dependency and lock-in effects which foster the learning in one particular form of research partnership. The experience repositories from past collaborations are measured by the stocks of Danish patent applications at the European Patent Office over the period 1978 and 2002 with respectively domestic co-applicants only, at least one non-Danish co-applicant, and no co-applicants. The model is based on a multinomial Logit model estimating the probability of the different kinds of collaborations (no collaboration as default).

In general, there seems to be considerable path dependence in the type of collaborations: higher experience with domestic (resp. international) collaborations leads to higher domestic (resp. international) collaborations vis-à-vis non-collaborations. Hence, there are considerable path dependence and lock-in effects. Moreover, experience with international research partnerships does not affect the choice of a domestic research partnership and vice versa. If there is any cross effect, it is negative. Absorptive capacity, measured as the total patent stock, decreases the probability of international research partnerships, however, there is no effect between absorptive capacity and domestic research partnerships. But experience with one type of collaboration increases the likelihood of further collaborations of either type.

Efforts to increase R&D collaborations will have long-lasting effects: once firms have experience with international (domestic) research partnerships they will continue to work in that direction. What matters is experience in collaborations that lead to joint patenting, not just in patenting per se. Moreover, evidence suggests that higher absorptive capacity increases the probability that firms will revert to internal technology development. This implies that firms with strong technological capabilities may fear potential knowledge leakage and therefore shift to more in-house technology development. Policy may therefore simplify and thus strengthen IPR protection schemes and by that means lower the risk averseness of companies in terms of cooperating in R&D and innovation.

DETERMINANTS OF FIRMS' COOPERATION IN INNOVATION

Almas Heshmati and Flávio Lenz-Cesar

This paper aims to investigate the factors that stimulate firms to cooperate in terms of their R&D and innovation activities. The determinants in this regard were defined according to a dataset from the Korean Innovation Survey 2005 (KIS 2005) conducted by STEPI (Science & Technology Policy Institute), which covered innovation activities from 2002 to 2004 conducted by firms with at least 10 employees. The authors introduced an agent-based model which was defined as a system of four different binary choice equations that aimed to identify firms' (and sectors') characteristics by investigating the probability of any possible cooperation of the given company with customers, suppliers, competitors, and private/public research institutions. The estimates are obtained from a multivariate Probit model using the GHK simulator and simulated maximum likelihood.

The results (restricted to coefficients significant at 5%) indicate that cooperation of whatever kind increases with size and R&D intensity. Foreign firms tend to cooperate less. Furthermore, horizontal cooperation increases with perceived risk; it is higher in high-tech sectors but surprisingly decreases with the innovative character of the industry. In other words, firms in high-tech sectors tend to cooperate more than those operating in low-tech sectors and those firms looking to conduct innovation in order to achieve higher product quality tend to develop innovation activities internally. Cooperation with customers and institutions increases with the lack of internal capabilities. Cooperation with (research) institutions increases with industry profitability, which in turn is negatively correlated to cooperation with competitors. The findings also include the speed of technological change as a factor affecting positively the cooperation with customers. Moreover, if a certain company belongs to a domestic corporate group its probability to collaborate with suppliers is affected. Foreign companies in South Korea are not likely to cooperate with institutions and competitors and tend also to neglect innovating with local suppliers (in contrast to Korean firms). Belonging to high-tech sector affects firms' attitude with regard to its cooperation with competitors, but it does not affect the other three types of cooperation. Finally, the industry average innovation size, defined as the average number of R&D employees, affects negatively any horizontal cooperation.

Any incentives targeting the investment in corporate R&D, if successful in stimulating R&D, will implicitly lead to more cooperation. It also seems that collaborations are complements rather than substitutes to internal capacity building. That is good news for the Commission's R&D policy, where public-private research partnerships are assumed to play a key role, with joint initiatives in such key sectors as medicines and fuel cars as emphasised by Commissioner Geoghegan-Quinn in her presentation in Plenary Session III (on March 4th 2010). As M. Fernández Sousa-Faro (representing Zeltia Group) outlined, MNC are aware of the benefits they can gain from international research collaborations.

The authors' results suggest that policy making – which is targeting an intensification in cooperation in R&D and innovation – should better focus on firms operating in high-tech industries (and thus the rather large scale companies). In this regard the company incentives and presumably the marginal impact of the policy measures may have the highest impact. In general, lowering the costs of conducting R&D jointly and also the individual innovation barriers shall be envisaged (in particular, simplifying IPR regimes, facilitating the public-private nexus, and improving HES and thus education level and human resources base).

MEASURING THE IMPACT OF INTERNATIONAL R&D COOPERATION: THE CASE OF SPANISH FIRMS PARTICIPATING IN EU FRAMEWORK PROGRAMMES

Ascensión Barajas, Elena Huergo, Lourdes Moreno

This study investigates the effect of participation on consortia supported by the R&D Framework Program (FP) of the European Union on intangible assets per employee and on labour productivity by using an unbalanced panel of 11,435 Spanish companies and altogether 2,536 proposals (over the period 1995 to 2005). The model is composed of four equations: a selection equation that explains the probability to apply to the Program, a selection equation that determines award of the grant conditional on participation, the proportion of intangible assets over employment, and a labour productivity equation. The model thus accounts for the endogeneity of selection into the program and of intangibles in the labour productivity equation.

The empirical analysis shows that exporting firms are more productive than non-exporting ones and, in general, cooperation in terms of a FP consortium does not have a direct impact on performance variables, both of which support the findings of previous studies. Nevertheless, five years after being involved in a FP research consortium, the participating firms in average deploy about 40% more intangible assets per employee and the labour productivity indeed increases by 12% if the ratio of intangibles per employee even doubles. Hence, participation in the FP has no direct impact on labour productivity, but an indirect effect via intangibles. In other words, cooperation within the FP leverages firms' (technological) capacity.

Since accumulation of intangible assets takes time, evaluating the success of projects financed within the FP program should allow a sufficient time span for these effects to become evident, namely allowing firms to introduce innovations made and transform this into market success. Otherwise, eventually the wrong policy conclusion might be drawn.

With regard to the individual impact of the FP on the participating firms – although if having some accounting data available such as R&D expenditures, on patents, software, etc. – it remains an analytical challenge to identify the effect intangibles may have. Hence, evaluating the success of the FP with

regard to a possible change of any participants' market performance may provide a biased picture. The effect should be rather reflected with regard to intangible asset building and dispersion than in direct measures of economic performance.

R&D MERCANTILISM OR COLLABORATION: LESSONS FROM THE MASSACHUSETTS BIOTECHNOLOGY AND HIGH TECHNOLOGY INDUSTRIES

Mark Trusheim and Christa Bleyleben

This paper discusses how the private sector, the venture capitalists and finally the government of Massachusetts shifted from a strategy qualified as “mercantilistic”, i.e. aimed at attracting investors to Massachusetts and maximizing jobs in Massachusetts, to a strategy in which cooperative liaisons with foreign authorities/initiatives/companies is playing a central role. Three case studies are illustrated: the agreement with Lombardy/Italy, Massachusetts' participation in the European sponsored TRANSBIO program, and the joint China-Massachusetts initiative.

The collaboration with Chinese partners in Shanghai demonstrated how the mercantilist and cooperative strategies can be blended. In collaborating with the Lombardy region, both sides have been initiating new and/or expanding existing industrial businesses within their regional agglomerations. The example of the TRANSBIO project demonstrated the potential of such transnational collaborations and also relevant limitations due to its shortness and nonrenewal.

Collaborative economic development implies a lot of challenges related to the coordination of numerous participants, rewards, aligning goals and incentives, for instance across regional stakeholders. In fact, time is needed to understand the strengths as well as the needs of each cooperation partner in order to overcome the natural reluctance to collaborate. Thus, involving private partners at an early stage in settling a regional cooperation is valuable. A long-term strategy in this regard needs to be adopted with a policy toehold regarding collaboration support activities such as negotiation facilitation, 'cultural translation' (infrastructure), professional intermediation etc. In this regard, the provided examples have shown that competitive participation tends to avoid inefficient governance and risks can be mitigated by allowing entry in the process at various stages. In general, mercantilistic and collaborative strategies do not exclude each other; in contrast they may even be complements! However, policy needs to transform targeted support programs from event focused activities to programs that are integrated, along all the R&D collaboration processes. This view has been supported by M. Fricke from Triangle Venture Capital Group Management (in her presentation on March 4th): “…It is imperative to bring private institutional investors to the market. They complement by their experience the role played by public support initiatives…".

RISK FACTORS AND MECHANISMS OF PRODUCT PIRACY – A FIRST EMPIRICAL APPROACH

Knut Blind, Alexander Cuntz, Florian Köhler

This paper estimates the determinants of counterfeiting and product piracy separately for technical components and for names and labels. The theoretical framework is based on the notions of enabling and signalling effects. The former refers to information disclosure that facilitates copying. The latter refers to pirating induced by the signalling of a new source of profits. Besides traditional intellectual property protection strategies and more general business strategies, firm exogenous variables are controlled. The estimation is based on survey data of 217 German companies that have patented at the German Patent Office, the European Patent Office or under the Patent Co-operation Treaty.

The main argument is that firms that rely on patents in order to protect their IPR establish a legal barrier against infringers, but they also signal new economic opportunities and enable new inventions by pirates through information disclosure. In this way, patenting might not always be an appropriate strategy and firms relying on trade secrecy may be better off. In fact, publication of research results encourages piracy, both in terms of technical components as well as names/labels whereas, in turn, the use of patents, brands, secrecy and other informal protection methods have no significant effect on piracy.

Conducting R&D abroad spurs product piracy, but higher R&D intensity dissuades piracy of technical components. Surprisingly, evidence from the study suggests that collaborations tend to decrease technical piracy and have no effect on copying of names/labels. While strategic IPR factors have a stronger effect on names and labels, general business strategies and further exogenous factors are more important for protecting technical components. For technical components, there is no significant difference between enabling and signalling sources, whereas for brand names the enabling sources dominate the signalling ones. To avoid 'patent infringement', the strategy space for IPR instruments therefore seems to be rather limited. Moreover, trademarks may have adverse effects on piracy of names or labels by signalling new products or expected brand premiums to pirates.

The benefits of trademark registrations need to be weighted against the danger of counterfeiting and companies likewise need to be aware of piracy risk when establishing R&D facilities abroad. In this regard, cooperation and increasing R&D intensity seem to be ways to deter piracy of technical components. Policy, by supporting cooperation as well as by ensuring a strict application of given IPR legislations, can help minimise the uncertainty and some intrinsic risks of corporate R&D (for instance to fail reaping the benefits of the engagement in R&D due to piracy).

AMERICAN ENTREPRENEURIAL CHAOS OR COLLABORATIVE INDUSTRIAL POLICY: THE EMERGENCE OF THE MASSACHUSETTS BIOTECHNOLOGY SUPER-CLUSTER

Mark Trusheim, Ernst Berndt, Fiona Murray, Scott Stern

This study analysed the Massachusetts biotechnology super-cluster: how it was formed, what drives it, and how it is affected by the recent financial crisis. By looking at it from a historic/dynamic point of view, the emergence and evolvement of the cluster as well as the changes in policy making necessary to adapt to the changing requirements of a growing cluster are considered. The paper describes in detail how the four critical factors - funding, talent, laws and norms, and diversity – affected the creation of the Massachusetts biotechnology super-cluster. It is outlined that the requirements regarding each factor are different for different innovation stages. In this regard, 'basic research', 'translation', and 'commercialisation' are distinguished. Moreover, the authors analysed how the cluster was adapting and how public policy measures were changed to cope with the challenges related to the financial crisis in 2008-2009. In this regard, for instance, it was found that venture capital [VC] shifted from biopharmaceuticals towards medical devices with shorter product development cycles and lower costs. However, the super-cluster has been able to adapt to the crisis by seeking alternative funding, additional training, expanding innovation centres, and new government programs. The major problems are related to the 'translation' funding, which could disrupt the technology flow from basic research to commercial products.

The Massachusetts biotechnology super-cluster can best be characterised as an evolving ecosystem successfully combining policy efforts and entrepreneurship. The experience shows that all pieces of the system have to grow and develop together, that multiple allocation approaches among government and private sector are possible, and that competition at all stages in this regard is overall beneficial. This is also the direction in which the EU Flagship initiative is going (as outlined by Commissioner Geoghegan-Quinn in the course of the Conference): combining research with demand side policies, such as smart regulation and pro-innovation public procurement. The same message was delivered to the Policy Makers' Forum on the second Conference day by M. Martinez Barea, General Secretary for Innovation of the Region of Andalucia. He pleads for a three-pronged approach based on innovation, education and ambition. M. Fricke, representing the CEO Triangle Venture Capital Group Management, furthermore argued that public policy, in general, should align with the interests of investors and not impose a set of predetermined objectives.

GLOBALIZATION OF CORPORATE INVENTION

Antoine Schoen, Ali Zakavati, Lionel Villard

By means of this study the authors present the 'Corporate Invention Board', which is a dataset constructed in order to combine patent data from PATSTAT with financial data from ORBIS as a potential complement to the 'Industrial R&D Investment Scoreboard' (released by the EC JRC-IPTS). Conceptually, patents are used as an approximation for R&D conducted abroad.

The 'Corporate Invention Board' database in its presented form contains about 5,3 million priority patents, which were applied in 1986 - 2005 by 2,312 multinational corporations. The data can be analysed along different dimensions: company, technology area or geographical location level.[23] It appears that the domestic control of patents is quite strong and, for instance in terms of biotechnology in Europe and North America, apparently even further increasing.

The presented analyses of the companies' patent portfolios (based on the 'Corporate Invention Board' database) suggest that the concerns regarding the globalisation and delocalisation of R&D (moving R&D away from Europe) might be overstated.

SUMMARY OF POLICY RELEVANT MESSAGES

To synthesise the empirical evidence and the main messages arising from the contributed papers (as discussed above), below the main policy relevant messages and resulting policy implications are highlighted.

- The presented studies underlined the importance of collaboration in terms of R&D and provided a policy toehold with regard to collaboration support activities such as negotiation facilitation, 'cultural translation' (infrastructure), professional intermediation, etc.

- Any successful efforts to increase R&D collaborations will have long-lasting effects: once firms have experience with international (domestic) research partnerships they will continue to work in that direction.

- Business collaborations are complements rather than substitutes to internal capacity building! Hence, policy making may well target intensifying cooperation in R&D and innovation, and thus focus on firms operating in high-tech industries (since marginal impact of such measures were found to be higher there). In general, it should be envisaged (where possible for public entities) to reduce the costs of conducting R&D cooperatively and also to lower individual innovation barriers (in particular, simplifying IPR schemes, facilitating the public-private nexus,

[23] In its current form, there is an Asiatic bias in the data base as three quarters of the priority patents belong to Japanese and Korean firms. However, this bias could be corrected.

improving Higher Education Systems [HES] and thus education level and human resources base).

- Cooperating in R&D and increasing R&D intensity appear to be ways to face main business challenges. Policy, by supporting cooperation as well as by ensuring a strict application of given IPR legislations, can help minimise uncertainty and some intrinsic risks of corporate R&D. In general, policy will simplify and thus strengthen IPR protection schemes and by that means lower the risk averseness of companies in terms of cooperating in R&D and innovation.

- Evidence suggests that the general concerns with regards to globalisation, internationalisation of corporate R&D and relocating it away from Europe seem to be overstated.

- Mercantilistic and collaborative strategies in terms of R&D do not exclude each other; in contrast they may even be complements! Policy needs to transform targeted support programs from event focused activities to programs that are integrated, along all the R&D collaboration processes and involve private partners at any stage.

- Support to corporate R&D needs to be combined with demand side policies, such as smart regulation and pro-innovation public procurement, and thus be embedded in further initiatives targeting education, regional/industrial development, etc.

- Supporting NTBFs in finding the right alliances, for instance through business innovation centres, science parks, and incubators, could be very beneficial. Moreover, creating a certification mechanism in this regard could be useful as it may relieve the information asymmetry problem and make it easier for NTBFs to find appropriate partners.

- In countries where the VC sector is still underdeveloped, policy measures may further push for improvement and thus facilitate access to finance for NTBFs. This may have the beneficial side effect of supporting the formation of international alliances. In this regard, direct support – provided in form of grants to innovative NTBFs (possibly in its very early stages of lifecycle) – appear also to be an appropriate instrument for leveraging TFP in general and the performance of NTBFs in particular.

- The success of FP projects should be reflected with regard to intangible asset building and dispersion rather than directly concerning firms' economic performance.

1.3 R&D and internationalisation: Does location matter?

While the 'original Lisbon Agenda' might be seen as controversial, the importance of knowledge, innovativeness, and R&D for Europe is not. In fact, Europe's economic and social future depends to a major extent on its ability to attract R&D (inward flowing investment on R&D as well as the amount Europe's firms invest in R&D in Europe vs. elsewhere). Stating this implicitly assumes that – in terms of R&D and internationalisation – location does indeed matter. However, turning the latter into a question, the Conference organisers called for papers investigating the impact of internationalisation on R&D.

In the scientific literature there are two different perspectives on 'internationalisation of R&D'. Although the actual terms used may vary, the essence is the following: The first perspective, which traditionally has been the dominant, assumes that the main motive for internationalisation of R&D rests on the companies' attempt to get higher returns from the accumulated knowledge resources that the firm posits. However, when expanding into new markets abroad this established knowledge may need to be adapted to the circumstances given there, and this may justify some investments in R&D. Hence, following this view, internationalisation of R&D is mainly perceived as a result of internationalisation of sales and production, and the motive is primarily to adapt the company's existing knowledge base to the peculiar characteristics of foreign markets/locations. In contrast, the second perspective looks at companies as relatively omnipotent creatures, actively searching for relevant knowledge (and creative knowledge environments) all over the globe. Following this perspective, internationalisation of R&D activities should be seen as a conscious strategy of knowledge seeking companies trying to tap into such globally dispersed reservoirs of knowledge by establishing R&D activities there.

The reason for highlighting the difference between these two interpretations is that the resulting policy implications differ. In the first instance, the consequences of R&D internationalisation are fairly minor and – if anything – rather beneficial for the country of origin. According to the second perspective, however, there is a danger of a hollowing out of the national system of innovation from which the firm originally emerged, since R&D resources will flow to the most attractive locations worldwide (leaving the home ground 'deserted' in terms of R&D). This possibility has not been unnoticed by policy makers who in many cases have devoted resources to the creation of knowledge environments (science parks, etc.) in the hope that these may attract a lot of R&D and highly educated labour from other locations.

With these theoretical conjectures and possible policy implications in mind, the evidence presented in the course of the conference can be put in context. Seven of the eight contributed papers falling into the thematic strand on internationalisation of R&D are empirical studies. One of these focuses on

global knowledge spillovers and the role of absorptive capacity, technological proximity, and geographical proximity; all of which were found to matter. However, since the sample considered for that study consisted mainly of large US (and to some extent Japanese) firms, the corresponding paper rather serves as benchmark for the remaining six papers which focus on the evidence for Europe.

In general, the contributed papers in this thematic strand relate to the drivers/motives for and the effects of the internationalisation of R&D activities. Thus, some focus more on the former and some on the latter. In terms of methodology, six papers use statistical (mainly econometric) analysis to test their hypotheses, one paper presents a proposal to combine complementary R&D statistics and another paper examines a number of national innovation and internationalisation strategies to identify a number of new trends in policy strategies and types of instruments used to promote the internationalisation of science, technology and innovation. The specific issues addressed and the main findings of each paper are outlined below in brief. At the end of this section the cross cutting messages will be highlighted.

THE GEOGRAPHICAL EXECUTION OF EUROPEAN CORPORATE R&D INVESTMENT

Claudio Cozza

This paper is a methodological note on how corporate R&D in European MNEs may be divided up geographically. Since the internationalisation of R&D activities is increasing, Cozza points out a major limitation of the mentioned Scoreboard: it is not possible to individuate the territory of actual execution of the R&D investment. To overcome this limitation, Cozza proposes a methodological framework of collaboration with European business R&D (BERD) statistics producers. The findings from a pilot exercise with the Italian Statistical Office demonstrate that BERD and the EU Industrial R&D Investment Scoreboard are actually complementary and can be beneficially used for analytical work.

GEOGRAPHIC AND TECHNOLOGICAL R&D SPILLOVERS WITHIN THE TRIAD: MICRO EVIDENCE FROM US PATENTS

Michele Cincera, Luigi Aldieri

The authors explore the magnitude of geographic and technological based R&D spillover effects on large international R&D companies' productivity growth, controlling at the same time for the firms' ability to identify, assimilate and absorb the external knowledge flow. Through the estimation of an extended production function for a representative sample of worldwide R&D intensive manufacturing firms over the period 1988-1997,[24] both the geographic and technological based R&D spillover stocks

[24] The study uses a database consisting of 808 large firms of which the great majority is American and Japanese (only about 15% from the EU) and another database on US patents developed earlier by Bronwyn Hall. Following previous work by Adam Jaffe, measures of knowledge spillovers reflecting technological and geographical proximity are con-

were found to have an important and positive impact on the productivity growth of firms, being the effects of the pure technological externalities higher than compared to the geographic spillovers. These results are confirmed when controlling for absorptive capacity. The findings also suggest a complementarity effect between own R&D and both sources of R&D spillovers. Overall, the paper suggests that both technological and geographical proximity (but particularly the former), influence spillovers and so does absorptive capacity. Further, both geographic and technological based R&D spillovers have an important and positive impact on companies' productivity growth.

HOW DO DIFFERENT MOTIVES FOR R&D INVESTMENT IN FOREIGN LOCATIONS AFFECT DOMESTIC FIRM PERFORMANCE? AN ANALYSIS BASED ON SWISS PANEL MICRO DATA

Spyros Arvanitis, Heinz Hollenstein

The authors focus on the determinants and the effects of R&D at foreign locations based on three different types of motives for foreign R&D: knowledge-oriented, market-oriented, and resource-oriented ones. Using data on Swiss manufacturing firms in the years 2002, 2005 and 2008 (survey conceptually similar to the CIS), the study finds that (i) factors related to firm-specific knowledge-oriented advantages are more important in explaining the likelihood of foreign R&D activities than factors reflecting disadvantages related to home location, although with differences among the three distinctive groups of motives; (ii) being engaged in foreign R&D activities primarily driven by knowledge-oriented motives is positively correlated to innovation performance; and (iii) foreign R&D activities driven by market-oriented or resource-oriented motives correlate positively with productivity. As a general conclusion it is pointed out that foreign R&D is complementary and not a substitute for domestic R&D.

THE MAIN DRIVERS FOR THE INTERNATIONALISATION OF R&D ACTIVITIES BY EU MNES

Michele Cincera, Claudio Cozza, Alexander Tübke

The study investigates what drives the decision to perform corporate R&D at a certain place. Using a representative sample of the largest R&D corporations in the EU, based on the 2008 IRMA survey of R&D Investment Business Trends, in general, market pull, improving productivity, technological opportunities, and (international) competition are identified as important with regards to the motivation of investing in R&D in a certain location. Moreover, for companies with low R&D intensity, regulation is also an important driver of R&D. Most respondents expressed a strong preference for doing R&D 'at home' due to the familiar environment, because of specific innovation system characteristics, and the

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structed. Absorptive capacity as reflected in the firm’s own R&D is also taken into account, thus following the suggestions made by Wesley Cohen and Dan Levinthal.

proximity to other activities of the company. Cost considerations generally tend to work into the opposite direction (favoured investments in the developing part of the world, in particular in China and India). As for EU policies the survey identified product market regulation and "indirect public aid" (subsidised loans and/or guarantees) as being the most conducive to R&D investment (location).

INTERNATIONALISATION, R&D AND PRODUCTIVITY: EVIDENCE FOR GREAT BRITAIN

Dolores Añón Higón, Miguel Manjón Antolín

The study investigates to what extent firms' internationalisation influences the endogenous relation between R&D and productivity. In particular, the contribution of R&D to productivity for a panel of UK manufacturing and services firms that differ in their degree of internationalisation (465 domestic, British multinationals, and foreign multinationals over the period 2002 to 2006) is assessed, thus using a structural approach to the estimation of production functions. The results show that the effect of being multi-national is not homogeneous, but rather relevant for the most inefficient firms. As a general finding and thus consistent with the literature, the study shows that returns are higher in multinational than purely domestic firms and (to a lesser degree) higher in services than in manufacturing. In fact, MNEs are on average more efficient than purely domestic firms as far as contributions of R&D to productivity are concerned, with the largest difference being at the lower bounds of the distribution. However, British-owned multinationals are superior to foreign multinationals, in terms of the estimated elasticity both at the mean point as well as at the different quantiles of the distribution, except for the lower ends, where foreign firms tend to stand out.

INTERNATIONALISATION OF RESEARCH AND INNOVATION – NEW POLICY DEVELOPMENTS

Sylvia Schwaag Serger, Emily Wise

The study, by focusing on policy rather than on empirical / micro-level evidence (like all other papers presented in this thematic strand), considers how countries design strategies and policies aimed at enabling national innovation systems to benefit from changing global knowledge and innovation geography. By examining the existing literature, a number of national innovation and internationalisation strategies, as well as recent strategy documents and position papers from EU and other international institutions, a number of new trends in policy strategies and types of instruments used to achieve objectives are identified. Thus, the comparative analysis highlights a trend towards strategic prioritisation of research areas and collaboration partner targets, a broadening of services offered to support internationalisation activities of business and research actors, and an increased role of the public sector as a neutral facilitator of international collaboration. The analysis also points out a number of policy challenges related to the internationalisation of innovation and, as a general remark, that internationalisation of R&D does not figure very prominently in the policy set ups albeit most countries have

some provisions for it. In fact, countries position themselves differently in this regard depending on differences in key characteristics such as size and development level.

The study concludes that policy can play an important role in enabling national innovation systems to reap the benefits of globalisation. In particular, four policy priorities are emphasised: (1) an evolution of the challenges that innovation policy should address, (2) an increase in strategic planning related to policies to support internationalisation of innovation activities, (3) increased demand for more complex internationalisation support services, and (4) an increased need for coordination across a range of policy areas.

HOME OR ABROAD? R&D AND PATENTING AMONG EUROPEAN FOOD AND BEVERAGE MULTINATIONALS

Catalina Martínez, Ruth Rama

Using a sample of 59 major European food and beverage multinationals and their subsidiaries worldwide, Martínez and Rama explore the inventive activity of European multinationals in this industry as reflected by corresponding patent statistics (EPO and USPO) and thus focus on the characteristics and evolution of the inventions made over time. Evidence from several statistical tests reveals that the innovations of EU-based companies (which are most closely related to their core businesses) tend to be located in EU countries. However, such companies do not display a geographical preference with regard to high value or technically complex innovations, which are generated at home and abroad, within or outside the EU. In turn, with regard to non-food technologies the study detected a preference of European food and beverage multinationals for foreign locations, which suggests a European weakness in this technical field. According to the authors, the latter may give reason for concern as these technologies are assumed to become strategically more important in the years to come. It is therefore suggested that the EU should pay more attention to the coordination of policies affecting science, R&D and education relevant for food industries and agriculture.

DOES LOCATION MATTER? CROSS-COUNTRY DIFFERENCES IN INNOVATION BEHAVIOUR OF GERMAN MNEs

Franziska Kampik, Bernhard Dachs

This study analyses the determinants of cross-country differences in the innovation behaviour of subsidiaries of German MNEs. Using data of more than 2,000 German subsidiaries from the fourth wave of the Community Innovation Survey [CIS], the authors find considerable differences in innovation input and output intensities between German subsidiaries located in 16 European countries. The analysis further suggests that these differences are mainly related to firm characteristics, in particular to firm size, intramural R&D activity, public funding and international market orientation rather than by

being foreign owned or not. The authors therefore argue that a policy directed at attracting foreign firms would make little sense per se and that policy should rather focus on raising firm level innovative activity more generally.

SUMMARY OF POLICY RELEVANT MESSAGES

Summarising the individual findings on Internationalisation of R&D as outlined above, in fact, several papers demonstrated that affiliates of foreign firms tend to do more R&D, innovate more and get higher returns from doing so than purely domestic firms. It was pointed out, however, that this is not necessarily the result of foreign ownership but due to the fact that these companies tend to be larger and more internationalised. In fact, according to the evidence presented, large domestic firms with international activities do not differ much from their foreign owned counterparts. Thus, while firm growth and internationalisation may be healthy both for the firms concerned and to the economy, attracting foreign firms (e.g. FDI) may not be the only possible/most appropriate policy option. It was argued that policies aimed at dynamising the domestic economy and supporting internationalisation may be even more important.

With respect to motives for R&D internationalisation, the papers presented indicated that most foreign R&D by European firms grows out of firms' existing knowledge bases, which are normally strongly linked to the country of origin (and its innovation system), or are adaptations to concrete circumstances in the host country. Most European firms have a strong preference for doing R&D at home, and if it is going to spread across different locations, to do it in Europe. The quality of the national innovation system, in which the R&D activities of many firms are well embedded, is an important factor behind this preference. There are some signs that European innovation systems are developing in some sectors but not in others; and this tendency deserves more consideration by policymakers as it may require stronger policy coordination.

Thus the available information, although scarce, seems to indicate that global sourcing of R&D resources in new areas is a rather rare phenomenon among European firms. To the extent that European firms take part in such global sourcing it seems mainly to be driven by cost considerations and limited to certain sectors and locations (e.g., India). Hence, outsourcing of R&D is of relatively small scale and lags considerably behind outsourcing of other types of activities. The evidence seems to suggest that this is not a phenomenon that policy makers should be very much concerned about at the present stage.

In general, R&D investments by European firms are determined by demand, competition, and business opportunities. However, regulation and standards are also important factors as well as availabil-

ity of finance (including public funding, tax incentives), especially for companies that traditionally do little R&D. In this regard, several papers indicated a certain need for policy action or at least point towards a toehold for R&D policy making. Thus, evidence suggests that 'indirect' effects of policy making (e.g. measures targeting general access to finance, i.e. not specifically linked to R&D activities) may be as important for R&D and innovation as the R&D targeted support programs. This is something that deserves more attention in future research. It is important to avoid the “lamp-post” syndrome, i.e. focusing only on the most obvious factors affecting corporate R&D and those policies especially designed for this purpose, when in fact there may be other factors more relevant (including unintended effects on business of other policies). This argument points towards the need for a holistic perspective on policy and a strong emphasis on coordination across different policy areas.

In a nutshell, evidence suggests that most of the firms are well embedded in their national innovation systems and have a strong preference for doing their R&D nationally. In fact, the presented research indicated that the quality of the innovation system matters significantly for firms’ decisions to locate their R&D activities, and the quality in Europe is (still) perceived as rather good. This in turn is good news for policy makers as it shows that catering for the domestic National Innovation Systems is a very good investment on their part and justifies their efforts in terms of supporting R&D. Moreover, European companies that consider it necessary to invest abroad in R&D, in the first place, prefer to do so in Europe. This is again good news for policymakers (at the EU level, this time) as it indicates a toehold for R&D policy also at European level and suggests developing well functioning (sectoral) innovation systems at European level (across national borders). Thus, efforts at national and European level should go well hand in hand in order to be most effective.

To synthesise the empirical evidence and main messages arising from the contributed papers, below the key policy messages and resulting policy implications are highlighted.

- Internal R&D activities and knowledge generated outside of the firm are complementary, both in terms of the effect of own R&D, geographic and technological spillovers. Foreign R&D complements domestic R&D!

- The main drivers for locating R&D activities abroad are the availability of researchers and the access to specialised knowledge.

- Supporting EU firms in growing outside their home country is effective, but it requires a policy mix, stimulating the access both to new knowledge and to researchers.

- If leveraging EU companies' excellence in terms of technology is envisaged, to target just a lowering of R&D costs may serve but might alone not be enough: public support is needed to reinforce the overall home base (represented by the proximity to other companies’ activities).

Thus, the indirect effects of any policy measure might be considered of higher importance (call for research in this regard!). In fact, policy should target the most limiting factors in terms of corporate R&D, which is not necessarily linked to the actual carrying out of R&D rather than to relevant bottlenecks for the business unit, for instance, available human and/or financial capital, lack of appropriate partners, etc.

- Subsidiaries of multinationals are specific in their innovation behaviour. In fact, foreign ownership influences the endogenous relation between R&D and productivity, although the effect is not a constant and depends on each firm's characteristics. Hence, public support should take into account the heterogeneity of firms, for instance, as the effect of multi-nationality on the relation between R&D and productivity apparently depends on each firm's efficiency.

- To attract multinationals, rather than offering benefits, policy may focus on improving the innovative capabilities of any firm as a way to attract further R&D activities.

- In general, policies to enable national innovation systems to benefit from a changing global knowledge and innovation geography include (i) evolution of the challenges that innovation policy should address, (ii) an increase in strategic planning related to policies to support internationalisation of innovation activities, (iii) an increased demand for more complex internationalisation support services – provided by public sector intermediaries, and (iv) an increased need for coordination across a range of policy areas. Policy making in this regard is obviously a multi-dimensional approach, which can benefit from additional efforts to develop indicators and statistical frameworks to track the effects of international cooperation and further areas where R&D and innovation activities could be coordinated (at national and/or the EU level). In this line, the collaboration among producers of R&D statistics could be helpful as this may allow elaborating more reliable indicators on (international) flows of R&D investment in Europe and on R&D and innovation activities in general. For a comprehensive impact assessment and also for a fine tuning of R&D supporting policy measures this seems to be an essential asset.

1.4 Financing corporate R&D

Although the financial crisis certainly has had a significant impact on 'Financing corporate R&D' and therefore the thematic strand was assumed to raise an overwhelming interest, only rather few applications were submitted in response to the CONCORD 2010 call for abstracts. This is presumably due to the lack of relevant data available at the time of the closure of submission of abstracts. Overall, only three studies met the quality criteria of pre-selection and were invited to be presented in this strand. Notwithstanding, firms' financial R&D constraints were discussed in general and, for instance, the particularities of small and medium enterprises [SME], the role of venture capital [VC] in this regard, and the impact the type of investor may have on total factor productivity [TFP] are subjects which have been investigated.

In general, the three studies examine the financing of corporate R&D from three different but closely related angles: large firms / MNEs, SMEs, and high tech start ups. In terms of R&D funding, the authors examine internal financial sources, bank finance, and venture capital. Accordingly, the three papers can be related to three groups of key questions: (.

(1) Do financial constraints limit the ability of firms to invest sufficiently in R&D? Are there even financial constraints on large firms' R&D investments (as this is commonly confirmed for SMEs)? And finally, are there major differences between European and American large firms?

This is addressed by Julien Ravet and Michele Cincera in: **FINANCING CONSTRAINTS AND R&D INVESTMENTS OF LARGE CORPORATIONS IN EUROPE AND THE USA**

The paper examines a newly constructed and comparable sample of 1,962 R&D performing large companies from the EU and the US, belonging to the manufacturing and services sectors. The authors made a great effort in creating this panel data set, including very recent periods (2000 – 2008) and including firms from all over Europe (not just a single country as Germany, the United Kingdom or France). The sample covers about 80% of all the R&D carried out in the private sector in the world and is therefore per se fairly representative, although being biased towards the large scale companies and thus missing somewhat the SME perspective. Nevertheless, the fact that considered companies appear to be similar in type limits heterogeneity (also noise) and in this regard may allow detecting relevant firm specifics.

Financing constraints are measured by the sensitivity of R&D investment decisions to cash-flow, under the assumption that the investments (in R&D) of those firms that face liquidity constraints are more likely to be sensitive to the availability of internal finance. In fact, capital market imperfections

and financing constraints such as credit rationing by lenders is assumed to greatly affect firms' investment decisions. These constraints may be pronounced in the case of intangible investments such as R&D.

By applying an error correction model for R&D investment and using GMM system estimators for these panel data analyses, the paper finds a positive impact of cash flow effects on the firms' R&D investment decisions. However, only EU companies were found to face liquidity constraints; not their US competitors. This result is shown to be robust to alternative modelling strategies and the application of different econometric methods and data sub-samples.

The results presented are novel and empirically somewhat contradictory to the findings of previous literature on the subject. The latter presumably can be related to the analysed period (the current decade rather than the period before 2000, as analysed in other studies). In fact, since the beginning of the millennium some major institutional changes occurred in Europe (which experienced more severe conditions for money lending and stronger competition versus little regulation in the US). However, as emerged in the discussion, more research is needed in order to identify the underlying causes of the contradicting results of related studies. In general, we need to know more about how financial constraints affect R&D in order to disentangle (more) appropriate policy measures. In this regard, first, research may further examine the financial constraints on R&D by comparing the 1991-2000 period and the 2001-2010 period for the US and Europe. Second, it may disentangle the role external sources play in the funding of large firms in EU and US, as these external sources can be very different in the US and in Europe. Third, it should be investigated which component of R&D (the "R" or the "D") is more financially constraint. Fourth, existing differences across sectors shall be highlighted. Fifth, if possible, the database might be disentangled in terms of location of MNEs that operate in various places (in particular in the US and in Europe).

(2) What do we know about the difference between large and small firms? What about liquidity constraints of SMEs? These questions were addressed by Maria Luisa Mancusi and Andrea Vezzulli in: **R&D, INNOVATION AND LIQUIDITY CONSTRAINTS**.

This study uses a 2001-2003 survey on a large number of Italian SMEs conducted by CAPITALIA. A direct indicator of financing constraints is introduced, based on firms' desire for additional financing liquidity. Thus constraints refer to bank financing. The analysis is focused on the role financial constraints play in terms of the firm level decision to engage in R&D projects (or not), and (if yes) on the relative amount of investment in R&D.

The background of this research concept is the fact that any R&D investment requires first the development and implementation of a firm level R&D strategy, acquiring the resources needed (human

capital, research facilities), etc., which altogether refers potentially to 'sunk costs'. The latter may, particularly in terms of SME, amount to a significant obstacle. Thus, fluctuations in the level of spending in ongoing R&D activities might be very costly, as R&D expenditures comprise, for instance, payments to highly trained scientists, engineers and other specialists, who are not perfectly elastic in supply (and anyway difficult to acquire for a SME). The existence of high adjustment costs for R&D might then imply that firms set the level of R&D investment in accordance with the "permanent" level of internal finance, and are therefore relatively unresponsive to transitory movements in internal funds.

Mancusi and Vezzulli employ a bivariate probit model to study how the probability to engage in R&D activity is affected by the presence of financing constraints, thus assuming the latter to be endogenous. In this regard, financial constraints are expected to be binding for firms that wished foradditional credit at the interest rate agreed with the main partner bank.

The paper suggests that credit constraints reduce primarily new R&D investment. By contrast, the effect of liquidity constraints on ongoing R&D projects was found to be less strong. There is a significantly negative effect on the probability to set up R&D activities due to the presence of financing constraints. The percentage reduction in R&D investment of a certain firm in response to face liquidity constraints is largely to be associated with a fall/reduction in the likelihood of doing R&D (the R&D participation decision), rather than with a reduced level of investment.

The discussion in the course of CONCORD 2010 stressed the relevance of the result of the unresponsiveness of R&D financing to transitory movements, and the novelty with respects to studies on other countries such as France and the Netherlands. However the results are highly specific to the Italian context, in which banks are the main source of financing. Interesting developments may concern two issues: differences across sectors – which probably matter extensively – and the analysis of the additionality of public R&D funding for SMEs.

(3) The third set of questions is on venture capital: Does Venture Capital play a role in supporting firms' productivity growth? How relevant is the role of Venture Capital in financing innovation, particularly with regard to high tech start ups in Europe?

This question is tackled by Fabio Bertoni, Massimo Colombo, Diego D'Adda and Samuele Murtinu in **VENTURE CAPITAL FINANCING AND INNOVATION IN EUROPEAN NEW TECHNOLOGY BASED FIRMS: A LONGITUDINAL ANALYSIS ON THE ROLE OF THE TYPE OF INVESTOR**.

New technology based firms most likely suffer from capital market imperfections and from poor access to external financing. This may greatly threaten R&D, survival and growth of this type of firms.

The issue of access and availability of finance may apply especially to bank loans as banks generally do not possess the competencies to evaluate ex ante and monitor ex post the investment projects by young high-tech firms. Hence, venture capital financing is considered a very suitable external financing mode for high tech start ups.

This presented study examined the role of Venture Capital in the innovation activity of European start ups, namely New Technology-Based Firms – [NTBF]. In this regard, innovative activity is measured by the dynamics of Total Factor Productivity [TFP]. The paper estimates econometrically the effect of Venture Capital – both in terms of independent venture capital and of corporate venture capital – on TFP with a longitudinal dataset of 3,687 NTBFs from six European countries (Belgium, Finland, France, Italy, Spain, UK), of which 313 NTBFs are Venture Capital-backed. The sample firms were established in 1984 or later, remained independent at least up to the end of 2008, and are observed since 1994. Since the firms in the sample are privately owned, the dataset does not suffer from the selection bias that affects samples exclusively composed of IPO firms. In addition, it is not subject to survivorship bias as it includes both surviving and non-surviving companies.

The results clearly show that Venture Capital financing may affect TFP, but only dependent venture capital has a positive and significant impact on TFP, while corporate venture capital does not. Hence, independent venture capital dominates corporate venture capital! In fact, the productivity boost caused by independent venture capital differs from what happens in terms of corporate venture capital. The discussion of these results emphasised that changes in TFP should be interpreted in terms of broader organisational changes and improvements in software and services, and not just in terms of product and process innovations. Moreover, the different impact of independent venture capital and corporate venture capital on TFP can be related to the fact that corporate venture capital does different things and has broader objectives than independent venture capital (it often implies the exploration of new technologies and search for synergies and complementary / more efficient assets). Moreover corporate venture capital is more heterogeneous than independent venture capital.

SUMMARY OF POLICY RELEVANT MESSAGES

The strand on 'Financing of corporate R&D' may be framed within two points as emphasised by earlier research of JRC-IPTS[25]: The R&D gap between Europe and the US is mainly due to structural effects since Europe's main economic sectors are generally less R&D intensive. Moreover, there is indeed a firm-population effect in this regard since there are less firms in the EU actually conducting R&D (in particular SMEs). This evidence suggests focusing the support to R&D for (established large) EU firms just on emerging sectors and, in general, to favour new high tech businesses rather than ex-

[25] With regard to the R&D gap between Europe and US see, for instance, the IRI Working Papers No. 01/2010, 3/2010, 02/2009, 04/2009, and 11/2009 (http://iri.jrc.ec.europa.eu/papers.htm).

isting (large) companies. In fact, one of the main reasons for why there are less NTBF / SMEs active in R&D intensive sectors in the EU compared to the US refers to the difficulties these companies face in terms of financing their (new R&D) investment. Since this is mostly relevant for recently founded SMEs and for firms operating in highly dynamic technological environments it is not surprising to find Europe lagging behind in terms of numbers of fast growing R&D-intensive companies active in high-tech industries, which are expected to become the key economic players of tomorrow.

The main policy messages arising from the 'Financing corporate R&D' strand of CONCORD - 2010 can be summarised as follows:

- Improving access and availability of sources of finance for R&D: (1) external sources (with an impact mainly on large scale companies) as well as (2) internal company resources to be used for R&D. In terms of the latter, particularly large European companies are lagging behind their American competitors. There is a positive impact of cash flow on R&D expenditures, but large European firms are constrained in this respect.

- Supporting the access to finance for SMEs (especially with regards to R&D activities): evidence shows that financing constraints negatively affect the probability of setting up R&D activities, which is particularly relevant for SMEs eager to engage in R&D.

- Augment supply of and access to VC in Europe since VC increases innovativeness (especially of NTBFs): distinguish tools and evaluation criteria with regards to supporting CVC and IVC since the two have different goals and different effects on innovation.

1.5 Policies supporting corporate R&D

The fifth thematic strand of CONCORD 2010 focused on 'Supporting corporate R&D' and thus on the toeholds of R&D policy making, on the corresponding needs for action, and on ways to provide appropriate support in this regard. Overall, four studies have been presented aimed at investigating the factors that influence the nature and scale of the socio-economic impact of public and private R&D investment, revising public agencies' selection procedures, analysing the national R&D policies and elaborating and discussing the use of new indicators in terms of support to corporate R&D.

THE HETEROGENEOUS IMPACT OF PUBLICLY FUNDED R&D ON FIRM R&D INVESTMENT, INNOVATION AND ECONOMIC PERFORMANCE: THE ITALIAN CASE

Giovanni Cerulli, Bianca Potì

This micro-level study explores the impact of an Italian R&D policy measure aimed to support corporate R&D activities. The authors have focused their work on the econometric analysis of additionality in inputs and outputs. By exploring the presence/absence of "own R&D" investment, based on a sample of Italian firms, a group of firms characterised by 'additionality' in this regard could be distinguished from the 'crowding-out' examples. The study further looks at the effect of the program on output additionality (→ innovation) by comparing the particular impact privately funded and publicly funded industrial R&D expenditures have on the number of patents filed. Finally, the impact of R&D and innovation and thus in particular the effect resulting from R&D support on firms' economic performance is investigated by analysing three indicators of business performance: productivity, profitability and rate of growth.

The study suggests that the considered Italian R&D policy measure is successful both in terms of its capacity to promote "input additionality" (own R&D performance) as well as "output additionality". But, the additionalities are not homogeneously distributed. Firms characterised by additionality are generally larger, more oriented towards patents, and seek to increase their fixed capital stock. Based on these results, the authors assume that these differences relate to the role played by "scale economies" on one hand and by certain "company strategies" on the other. In fact, larger firms may generally take more advantage of public support policies by exploiting higher scale economies through greater internal division of labour (specialisation), access to wider internal and external networks, ability in generating and absorbing spillovers, market/political power, easier access to credit and equity, and in this regard outperform SMEs. The argument that different company strategies affect the appearance of additionality relates to the finding that larger firms appear more forward looking and their R&D activities may relate to a rather long-term objective. In turn, evidence suggests that (at least Italian) SMEs seem to be historically more oriented towards short-term returns (immediate profits).

These results call for a rethinking of the selection criteria adopted by the supportive agency. In fact, aspects related to firm behaviour/objectives seem to be more relevant for leveraging R&D and innovation investment levels. Moreover, firm size is a crucial factor. It has been suggested that, if supportive measures are envisaged or individual projects are launched, firms should better demonstrate ex ante the additionality of the support in order to qualify. Ex post this will be reviewed for assessing the appropriateness of the applied measure (and for further fine tuning of public initiatives to come).

MANAGING STRATEGIC ISSUES IN GLOBAL TECHNOLOGICAL INNOVATION PROJECTS

Roberto Sbragia, Marcos R. Piscopo

This study analyses global technological innovation projects developed by 34 Brazilian multinational companies and aims to understand how strategic issues affect the outcome of the projects. Thus, the analysis has two very interesting ties, first, internationalisation of R&D as a milestone for a company on the way towards competing globally and, second, the perception of R&D from the perspective of a MNE originated in an emerging economy.

By analysing strategic issues and their impact on the performance of selected innovation projects, the authors consider the following dimensions: i) project efficiency, (ii) impact on customer, (iii) impact on team, (iv) business results, and (v) preparation for the future. Evidence from the study suggests that Brazilian MNEs go beyond the iron triangle (schedule, costs and technology performance) by considering other project performance dimensions, such as customer satisfaction, business results and preparation for the future, which was previously unknown or neglected when measuring the performance of their global technological innovation undertakings. Moreover, the analysed companies seek to understand how their innovation efforts contribute to organisational growth and, however, aim to adjust accordingly by capability building, which is one of the greatest challenges MNEs from emerging economies are facing. The authors further stress how much the analysed MNEs care about their customers' satisfaction and that they increasingly pay attention to stakeholders' interests.

In spite of some methodological and data limitations, this study put forward the necessity to revise the evaluation criteria in the case of technological innovation projects, and this applies equally to publicly as well as privately financed projects. In this regard the importance of strategic issues (with general regard to the project results) and deficient project management (with regard to consequent cost escalation) has been stressed. Funding decisions for R&D and innovation support should take into account these findings and adjust the criteria accordingly.

THE SOCIO-ECONOMIC RETURN OF R&D SUPPORT PROGRAMMES

Mariana Carvalho, Paula Ferreira, Madalena Araújo, Enrique Goméz

This study focuses on the evaluation of socio-economic returns of public support to corporate R&D by analysing existing programmes with a particular emphasis on achieving an ordered structure of indicators to be preferably used in this regard. In fact, evaluating socio-economic returns to R&D support is challenging. The existing methodological approach seems to be insufficient and, in particular, appropriate indicators for evaluating intangible aspects are needed in order to capture the contribution R&D is providing to general social welfare. In this regard, based on a 'participatory methodology', the authors propose an organised structure of indicators (developed based on the literature) to be validated and in its structure balanced by individual 'weights' set as a result of comprehensive expert interviews (experts from both companies as well as public R&D support / funding organisations will be involved). The authors suggest using these indicators for improving the evaluation of R&D funding programmes.

The presented study is work in progress and the authors need to revise the proposed methodological approach, thus taking into account the comments and suggestions received in the course of CONCORD 2010. Nevertheless, although the results of this pilot study should be handled with caution due to the limitations of the data base, a general call for improving public support to R&D by outlining for each measure clearly the specific objective to be achieved is of great importance for both ex ante as well as ex post impact assessment. Moreover, the selection criteria need to be set out in order to allow general transparency.

INNOVATION PERFORMANCE AND POLICY REFORMS

Andrea Conte, Barbara Moench

The presented paper comprises of a comprehensive review of policy initiatives across the 27 EU Members States in the field of R&D and innovation. With focus on R&D policy approaches across the countries, the authors investigate the drivers of policy (reforms) by means of an original dataset thus allowing distinguishing sector specifics. In particular, the link between economic performance and reform measures adopted in the field of R&D policies is investigated. The authors base their analysis on the detailed information on R&D spending provided by EUROSTAT and the original European Commission MICREF database (released in October 2009), which traces product market reforms over the period 2004 - 2008 for EU-27. Conceptually, the study aims to verify R&D policy making (at national level) in the light of an ex post review of R&D performance in order to identify those types of instruments which appear more appropriate (successful) in stimulating corporate R&D activities by increasing additionality and avoiding possible crowding-out effects.

The results of this study suggest some interesting patterns emerging among different policy measures, for instance, certain complementarities between reforms in the public and private R&D domains with respect to business cycle conditions.

SUMMARY OF POLICY RELEVANT MESSAGES

The evidence from the four studies presented in the thematic strand 'Supporting corporate R&D' of CONCORD 2010 emphasises the importance of rethinking the design of policy interventions aiming to increase corporate R&D and innovation activities as a mean to achieve economic progress and social prosperity. In fact, it is not just about providing more (public) resources in this regard but rather raising effectiveness of the applied measures and thus taking into account further aspects such as agents' behaviour, individual objectives / incentives, business development paths, market situation and strategic issues. The main policy messages arising from the contributed papers can be summarised as follows:

- In order to use funds efficiently, any applied R&D policy support should be reviewed vis-à-vis the explicit aim of the support measure (firms' R&D performance), for instance by ex-ante or ex-post evaluations or by so called value-for-money audits, in other words, implementing a quantitative feed-back control system for policy impact assessment. Thus, individual measures (at country, region, sector, firm level) should be benchmarked against the corresponding best practice (which would ideally have an EU-27 wide scope).

- Member States will be encouraged to collect and share more detailed data in terms of R&D support measures and the corresponding impact on the performance of R&D and innovation activities in order to improve/facilitate ex-post/ex-ante impact assessment of R&D policy measures. In fact, such data would provide a wealth of information and thus allow comprehensive analyses of the link between corporate R&D and business performance and, by that means, help providing empirically based support to sound policy making in terms of R&D.

- Strategic and management issues are relevant for the success of technological innovation projects and should therefore be considered when selecting a certain project for public funding. In particular, companies should demonstrate additionality with regard to their R&D activities and by this means justify public support to corporate R&D.

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  Mutual Dependence of R&D and Trade

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