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EUROPEAN RESEARCH AREA (ERA) FROM THE INNOVATION PERSPECTIVE: KNOWLEDGE SPILLOVERS, COST OF INVENTING AND VOLUNTARY COOPERATION

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Abstract

The paper analyses the European Research Area policy (ERA) from the innovation perspective. The Lisbon Treaty gives the Union the objective of free circulation of researchers, scientific knowledge and technology. The five ERA initiatives implement the ERA policy on the basis of voluntary cooperation. The ERA and innovation are linked through the business sector R&D investment. The economic value of the ERA comes from accelerated cross-European knowledge spillovers reducing the cost of inventing. In general, important obstacles hinder the knowledge spillovers making them largely intra-national. These obstacles arise due to the incentives in providing and sharing knowledge and to costs of capturing knowledge spillovers. Funding of knowledge from national budgets and uncertain benefits from knowledge circulation across the heterogenous member states complicates situation further.

The analysis of Joint Programming and Better Careers and Mobility initiatives reveals multiple sources of obstacles to cross-European knowledge spillovers. Weak incentives in the member states and limited possibilities at the EU level block the implementation of ERA. In this constellation, the ERA initiatives need to support openness and competition in publicly funded research and universities as well as better models of scientific management to guarantee highest scientific quality. Accelerated (ERA) knowledge spillovers require extended and dynamic markets.

Keywords

European Research Area (ERA), knowledge spillovers, innovation, incentives, voluntary cooperation

Introduction*

This paper looks at the European Research Area (ERA) from an innovation perspective. Today, the European research area policy has a prominent role in the Lisbon Treaty[1]; the Union has been given the objective of free circulation of researchers, scientific knowledge and technology. The so-called five ERA initiatives[2] on the basis of partnership between the Commission and the Member states are already in action to implement ERA (ERA Green Paper 2007).

This paper addresses the question as to why Member states do not show a stronger commitment to implement the ERA policy in a situation of ever pressing economic problems. One obvious reason is that the economic value of the ERA policy and the individual ERA initiatives are not yet well understood. In order to answer these questions we examine the role of the European Research Area (ERA) in contributing to the European innovation performance. Also the conditions and incentives slowing down the implementation of the ERA initiatives become visible.

The ERA and innovation are linked through business sector R&D investment which is the basis for analysing the influence of the free circulation of knowledge on the innovation activities in Europe. The economic value of ERA comes from accelerated cross-European knowledge spillovers which reduce the cost of inventing. The business sector R&D activities look for the best quality knowledge in the world as basis for innovating.

However, important obstacles slow down the cross European knowledge spillovers making them largely intra-national. These obstacles arise to the most part endogenous due to the incentives in providing and sharing knowledge with an economic value and due to costs of capturing knowledge spillovers. The European specificity of the funding of knowledge from national budgets complicates the situation further. In addition, benefits from cross-border knowledge circulation (reduced cost of inventing) are not only uncertain but also differ across the heterogeneous member states.

The analysis of the Joint Programming and the Better Careers and Mobility initiatives shows that multiple sources of obstacles to cross-European knowledge spillovers and the related incentive problems are indeed present. The multiple and interacting sources of obstacles makes the EU level support to ERA implementation very complex. The traditional instruments of financial compensation are not effective. The R&D cooperation literature shows that the effectiveness of the traditional financial compensation (asymmetric partners) is weak while the EU budget also constrains the possibilities. Instead – to unblock the situation of weak incentives at the member states level and of limited possibilities at the EU level - the ERA initiatives should support more openness and competition in publicly funded research institutes and universities as well as efficient models of scientific management to guarantee highest scientific quality. Finally, the market cutting effects of knowledge spillovers call for European measures to increase the market size and dynamism for innovative products and services in Europe and access to markets outside of Europe.

The insights from this analysis contribute to European research and innovation policy making, in particular to the ERA's link to innovation and business sector R&D including the 3 % objective. They can also serve for a better implementation of the challenge-oriented "Europe 2020 Strategy".

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1 OJ 2008, The Treaty of the European Union and the Treaty on the Functioning of the European Union.

2 Joint Programming, Careers and Mobility, Research Infrastructure, Sharing knowledge and International cooperation.

The paper starts with an analysis of R&D expenditure in Europe, Japan, USA and some emerging countries in Asia showing the well known, permanent research and innovation gap vis-à-vis the USA – and possibly an emerging one with Asia. ERA policy is designed to reduce fragmentation in research and through this reverse the European research gap. The objectives of the five ERA initiatives are described and how the policy making mode (New Partnership) is organized. There is a short review about the recent academic discussion on the European research policy.

Chapter 2 develops an analytical basis for analyzing the ERA's contribution to innovation. The link between the ERA and European innovations comes from business sector R&D investment. The partial analytical literature on supply side determinants of business sector R&D and the effects of knowledge spillovers on the cost of inventing is presented. At the same time, demand side is equally important for business sector R&D decisions. The literature on incentives for sharing economically valuable knowledge and information (adverse selection, moral hazard, transaction costs) and the cost of knowledge spillovers explain the obstacles to knowledge spillovers. Recent literature shows that business sector R&D seeks to capture knowledge of from the highest academic quality.

In the 3rd Chapter it will be shown that the benefits of the ERA initiatives on innovation arise from the accelerated knowledge spillovers from publicly financed knowledge (research and higher education) to the cost of inventing. It will be shown that the obstacles and weak incentives to knowledge spillovers known from the economic literature as well as the financing of knowledge from national budgets explain also the weak voluntary cooperation for ERA initiatives. Two of the ERA initiatives (Joint programming and Better Careers and Mobility) will be discussed in terms of incentives for voluntary cooperation and European knowledge spillovers.

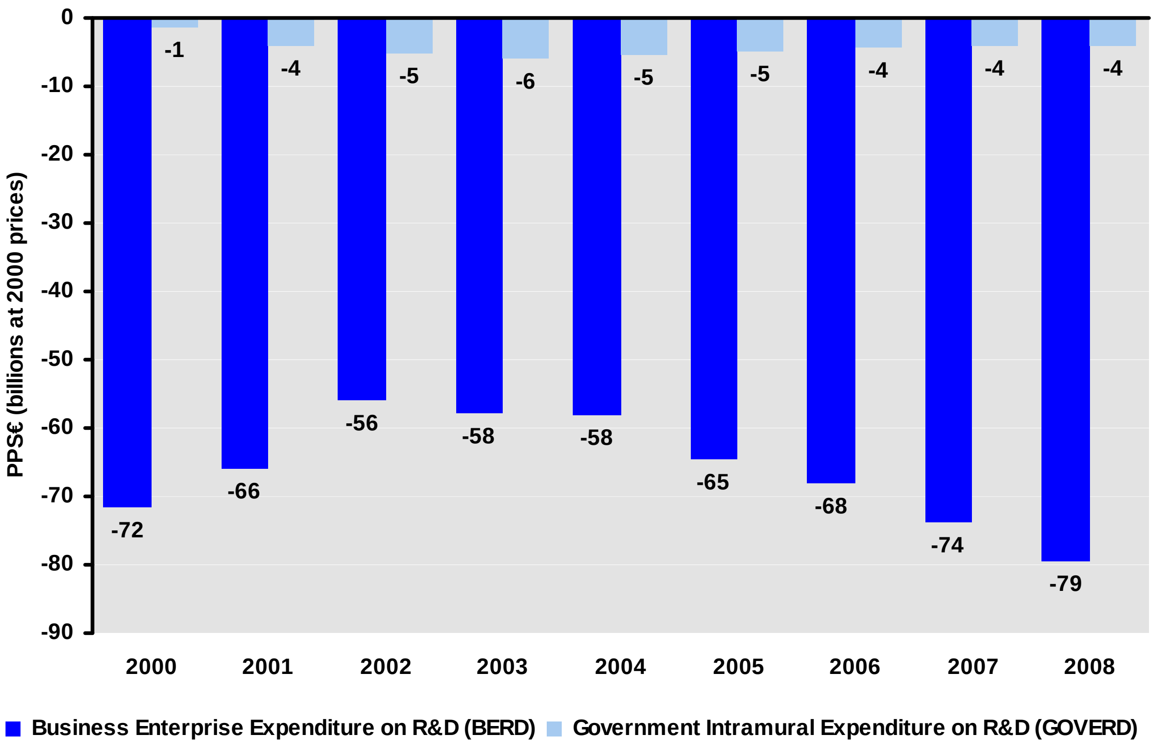
The Chapter 4 discusses how the EU level policy can support the implementation of Joint Programming and Careers and Mobility initiatives in spite of weak incentives and limited EU financial possibilities. The R&D cooperation literature shows that the effectiveness of the traditional financial compensation (asymmetric partners) is weak. As the recent academic literature discusses, the ERA initiatives should support more openness and competition in publicly funded research and universities. Efficient models of scientific management need to guarantee competition for highest scientific quality. The literature on business sector R&D investment and knowledge spillovers shows that an acceleration of ERA knowledge spillovers needs to be complemented by extended and dynamic product and services markets.

1. European research and innovation challenges and policies

1.1. European research gap dynamics

In the post war period the EU-27 invests permanently less in research than the USA giving rise to a permanent research gap. In particular, the business sector is investing much less in R&D in Europe than in the USA. Business sector R&D reflects directly the innovation activities in the business sector and therefore the gap indicates to the relative weak innovation efforts in Europe (see Figure 1 and Table 1). The public sector R&D is only slightly lower in the EU-27 in comparison to that of the USA.

Figure 1: EU 27 – USA Gap in research, 2000 – 2007, in Million PPS Euro at 2000



Source: DG Research
Data: Eurostat

However, there is a considerable diversity across the Member states in terms of their public and private research investment. While in 2007 the total average R&D expenditure per capita in EU-27 accounts to 462,4 Euro per capita it comes up to 1310,3 Euro per capita in Sweden and to 18,2 Euro per capita in Bulgaria. The Swedish per head R&D efforts are even higher than those of the USA (902,6 Euro per capita in 2007).

The European research, technology and innovation gaps and the associated relatively weak economic performance of the EU are not new phenomenon. The permanently lower R&D investment implies a (relatively) lower cumulative knowledge stock in Europe in comparison to the USA. Applying knowledge based growth theory (for example see Grossman/Helpmann 1991; Romer 1990) in particular the low business sector R&D investment is not contributing to the knowledge stock and the productivity of future R&D efforts. This is a problem because the overall knowledge stock and its growth (through R&D investment) are important sources of knowledge for innovation and long term growth both for individual Member states and for the EU as a whole. The relative smaller European knowledge stock and lower spillovers is accompanied with locally separated (national) knowledge stocks and (intra-national) spillovers. Therefore, the relatively slow overall accumulation of knowledge and innovation investment matters for all individual EU countries. The persistent research gap vis-à-vis the USA and diversity across member states on the other hand is an indication for important obstacles to accelerated knowledge spillovers in Europe.

Today, this situation is confronted with the very high increase of R&D activities in the emerging countries like China (218%) and Korea (93%) in 2000 – 2007 (see Table 2). In particular, business sector research is increasing even faster with 284% and 98% respectively in contrast to EU-27 19% and USA 12%. These extremely high growth rates are of course based at low initial levels but in China the increase of business sector R&D in this period corresponds in absolute numbers 40,3 billion PPS at

2000 Euro which is much larger than in the total EU with 19,6 billion PPS at 2000 Euro and even in the USA with 21,6 billion PPS at 2000 Euro. These figures can be taken as an indication that the business sector R&D worldwide orientates towards the economically dynamic regions in creating innovations and contributing to its knowledge stock and future R&D investment.

The levels and increases in publicly funded research (GOVERD) are much lower. In Japan publicly funded R&D expenditure even decreases in the period 2000 to 2007. Again the absolute increase of publicly funded research is the highest in China while the level is considerably lower (Tables 1 and 2).

Table 1: R&D investment 2007, in billion current Euro

Region	Total R&D, Euro	Business R&D, Euro	Public sector R&D, Euro
EU 27	229,0	146,7	28,9
USA	272,2	196,5	29,5
Japan	110,1	85,8	8,6
China	35,6	25,7	2,9
Korea	24,6	18,7	6,8

Source: New Cronos. China, excl. Hong Kong.

Table 2: Development of R&D investment 2000 – 2007, in billion PPS at 2000 Euro

Region	Increase in total, %	Increase in business sector, %	Increase in public sector, %	Increase in absolute, total	Increase in absolute, Business sector	Increase in absolute, public sector
	GERD	BERD	GOVERD	GERD	BERD	GOVERD
EU 27	20,1	19,2	10,4	32,2	19,6	2,4
USA	16,1	12,4	22,0	37,7	21,6	5,3
Japan	26,1	38,4	-0,01	22,5	23,5	-0,08
China	218,3	283,8	94,5	51,7	40,3	7,0
Korea	92,5	98,3	68,6	14,3	11,3	1,4

Source: New Cronos. China, excl. Hong Kong.

1.2. European research policy governance: Member states and the EU level

The individual Member states are the main actors in research and innovation policies in Europe. The governments address their national issues in research, innovation and science policy including their involvement in the EU level, international and intergovernmental R&D cooperation. In 2007, the governments of the 27 member states funded basic research (with 29 billion Euro), research in higher education (with 41 Billion Euro) and business sector R&D (with 10.0 Billion Euro) while the EU level funding instruments are rather very low.[3] The corresponding figures for the USA were 29,5 billion for public funded research, 23,8 billion for research in higher education and 1,9 billion for business sector research.[4]

The EU level is responsible for the implementation of the multi-annual Research Framework Programme (FP), coordinating national research policies and the ERA policy (Lisbon Treaty). The

[3] The EU level does not provide direct financial subsidies or tax incentives to the business sector R&D.

[4] These figures do not include other types of supporting instruments such as taxes.

multi annual Research Framework Programme is financed from the EU budget and the present FP7 has a budget of around 54 billion Euro running for the period 2007 - 2013.[5] The FP subsidies cross-national, cross-sectoral R&D cooperation through competitive calls, cross-national mobility grants of researchers, networking and today also basic research on the basis of individual grants (European Research Council (ERC)) as well as support for R&D in Small and Medium sized Enterprises.

Other EU level funding instruments for research and innovation are the Competitiveness and Innovation Programme (CIP) and Structural funds where the first has provided an average annual funding for research and innovation for 2000-2006 4,4 Billion euro to be increase to almost 15 billion euro for 2007-2013 (Key Figures 2009). The use of Structural Funds is in the responsibility of the Member states and regions. The EU level is called for guaranteeing an efficient governance between its funding instruments (EC 2010; Paasi 2008).

The small size of the EU level funding is striking when compared with the USA federal level efforts. Alone in 2006 it comes up to 94 billion US$ in 2006 (making 28% of all funding in the USA (NSF Science and Engineering Indicators 2008). Or in terms of research fields, US National Institute for Health (NIH) on medical research alone counts to 28.4 billion US$ each year which is roughly the half of the overall 7 year FP budget (Eucaoua 2009).

Today, the Treaty on European Union integrates a new element about "strengthen its scientific and technological bases by achieving a European research area in which researchers, scientific knowledge and technology circulate freely…"[6]. Yet, the Lisbon Treaty explicitly points out the independency of Member states in European research policy and the requirement to respect the fundamental orientations and choices of the Member states (see TFEU Art. 4 (3).

The new Treaty strengthens also the role of the EU in research policy coordination (TFEU Art. 181(2)) in using the Open method of coordination in the context of the 3% Barcelona objective and the involvement of CREST (Comité de la recherché scientific et technique) aiming to stimulate and coordinate national R&D policies in the context of the Lisbon strategy; today in the context of "the Europe 2020 Strategy".

Academic discussion on EU research policies

Since the Sapir report (2002) and the launch of the Lisbon Strategy to support knowledge based economy (2000) it has been recognised that the structure and size of the EU budget needs to reflect policy objectives and challenges of the EU. In particular, in order to support the Lisbon strategy it is argued that the level and share of knowledge policies needs to be increased in relation to Common Agricultural Policy (CAP). Arguably, an adequate design of expenditure and revenues and their structure towards knowledge investment in the EU budget can make a difference on European growth dynamism (Sapir et al 2002). Theoretically, research policy at the EU level is justified by positive externalities due to cross-border spill-overs from research (having the characteristics of a public good and economies of scale in the R&D activities) (see Korkman 2005; Pisani/von Hagen 2003).[7]

It has also been argued that the EU level funding instruments for research themselves (because of low quantity) do not make a difference to the rate and direction of technological progress but the EU has other policy areas which matter for innovation and R&D investment such as regulations or

5 The present FP7 has 4 Specific Programmes: Cooperation, People, Ideas, Capacities.

6 Articles 179-190: Art 179 "The Union shall have the objective of strengthening its scientific and technological bases by achieving a European research area in which researchers, scientific knowledge and technology circulate freely with view of the competitiveness of the European industry.

7 The assignment criteria depends on the assumption about the characteristics of public goods and the externalities (costless, immediate, equally distributed). In this paper we will see that the knowledge spillovers differ importantly from these characteristics (see below).

standards[8] (Pavitt 1998). Already the Aho report 2006 (initiating the Broad based innovation policy) and discussions in some Member states (Finland and Germany for example) have recognised the broader view on innovation rather than the research perspective alone. Recently, the increasing importance of horizontal policies for research and innovation policy when countries and Europe approach the technological frontier has been pointed out (Aghion et al. 2006).

In contrast to the so-called European paradox (European scientific inputs and outputs are relatively high but the problem lies in the weak transformation to innovations), it has now been recognised that the EU has an important problem also in the quality of its science (Marimon/Graca Carvalho 2008a and 2008b; Bonaccorsi 2007). The underlying reason is the low competition in academic research due to institutional regulations forming barriers between the national science systems, in particular in publicly financed research and universities in Europe. The national science system lack on openness and competition while coordination and opening at the EU level can bring important benefits for quality (Marimon et al. 2008a; Marimon et al 2008b; Pavitt 1998).

Intensive discussions about the orientations of European research policy have taken place in the so-called Knowledge for Growth group[9] and various expert groups. These groups have laid down important principles for the European research (and innovation) policy towards solving economic, societal and environmental challenges (along with the quantitative goal of 3% research intensity) and based on a new ecology of the research system (with reformed actors and linkages) (Georghiou 2008). The ERA expert group "The role of community research policy in the knowledge-based economy (European Commission 2009) reinforces the orientation of European research and innovation policy towards economic, societal and environmental challenges while taking strongly into account the globalisation of the innovation environment and the ongoing economic crisis.

Indeed, a certain progress is visible along the lines of academic discourse: The budget of FP7 was increased (although less than originally proposed by the Commission), the ERC based on high autonomy – expanding EU R&D policy on basic research - has been launched, broad based innovation policy has been launched and, in particular, the ERA to support knowledge circulation in cooperation with the Member states' research policies is integrated in the Lisbon Treaty. Today, the European research and innovation strategy is strongly challenge oriented in areas such as environment, energy, financial crisis and social matters.

1.3. European Research Area (ERA) policy: ERA initiatives and new partnership

The idea of a European Research Area (ERA) was launched already 2000 (EC COM (2000) 6 final) and clearly takes the position that the fragmentation of European research and the absence of a real European research policy are responsible for Europe's relatively weak research, innovation and economic performance (Banchoff 2002). Also today the success of ERA is seen as critical for Europe's innovation and economic performance but also for achieving EU policy objectives, in particular for Barroso's political programme "Europe 2020 Strategy" for 2010-2014 (EC 2010).

The ERA's central idea concerning free circulation of knowledge or the establishment of an "internal market for research" needs concrete measures of implementation which are included in the ERA Green Paper 2007 in terms of five concrete initiatives (EC COM(2007 161).[10]

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8 Also in Lisbon Treaty Art. 179(2):.. "to exploit the internal market potential to the full, in particular through the opening-up of national public contracts, the definition of common standards and the removal of legal and fiscal obstable to that cooperation."

9 See http://ec.europa.eu/invest-in-research/monitoring/knowledge_en.htm

10 For a comprehensive discussion of ERA's past actions and future plans, see EC 2009, The European Research Area Partnership. 2008 Initiatives. Luxembourg.

Box 1: The five ERA initiatives

1. Towards Joint Programming in Research (EC COM(2008) 468): The aim is to decrease fragmentation and to make a better use of Europe's limited public sector R&D funds through voluntary cooperation. In particular, in the areas of common societal challenges (not national priorities) where resources need to be pooled for achieving results.

2. Better Careers and more mobility (EC COM(2008) 317): The aim is to ensure the availability and quality of the necessary researchers in partnership with Member states in the areas of open recruitment, social security and pensions issues, attractive employment and working conditions and issues on right training.

3. Research Infrastructure (EC COM(2008) 467): The legal framework of European Research Infrastructure is designed to facilitate the joint establishment and operation of research facilities of European interest between several Member states and associated states.

4. Sharing knowledge (EC C(2008) 1329): This initiative aims mainly to improve the management of IPRs in public research organisations, better dissemination of knowledge from academic – industry collaboration (licencing, spin-offs) and rules of governance for contract research.

5. International cooperation (EC COM(2008) 588): Strengthening the partnership between the Member states and the EC contributes to stability, security and prosperity in the world and promotes European policy goals and European technologies worldwide.

Source: ERA initiatives 2008.

The implementation of the ERA's initiatives is based on the concept of a New Partnership between the Commission and the Member States in order to strengthen the commitment of member states to implement the ERA policy.[11] This so-called 'Ljubljana Process' enhances the political governance of the ERA by building links between research and other policies and by setting up the long term vision European Research Area Vision 2020 (see Council of the European Union, 2891st Competitiveness Council, 2. December 2008).

1.4. Conclusions

The permanent R&D gap in Europe vis-à-vis the USA indicates that the EU level and Member states' research policies have not been effective and sufficient. The long term persistence of European research gaps results in a relatively smaller knowledge stock and therefore further weak future prospects for research and innovation in Europe and in the individual member states. In the following chapter an analytical frame is developed which allows the identification of the economic value of the ERA. The link between the ERA and innovation is the business sector R&D and knowledge spillovers.

2. Analytical framework for research, innovation and knowledge spillovers

2.1. Competition, research and innovation: driving forces

It is initially the competition on the product markets and the profit prospective which induces innovation (Schumpeter 1942). The business sector R&D reflects the efforts of a firm to increase its

[11] The voluntary cooperation between Member states does not necessarily concern all Member states but eventually only a group. Member states have establish five ERA groups with the Commission as rapporteur which work out the implementation strategies for each individual ERA initiative. The organisation of the ERA groups are different in different initiatives.

performance and competitiveness through innovative products.[12] Economic variables and incentives determine technological progress, i.e. knowledge is produced by R&D investment (endogenously) and it is used as a production factors in the production of knowledge so long there are economic incentives to do so (for example Grossman/Helpman 1991, referring to Arrow 1962).

In particular, the endogenous growth theory was capable of showing how knowledge production and the technological spillovers from it to a general knowledge stock can generate long term growth. In turn, the knowledge spillovers (from the general stock of knowledge) increase the productivity of future R&D investment of firms or reduce their costs which add further to the stock of general knowledge (Grossman/Helpman 1991; Romer 1990).[13]

The general equilibrium model shows how both costs of R&D and the rewards for innovation are affected by conditions in product, factor and capital markets (Grossman/Helpman 1991). However, a substantial empirical and partial analytical literature has shown that knowledge spillovers are an important part of firm's innovation decisions and that they are not automatic.

Innovation context: consequences for research policy

In the economic analysis and models very often research and innovation are treated as synonyms which however blur important policy and economic incentive issues.[14] In particular, the economic policy has strongly focused on the specific characteristics of research, its outputs and their consequences on market efficiencies and incentives.[15] Policies have been developed to compensate the gap between private and social rate of return (calling for IPR policies, subsidies or joint research ventures). Government funding is called for financing the academic/basic research which is assumed to have non-rival and non-excludable output.

In the knowledge based growth theory obviously the knowledge spillovers are so small that they do not disturb the incentives to knowledge production while contributing to a general knowledge stock. Knowledge sharing out of it does not pose any information or incentives problems or any other types of obstacles which are known in the partial-analytical literature. This growth theory points out that for innovations also product and factor markets matter but so do types of knowledge and the incentives for their spillovers.[16]

The difference between public ("general knowledge stock") and private knowledge and their weak interactions and endogenous nature has been well recognized (David/Dagupta 1994; Foray 2004). In the innovation context all knowledge becomes economically valuable knowledge because of the role of knowledge for the competition in the product market. In addition, the economics of information point out to many important obstacles or inefficiencies in the knowledge market and sharing which gives rise to transaction costs also in the knowledge spillovers.

The unspecified treatment of R&D investment is misleading in the context of research and innovation policy because "research" is closer to the invention (as output from knowledge production) and D closer to the innovation of a firm (new product on the market). An innovation is accomplished

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12 ERA concept does not include other types of intangibles and the so-called non-technological innovations.

13 Or alternatively long term growth arises from knowledge spillovers from the investment in human capital.

14 Partly, due to weak data availability and measurement for innovation R&D expenditure (often measured by total R&D expenditure) has been taken as synonym for innovation in empirical models.

15 "Market failures", i.e. market forces left alone under-invest in research activities result from weak appropriability of knowledge outputs, but also from uncertainties and indivisibilities (fixed cost character of R&D activity) in the knowledge production (Arrow 1962; Nelson 1959).

16 While (technological) knowledge spillovers is the basis for the new growth theories, in the technological rivalry of firms knowledge is proprietary calling for IPRs. Already Nelson 1982 speaks about a schizophrenia of economics for this dichotomy.

only with the first commercial transaction involving the new products and processes (Stoneman 1983). Market conditions matter for the decisions to develop new technologies.

Further, R&D is untypical investment because circa 50 % of it is wages and salaries of highly educated scientists and engineers. In the firms research personnel cannot be easily fired because of the tacit knowledge (zero elasticity of substitution with other types of labor) (Hall/Lerner 2009). Tacit knowledge embodied in the human capital is an important input factor for knowledge creation and its mobility creates knowledge spillovers (see below).

2.2. Determinants of Business R&D investment

2.2.1 Supply and demand side determinants for business sector R&D

Business sector investment in knowledge (R&D activities) is produced due to economic incentives. The expected profits of R&D investment depend on the supply and demand factors and they determine the level and direction of the investment, i.e. firms' R&D strategy (Pakes/Schankerman 1987; Nelson 1982).[17]

The supply of scientific and technological knowledge and opportunities determine the expected cost of producing new industrial knowledge, i.e. the cost of inventing (Nelson 1982). The quantity and quality of scientific and engineering knowledge differ across industries, technologies and sciences – and countries. According to these arguments differences in the cost of producing knowledge across industries explains therefore the observed differences in the industrial R&D investment and the rate of technical change (Rosenberg 1963, 1969, 1974, Scherer 1965).

Demand and the size of the market become the main determinants of the business sector R&D investment and technical change under elastic supply of new industrial knowledge, i.e. scientific knowledge is provided at the same level of costs for all industries (countries). (Schmookler 1966, for capital goods). The size of the market for the innovative product is proportional to the expected rewards of the business sector R&D investment. Knowledge spillovers from research reduce the market size because increased number of competing firms about market shares (Grossman/Helpman 1991).[18]

It is rather the science which brings radical innovation than a demand pull. Demand side is usually determining the incremental innovations rather than radical ones which come from the scientific discovery (Gerolski 2003).

2.2.2. Human resources in the knowledge production[19]

The production of knowledge depends on the availability of human resources for research (researchers and engineers), in particular at the technology frontier (see for example Phelps/Nelson 1966; Aghion 2006). More abundant stock of researchers is related to lower wage and therefore a lower cost of inventing. Increase in research and innovation activities requires an increase in the quantity with right quality of human capital (researchers, engineers) (Romer 2000).

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17 Also relative prices matter, for example factor prices for factor saving technical progress. Policy can use regulations to influence relative prices like in supporting environmental innovations.

18 The market size depends on the IPR which guarantee a temporary monopoly for an innovating firm. Also government demand and public procurement policy matter. It can also influence the direction of technical change, i.e. market size for a special type of technology. International policy and export markets are critical in particular for small countries.

19 Another important issue is the availability of finance (risk capital) and problems of asymmetric information in the financial markets (leading to a finance gap for R&D, Hall/Lerner 2009). Risk capital is not included in this paper which concentrates on knowledge spillovers.

However, labour markets for researches are imperfect because of intangible character of education investment (market failures), various institutional (regulations) conditions but also due to asymmetric information. Public sector finances the higher education and research system in many countries, in particular in Europe. Supply and demand for human resources does not always match. Therefore it is possible that it becomes a bottleneck for business sector R&D investment.

2.3. Business sector R&D and sources of knowledge: cost of inventing

Knowledge spillovers for business sector research and the cost of inventing

Innovation and growth theories recognise that along with technological opportunities (supply of knowledge) also knowledge spillovers determine the expected costs of producing new technology. Knowledge spillovers are an important input to firms' own research process (business sector R&D) increasing its effectiveness and reducing (cost of inventing. Inventing and innovation activities of firms utilise today a multiple sources of knowledge which is a different understanding that the linear innovation model where innovation was a direct result from and initiated by basic research (Cohen et al 2005).

Industry's technological opportunities depend on various other sources of extra-industry and intra-industry knowledge. Such sources for knowledge spillovers are basic academic research and applied research, external sources of technological knowledge (like upstream suppliers like materials) or down-stream users of industry's products (Cohen 1996). Recently the relevant range of knowledge and information sources has been extended to cover also competitors, customers, suppliers, consultants and contracts with R&D firms along with joint ventures and the firm's own manufacturing operations (Cohen et al 2005, p.5). International knowledge spillovers are an important source as well (Griliches 1992; Mohnen 2001; Grossman/Helpman 1991).

There is a substantial literature on inter-firm, inter-industry and intra-industry knowledge spillovers, in particular in the context of spillovers which reduce the incentives to invest in knowledge production (see above). The importance and sources of knowledge spillovers differ across industries (Cohen et al 2005; Nelson 1982). In the R&D intensive industries the knowledge spillovers can be an incentive for R&D investment rather than disincentive (Gerolski 1996).

In the following we will concentrate on those sources of knowledge spillovers which are relevant for two ERA initiatives "Joint programming of publicly funded research" and "Careers and Mobility of Researchers" as well as for the demand oriented innovation policy. Therefore, the main focus is on the academic research and cross-border, international knowledge spillovers embodied in human capital.

The role of public sector and university research for business sector R&D

Academic research is rather curiosity driven than profit-driven and the intended outcome of research is non-rival and non-excludable (Grossman/Helmann 1991). The output (scientific results and researchers) from academic research[20] contribute to the public knowledge stock which provides inputs (knowledge spillovers) to the future research activities. This lowers the costs of future technical breakthroughs. Therefore, the productivity of business sector and applied public sector research activities increases the rates of return of business sector R&D investment, or in other words, the knowledge spillovers lower the cost of inventing (David/Dasgupta 1994; Nelson 1982; Pakes/Schankerman 1987).

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[20] Academic research is considered as public good which is financed by the government (ideally by taxes according to the economics of public goods literature) and therefore provided free to everybody.

Recent academic literature points out that recently the importance of academic research for inventing activities has increased in the USA (Cohen et al 2005; Brandstetter et al 2005). Also the propensity to conduct (business sector) research abroad seems to be related to a critical mass of quality academic research and local scientific networks of university researchers (Belderbos et al 2009). Earlier empirical research (Mansfield 1994; Jaffe, A. 1989) has produced the same result that quality of academic research (university department), the size and the geographical proximity are the most important factors for the industrial research. Firms tend to support applied research in their proximity but insist and choose for highest quality of academic research even in other locations.

Public research institutes and universities are also the source of research skills for the skilled-biased innovations and technological progress and for a sufficient supply of researchers for research and for the business sector research (Cohen et al 2005). For guaranteeing the highest quality also adequate incentive systems for research professionals are needed. However, as basic research does not compete through the product market like the business sector R&D duplication and quality problems exist (Pavitt 1998; Grossman/Helpman 1991).

International diffusion and spillovers

Analogous to other (public sector; general knowledge stock) knowledge spillovers, international knowledge spillovers can play an important role for the growth dynamism. In particular, integrated or open economies can utilize these sources of knowledge spillovers for example international mobility of researchers, R&D cooperation or scientific publications that is empirically quite well demonstrated (Mohnen 2001; Coe/Helpman 1995; Aghion/Howitt 2009).

Demand and customers as source of knowledge

The recent (demand led) innovation theories pays more attention to the interaction between lead users and innovators (innovation communities). They are the source of information concerning needs and solutions which support the design of innovative products and services.

2.4. Obstacles to Knowledge spillovers

In the new growth theory knowledge spillovers are the driver of growth but a look at the real world reveals that they are not taking place automatically or without efforts. The issues about lags and the intra-national or global scope of knowledge spillovers are particularly important to growth and trade policy (Grossman/Helpman 1991). Intra-national spillovers (national component of the knowledge stock) lead to reinforcing comparative advantages, global spillovers lead to the validity of traditional trade theory.

Certain types of spillovers take place more or less automatically (although not necessarily without cost) due to embodedness in goods or codified in publications. However, there is a range of reasons why spillovers are not immediate and tend to stay local.[21] One type of obstacles to global and immediate knowledge spillovers is the existence of cost of exploitation (efforts, investment) which depends on various parameters (absorptive capacity, technological distance). Another type of obstacles lies in the characteristics of knowledge and information themselves which influence the incentives of knowledge sharing, inefficient markets and needs for institutions because transaction costs occur.

Knowledge spillovers are endogenous and costly: role of absorptive capacities

Capturing knowledge spillovers requires efforts which depend on costs and benefits. The large the technological distance and lower the absorptive capacities, the weaker the knowledge spillover. In

[21] There is a rich literature on regional knowledge spillovers as well as the New Regional Development Theory.

particular, the in-house R&D efforts and education build up the necessary absorptive capacity to exploit externally created knowledge (Cohen, W./Levinthal, D. 1990). Therefore, for countries at lower technological level the higher education (the absorptive capacities) and capabilities for experimental use of new instruments requires the capacity to conduct basic research.

Systemic differences in incentive for knowledge sharing: science - industry

A real challenge for policy maker is to design the science – industry interactions (David/Dasgupta 1994, 510) which do not occur automatically because knowledge disclosure depends on different incentives, organisations and norms in the academic and industrial research systems and institutions.[22] The types of research are not determined by the location of their production but are endogenous. The input of the knowledge from basic research in the context of product market competition means that its use by rivals (reduction of the expected costs of inventing) the profit opportunities (Witt 2007; Grossman/Helpman 1991), i.e. basic research is not non-rival in this context.

Incentives to knowledge sharing: role transaction costs

Exchange and sharing of economically valuable knowledge are bound to important constraints because of its specific characteristics and asymmetric information (between seller and buyer, see Akerlof 1970 Lemon's problem). Arrow's paradox (Arrow 1962) describes the situation: if the potential buyer does not know content of the information, he cannot appreciate its value. When he does know it, he does not need to buy it anymore. There is an uncertainty about the (future) economic value of the knowledge and it is not clear what the risks of the transaction are. The market imperfections give raise to so-called transaction costs which are necessary for the transaction to take place (Williamson 1975).

The transaction costs are particularly large with exchange of knowledge and information. Uncertainty and asymmetric information is the normal situation leading to moral hazard and adverse selection. Further there is the possibility of opportunistic behaviour of the partners (Durth 2001, p. 307). This situation brings high costs to sharing of knowledge and in the worst case prevents the sharing and spillovers of knowledge. Role of policy is therefore to support the transactions concerning knowledge (trust, contracts, coordination).

Human resources and knowledge spillovers

Human capital is the carrier of tacit knowledge and therefore the mobility of researchers (with tacit knowledge) is one of the most important means of knowledge spillovers across sectors, industries and countries. Mobility is however slowed down due to differences in incentive systems, to information, search and mobility cost, asymmetric information and in cross-country context due to national regulations.

Additional obstacles to international diffusion

International knowledge spillovers are usually assumed have additional barriers like language, geographical distance or differences in (science) institutions which increase the information and search costs and would explain slower knowledge diffusion. However, these obstacles might not be that serious if firms (even with higher search and information costs) – as already indicated – look for the best and most excellence academic research results and for R&D cooperation regardless of the distance or nationality (see above). International context nevertheless is likely to create higher transaction costs because institutional differences and different languages may weaken the trust relationships between the partners.

[22] This argument is in line with the so-called systemic failure in the knowledge system which prevents important interactions (and learning and diffusion) between knowledge producing actors of different knowledge types and sub-systems (Nelson/Winter 1977).

Knowledge spillovers from customers (markets)

Customers are an important source of knowledge with respect of needs and solutions which give orientations to the firms' R&D investment. However, the need information and solution information are sticky and there is the problem of asymmetry (Akerlof's Lemon problem) (von Hippel, E. 2006). However, the place of this type knowledge source still needs to be in integrated in the context of the endogenous growth theory while it is relatively easy to see as knowledge source which reduces cost of inventing. Simultaneously customer information influences demand side for business sector R&D.

2.5. Conclusions

Knowledge spillovers from business sector R&D investment or other sources of knowledge accumulate the general knowledge stock which allows higher productivity in the future scientific and technological research activities. In the innovation perspective the (inward) knowledge spillovers reduce the cost of inventing (more efficient business sector R&D investment). As profits of business sector R&D investment are directly proportional with the size of the market outward knowledge spillovers to competitors reduce the market size and rewards to business sector R&D.

Various types of obstacles to knowledge spillovers tend to make knowledge to an intra-national asset. This has strong implications (arguments initially developed for trade policy) for research and innovation policy, in particular for European research policy. A policy which aims to support circulation of knowledge has to consider the delicate balance between the incentives for production of knowledge and for knowledge spillovers in Europe. From the point of view of economic policy a serious issues is that certain knowledge spillovers can become intra-national because of a complex system of interacting incentives and other obstacles.

3. European Research Area (ERA) policy and knowledge spillovers

3.1. The economic value of ERA: knowledge spillovers and the cost of inventing

Applying the above theoretical framework(s) this chapter will analyse through which mechanisms ERA and its individual Initiatives can influence the circulation of knowledge, technology and researchers, how this influences the business sector R&D investment in Europe and what are the Member states incentives for voluntary cooperation in the context of European multi-level research policy.

Applying the knowledge based growth theory the permanent research and innovation gap lowers the relative knowledge stock in Europe and the incentives for future innovation efforts which in turn generates fewer knowledge spillovers into the general stock of knowledge. It can be argued that the fragmentation of European research system creates barriers to the circulation of knowledge, weak competition and lack of critical mass. This results in separate national knowledge stocks which are both too low in quantity and too low in quality of scientific research relative to its own potential and relative to the competitor USA.

The low quantity and quality of the scientific and technological knowledge stock negatively influences the cost of inventing, the business sector R&D investment and capacity to create new technologies in Europe. The cost of inventing is too high even within each Member state which exploits mainly its intra-national knowledge pools and human resources. Even those member states which do not have a research and innovation gap relative to the USA[23] suffer if they cannot exploit a

[23] The fragmentation of European research systems seems not to be a problem for the research and innovation performance in some Member states (at least until now).

large and high quality European knowledge pool as a result of their innovation efforts. This is the case if the knowledge spillovers are local due to various barriers as indicated in the theoretical discussion and cannot be substituted by other sources. Business sector R&D goes to where the best research takes place because high quality science is essential for technological breakthroughs (Bonaccosi 2007; Gerolski 2003; Brandstetter 2005; Mansfield 1994; Jaffe 1989). In this context China's extremely high growth rates of R&D with high absolute amounts can influence the business sector R&D decisions in Europe.

Therefore, the role of the ERA initiatives is to increase the circulation of knowledge (growing, larger and producing a more efficient knowledge pool) and to underpin stronger competition and better conditions for knowledge production which will make the national and European business sector R&D investment more efficient and will lower the cost of inventing in Europe. When the ERA can create favourable conditions (growing knowledge stock) higher business sector R&D investment in Europe will be possible if the demand is growing simultaneously.

While the rationals for a demand-led innovation policy at the EU level may be difficult to argue theoretically including a demand and market perspective in the European research policy makes sense. Markets for the products and services incorporating new knowledge are fragmented in Europe due to national IPR systems and regulations but also due to asymmetric information and search costs. Yet, the market size determines directly the expected rewards of business sector R&D investment which is important to compensate the disincentives from increased knowledge spillovers. The EU level is responsible for policies which influence the size and dynamism of European product and service markets (see below).

3.2. ERA knowledge spillovers and economics of voluntary cooperation

We have identified the economic value of ERA, i.e. the reduced cost of inventing but capturing this benefit in the member states comes only through implementation of the ERA initiatives. ERA and its initiatives operate on the basis of voluntary cooperation between member states or from voluntary adjustments of their national institutions in partnership with the Commission. In the European research policy context there is no legal framework to force contracts or policies at the member state level.[24] We now need to turn to the issue of incentives for voluntary cooperation which is the policy making model of the ERA policy and its initiatives.

The Member states are invited to reduce the inefficiency of European research by implementing the ERA initiatives which theoretically provide benefits at the EU level (in terms of efficiency and reduced costs of inventing). Yet, it is essential to show that an individual member state gets – at least in theory – can capture an additional benefit from the ERA knowledge spillovers through reduced costs of future technological breakthroughs. This is critical because the ERA initiatives influence the competitiveness of national industries and involve important political and legal aspects such as government funding (from tax payers money) for national public goods (education, basic research).[25]

Theoretically, the greatest benefits from ERA and its initiatives come when possibly high number (all) of the Member States participates in the initiatives. However, there are several reasons why the incentives for Member States of voluntary cooperation in European research policy are rather weak.

Firstly, research and innovation belong to the national competitiveness strategies of the Member states whose industries compete with each others at the European and international markets. In the context of competition in the product markets all – also from basic research - knowledge spillovers become rivals. Therefore, from the point of view of an individual member state basic research is

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24 However, the FTEU has been reinforced the role of EU level in coordinating research policies.

25 Also the national legal framework can prevent to use Member States' own financial funds (tax payers money) for international cooperation but this is a legal issue rather than an issue about economic incentives.

economically valuable knowledge which is financed from the national budget. The incentives for knowledge spillovers from the national public goods have probably a intra-national tendency. The Member States have weak incentives to produce European public goods from national funds (where also the free riding problem exists).

Secondly, the nature of knowledge and information has important consequences for the functioning of markets and institutions (due to asymmetric information issues) leading to transaction costs and other problems. Due to the characteristics of knowledge the benefits from cooperation are not clear (asymmetric information, quality (lemons) problem leading to inefficient markets). In this situation, a member state cannot assess a priori what it gets in return from its own efforts.

Thirdly, while the advantage cannot be assessed thus making impossible to assess the reduced cost of inventing, the necessary own efforts for capturing knowledge spillovers reduce their scope. The participants need to be convinced that the benefits are higher than the costs. These potential benefits and their conditionality can influence the incentives for voluntary cooperation of the Member States in the individual ERA initiatives. Such costs of spillovers may depend on geographical proximity but specially depend on the technological distance (quality of knowledge) and absorptive capacity.

The heterogeneity of member states in terms of size, technological level and absorptive capacity is an important determinant for the voluntary cooperation and choice of partners. Incentives to cooperate seem to be rather weak and in particular large and technology frontier countries being self-sufficient have fewer incentives to cooperate on ERA initiatives (Marimon/Graca Carvalho 2008a). In addition, it needs to be taken into account that the individual ERA initiatives have different mechanisms for supporting knowledge spillovers in Europe and each of them faces a variety of specific obstacles. We now turn to analysing the incentives for implementing Joint Programming and Better Careers and Mobility.

3.3. ERA initiatives and the incentives for voluntary cooperation[26]

3.3.1. Towards Joint Programming in publicly funded research

The ERA initiative “Joint Programming” in publicly funded research between a group of volunteer member states with the possible participation of the EU is justified due to the increase in the critical mass (economies of scale in R&D activities; reduces duplication). National funds should be pooled and research programmes and calls organised jointly together while the Commission may provide financial input. The final results are envisaged into be transformed to innovation (EC 2008).[27]

Joint programming is important because in contrast to the business sector R&D for which competition on the product markets abolishes duplication and leads to low quality research (Pavitt 1998; Grossman/Helpman 1991) public sector research activities are not open to European or international competition.[28] It is probable that the European public sector research involves duplication of effort and lower scientific quality (than the USA). The rationale for joint programming is therefore not primarily the aspect of critical mass and reduction of duplication for stronger economies of scale but increasing the degree of competition and higher scientific quality.

[26] The individual analysis does not cover the ERA initiatives on Research Infrastructure, Knowledge sharing and International cooperation.

[27] The Europe 2020 Strategy foresees that Joint Programming could take place in the areas of major environmental and societal challenges in Europe.

[28] Research outputs and researchers from basic research however do compete at the world academic markets according to the reputational system.

Joint Programming can reduce the cost of inventing in Europe which is higher than in the USA. And the cost of inventing also differs in each individual member state. However, in the innovation context also basic research constitutes economically useful knowledge (it is rival) and it matters who gets the benefits (reduced cost of inventing). Knowledge spillovers reduce own (industry's) profit opportunities (Witt 2007; d'Aspremont/Jacquemin 1988).[29] Who gets the economic benefits from joint programming is not clear a priori.

In this context, it is useful to apply the literature on joint research venture between firms where the R&D cooperation is the means to internalise externalities (knowledge spillovers). The benefits arise due to risk sharing, knowledge sharing, minimising transaction costs, economies of scale (among others Cassiman 2009; d'Aspremont/Jacquemin 1988; Wiethaus 2006).[30] The R&D cooperation literature informs us also about several reasons for weak incentives towards joint R&D activities like technical and incentive obstacles such as additional costs (transaction costs), knowledge disclosure is not perfect, the benefits are unclear with asymmetric partners and spillovers require efforts (see Chapter 3).

A two stage model of R&D cooperation provides us with clearer insights about these types of problems. In the two stage model of R&D cooperation[31] research efforts in basic and developmental research are conducted independently. Due to strategic issues on both sides the sharing of knowledge in the (basic) research phase creates an adverse selection problem and in the developmental phase a moral hazard problem. Therefore, there is an interaction between moral hazard and adverse selection problem. In particular, if the quality of knowledge differs and all knowledge levels are shared then only the most knowledgeable agents's knowledge is useful to the technology for efficient development effort at the subsequent stages (D'Apremont et al 1998). This means a strong free riding element and in the context of joint programming this indicates that (basic) research cooperation between qualitatively unequal partners becomes impossible (moral hazard, adverse selection, free riding, transaction costs, contracts, see in particular Silipo, D. 2008; Cassiman 2009; Durth 2001).[32]

Research outputs (even from basic research) are not simply information and recently it has been shown that when the knowledge spillover are costly (need absorptive capacities) and endogenous the incentives for R&D cooperation are reduced (Wiethaus 2006). It is also difficult to see how profit sharing (benefits) takes place in a country context, also because the costs of transforming the results from (joint) basic research to (national) innovations (national benefits or incentives) differ and are uncertain. Therefore, the theory of contracts could provide important insights to these problems.

3.3.2. The Better Careers and Mobility Initiative

The initiative Better Careers and More Mobility aims to ensure the availability and high quality of researchers (freedom of knowledge) in partnership with Member states in Europe. The initiative includes issues on right training, attractive careers and removal of barriers to mobility including open recruitment (in the public sector) and portability of grants, social security with supplementary pension

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29 How to analyse the incentives for R&D cooperation between basic research institutions depends on the underlying assumption about its characteristics. Assuming that basic research in an individual member state had the pure public goods characteristics leading to free riding and underinvestment in Europe. Then the policy issue would be that basic research has a too low level in Europe, and it should be provide by a EU level organisation at world level competition and financed by the EU budget (as discussed by Sapir et al 2002; Pisani-Ferry/Sapir 2005).

30 There is a large literature on joint research ventures usually focusing on impact of JRVs on R&D investment, welfare effects and consequences for competition. For an review in the European context, see for example Hagerdoorn et al 2000.

31 Results from the Joint Programming initiative are expected to contribute into innovations.

32 Important stability conditions for cooperation exist and have been worked out for firms' cooperation (see Cassiman 2009) such as in- and outgoing spillovers, free riding, information sharing.

schemes and attractive working conditions. It is also linked to the Bologna process of reforming on higher education in Europe.[33]

Insufficient availability of researchers in Europe is a combined result of ageing, weak attractiveness for foreigners and low entry points in researcher careers. In addition, the USA attracts a considerable number of – probably the best - European researchers. The lack of a European labour market for researchers leads to mismatches (due to information costs for example) between demand and supply across Europe preventing effective use of the human capital stock in European research. Increases in R&D activities result in increase of wages rather than higher employment of researchers if additional human resources cannot be found. There is no competition based recruitment in the public sector preventing mobility and healthy scientific competition.

Theoretically, this situation poses an obstacle to the business sector and to the public sector research activities and reduces the knowledge spillovers across Europe which arises from the mobility of tacit knowledge embodied in human capital. Human capital and its quality being the main factor of production for research the cost of inventing increases across individual member states' industry. In particular, mobility of researchers goes together with higher competition and associated institutional reforms in Europe (Marimon/Garcia Carvalho 2008a; Marimon/Garcia Carvalho 2008b; Aghion et al 2007). Scientific quality increases importantly.

However, from the point of view of a member state strong mobility is problematic because higher education is to a large degreefinanced by government budgets in expectation of mainly local use of human resources. It is also not without cost to attract researchers from other locations and introducting more competition across own institutions will create resistance (as described in Banchoff 2002). The balance and quality between the inward and outward flows of human capital is unknown a priori. Uncertainty about the benefits also weakens the willingness for necessary reforms.

With more openness public investment in higher education and universities might be reduce d because knowledge spillovers attract "free riding" with other regions or countries educational investment rather than financing from national budgets (national public goods) EU level public goods. However, better opportunities for mobility increase the private rates of returns to education investment and the incentives to invest privately in education; in particular, high mobility disciplines (Poutvaara 2005).

4. Supporting voluntary cooperation and reforms for ERA

The above analysis shows that ERA policy and the two selected initiatives provide potential economic benefits in terms of reduced cost of inventing, higher scientific quality and under certain conditions of increased business sector R&D in Europe. The benefits arise however only if the Member states apply the ERA initiatives.

Considering the potential benefits for innovation in Europe this raises the question of how the EU level policies could support the incentives for voluntary cooperation in all Member states. In the following we will discuss various EU level policy options which can support implementation of the ERA (Joint Programming and Better careers and Mobility) initiatives.

4.1. Financial compensation: limited effectiveness

Both the Joint Programming and Better Careers and Mobility initiatives face various types of obstacle and incentives which prevent voluntary cooperation and therefore knowledge sharing and spillovers. In the case of Joint Programming the R&D cooperation literature points out issues like asymmetric

[33] The need to have sufficient human resources for R&D in Europe has been visible since before the launch of the Lisbon Strategy 2000. Several initiatives have been launched (mobility and careers; code of conduct; pension rights).

partners and inefficiency problems from asymmetric information[34] while the ERA initiative Better Careers and Mobility faces obstacles due to national financing of higher education and the difficulty to introduce reforms in the national science systems.

The FP7 already gives financial incentives for European R&D cooperation between various research partners and organisations in Europe and compensates transaction and coordination costs (management of projects).[35] However, the management of the Framework programme is too heavy and complex and it takes too long to establish a contract. Therefore, the costs of project management are eventually higher than the benefits. This calls for the simplification of EU legal environment of complex rules with heavy management procedures.

Yet, there are even more serious issues concerning economic incentives and it is really difficult to see how financial compensation could work in practice to support joint programming. When partners are asymmetric (due to size or technological level) obstacles for voluntary cooperation arise because the inputs and benefits (knowledge spillovers) are not at equal levels both absolutely and relatively. Theoretically one could envisage that the EU level research policy may include instruments which try to improve cooperation between countries with same scientific quality (small and large for example). However, financial support can never compensate for differences in scientific quality.[36]

Secondly, the ERA's objective to support researchers' careers and mobility can reduce the member states' (public funding) incentives to invest in higher education and research in the universities if the local availability and knowledge spillovers weakens. An important free riding problem can emerge at the EU level even if private incentives to education investment in high mobility disciplines probably increase. If human capital becomes a European public good as the result of permanent higher mobility, the EU level might need to compensate the nationally reduced investment in higher education and universities with internationally competitive transnational research institutions and European level education.[37]

This type of additional financial instruments and compensations would increase the absolute size or relative share of research and education in the EU budget. The already existing demand to reduce the share of Common Agricultural Policy is still valid. This is difficult to achieve politically but a more serious problem is the effect of financial compensation on the incentives to the member states. Like the present policy of financial compensation for R&D cooperation through the FP has also sent wrong incentives for the member states. In some member states the FP is seen as substitute rather than complement to national research creating its own interest groups (Banchoff 2002). It also has been accompanied by the very harmful "Juste retour" thinking for European innovation dynamism.

4.2. Competitive and open science systems: higher academic quality

A more effective ERA policy is to apply the ERA initiatives to open up the national science systems. Competition and openness rather than financial incentives bring the necessary quality increase in all member states and at all levels (Marimon/Graca 2008a, 2008b; Bonaccio 2007). The academic literature has already recognised that opening up and introduction of more competition into the European science through institutional reforms is urgently needed in order to improve the quality of

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34 Costs and need for absorptive capacity for knowledge spillovers does not really call for EU level measures. However, the member states could use the Structural Funds themselves.

35 Various types of funding schemes exist for supporting European R&D cooperation between private and public research conducted by firms, universities, research organisations.

36 However, there are some examples about Joint Programming in environmental and societal challenges (SET-Plan and Alzheimer cooperation project) which can give insights about the conditions to cooperate successfully.

37 The FP already includes important programmes and instruments such as Marie Curie Programme (People) whose aim is temporary mobility of researchers. It supports financially the mobility of excellent researchers in Europe and in the world as well as their return to the home base.

research in Europe (Bonaccio 2007; Marimon/Graca 2008a; Marimon/Graca 2008b “Open, integrated and competitive ERA”; Aghion et al 2007 on university reforms; also EC, Better Careers and More Mobility, COM (2008) 317 final).

This need is reinforced in the innovation context because the quality of research, researchers and their mobility determine the cost of inventing (directly in the knowledge production and through knowledge spillovers). The highest academic excellence of research and of human capital is essential for the business sector R&D decisions. In particular, today, business sector R&D decisions are mostly internationally oriented and try to find the best knowledge sources worldwide. The overall improvement of scientific quality in Europe can be seen as a sort of externality to the European innovation activities.

The implementation of ERA initiatives "Joint Programming" and "Better Careers and Mobility" require (voluntary) institutional reforms in the public research sector and universities but reforms are costly and face resistance (Banchoff 2002; Marimon/Graca Carvalho 2008). However, overall mutual opening up has the highest competition effects and creates new opportunities to the participants from all countries. If for example all European universities had a rule of mobility then it is more probably that all benefit when they compete about the best researchers (with grants). Also the portability of ERC grants (from the FP and therefore EU budget) has increased competition and increased the efforts of universities to be an attractive research location.

Also Joint Programming should be seen as an instrument to increase competition, openness and therefore the quality of European basic research rather than creating a (quantitative) critical mass. The more countries participate the more there are new opportunities. The management model need to be focused on quality guaranteeing tasks at all levels from organising joint calls to evaluations (for example in using ERC as a model). The member states would benefit the most if their national funding agencies and competition rules always respect certain quality improving guidelines which at the end will support all European regions (Marimon/Gracia 2008b). In particular, the goal of excellence need to be connected to R&D structural funds, otherwise capacities and quality will never be built up (Marimon/Graca Carvalho 2008a).

4.3. Expanding demand and markets: compensating knowledge spillovers

ERA policy and its initiatives focus on the supply of knowledge, in particular on knowledge accumulation and spillovers including human capital. Yet, the potential benefits from knowledge spillovers and reduced the cost of inventions depend also how the demand for products or services integrating knowledge develops. Knowledge spillovers – even from public research – benefit also the competitors that is equivalent to decreasing market size and shares and therefore the expected profits.[38] Indeed, the relative low share of researchers in the European industry (in comparison to the USA) indicates that rather demand than supply is the limiting factor.

Therefore all EU level policies which reduce fragmentation and support dynamism of markets for innovative products belong to the European research and innovation policy.[39],[40] They include issues like the European Union patent, internal market (regulations, standards, directives), public procurement and Lead Market Initiative (user information)which support the incentives for voluntary implementation of ERA. In particular, innovative ideas are embodied in products and services with high income elasticity indicating that access to fast growing, large markets is crucial. Such market

[38] The aspect of rivalry on the product markets has important impacts on the incentives for knowledge spillovers and knowledge sharing.

[39] FTEU Art. 179 (2) includes the internal market and public procurement.

[40] For example the low share of researchers in the business sector labour force indicates that the business sector’s demand for human capital matters along with institutional barriers on scientists’ labour market and scientific institutions in Europe.

conditions are presently more likely to be found outside of Europe pointing out the importance of the EU level efforts on WTO agreements, including trade related aspects of intellectual property rights (TRIPs).

Lisbon type of structural policies in the Member state (removing institutional barriers to structural change; Encaoua 2009) together with policies on supporting take up of new activities (new innovative firms, conditions to take-ups, SMEs, access to markets) support equally the demand for knowledge functioning as carriers of knowledge diffusion.

5. Conclusions for European research and innovation policies

The innovation and business sector R&D perspective helps in identifying the economic value of the ERA policy, i.e. reducing cost of inventing in Europe. It is also the innovation context which reveals more clearly why the incentives of the Member States for voluntary cooperation in implementing the two ERA initiatives are rather weak.

ERA policy and EU level research and innovation policy have not yet addressed the importance of incentives and obstacles to knowledge spillovers. Nor has the underlying growth theory taken into account the obstacles to the knowledge spillovers which block this source of long term growth. The insights from partial analytical and empirical literature need to be integrated into the endogenous growth theory. These obstacles make tendencially the knowledge spillovers intra-national. More academic research is needed on the incentives for producing and sharing knowledge and the role of markets on the relationship between knowledge spillovers and business sector R&D in the growth context.

Furthermore, the obstacles to ERA knowledge spillovers have multiple sources and they interact. This makes the design of economic policy is very difficult. The traditional EU level research policy is based on the financial compensation of additional costs in the European R&D cooperation. It has however only limited effectiveness or even creates counter productive incentives (juste retour strategies). A stronger EU level of financing of basic research and higher education would reinforce the already old and valid request to increase knowledge investment by reducing the share of the Community Agricultural Policy – a difficult political task.

It was seen that the principal problem is the low competition in publicly funded research and education in comparison to that of the business sector where competition on the market eliminates low quality of research. Therefore, all countries, including those with lower technological levels can use the ERA initiative to open up their (publicly funded) research institutions and universities to inter-European competition and openness. Already a mutual opening universities for foreign (other national universities and European) researchers and introducing mobility periods for own staff would increase scientific competition. The higher the degree of mutual opening, the more opportunities are created. Probably new management models which implement the openness and completion through ERA initiatives are needed. Also the structural funds can be used to reinforce openness and competition.

The accelerated knowledge spillovers (from nationally funded research and higher education) reduce also the cost of inventing of competitors and reduce (even from publicly financed research) the market size of domestic firms when they benefit the competitor. Therefore, policies which increase the market size and dynamism are essential. The demand oriented research and innovation policy include issues like IPR with European dimensions, public procurement, internal market and trade policy; in particular it is important to guarantee the access to dynamic world markets.

ERA policy and its initiatives have the potential to reduce the cost of inventing in Europe which could reverse the persistent research and innovation gap in Europe. This gap and the rather intra-national knowledge spillovers also harm the individual member states' innovation performances.

Consequently, the national research and innovation policies need to integrate the ERA dimension in terms of competition and openness.

The above analysis of the ERA's contribution to innovation and the inherent obstacles to voluntary cooperation provide important information to the design of President Barroso's political program "Europe 2020" which orientates towards common European societal, economic and environmental challenges. Further this analytical approach also helps to see ERA's link to innovation – with the complementary demand side measures – and to the 3% objective and directly to the target of ¾ coming directly from the business sector.

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