INSTITUTE OF TECHNOLOGY AND REGIONAL POLICY
INTEREG **WORKING PAPER SERIES**

ISSN 1810-5807

InTeReg Working Paper No. 37-2007

PUBLIC VERSUS PRIVATE FUNDED BUSINESS R&D

SECTOR SPECIFIC SPECIALISATION INDICES AS A TOOL FOR POLICY ANALYSIS

Michael Dinges, Martin Berger (JOANNEUM RESEARCH Forschungsgesellschaft mbH)

Rainer Frietsch (Fraunhofer-Institut für System- und Innovationsforschung - ISI)

Aris Kaloudis (NIFU STEP)

March 2007

JOANNEUM RESEARCH Forschungsgesellschaft mbH – Institute of Technology and Regional Policy (InTeReg)

Vienna Office:
Haus der Forschung, Sensengasse 1
A-1090 Vienna, Austria
Phone: +43-1-581 75 20
E-Mail: intereg@joanneum.at

Graz Office:
Elisabethstraße 20
A-8010 Graz, Austria
Phone: +43-316-876 1488
E-Mail: intereg@joanneum.at

InTeReg Working Paper No. 37-2007

PUBLIC VERSUS PRIVATE FUNDED BUSINESS R&D

SECTOR SPECIFIC SPECIALISATION INDICES AS A TOOL FOR POLICY ANALYSIS

Michael Dinges, Martin Berger

JOANNEUM RESEARCH, Institute of Technology and Regional Policy
Haus der Forschung, Sensengasse 1, Austria
e-mail: michael.dinges@joanneum.at; martin.berger@joanneum.at
Tel: +43-1-581 75 20-2818 ,-2827

Rainer Frietsch

Fraunhofer-Institut für System- und Innovationsforschung (ISI)
Breslauer Straße 48, D-76139 Karlsruhe, Germany
e-mail: rainer.frietsch@isi.fraunhofer.de
Tel: +49-721-6809-197

Aris Kaloudis

NIFU STEP, Studies in Innovation, Research and Education,
Wergelandsveien 7, N-0167 Oslo, Norway
e-mail: aris.kaloudis@nifustep.no
Tel: +47 / 22 59 51 20

Abstract:

Against the background of a steady decline of publicly funded R&D performed by the private business sector we analyse the specialization of public and private funded business R&D by sector of performance. The primary research question is whether and to which extent sector specific R&D specialisation indices can contribute to the analyses of R&D policy, ultimately aiming at enhancing effectiveness of public R&D policies so as to support business R&D. For this aim we pursue a benchmarking analysis following the major concept of R&D specialisation by means of a revealed comparative advantage analysis (see Grupp, 1997) and discuss the usability and the limitations of the benchmarking concept for a selection of two large European countries (Germany, United Kingdom) and two smaller ones (Austria, Norway). The article bases upon the results of a feasibility study on public R&D specialisation conducted within the framework of the EU funded ERAWATCH Network, which surveys national research policies, structures, programmes and organisations.

Keywords: Public versus private R&D funding, Benchmarking

JEL Classification: O33, O38

1 Introduction

In the future development of the European Research Area the ability of government policy instruments supporting business research activities to spur private R&D investments and the responsiveness of public and private R&D bases are key issues. The efficient use of public support measures is a precondition in order to contribute to the Barcelona objective of increasing R&D intensity within the EU to 3 percent by 2010 and to increase the private sector's financing share to 66 percent of total R&D spending. Sophisticated and ready to use evaluation tools are needed as there is a growing interest in analyzing the effectiveness of public support.

The discussion hereby is an attempt to provide a methodology for analysing in particular the role of direct public funding of business R&D by economic sectors. Against the background of a steady decline of publicly funded R&D performed by the private business sector we analyse the specialization of public and private funded business R&D by sector of performance in order to investigate the interrelation between them.

Our primary research question is whether and to which extent sector specific R&D specialisation indices can contribute to the analyses of R&D policy ultimately aiming at enhancing the efficiency and effectiveness of public R&D policies so as to support business R&D. For two reasons country specific public and private R&D funding specialisation indices of intramural business R&D expenditures based upon data in the OECD Research and Development database provide a valuable entry point for policy analysis:

1. For analytical purposes specialisations in public and private funding of firms R&D provide information on sectoral specialisations of the national innovation systems.
2. For policy purposes data on public funding of firms R&D provide valuable information on beneficiaries of public R&D funding in international comparison. The benchmarking analysis performed in this paper highlights
    a. differences in the sectoral distribution of public R&D funding between countries and
    b. testifies on the coherence/correlation between public and private funding of firms R&D.

We pursue a benchmarking analysis following the major concept of R&D specialisation by means of a revealed comparative advantage analysis (see Grupp, 1997) and discuss the usability and the limitations of the benchmarking concept for a selection of two large European countries (Germany, United Kingdom) and two smaller ones (Austria, Norway). The article bases upon the results of a feasibility study on public R&D specialisation conducted within the framework of the EU funded ERAWATCH Network[1], which surveys national research policies, structures, programmes and organisations.

For the purpose of the analysis the paper is structured as follows: We first review the main theoretical rationale for public support of business R&D and outline shifts in thematic orientation of public R&D funding. Thereby we exemplify that thematic priorities and industry considerations play a distinct role in

[1] http://cordis.europa.eu/erawatch/

public R&D policies. The following section outlines how international available R&D statistics provide information for tracing changes in public R&D funding strategies in terms of thematic and sectoral orientation. Using firms' R&D funding data differentiated by industrial sector and source of funding we then develop a methodology for analysing sectoral public and private funding specialisation of firms R&D. We apply the model to a set of countries in order to illustrate the usability of the methodology. We conclude by discussing policy relevance and limitations of the methodology and outline paths for future research.

2 Rationales for public R&D support

The main theoretical arguments for public support of private sector R&D are well known: Large public interest and/or market failures or market mechanisms respectively, which would result in an underinvestment in certain fields (Arrow, 1962), provide motives for governments to invest in private R&D. Companies tend to be risk aversive in areas of high uncertainty and markets may fail where the necessary investment is too large to be undertaken by one company. Public funding of private R&D may also take place where the competitiveness or other market thresholds are seen to be too high for a national company or institution, but where a public interest is evident. The latter is the classical case of start-up or knock-on financing in new and emerging fields. Furthermore the system failures rationale (Smith, 1998) such as path-depending developments which cause lock-in problems and transition/adaption problems may rationalise public R&D support to the private sector is another prominent reason which may call for public interventions in private R&D. Finally, public authorities may just need to "buy" the R&D services from the private sector. This is mainly service project funding directed, for example, to private research institutes or to technical and engineering offices to get expert's opinions and is therefore a matter of public procurement of R&D services.

The general arguments provide solid theoretical rationales for public R&D funding of private firms. However, political rationales for business R&D support go far beyond considerations of market and business failures by linking R&D to labour productivity, economic growth and hence overall competitiveness. In the European Union R&D investments are seen as a key for fostering overall economic performance and the Barcelona target calls that overall spending on R&D and innovation in the EU should be increased with the aim of approaching 3% of GDP, where two-thirds of this new investment should come from the private sector. Policy should make Europe more attractive for its best brains and promote new technologies. The Kok-report (European Commission, 2004) recalls that up to 40 % of labour productivity growth is generated by R&D spending and that there are powerful spillover effects into other areas of the economy, depending on the way in which the money is spent.

Hence, growing policy interest in stimulating business R&D and innovation has heightened the need for more sophisticated evaluation tools (OECD, 2006, p.9). A lot of attention has been geared towards the analysis of the efficiency and additionality of individual measures in terms of input, output and behavioural additionality (see OECD, 2006), and the complementarity of different policy instruments and favourable policy mixes for business R&D support (see Eurpean Commission 2003, Schibany and Jörg 2005).

Approaches dealing in particular with the impact of public R&D support on behaviour of firms and complementarity and efficiency of measures are of course crucial aspects for policy analyses. Despite the fact that sectoral considerations have always been important in public R&D policy, sectoral aspects have been fairly neglected in quantitative public R&D policy analysis. In the first two decades after World War II Science and Technology policy was dominated by a traditional mission orientation in the area of (nuclear) energy, space and defence technologies for which the widespread diffusion and private application of research results played only a minor role for the definition of the mission. Gassler et al (2006) outline that since the mid 1960ies the promotion of 'key technologies' with a considerable commercial potential in many industries (such as ICT in general, new materials or semiconductors) played a prominent role in national R&D policies. They argue that the expansion to civilian "key technologies" was seen as an appropriate measure for the US to make use of the large public infrastructures created in the fifties and for countries like Germany, France or Japan which perceived a technology gap relative to the dominant USA, to initiate a sustainable catching up process (Brude 1986; Giersch 1987; Fier 2002, 36ff; Mowery 1994,222ff). Also nowadays thematic priorities are again high on the political agenda. The ‘new missions’ and priorities in Science and Technology policy include Life Sciences, ICT, Nanotechnology, environmental technologies and “security related” research and can be found in almost all industrial countries next to generic measures focusing on so-called functional priorities such as the promotion of co-operations, high-tech start-ups, regional networks etc. which emerged in the beginning of the 1990s as part of a systems of innovation approach to technology policy (Rammer, 2006).

3 Monitoring trends in public funding strategies

Although the relatively close nexus between thematic priorities in S&T Policy and economic sectors little is known about which economic sectors are affected most by public research support measures. Research suggests that some economic sectors bear considerable potential for productivity growth. For example, for the electronics sector Amable (2000) demonstrates that inter-industry specialisation and comparative advantage in electronics have a positive influence on productivity growth using a comparative advantage trade model. Tsipouri (2001) argues that in countries with a productive structure that demonstrates a high specialisation in electronics, ICT, early life-cycles, capital goods and specialised industries, we would expect R&D to contribute more to growth than in other countries. But, do/did governments invest in the "right" sectors? Is there a fit between public R&D support of firms and private R&D specialization and which conclusions can be drawn from such funding patterns?

International available R&D statistics provide some information in order to trace changes in public R&D funding strategies in terms of thematic and sectoral orientation. GBAORD data reveal changes in the structure of public R&D funding. For example, comparing the EU15 and the USA we can see that especially trends in a) funding of Health and Environment Programmes, and b) in Defence R&D were main pillars for growth in public R&D funding between 2001 and 2004.

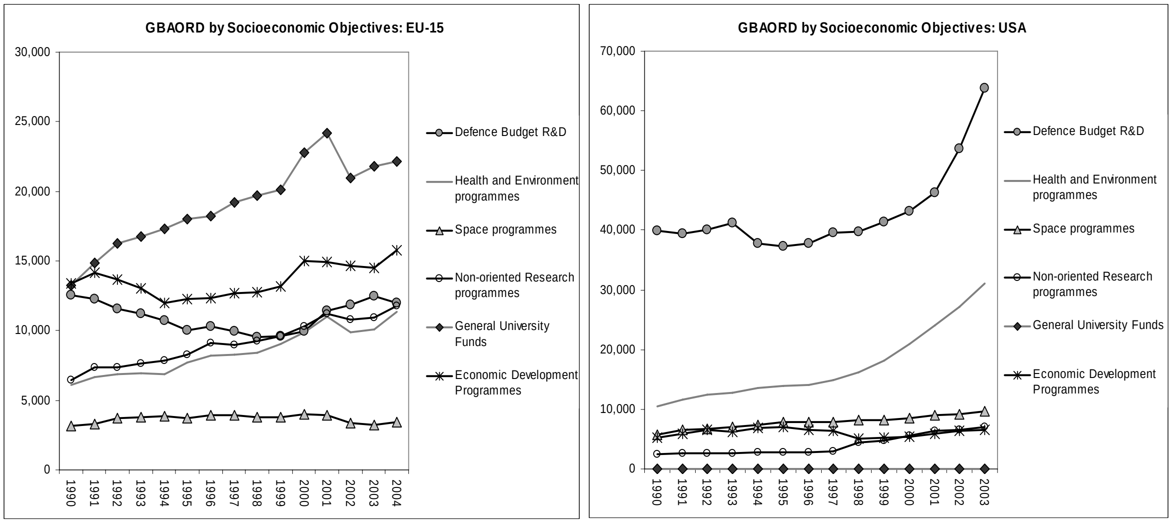
Source: OECD MSTI 2005-2

Figure 1 shows that in the USA the budget for defence R&D increased considerably between 2001 and 2004. Schibany and Jörg (2005) point out that public R&D devoted to military research increased from 43 billion US$ in 2000, to 67 billion US$ in 2004, an increase of 56%. Currently the share of military research R&D in the USA accounts for 55% of total GBAORD. The second pillar responsible for the increase of public US research funding is funding for Health and Environment research. It mainly stems from the increase of the budget for the National Institute of Health (NIH) (Schibany and Jörg, 2005). Within 1998 and 2003 the R&D resources for the NIH more than doubled from 11.7 billion US$ to 25.1 billion US$. In the period from 1990 to 2003 expenditures for Life Sciences more than tripled.

As opposed to the USA, for the EU15 an increase in general university funding largely contributed to the dynamics of public R&D spending. In 2004, the EU15 invested 11.9 billion US$ in defence R&D, which accounts for 22% of total GBAORD excluding GUFs.[2] Within the EU15, France and UK account for the largest shares in defence R&D. In the UK, 32% of total GBAORD are reserved for defence R&D, in France 23%. In Germany, defence R&D only plays a minor role with 6% of all GBAORD devoted for military research. Hence, in the EU the level of defence R&D is of less importance than in the US, and characterised by a diminishing importance. Expenditures for Health and Environment reach nowadays about 1/3 of the US level. The level of growth was lower than the US-level as well. In 2003 the EU15 reached 186% of the 1990 level of funding. In the same time period the UK GBAORD data for life sciences rose by 268%, the Austrian level reached 284% whereas in Germany the level was 150% only.

Whereas GBAORD data provide information on shifts in public R&D funding in general, the data so far do not provide information on shifts in public funding of R&D in firms. GBAORD data in particular do not distinguish between beneficiaries in terms of public and private sector.

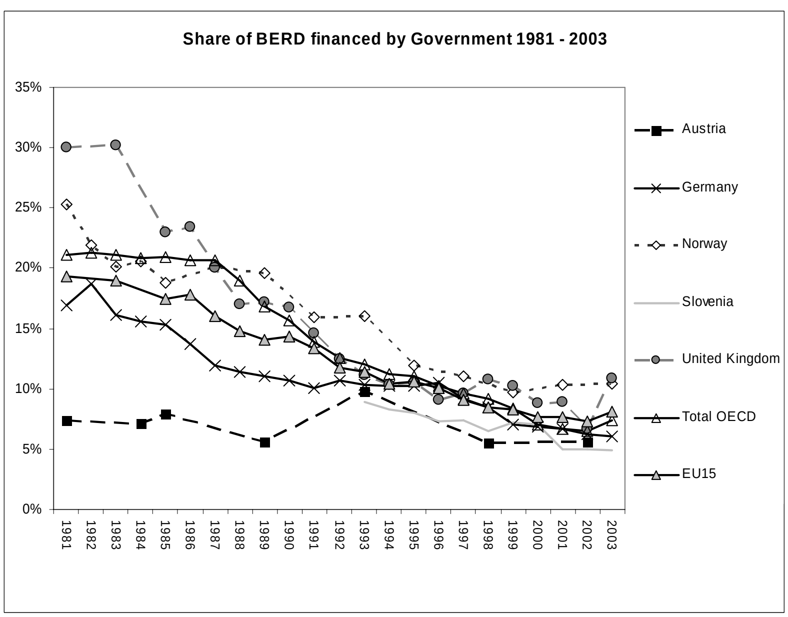
[2] As GBAORD data for the USA do not include General University Funds (GUFs) we had to exclude these, in order to be able to compare the shares of Defence and Health R&D funding.



Source: OECD MSTI 2005-2

Figure 1: Development of GBAORD the EU15 and US

Opposed to GBAORD data intramural business R&D expenditures can be differentiated by sources of funds. For government funding of firms R&D we can see that an enormous structural change of R&D funding in the last 25 years in all countries under consideration occurred (see Figure 2). In the OECD area the level of government funding in intramural business R&D declined from 23%, to 17% in 1990, and finally to a mere 7.4% in 2003.



Source: OECD MSTI 2005-2

Figure 2: BERD financed by Government 1981 – 2003

Rammer (2006) states that the decrease in public financing of R&D in firms was most pronounced in the USA, Great Britain and France and mainly affected the area of military research. On the other hand he also highlights that government funding of business R&D does not take into account indirect measures to support business R&D, such as tax credits or R&D allowances on social security fees of researchers, which are substitutes to direct funding of business R&D (Guellec and Pottelsberghe, 2003). He shows that total subsidy ratios of R&D increases to almost 15 per cent for France, and 12 per cent for the USA and Great Britain when taking indirect measures into account. Germany, in contrast, has not applied such indirect measures.

Apart from sources of financing intramural business R&D can also differentiated by industrial sectors. This allows us to develop a simple framework to analyse the sectoral specialization and inter-relation of public and private funding of R&D in firms.

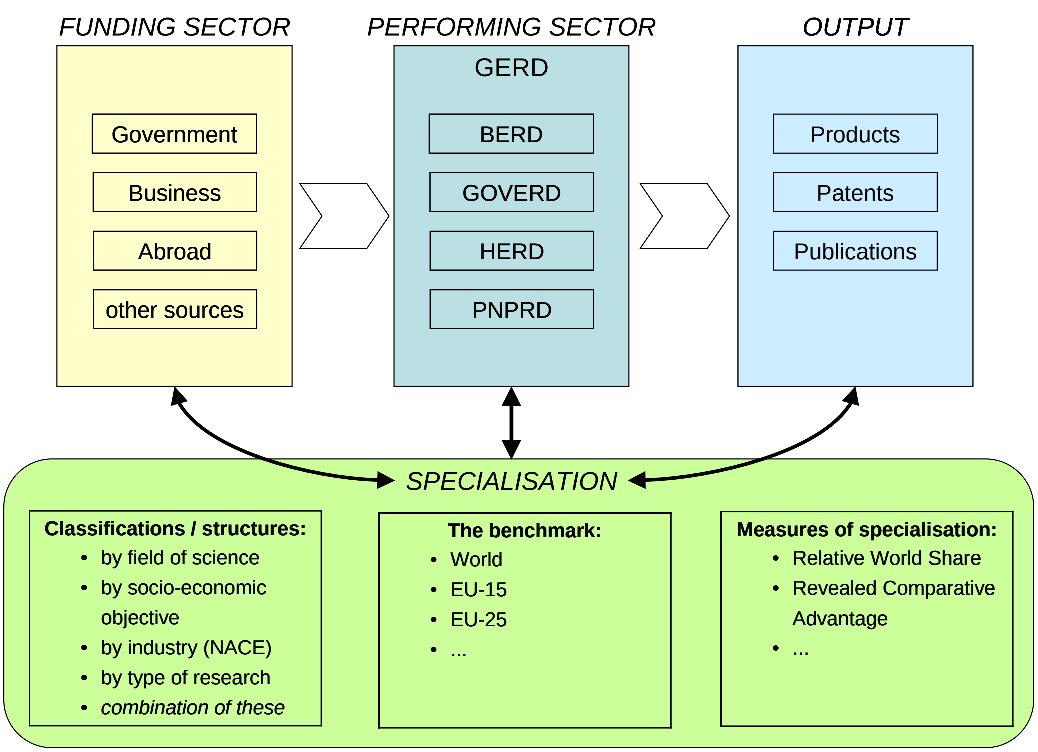
4 A methodology for analysing sector specific R&D investment

We define private R&D funding in firms (PBERD) and government funding of R&D in firms (GBERD) in this paper as follows:

PBERD is all intramural business R&D financed by the enterprise sector plus all funding from abroad. This means that supra-national funds such as EU grants eligible private enterprises are included within PBERD, as funding from abroad includes both private and supranational (EU) funds.

GBERD investment herein is defined as total national public R&D funding of intramural business R&D. Hence it includes all R&D funding from the federal state, federal regions, and municipalities.

Figure 3 displays the general notion of a R&D system in accordance with the OECD Frascati terminology. Several funding sources (left) provide money for R&D which is carried out in different performing sectors (centre). The outcome of this R&D work is mainly new products, patents or publications (right).



Source: Joanneum Research, InTeReg

Figure 3: Conceptualising the specialisation in R&D

Each of these three dimensions and their respective subgroups displays a specific specialisation. Hereby, the term ‘specialisation’ needs some elaboration:

Classifications are needed to answer the question ‘what is the area of specialisation?’ For this, several classifications are proposed by the OECD Frascati Manual (OECD, 2002) and provided by statistical offices, such as the field of science, the socioeconomic objective or the industry sector (NACE/ISIC) in which R&D funds are invested or the type of research that is sponsored. However, especially as regards classifications on the emphases/orientation of public R&D funding one has to be aware that information on these classifications is limited. In OECD and EUROSTAT statistics GBAORD data are categorized by socioeconomic objectives but no repartition for beneficiaries is available. Higher education R&D is classified by sources of financing and by field of science - but only at a very rudimentary level - distinguishing for example between Social Sciences and Humanities. Intramural business R&D can be distinguished by sources of financing (Private, Public, Abroad) and by sector of industry and hence provides the most differentiated picture on public R&D funding.

Since specialisation is a relative term, a benchmark is needed that shows in which areas a given country is specialised compared to this benchmark. The selection of the benchmark has, of course, a severe impact on the result, but at the same time it is heavily influenced by the availability of data.

Specialisation needs to be measured with a particular parameter. The most commonly used indicators are related to trade specialisation, namely the revealed comparative advantage (Balassa 1965) even though alternative measures might be available.

For R&D specialisation of industry the *area of specialisation* under investigation is the branch specific investment of public and private intramural business R&D at the NACE 2 digit level. Our data stem from the OECD – Research and Development Statistics database (formerly “Basic Science and Technology Statistics), for which details on national specifications and comparability issues are available in OECD (2005).

The benchmark for the subsequent analysis consists of a pool of countries. Within the ERAWATCH project the focus was on EU-25 plus accession and candidates countries and plus US and Japan.[3] Unfortunately, data availability on government funding of business R&D at a disaggregated level was only available for a limited range of countries. Especially data availability for the United States was too scattered, which prevented us from including the USA in the benchmark. We decided to construct a benchmark consisting of four countries especially tackled in the framework of the ERAWATCH R&D specialisation project (Austria, Norway, Germany and United Kingdom), plus a selection of European Union countries (France, Italy, Spain, Poland, Finland, Sweden) plus Japan. Hence, the benchmark of countries for which the methodology of assessing R&D specialisation consists of a proper mix of large and small countries.

As a parameter to determine PBERD and GBERD specialisation we use the Revealed Comparative Advantage (RCA) methodology according to the formula of Balassa (1965). This RCA value, also known as the Relative World Market Share (RWS) (Grupp 1997) has the following definition for PBERD:

$$RCA_{ki} = 100 \times \tanh \ln \left(\frac{GBERD_{ki} / \sum_i GBERD_k}{\sum_k GBERD_{ki} / \sum_{ki} GBERD_{ki}} \right)$$

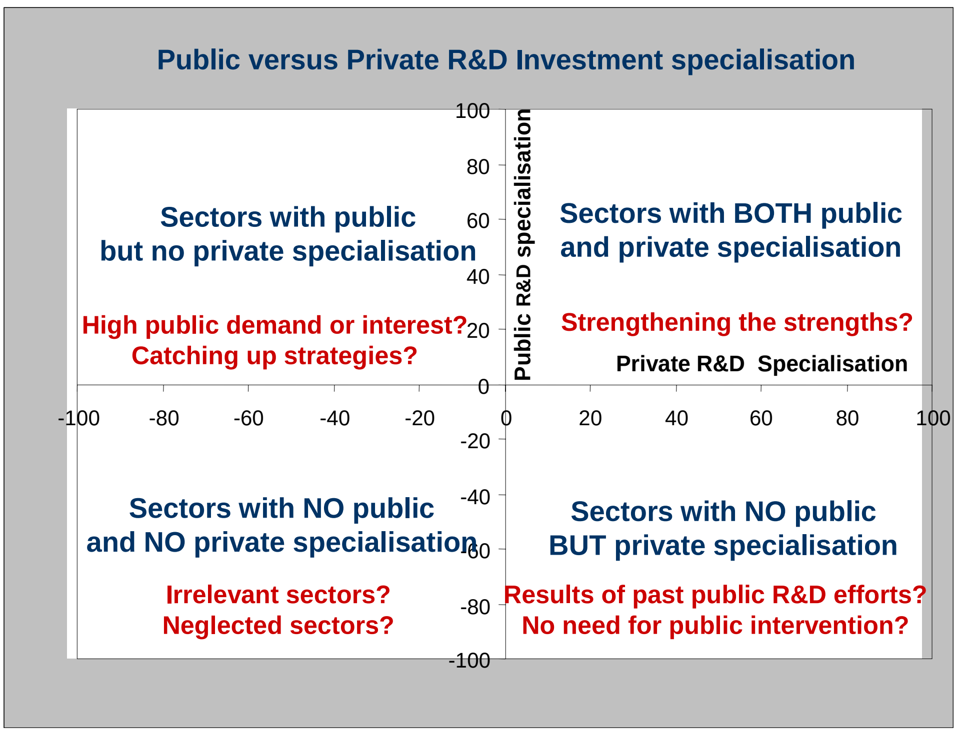
with $GBERD_{ki}$ indicating the amount of government funding of country k in the economic sector i. (Grupp, 1997). The RCA value for PBERD is constructed in the same manner.

[3] Japan does not report data for sector "office mach etc." (30). The data seem to be included in sector "electr. equipment" (32). As Japan has a high influence on the benchmark and also some activities in these fields that are not displayed properly, a correction method was applied. The correction method is that 20% of total BERD and GBERD of these two sectors have been assigned to sector 30 and 80% to sector 32. This seems to be a rather arbitrary selection. However, the specialization profiles especially in sector 30 are closer to reality after this correction. Otherwise the performance of this sector in most countries would have been overestimated.

LN centres the data around zero and the hyperbolic tangent multiplied by 100 limits the RCA values to a range of +100 to -100. Positive values for sector i point to the fact that the sector has a higher weight in the portfolio of the country than its weight in the world (all government funding from all countries taken together). Negative values indicate specialisation of government funding below the average, respectively. The RCA indicator allows the assessment of the relative position of an economic sector in a country beyond any size effects. Neither the size of the technological field nor the size of the country has an impact on the outcome of this indicator. Therefore, it is possible to directly compare countries and technologies.

The performance of the analyses according to the concept of public and private business R&D specialisation results in four distinct specialisation quadrants portrayed in Figure 4:

3. Sectors with neither specialisation in PBERD nor in GBERD (lower left quadrant)
4. Sectors with **a specialisation in PBERD and GBERD** (upper right quadrant)
5. Sectors with a specialisation in PBERD but none in GBERD (lower right quadrant)
6. Sectors that display a **specialisation in GBERD but not in PBERD** (upper left quadrant)



Source: Joanneum Research

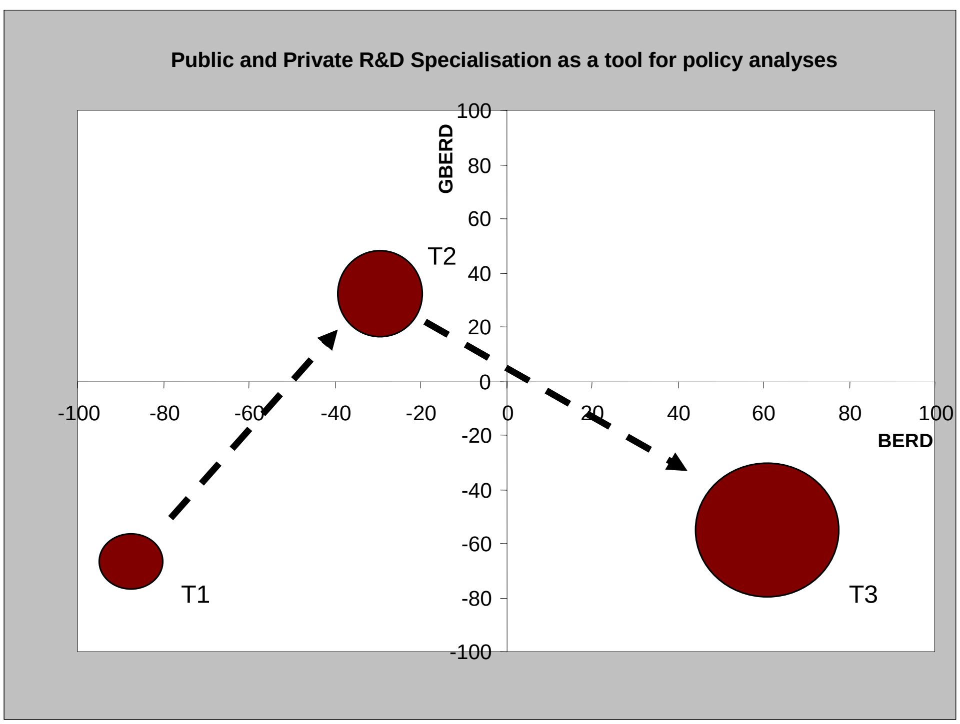
Figure 4: Public and private specialisation in business R&D

The resulting picture allows the following interpretations:

1. It shows the extent of correlation between public specialisation and private R&D funding specialisation in firms.
2. It allows to distinguish between sectors of high and low public specialisation as compared to the benchmark.

Sectors showing up in the upper right quadrant are sectors with above average public and private R&D investment compared with the benchmarking countries. The lower right quadrant characterises sectors in which private investment is above the international average, but public investment is below the international average. This could be interpreted either as the results of public R&D efforts, sectors with no need for public specialisation, or sectors for which public support mechanisms other than R&D funding apply such as price regulations for pharmaceutical industry or indirect fiscal measures. The upper left quadrant points to sectors with high public demand/interest as public R&D financing is above the international average but private R&D financing is below the average of the benchmarking countries. Hence, the upper left quadrant may reflect sectors for which public catching up strategies are currently at place or sectors for which market restrictions are at place.

We have to be aware that the analysis is cross-sectional, thus so far it ignores issues related to dynamics: present business R&D specialisation may be the result of past funds provided by government, and current public specialisation may result in BERD specialisation in the future. This could result in specialisation patterns in which the constructed variables of PBERD specialisation and GBERD specialisation move independently from each other. On the other hand, the issue of dynamics makes this easy to use methodological tool also interesting, as the concept allows tracing changing patterns of public and private R&D investments benchmarked against the international context Figure 5. tries to exemplify a possible ‘movement’ of a sector over time through the specialisation diagram, indicating its overall growth (size of the circle), its relative private specialisation (the horizontal axis) and the relative public specialisation (vertical axis). Therefore the tool could be used as a method to survey the effects of public investments in specific sectors of private R&D as well as a ‘warning system’ or monitoring device which indicates increasing specialisation or de-specialisation of sectors.

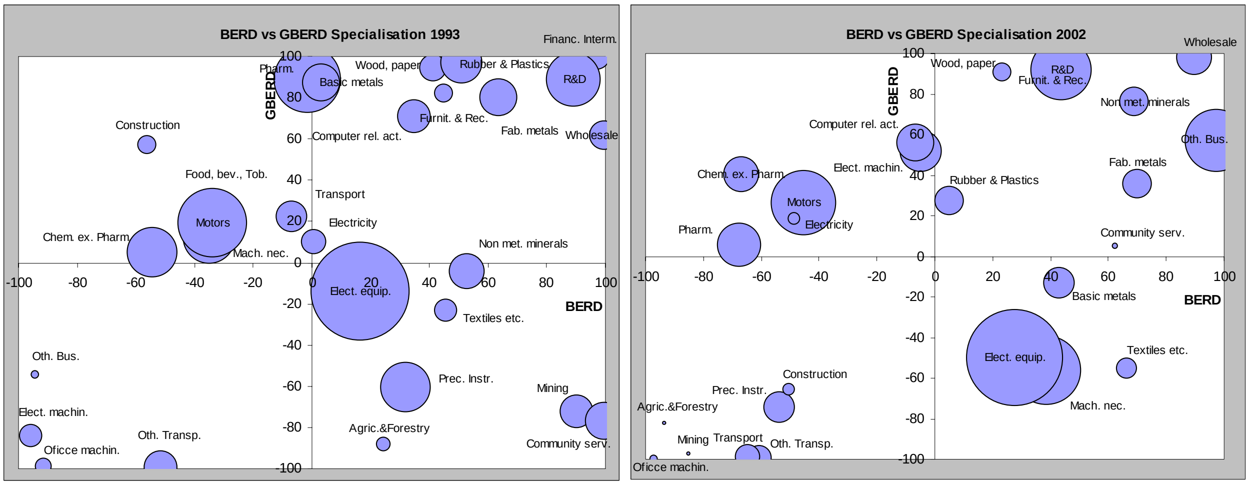


Source: Joanneum Research

Figure 5: BERD and GBERD specialisation as a monitoring tool for public policy

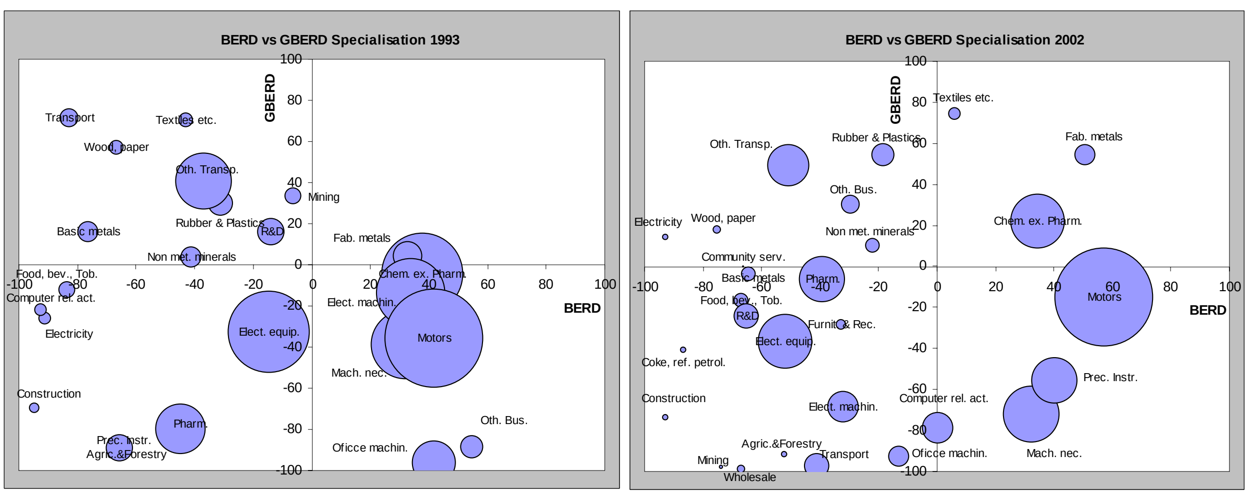
5 Results for the sample countries

For Austria, Germany, Norway and the United Kingdom the results of the specialisation analyses are presented in figures 3 – 6 for 1993 and 2002. The total amount of R&D expenditures of the specific sectors is represented by the area of the circles.



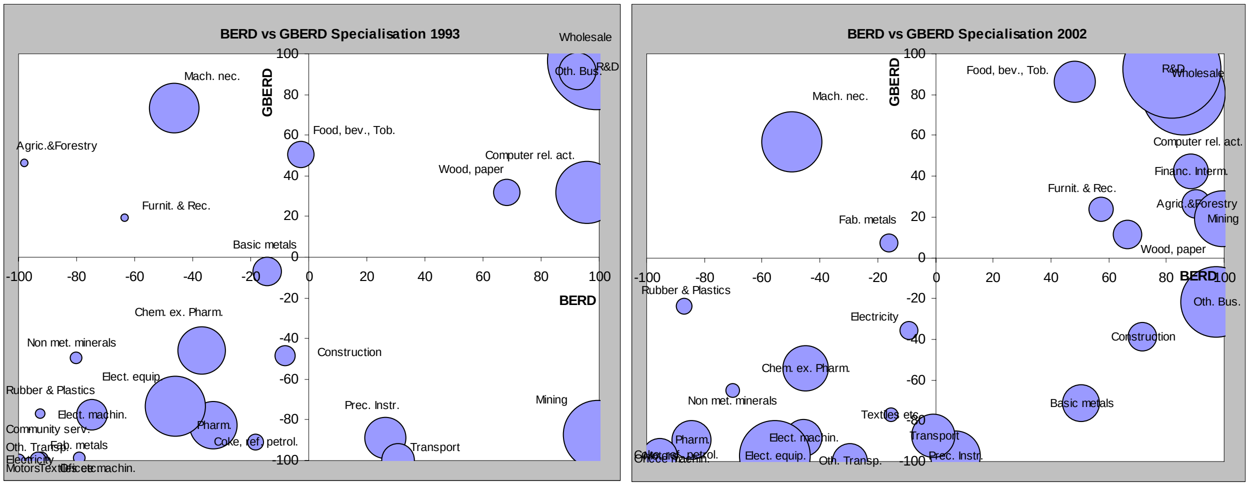
Source: Joanneum Research - based on OECD RDS Database

Figure 6: BERD vs GBERD Specialisation in Austria, 1993 & 2002



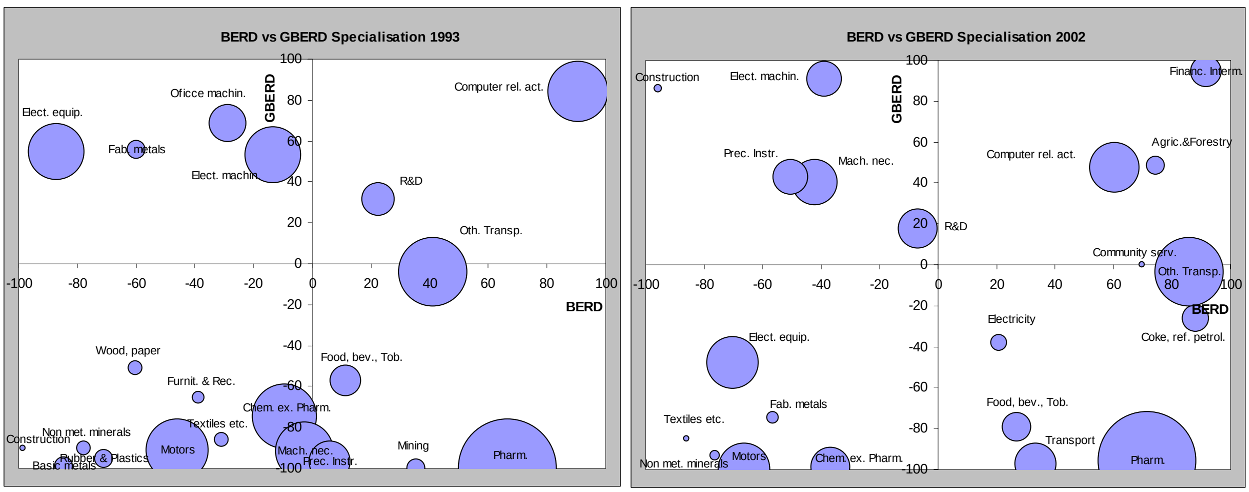
Source: Joanneum Research - based on OECD RDS Database

Figure 7: BERD vs GBERD Specialisation in Germany, 1993 & 2002



Source: Joanneum Research - based on OECD RDS Database

Figure 8: BERD vs GBERD Specialisation in Norway, 1993 & 2002



Source: Joanneum Research - based on OECD RDS Database

Figure 9:BERD vs GBERD Specialisation in United Kingdom, 1993 & 2002

As regards the aspect of correlation between public and private R&D specialisation the figures show that the extent of correlation varies considerably between the countries under consideration. In 2002 the smaller countries in the sample have a medium positive correlation between public and private R&D specialisation: Norway (0.68) and Austria (0.59). On the other hand Germany (0.25) and the UK (0.15) have a low correlation between BERD specialisation and GBERD specialisation. There seems to be a size effect at place as by the definition of the specialisation index, larger countries (UK, Germany) have a high impact on the benchmark. This will result in values close to the centre of the specialisation index.

Apart from the correlation aspect, the resulting picture on BERD and GBERD specialisation allows distinguishing between sectors of higher and lower public interest.

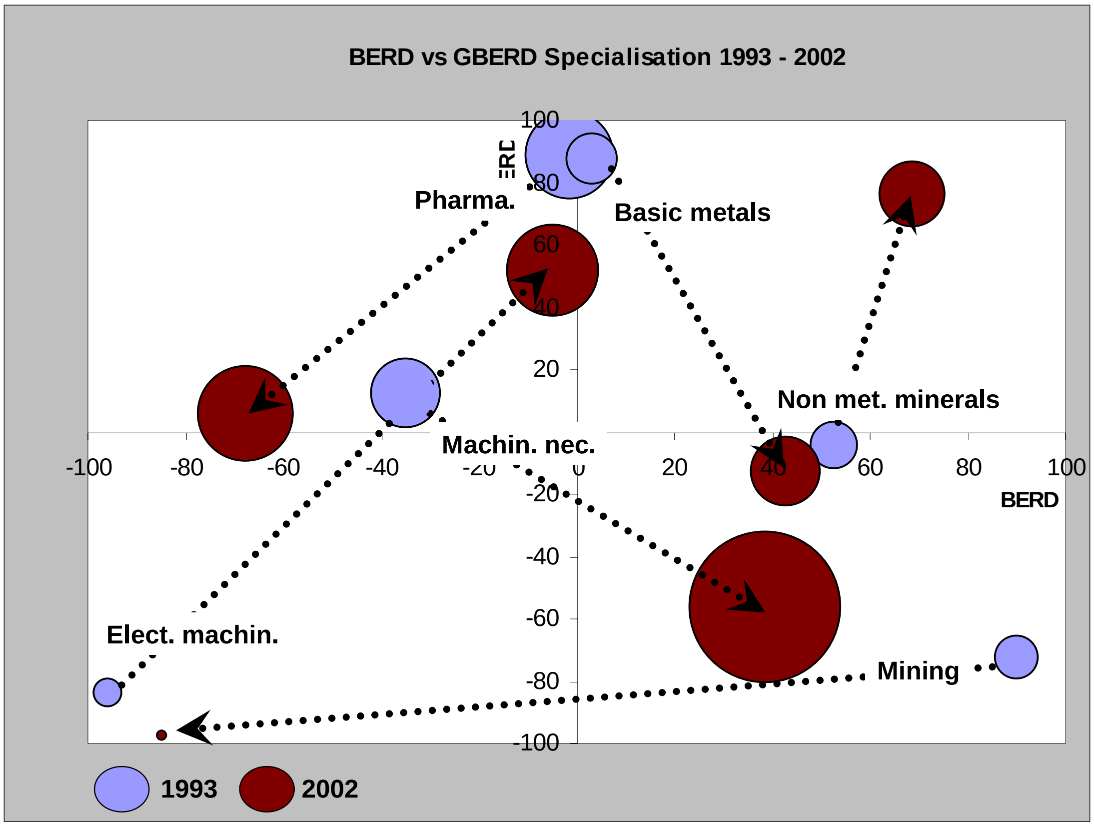
The cases of the UK and Germany show that the disparities between public and private R&D funding specialisation are largely due to the strong government emphasis on sectors related to defence and aerospace. For Germany the inspection of government funding of business R&D reveals that aerospace (other transport NACE 35) still receives only slightly more than 5% of the total spending on R&D of the German government (GOVERD), but more than 55% of the total direct funding of R&D in firms are devoted to Aerospace. This means, within the intramural business funding activities of the government it plays a very prominent role. The reasons here are a strong public interest and an expected market failure that justifies these massive investments, coming along with the state being the most important customer of aerospace goods and services. Also in the UK a large amount of public R&D funding to the private sector (26%) are reserved for the aerospace sector. But whereas in the UK the aerospace sector also shows a positive specialisation in private R&D funding in this sector this does not hold true for Germany, where only public R&D expenditures in the sector show a positive specialisation.

Another example for high specialisation in GBERD but no specialisation in PBERD can be found in Austria for chemicals and motors (NACE 34). In Austria, the support scheme General Programmes of the Austrian Research Promotion Agency (FFG), which provides about 2/3 of total Business R&D support via a bottom-up funding scheme, play a prominent role as they show high shares of funding for these sectors: In 2003, of the 127 million the Euros cash value of total funding 18.5% were provided for chemicals and chemical products, 13.4% for computer related activities, and 6.6% for motor vehicles (BMBWK, 2005). Whereas the motors sector has generally gained momentum in the Austrian economy, the chemicals/pharmaceutical sector is internationally compared rather small but relatively competitive in terms of performed research. The Austrian chemicals sector is also a very important sector as regards manufacturing employment (approx. 10.85% in 2003) and manufacturing production (11.4%) (Aiginger and Novak, 2004).

On the other hand, there are sectors in which countries have a strong PBERD specialisation but no GBERD specialisation. This is for instance the case for pharmaceuticals in the UK, and for the motor vehicles sector in Germany. Here, the strong private R&D specialisation is not accompanied by a strong GBERD specialisation. Reasons for this might be that the private R&D investment (and specialisation) in the sector seems to be so strong, that either no public intervention is justified or that the public intervention may operate through other mechanisms than R&D funding for the private sector. For example, in the case of the UK we've seen that a large increase of public research funding in the life sciences has been channelled through the higher education institutions. Furthermore, especially in the pharmaceutical sector, other indirect public support mechanisms as price regulations and tax incentives might be at work.

As regards strong public and private R&D specialisation the R&D sector (NACE 73) of Norway and Austria stands out both in absolute and relative terms. This, however, might be due to peculiarities in the official R&D statistics. For example, in Austria business sector comprises a private business sector and a co-operative sector, which includes large semi-publicly owned research companies as for example ARC-Seibersdorf Research GmbH and Joanneum Research – GmbH. According to the Frascati Manual (OECD, 2002), the business enterprise sector (and hence BERD) "includes public enterprises mainly engaged in market production and sale of the kind of goods and services which are often produced by private enterprises …" In Austria, of all public R&D funding for the business sector (176 million the Euros in 2002), 73 million the Euros were devoted to this so called co-operative sector (BMBWK, 2005) – whereas in other countries likewise organisations are to be found within the state sector.

Finally, for the case of Austria Figure 10 illustrates movement of public and private R&D specialisation over time. The figure confirms that not only private R&D specialisation changes over time, but also the public attitude towards investments in private sectors. The figure shows a mix of increasing specialisation and de-specialisation processes over time, of which the most interesting one are the sectors electrical machinery and machinery necessities: Whereas in 1993 the electrical machinery sector in Austria was characterised by below average public and private R&D investment, the sector shows nowadays a distinct public specialisation and private investments close to the "world" average. The Machinery necessity sector already showed a slight public specialisation in 1993, but as private investments increased dramatically public de-specialisation processes took place. Public and private de-specialisation processes also occurred in pharmaceuticals: whereas in 1993 funding for pharmaceutical industry was highly specialised, public R&D specialisation is nowadays just about at the average of the sample countries.



Source: Joanneum Research - based on OECD RDS Database

Figure 10: Specialisation processes – the case of Austria, 1993 – 2002

6 Relevance, limitations and paths for future research

The presented PBERD versus GBERD specialisation analysis provides a simple quantitative tool to analyse national emphasis and coherence of direct public funding of private R&D. National specialisation indices in terms of public and private funding of firm R&D could be calculated for several ERA countries. Whereas there is a positive correlation between PBERD and GBERD specialization in smaller countries, this does not hold true for larger European countries.

As the main objective of the ERAWATCH R&D specialisation project was to identify indicators for future data analysis, we tested if these indicators provide additional and useful information for policy makers. For this purpose, interviews with eleven national policy experts from research councils and ministries in charge of S&T policy in Austria and Norway have been carried out (see Technical Report concerning information collection and analysis on R&D specialisation in Europe, 2006, IPTS). The policy experts stated that specialisation indices offer new and relevant information. Several suggestions by the interviewees, such as time series and total values, have been integrated into this paper. Remaining remarks related to difficulty in communicating complex measures to those responsible for S&T policy, concerns about the available benchmark and the need for further qualitative interpretation of the results since the specialisation profiles provide large quantities of concentrated information. Nevertheless, by and large, the response from by the policy experts led to the conclusion that specialisation profiles are perceived as a useful monitoring device and a good entry point for discussing the role of public financing of firms R&D.

Having said this, the presented method is subject to some severe limitations which are caused by both the available data and the methodology. These have to be taken into account in order to avoid misinterpretation and to evaluate the practical applicability of the tool for policy advice. The major limitations are:

1. Direct government funding of private R&D is only one – albeit important – part of the R&D promotion portfolio. For example, many governments have recently increased indirect schemes such as tax incentives (OECD 2006: 67). In addition, there are other ‘soft measures’ to induce private R&D investment. Hence,
    a. our tool only considers one part of the R&D policy portfolio, and
    b. there might be different policy instruments utilised for different sectors. Consequently, our tool gives a distorted impression, if some sector policies make more use of indirect/ soft measures than others.

2. Not all public funds are included in GBERD, nor is PBERD exclusively private money. PBERD includes some public funds, because the funding source *abroad* includes public (e.g. EU) as well as private funds. Due to the statistical classification these two groups can not be divided. However, data for Austria (2002) shows that the share of EU funds at BERD funded from *abroad* is only about 3% (BMBWK 2005: 168). In Germany, sources from *abroad* funded about 2.4% of BERD in 2003 (no separate figures for EU funding are available, BMBF 2006).

3. The tool uses a specialisation index which is a relative indicator and requires a benchmark. Due to difficulty in data availability (see section 4), our benchmark only consists of eleven countries (AT, DE, ES, FI, FR, IT, JP, NO, PL, SE, UK). This implies several caveats:

a. The benchmark is incomplete and might lead to distorted specialisation pattern.
b. The benchmark population is small. Consequently, large countries with high R&D-investments, such as Germany, have a strong impact on the benchmark, which causes them to be closer to the benchmark average. Hence, they frequently display less pronounced specialisation patterns.
c. The benchmark approach requires that methods and classification across countries are comparable. This is not generally the case (see OECD Statistics 2000). For example, classification of public/ semi-public research institutes[4] and allocation to industry classes differ.

4. The purpose of the tool is to compare specialisation patterns of a given country at different points in time. However, the interpretation of changes in the specialisation pattern is not straightforward, because the index of a given sector might change due to (a combination of) different causes. The specialisation changes, if (ceterus paribus):
    a. more/ less money is spent on that sector (in absolute terms) in the analysed country;
    b. the structure of spending within the analysed country changes (i.e. the money spent on the given sector changes in relative terms);
    c. more/ less money is spend on the given sector (in absolute terms) in one/some of the benchmark countries;
    d. the structure of spending within the benchmark changes (i.e. the money spend on the given sector in the benchmark changes in relative terms).

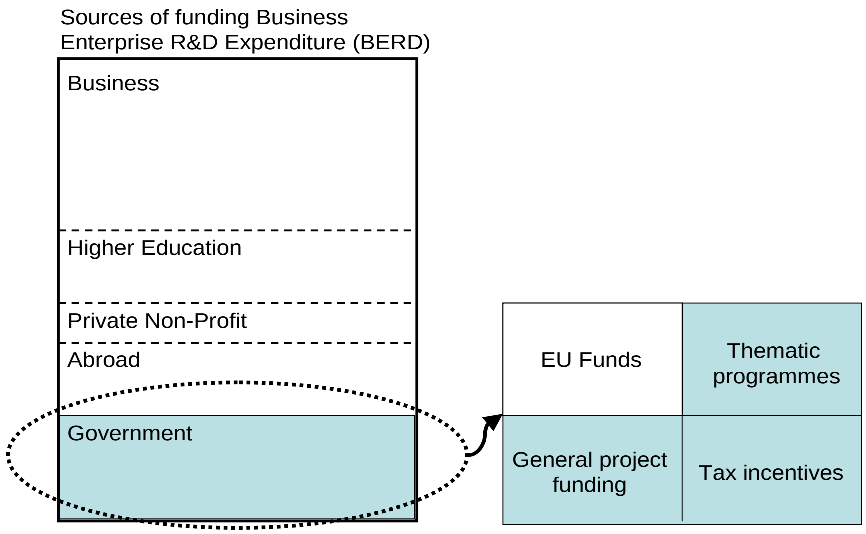
In practical terms, the application of the tool suffers from a missing match between sectors and technologies: While RTDI policy tends to 'think' in terms of technology programs it is difficult to clearly relate these to economic sectors (see Schmoch et al. 2003). Especially, new cross sector technologies (such as nanotechnology or ICT technology) pose an attribution problem. Hence, the change of specialisation patterns can be observed, but it can not be directly related to specific policy measures. Consequently, subsequent research is needed to take into account the following issues:

First, international data on GBERD and PBERD should be made available for more countries and it would be helpful, if data which has been especially prepared for international comparison (see OECD's Analytical BERD database), would allow to distinguish PBERD and GBERD.

Second, our tool suffers from interpreting problems concerning time series, because several driving forces can cause the index to change. Additional indicators that are easy to read and which shed some light on the underlying cause would be most welcomed.

Third, the presented quantitative information requires additional qualitative information on the individual reasons for the (changing) patterns in the observed countries.

[4] For example in Austria large research organisations such as ARC Seibersdorf Research GmbH or Joanneum research are classified as enterprise sector, whereas comparable institutions in Germany such institutes of Fraunhofer Society, Helmholtz Association or Leibniz Society are classified as government sector.



NB:

General project funding (national): These are free/open schemes, i.e. any company/ research consortia may apply for R&D funding and its R&D project will be granted on specific rules such as scientific quality.

Thematic/Mission oriented programmes (national): These are programmes where the funding agency targets a specific group of firms and has consequently stated certain requirements which the applicant needs to meet. These can relate either to thematic fields (e.g. nanotechnology), to characteristics of the company (e.g. SMEs). It can also include the requirement to form new networks or other types of formal or informal collaborations (e.g. research networks with public research institutions).

EU funds for R&D: In some countries a significant share of R&D funds for private firms is provided via EU-funds (e.g. Framework Programmes). This funding is reported in the OECD and EUROSTAT statistics along with all other types of R&D funding from abroad. It would be, however, relevant to know what is the exact distribution of EU-funding by Member States and by sectors as government funding from abroad.

Tax incentives for R&D activities: While the first three instruments provide direct support/ funds to firms, this is an indirect instrument, and includes the total amount of money companies deduct from their taxable income as approved R&D expenditure, new R&D-activities, etc. for tax incentives international comparable data is limited although tax incentives are used in a number of countries with higher levels of business R&D intensity, including Korea, Japan, France and the United States (OECD, 2005a; OECD, 2005b,European Commission, 2003). So far the so-called “b-index” (Warda 1996) gives a synthetic view of tax-generosity.

Figure 11: The policy mix in funding private R&D

Fourth, additional information on general R&D support schemes in the respective countries would be fruitful, because direct R&D funding is only one promotion mechanism. An important challenge for future work would be to distinguish between different channels or sources of direct and indirect government funding of R&D in the business sector. Moreover, the presented analysis could not consider the distinction between foreign and national public funding (such as EU-funds). Therefore, it would be appreciated if future research could distinguish between three domestic and one foreign (i.e. EU) instruments/sources that deliver public R&D funds to private firms (see Figure 11). Though official R&D statistics for these categories are poor, methods could be employed to gather additional data from funding agencies. For example, within the ENIP project an approach has been developed and tested for a small group of countries (Austria, Italy, France, Norway, Netherlands, and Switzerland) to analyse the evolution of project funding by using data from funding agencies (Lepori et al., 2006). Basically, the methodology allows gathering information on three of these categories (general, thematic and EU funding) (see Dinges, 2006, Lepori, 2005, Poti and Reale 2005). However, this methodology did not allow for a NACE 2-digit disaggregation level. Hence, future research might want to follow this path.

7 Literature

Aiginger, K., Novak, T. (2004), Historische Daten über die Entwicklung der österreichischen Industrie, WIFO Report, Vienna.

Amable, B. (2000), International Specialisation and Growth, Structural Change and Economic Dynamics, 11, pages 413-431.

Arrow, K.J., (1962, Economic Welfare and the Allocation of Resources for Invention, in Nelson, editor, The Rate and Direction of Inventive Activity.

Balassa, B. 1965, "Trade Liberalization and 'Revealed' Comparative Advantage," Manchester School 33, pp. 99-123.

Bundesministerium fuer Bildung und Forschung (BMBF) (ed.) (2006): Basic and structural data 2005, Berlin: BMBF. http://www.bmbf.de/pub/GuS_2005_ges_engl.pdf

BMBWK (2005). Austrian Research and Technology Report 2005, http://www.bmbwk.gv.at/medienpool/13075/ftb_2005_engl.pdf

Bruder, W. (Ed.) (1986). Forschungs- und Technologiepolitik in der Bundesrepublik Deutschland. Beiträge zur sozialwissenschaftlichen Forschung, Band 94, Opladen.

Dinges, M. (2006), Project Funding Report – Austria, National Report on Public Project Funding, www.enip-europe.org.

European Commission (2003), Raising EU R&D Intensity. Improving the Effectiveness of Public Support Mechanisms for Private Sector Research and Development: Direct Measures. Brussels.

European Commission (2004), Facing the challenge – The Lisbon Strategy for Growth and Employment, Report from the High Level Group chaired by Wim Kok, http://ec.europa.eu/growthandjobs/pdf/kok_report_en.pdf.

Fier, A.(2002). Staatliche Förderung industrieller Forschung in Deutschland. Eine empirische Wirkungsanalyse der direkten Programmförderung des Bundes. ZEW-Wirtschaftsanalysen, Band 62, Nomos, Baden-Baden.

Gassler, H., Polt, W., Rammer Ch. l (2006), Schwerpunktsetzungen in der Forschungs- und Technologiepolitik – eine Analyse der Paradigmenwechsel seit 1945, Österreichische Zeitschrift für Politikwissenschaften, 2006/1, Nomos Verlag.

Giersch, H. (Ed.) (1987). Wettlauf um die Zukunft. Technologiepolitik im internationalen Vergleich. Kieler Studien Nr. 206, Tübingen.

Grupp, H. (1997) Messung und Erklärung des technischen Wandels: Grundzüge einer empirischen Innovationsökonomik. Springer. Berlin.

Guellec, D. and B. van Pottelsberghe de la Potterie, (2003): The Impact of Public R&D Expenditure on Business R&D, Economics of Innovation and New Technology 13 (3), pp. 225-243.

IPTS, (2006), Technical Report on Technical Report concerning information collection and analysis on R&D specialisation in Europe, ERAWATCH NETWORK ASBL, prepared by Joanneum Research, Logotech, NIFU-STEP, SPRU – University of Sussex, ISI Fraunhofer.

Lepori B. Dinges M., Mamphuis R., Potì B., Reale E., Slipersaeter S., Theves J., van der Meulen B. (2006), Indicators for Comparative Analysis of Public Project Funding. Concepts, Implementation and Evaluation, paper presented at the international conference on S&T indicators, Leuven, September 2006.

Lepori, B. (2006), Methodologies for the analysis of research funding and expenditure: from input to positioning indicators, Research Evaluation, Volume 15(2) August 2006, p.133-145.

Mowery, D. C. (1994). Science and Technology Policy in Interdependent Economies, Norwell.

OECD (2002), Frascati Manual: Proposed standard practice for surveys on Research and Experimental Development. Paris: OECD.

OECD (2005), Research and Development Statistics.

OECD (2005a), Policies to improve innovation performance in OECD countries, ECO/CPE/WP1(2005)15

OECD (2005b), “Innovation policies: innovation in the business sector”, (ECO/CPE/WP1(2005)2)

OECD (2006), OECD Science, Technology and Industry Outlook 2006, Paris.

OECD Statistics (2000), Research and Development Expenditure in Industry 1973-1998, https://www.oecd.int/olisnet1/olis/OECDDATA.NSF/bc0d7fcd089b6f4cc125673c005b7244/b9e25e0fb44fbc81c1256777004b98e0/$FILE/doc_ANB00.pdf

OECD, (2006), Government R&D funding and company behaviour: measuring behavioural additionality, Paris: OECD.

Potì B., Reale E. (2005), Project funding. Italy. Country report. European network of Indicators Producers.

Rammer, Ch. (2006), Trends in Innovation Policy: An international comparison; in Schmoch, U., Rammer, Ch., Legler, H.: National Systems of Innovation in Comparison – Structure and Performance Indicators for Knowledge Societies, Springer.

Schibany, A., Jörg, L.,(2005), Instrumente der Technologieförderung und ihr Mix, InTeReg Research Report Nr.37-2005, Vienna.

Schmoch, U.; Laville, F.; Patel, P.; Frietsch, R. (2003): Linking Technology Areas to Industrial Sectors, Final Report to the European Commission, DG Research, Karlsruhe: Fraunhofer ISI, http://www.isi.fhg.de/p/Downloads/Microsoft%20Word%20-%20Report%20Technology%20Industry%20.pdf

Smith, K. (1998) Innovation as a Systemic Phenomenon: Rethinking the Role of Policy, in: Bryant, K., Wells, A. (Hrsg.) A New Economic Paradigm? Innovation-Based Evolutionary Systems: Discussions of Science and Innovation 4, Canberra, S. 17-52.

Tsipouri, L. (2001), Can we benchmark the contribution of research and development investment to growth and competitiveness?, Science and Public Policy, Vol. 28 Nr. 4, pages 295-302.

Warda, J. (1996), Measuring the Value of R&D Tax Provisions, in OECD, Fiscal Measures to Promote R&D and Innovation, [OCDE/GD(96)165], pp. 9-22, OECD, Paris.

InTeReg Working Paper Series

The Working Paper Series seeks to disseminate the results of research conducted within the Institute of Technology and Regional Policy of Joanneum Research to the broad academic community and other interested parties. Since much of the research is ongoing, the authors welcome comments from readers.

Electronic copies of the Working Paper Series can be found at: http://www.joanneum.at/rtg/wp. For further questions, please contact intereg@joanneum.at.

JOANNEUM RESEARCH Forschungsgesellschaft mbH – Institute of Technology and Regional Policy (InTeReg)

Vienna Office:
Haus der Forschung, Sensengasse 1
A-1090 Vienna, Austria
Phone: +43-1-581 75 20
E-Mail: intereg@joanneum.at

Graz Office:
Elisabethstraße 20
A-8010 Graz, Austria
Phone: +43-316-876 1488
E-Mail: intereg@joanneum.at