



Measuring the internationalisation of EU corporate R&D: a novel complementary use of statistical sources

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Abstract

The report summarises the main results of a research activity aimed at testing a novel approach for the measurement of EU business R&D internationalisation. Such approach is based on the complementary use of two different sources of data: on the one hand, statistical data from private R&D expenditure taken from national surveys (BERD); on the other hand, data collected from companies' annual reports and accounts (as in the EU Industrial R&D Investment Scoreboard). The main objectives of the study were: i) to explore the methodological rationale for comparing the two sets of data; ii) to test the robustness of the novel methodology through an analysis applied to four EU countries (Belgium, Finland, Germany and Italy); iii) to provide indications of possible further research and follow up activities.

The main results from the project are as follows:

- BERD and Scoreboard values, though addressing slightly different concepts, are comparable and can be used in a complementary way.
- Data regarding top EU R&D performers (that is, companies included in Scoreboard rankings who are the active part of the R&D internationalisation process) have to be considered from the starting point of such complementary use, instead of as final data at the country level resulting from official statistics.
- Using top R&D performers' global values and adding aggregate values from national R&D statistics allows novel insights on the R&D internationalisation process to be given, at least for the four EU countries involved.
- Further research could rely on the forthcoming Euro-Group Register under development at EUROSTAT, to obtain a clear view of intra-EU cross-country R&D flows.

1. Introduction: the growing interest in the measurement of R&D internationalisation

Very recently, a strong interest in better information on business R&D has been raised by different actors. Among them, national and local policy makers are more and more interested in the measurement of the relative strengths and weaknesses of their territories in performing and attracting R&D investment. Additionally, scientific and methodological groups are interested in providing useful tools for their counterparts in this regard. Collaboration among different institutions is growing and

several improvements are being undertaken both in the framework of EUROSTAT and OECD activities. Among others, one of the topics where such collaboration is growing is that of R&D internationalisation.

The literature on R&D internationalisation is nowadays well established, after three decades of strong development. After the first contributions in the late 1970s (Ronstadt, 1978; Lall, 1979; Mansfield and Romeo, 1980), when R&D abroad was considered just an extension of the innovative activity performed at home (usually in the US), during the 1990s several studies highlighted an important shift in global R&D investment. The internationalisation of R&D is still undertaken to exploit the strengths developed in the home country, but is now also used to tap into new technology advantages created abroad. The first strategy was named "Home Base Exploiting" (Kuemmerle, 1997) or "Asset Exploiting" (Dunning and Narula, 1995), while the second was "Home Base Augmenting" or "Asset Seeking" (respectively, by the same authors). More recently, although following the same framework, additional definitions have been provided to better distinguish between Research abroad and Development abroad (von Zedtwitz and Gassmann, 2002), or factors explaining their development (Thursby and Thursby, 2006).

While all these theoretical contributions have provided strong advances in the field, their measurement has often been limited by the available sets of data. In particular, the majority of empirical studies rely on patent data or *ad hoc* surveys, rather than the statistics of business expenditure in R&D (hereinafter, BERD¹) provided annually by national statistics offices. This is due to the unavailability of micro-data, leading to limitations in the analysis of the main points developed theoretically: e.g. the cross-country engagement of large industrial corporations; how much they invest in their home country rather than abroad; or to what extent such activities are controlled directly or indirectly through a complex network of worldwide subsidiaries.

Although some efforts have been made to compare R&D internationalisation strategies in different countries using data at the national level (see OECD, 2008), it is still quite challenging to assess the geographical distribution of R&D investment undertaken by global R&D performers. Most of all, in data production there is still a dichotomy between BERD statistics (which are mainly aimed at the production of estimates for national R&D execution) and that from global companies (such as those in the EU Industrial R&D Investment Scoreboard, whose R&D investment can be executed anywhere in the world).

¹ We refer here to national business R&D surveys carried out according to the Frascati Manual (OECD, 2002). BERD stands for Business Expenditure on R&D and represents a sub-aggregate of GERD (Gross Domestic Expenditure on R&D), together with R&D expenditure performed by the other three sectors of R&D performance: Government, Higher Education and Non-profit institutions.

To overcome this problem, the project on "Measuring the internationalisation of EU corporate R&D" performed activities in 2009/2010 in the context of the Industrial Research Monitoring and Analysis (IRMA), jointly carried out by the European Commission's Joint Research Centre (JRC) – Institute for Prospective Technological Studies (IPTS) and the Directorate General Research – Directorate C, European Research Area: Knowledge-based economy. In this report, we present the main results of this project. It relied on the active cooperation of national statistics office representatives in charge of R&D statistics (hereinafter, BERD producers) from the four partner countries participating on a voluntary basis: Belgium, Finland, Germany and Italy.

The report is structured as follows: in section 2, we summarise the main efforts undertaken at OECD and EUROSTAT to measure R&D internationalisation using R&D statistics; in section 3, we propose a methodological framework for the complementary use of R&D statistics and Scoreboard data; in sections 4 and 5, we present the main empirical results of the project; in section 6, we report the main issues from the final workshop project which took place at EUROSTAT in May 2010; finally in section 7, we present some policy questions and conclusions.

2. Past efforts in measuring R&D internationalisation using R&D statistics²

The growing need for statistics regarding economic globalisation can be seen as a major challenge for national and international institutions. A comprehensive set of statistical indicators on the economic globalisation processes is available from the OECD (2005a and 2005b). It includes indicators for international trade and FDI, as well as data on the activities of foreign affiliates (and their Science and Technology activities) in several countries. The European context is less developed and is mostly related – in addition to traditional trade and FDI statistics – with the development of a set of foreign affiliate statistics, including both economic and R&D data. The progress made in the European system is shown by the European Regulation (CE) No 716/2007. Regarding R&D internationalisation, it has become compulsory for Member States to provide biennial "Inward R&D" data (since the reference year 2007), and in a limited number of cases "Outward R&D" data are being provided on a voluntary basis.

² This section largely relies on the ideas developed in a working paper jointly written with Giulio Perani, whom I thank for three years of valuable cooperation. In addition, I would like to acknowledge all comments received in the events where we presented such ideas: a KEI workshop in Helsinki, the OECD Blue Sky Forum in Ottawa, the SPRU 40th anniversary conference, a PRIME conference in Lugano and the 2007 OECD NESTI meeting in Paris.

Until recently, the majority of efforts to measure business R&D internationalisation were done within the OECD framework. We are mainly referring to the OECD NESTI³ work on the subject, undertaken between 2005-2007, and the 2006 Blue Sky Forum in Ottawa; in parallel, other interesting results came from the KEI project⁴. A good summary of the subject is found in the document *NESTI work on R&D Internationalisation: issues for discussion* presented by Alessandra Colecchia at the NESTI 2007 meeting. An initial activity was the mini-questionnaire aimed at assessing if/how different OECD countries could have Inward and Outward information in their R&D Survey. Eight countries (the four actually included in the project presented here, plus the Netherlands, Sweden, UK and US) provided the OECD with aggregate data on R&D expenditure and personnel, classified by country of origin / destination. Some results were presented at the NESTI meetings.

Following this exercise, further statistical activities by international agencies were suggested, mainly taking place along three distinct lines of action:

- developing new data collection exercises at international level⁵;
- developing statistics on foreign affiliates (EUROSTAT FATS⁶ domain);
- promoting the flow of international R&D data among EU Member States.

A survey on MNEs – mainly carried out at international (European) level – would offer several advantages in comparison with the collection of data from member countries. Phenomena like intra-company trade and the establishment of international R&D networks within large multinational groups could be extensively surveyed using only a supranational exercise.

On the other hand, the implementation of a Europe-wide survey may be affected by serious methodological and technical problems ranging from the correct identification of statistical units to the management of non-responses or errors. In the short term, it may be an expensive effort with a low probability of success. Thus, it is not surprising that the OECD and EUROSTAT still rely largely on data collected at the national level. As to the specific R&D domain, the OECD *R&D Internationalisation project* provided a very good example about the potential and limits of a systematic collection of national statistics on the R&D performed by foreign affiliates and by affiliates

³ "The OECD Working Party of National Experts on Science and Technology Indicators (NESTI) is a forum composed of a group of delegates from member countries, supported by the OECD Secretariat. [...] NESTI meets annually to discuss agenda items on which to reach consensus. [...] The Working Party was established in 1962 to finalise the Frascati Manual and to carry out the first R&D surveys". (Sirilli, 2006).

⁴ kei.publicstatistics.net

⁵ That is one of the main suggestions deriving from the KEI project, see Akerblom and Luhtala (2006).

⁶ FATS is the acronym for Foreign AffiliaTes Statistics. For further information, see: EUROSTAT (2007).

abroad of nationally-based MNEs. After the presentations of NESTI project findings, OECD researchers (see Colecchia, 2006) addressed two key questions about future developments:

- *What are the difficulties in identifying foreign-controlled affiliates and in measuring data concerning affiliates performing R&D abroad? Can an exchange of practices, and perhaps bilateral exchange of otherwise confidential information, help in improving the coverage of this population?*
- *Can the sources of discrepancies between the Outward and Inward R&D data be identified? Can they be reconciled? What is the feasibility of using such bilateral and mirror information to improve the measurement of Outward R&D statistics?*

The main idea behind these questions was to develop the project towards a different structure, allowing for a more flexible data collection approach, including data exchange activities not necessarily involving an international organisation but focusing on bilateral or multilateral data sharing among participant countries.

Such an ambitious strategy has proved partially inefficient. Apart from collecting challenging ideas from experts and scholars, the multilateral strategy has surely suffered from a lack of coordination. In addition, there has been an imbalance in terms of reference values between the Inward and the Outward concept. While the BERD (therefore, conceptually, the single country) is always a valid denominator for Inward values, to comprise the Outward value there is a need for a wider concept. As will be shown in the rest of the report, we believe this is mainly related to the individualisation of the "ownership composition" of multinational groups, as well as private R&D implementation matching with the geographical territory.

In other words, jumping directly from the single R&D performer to its ultimate owner might cover the real "industrial ownership" of the R&D process. In many cases, in fact, the ultimate owner is geographically located in accordance with fiscal or administrative reasons, and not industrial or technological ones. Instead of individualising the global ultimate owner, it might be more useful to individualise the industrial controller. This is not necessarily the direct controller but the highest company in the control chain of a multinational group, with an "industrial meaning". To do this, the whole internal (ownership) network for each group, and then the performing research network, which exists in the whole internal network, need to be identified. In other words, the ultimate aim is to find out all cross-country linkages connecting R&D performing companies / subsidiaries within the main multinational groups. To achieve this goal, we suggest the following conceptual steps:

1. The individualisation of all the subsidiaries in the world belonging to global R&D performers (their "ownership composition").

2. The sum of R&D performed by all these companies, per group, according to BERD micro data from different countries.
3. Finally, an observation of the actual international flows of R&D investment.

Given the difficulty of doing this for all world companies, we consider it useful to perform a pilot project on only the top R&D performers, as individualised in the Scoreboard rankings (e.g. European Commission, 2009a; DIUS, 2009).

3. The methodological challenge: convergence between the EU R&D Scoreboard and BERD data

The EU Industrial R&D Investment Scoreboard (hereinafter, the Scoreboard) is an annual publication by the European Commission⁷, first released in 2004. It comprises data on R&D investment, as well as other economic figures (e.g. net sales, operating profits, employees), for the top 2,000 R&D global performers: 1,000 companies based in the EU and 1,000 based outside the EU. In the first edition (2004), the top companies were 500 EU and 500 non-EU; while in the second edition (2005), there were 750 for each area; since the third, the total has been 2,000.

The fact that Scoreboard companies are global players implementing R&D investment all over the world, and not only in the country where they have their registered office, is often seen as a limitation for the assessment of the R&D internationalisation process. However, our analysis relies on the assumption of the centrality of the Scoreboard. Its strength is that it allows the individualisation of the main global R&D players. It is well known that these players control the majority of private world R&D investment (European Commission, 2009a; UNCTAD, 2005; DTI, 2004). Therefore, it may be a promising starting point for the exchange and comparison of international R&D data based on BERD surveys.

As reported in a previous work at the European Commission, JRC-IPTS⁸ (Azagra Caro and Grablowitz, 2008), Scoreboard and BERD data “present complementary information and the differences between their methodologies are much deeper”. The authors’ analysis is particularly accurate and clearly addresses all the differences between the two sets of data, as shown in table 1.

⁷ This activity is jointly carried out by the European Commission's Joint Research Centre (JRC) - Institute for Prospective Technological Studies (IPTS) and Directorate General Research - Directorate C, European Research Area: Knowledge-based economy.

⁸ It has to be underlined that in the cited report BERD and Scoreboard are compared as final aggregates, while the current project has relied on meso-data. Therefore, methodological suggestions are similar but not necessarily the same.

After explaining all the differences reported in the table in detail, the authors highlight three important conclusions:

- 1) “a direct comparison is not appropriate”;
- 2) “BERD and Scoreboard have been designed for different uses and any comparison between them requires careful interpretation”;
- 3) “really understanding the differences between BERD and the Scoreboard would require matching the two data series at company level, but the BERD micro data are not publicly available”.

Table 1 – Overview of main characteristics of EUROSTAT BERD and the JRC-IPTS/DGRTD-C Scoreboard

Characteristic	Eurostat BERD	JRC-IPTS Scoreboard
Monetary flows	All R&D expenditures by those parts of companies located within the EU, regardless of where the funds for that R&D activity come from	All R&D financed by a particular company from its own funds, regardless of where that R&D activity is performed
Sample	A stratified sample, covering all large companies and a representative sample of smaller companies	Top R&D investing-companies
Statistical unit	Business enterprises: subsidiaries counted separately, R&D attributed to R&D headquarters or registered offices	Companies: subsidiaries counted within the group, R&D systematically attributed to the registered offices
Data collection frameworks	Frascati Manual	International Accounting Standard (IAS) 38
Geographical area	EU Member States and Candidate Countries, EFTA Countries, Russian	World

Source: European Commission, JRC-IPTS, Azagra Caro and Grablowitz (2008)

In this report, we individualise a methodology to overcome this limitation, respecting the confidentiality issue. Aggregate data – not at the company level, but as the sum of a clearly defined set of R&D performers – from BERD can in fact be compared to Scoreboard aggregate values. In this section, we present the main methodological caveats for this attempt, while in the following two sections we show results for the reference years 2006 and 2007 in selected EU countries.

First of all, to make our comparison typology between Scoreboard and BERD values possible, we have to recall the conceptual reasons for these two sets of data being different. Firstly, technical speaking, BERD data come from a survey, while Scoreboard data are from companies' annual reports and accounts, usually based on the consolidated group accounts of the ultimate parent company. Furthermore, R&D surveys are usually compiled by R&D managers themselves and not by the accounting offices of companies, as with audit reports⁹.

⁹ See methodological notes in OECD (2002) and European Commission (2009a).

Additionally, we have identified the three main differences to be controlled and adjusted to reach the project objectives, as follows:

A) capitalisation of R&D

As explained in annex 3 of the Frascati Manual, there is a different "treatment of fixed capital: whereas the cost approach counts consumption of existing fixed capital, the expenditure approach counts the expenditure (purchase) of new fixed capital". BERD surveys exclude any form of capitalisation, considering everything as an expenditure, while company reports¹⁰ allow – only for development costs – the possibility of capitalisation under certain conditions (according to the International Accounting Standard – IAS – 38, used for company reports). Corollary: company reports might suffer the misinterpretation of “R&D definition” as the broader concept of “innovation”.

b) ownership composition

BERD surveys consider the company (including all activities in all plants) as the statistical unit, not the entire group; while company reports usually calculate the consolidation of all the (possible) companies in a group. This implies that, when a “national R&D total” is calculated in the Scoreboard, this value also includes R&D activities undertaken abroad by companies with the registered office in that country; while excluding foreign-owned R&D activities undertaken in that country. On the other hand, for BERD surveys, the R&D activities of each single enterprise contribute to the “national R&D total” of their resident country, irrespective of the group they belong to.

c) source of funding

Scoreboard data (i.e. the consolidated group's audited accounting data) exclude R&D investment NOT funded by the company itself (only "cash investment funded by the company"), while BERD surveys include and disaggregate R&D expenditure by all funding sources (not only "own funds" but even other companies, Government, EU, etc.).

Therefore, there are three main problems associated with the divergences outlined:

¹⁰ As regards this divergence, it has to be noticed that the data producer for the Scoreboard operates an adjustment on the company reports to bring them into line with the Frascati Manual recommendations. In other words, in the Scoreboard data the R&D capitalisation problem is solved at the origin and can be considered as the actual expenditure of the company in the reporting year.

- BERD and Scoreboard national totals can be very different¹¹.
- The geographical execution of R&D by Scoreboard companies is not recorded.
- The sector attribution of Scoreboard companies could be misleading.

To try and solve some of these problems, we focused on the following two assumptions:

- 1) The *divergence between BERD and Scoreboard data can be reduced* if we control the:
 - Ownership composition of Scoreboard companies, at least among the four countries involved in the project;
 - Source of funding, using the richness of BERD data (Frascati Manual, section 6.3).
- 2) The assessment of the *geographical execution of R&D* (and therefore its degree of internationalisation) can be achieved through the improvement of meso-data exchange among partner countries.

We first focus on the "ownership composition problem" because we consider it as *crucial*. In other words, it is not helpful to try to directly link Scoreboard data with external data sources (such as the BERD), because the statistical unit of analysis is completely different. Such an attempt would probably lead to partial matching. In other words, although the company name and its country of residence are attributed according to the parent company in the Scoreboard, its R&D activities are those undertaken by all companies in the group.

Of course, not all subsidiaries are actually undertaking research. However, from a methodological point of view, it seems necessary to include all of them as a possible R&D investment geographical destination. To obtain a quantification of companies' R&D Investment in each EU Member State, we have to rely on the collaboration with the producers of BERD values. Therefore, a first collaboration with a BERD producer (ISTAT, Italian National Institute of Statistics, which was the first to make itself available for this project) has been set in 2009 with regards to R&D investment in Italy for the reference year 2006. Given the positive results of this pilot exercise, in 2009/2010, the collaboration was extended to the other three BERD producers from EU countries (Belgium, Finland and Germany), with regards to private R&D investment in the reference year 2007. In the following two sections we present the main results of this collaboration.

¹¹ As a remark, we add other minor explanations which are usually suggested for this divergence: small companies are excluded from the Scoreboard, though it is very difficult that they are accountable for large R&D investment; R&D reporting is compulsory almost only for companies present in stock markets, therefore there might be a bias towards them.

4. Results of the pilot exercise: Italy

The Italian pilot project's aim was to test the feasibility of the methodological framework, as outlined in the previous section. Thanks to the collaboration with ISTAT, we performed a pilot exercise for the period March-June 2009. This allowed the outlined hypothesis to be tested on a significant sample of Scoreboard companies. The valuable results from this pilot exercise are summarised in three blocks, as follows: the individualisation of the "ownership structure"; the relationship between Scoreboard and BERD values; the geographical implementation of R&D by Italian companies.

The "ownership composition" of Italian Scoreboard companies

As a first step, we have individualised the entire network of companies belonging to each Italian group in the Scoreboard. Waiting for an integrated European archive¹², we used a commercial database named GRS (Global Reference Solution – formerly "Who Owns Whom" – provided by Dun & Bradstreet): this database contains a continuously updated list of all companies belonging to global industrial groups and their ownership composition.

In the 2007 edition of the Scoreboard¹³, 48 Italian companies were ranked. Among them, two separate clusters were observed: the first containing 9 companies (generically the largest R&D spenders according to ISTAT) whose ownership composition was already known by ISTAT itself; and the second with 39 companies, for which we have been asked to provide ISTAT with our estimation of their ownership composition.

Therefore, using the GRS database, we individualised a list of 409 companies, belonging to the second cluster of Scoreboard companies. It is important to notice that, given the GRS continuous update, this list refers to June 2009 (when the last version of the list was extracted).

As well as their names, we provided ISTAT with those companies' VATIN¹⁴. An initial valuable result was that VATIN was a very good key for matching: although the ISTAT internal archive used for the 2006 survey refers to 2007 (instead of 2009), it was possible to match 97% of companies. Our strategy of providing the national BERD producer with a list of VATIN from the GRS database appeared therefore to be highly reliable.

¹² That should be available after the conclusion of the EUROSTAT Euro-Group Register (EGR) project.

¹³ The use of the 2007 edition was requested because the R&D data referring to 2006 was the last year for which BERD data were available when undertaking the pilot project.

¹⁴ VATIN stands for Value Added Tax Identification Number and represents a unique identifier for companies in the EU and in many non-EU countries.

On the other hand, a very limited number of additional firms (not included in our list) were individualised by ISTAT: mainly due to misspellings and changes in the VATIN over time. This means that we were able to track the exact firm through GRS and only its coding was incorrect.

As a first conclusion, the pilot exercise with ISTAT confirmed our belief that the individualisation of the ownership composition is a necessary step to exchange national data with a BERD producer. In fact, starting with such a list of potential performers enabled ISTAT to put together companies which were not considered as part of the same industrial group. After this aggregation, it was easier for ISTAT colleagues to match Italian BERD data with Scoreboard ones.

The opposite strategy (starting with a list from the national R&D survey) would be more complicated. In fact, there would be no standard for putting together firms in the same group. There is usually a question regarding ownership composition in the R&D questionnaire but, as it is not compulsory, it cannot be considered fully reliable. Secondly, the absence of some companies in the control chain (namely those which are not expected to undertake R&D) would cause a partial reconstruction of the ownership composition. Finally, the global nature of Scoreboard companies requires a wider starting point. This is why we consider the first step as unavoidable.

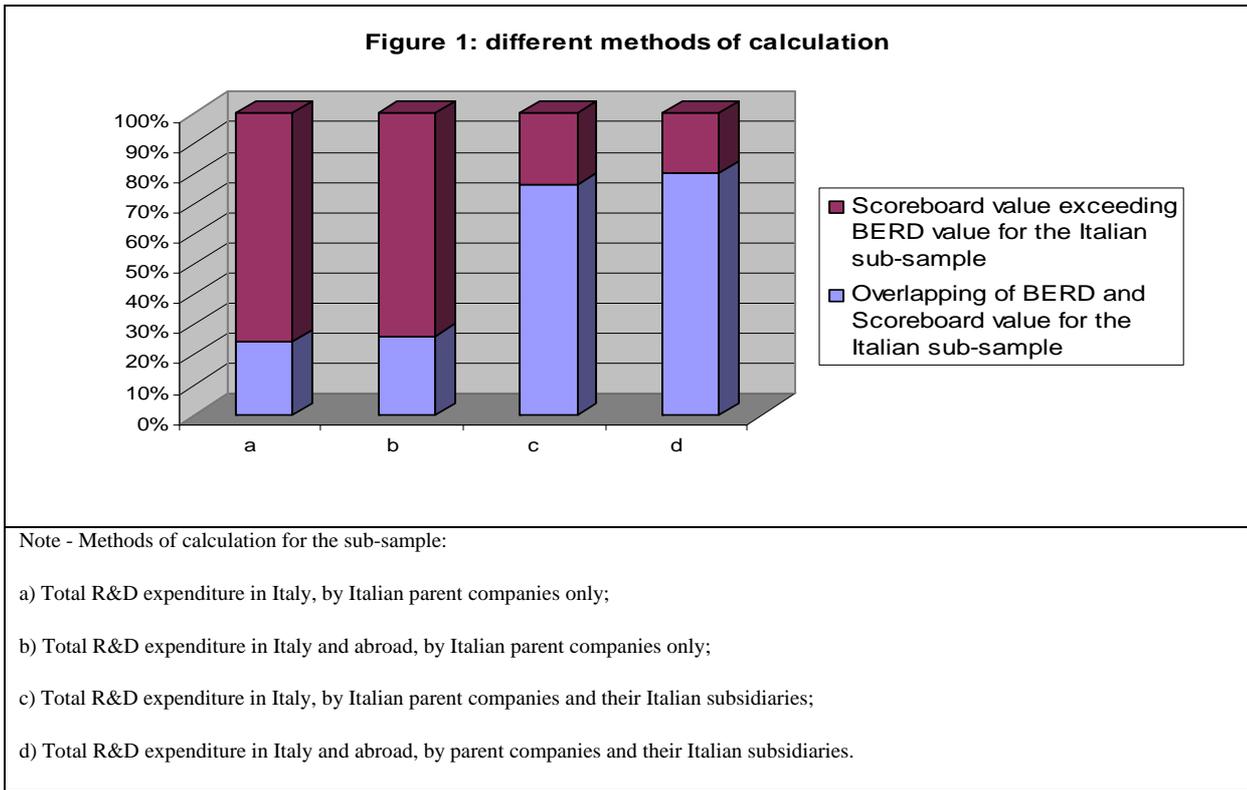
The relationship between BERD and Scoreboard data for Italy

As mentioned, previous studies on the comparability between BERD and Scoreboard values conclude that a direct comparison is impossible. A simple matching by country, in fact, gives very different values. For instance, according to the Scoreboard R&D investment for Italy in 2006 was about €4,941m, while the Italian BERD value was about €3,210m. Despite the large number of SMEs in Italy, it is unlikely to imagine that the missing 40% of business R&D in Italy is performed by such companies. Therefore, Scoreboard appears to cover only the 60% of Italian BERD, leading to the conclusion that BERD and the Scoreboard address different concepts and cannot be compared. However, we want to demonstrate that the main reason for this difference is the underestimation of the role played by the ownership composition of companies. In other words, Scoreboard values should be adjusted to BERD using two operations: firstly, by deducting R&D activities performed by Scoreboard companies abroad, through foreign affiliates; and secondly, by adding R&D activities performed by subsidiaries belonging to the same Scoreboard company and resident in the same home country.

Again, in the case of Italy, we can show that:

- The BERD value is actually lower than the Scoreboard one, due to the effect of R&D performed abroad.
- Our methodology allows the individualisation of a substantial overlap.

In order to do this, we agreed a further analysis step with ISTAT, focusing on the attention of a sub-sample of Italian firms in the 2007 edition of the Scoreboard. This sub-sample consists of 28 Scoreboard companies, slightly more than the half of the total sample, whose R&D Investment accounts for 83% of the Italian total for 2006. ISTAT has eliminated those companies whose difference was too high to be explained: it is usually due to the complexity of the value estimated by ISTAT with non respondents or integration of data from external sources.



Source: European Commission, JRC – IPTS, 2010.

We then asked ISTAT (see figure 1) to compare this total value for the sub-sample – about €4,100m– with four different aggregate values from the Italian R&D Survey: the R&D expenditure by those 28 parent companies in Italy; the sum of this and their R&D expenditure abroad; the R&D expenditure in Italy by all Italian companies belonging to those 28 groups; the sum of this third value with their R&D expenditure abroad.

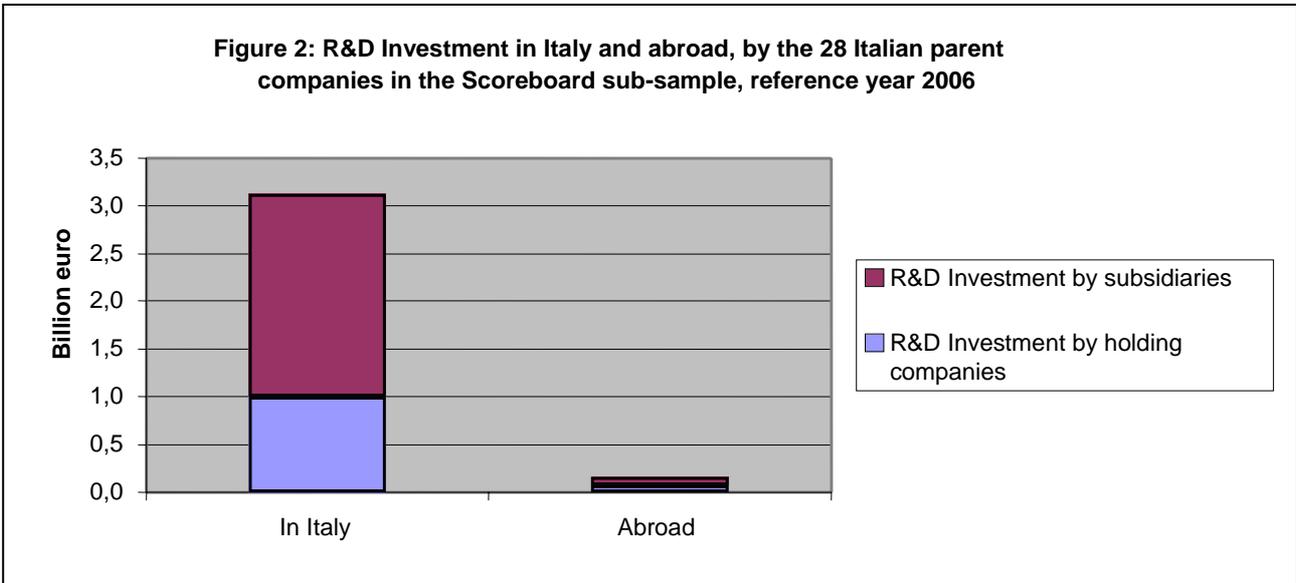
This results in the Scoreboard value appearing to be higher than that calculated by the statistics office, which is consistent with the idea that such big multinational groups perform a part of their R&D outside the country of residence.

Then, as a confirmation of our hypothesis, it can be seen how shifting from one method of calculation to the other, the BERD value gets closer to the Scoreboard one: from 24% (by only including the expenditure of the parent companies in Italy) to 80% (the estimation of their global value). Most of all,

at least for Italy, it is clear that the major improvement does not derive from the inclusion of foreign R&D activities owned by parent companies (a shift from 24% to 26%); rather the inclusion of their Italian affiliates (shift from 26% to 76%). Finally, the usefulness of the individualisation of the entire (national and foreign) ownership composition of Scoreboard companies (up to 80%) is confirmed.

The geographical execution of R&D by Italian Scoreboard companies

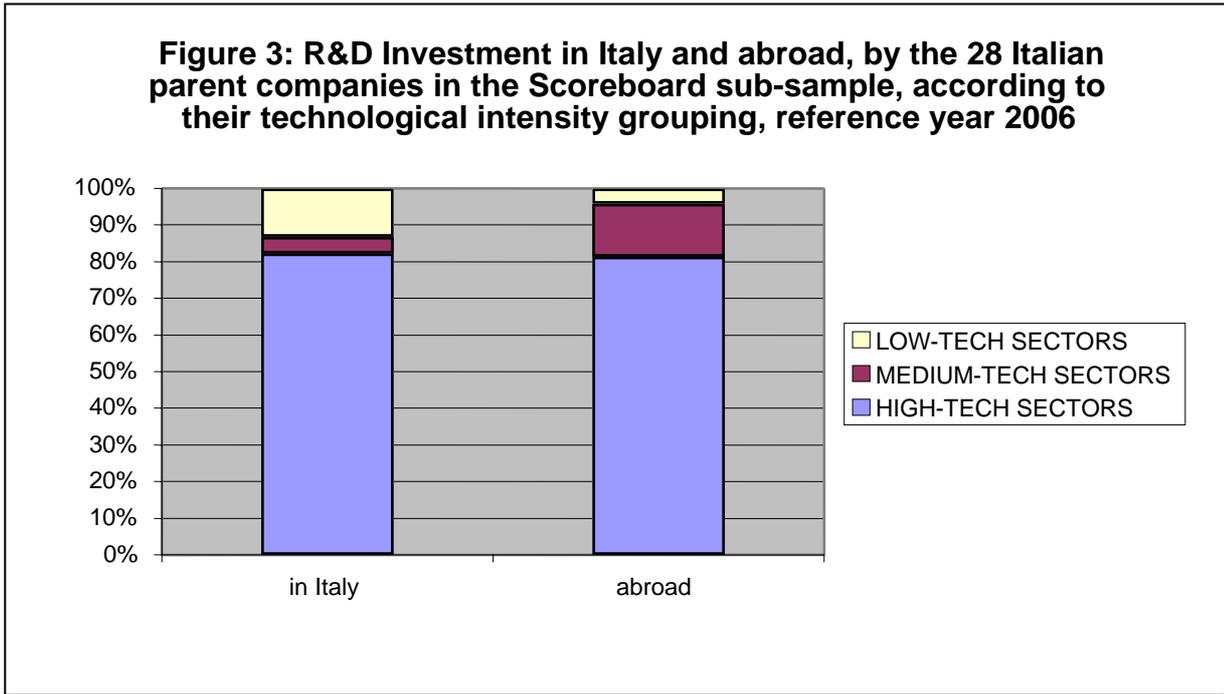
Our last request to the BERD partner was about splitting the total amount of R&D overlapping geographically and by sector. Although the coverage of Italian firms was partial (as already mentioned, 58% of the 2007 Scoreboard list of firms and 83% of their R&D investment), this exercise allowed their total value to be split in two parts: the R&D investment undertaken by the sub-sample in Italy and abroad. In addition, it was even possible to split each part in two: the R&D investment undertaken directly by the parent companies and that by their subsidiaries (see figure 2).



Source: European Commission, JRC – IPTS, 2010.

This second figure suggests R&D investment abroad played a marginal role for Italian companies, as well as the importance of Italian subsidiaries in the total amount of R&D, compared with their parent companies. These findings are in line with the traditional view of Italian R&D as "not internationalised" and concentrated in a few companies (see, for example: Evangelista et al. 2002). Our main finding is that such a concentration refers to a few groups but not necessarily a few companies: the role of Italian subsidiaries is apparently higher than that of their Italian parent companies.

Finally, we asked ISTAT to split national and foreign R&D investment into three main technological groups¹⁵, as in the Scoreboard classification, and these are reported in figure 3. This figure confirms the importance of high-tech sectors, which account for more than 80% of the R&D in our sub-sample. Interestingly, the second most important sector is the low-tech one for R&D performed in Italy, while it is medium-tech for R&D investment abroad. That seems to confirm the peculiarity of the Italian industrial structure, with many companies active in traditional and low-tech sectors.



Source: European Commission, JRC – IPTS, 2010.

Such kind of descriptive analysis is considered useful because its replication for several countries might give more insight into R&D internationalisation. In any case, a comparative study has to be based on comparable data and methodology. Therefore, a proposal for extending the analysis to a set of countries is presented in the following section.

¹⁵ In this figure, parent companies are grouped according to ICB sectors. High-tech sectors consist of: Aerospace & defence, Automobiles & parts, Electrical components & equipment, Electronic equipment, Pharmaceuticals, Software, Telecommunications equipment. Medium-tech sectors consist of: Chemicals, Commercial vehicles & trucks, Health care equipment & services, Household goods, Industrial machinery. Low-tech sectors consist of: Banks, Electricity, Fixed line telecommunications, Oil & gas producers, Personal goods. Such a classification is referred to in Ortega-Argilés, Potters and Vivarelli (2009), which is a further elaboration of the OECD classification (see, for example: OECD, 2009).

5. Main results of the project: Belgium, Finland, Germany and Italy

The extension of the analysis to three other EU countries has confirmed the preliminary results shown in the previous section. To summarise them, this section is divided into three parts:

- Methodology;
- Relationship between BERD and Scoreboard total national values;
- Assessment across countries, R&D Investment by Scoreboard companies.

Methodology

The main limitation of the pilot experiment for Italy is that an exercise performed in a single country might be affected by singular circumstances. In addition, although relatively important, R&D investment by Italian companies is only a part of EU-based R&D. For these reasons, we decided to replicate the analysis with BERD data producers from the other three EU Member States (Belgium, Finland and Germany) who agreed to collaborate voluntarily.

As a result, a second phase of the project started on October 2009. Given that the BERD data for the reference year 2007 had been produced, we used the 2008 edition of the Scoreboard, and individualised a sample of 100 R&D performers. It was decided to use a limited number of Scoreboard companies in the sub-sample to reduce the complexity of the calculations. The overall number of companies in the four countries (340) in Scoreboard 2008 would have needed excessive work on the partners' side. In addition, we decided to replicate the relative weight of the four countries regarding total R&D investment in Scoreboard 2008. Therefore we asked the partners to produce meso-data for a variable number of Scoreboard companies; namely:

- The top 50 companies with a registered office in Germany;
- The top 20 companies with a registered office in Finland;
- The top 15 companies with a registered office in Italy;
- The top 15 companies with a registered office in Belgium.

Then, using the same source as in the pilot exercise (that is the D&B Global Reference Solution database) we individualised all the subsidiaries (around 5,000) belonging to these 100 companies and located over the four countries. Then, the four BERD producers were provided with this list of subsidiaries (including company names, VATIN and address) and asked to perform the same matching

exercise as in the pilot exercise, shown in the previous section. This matching was performed at the beginning of 2010 individually by the four BERD partners. After doing this, they provided some aggregate values, namely:

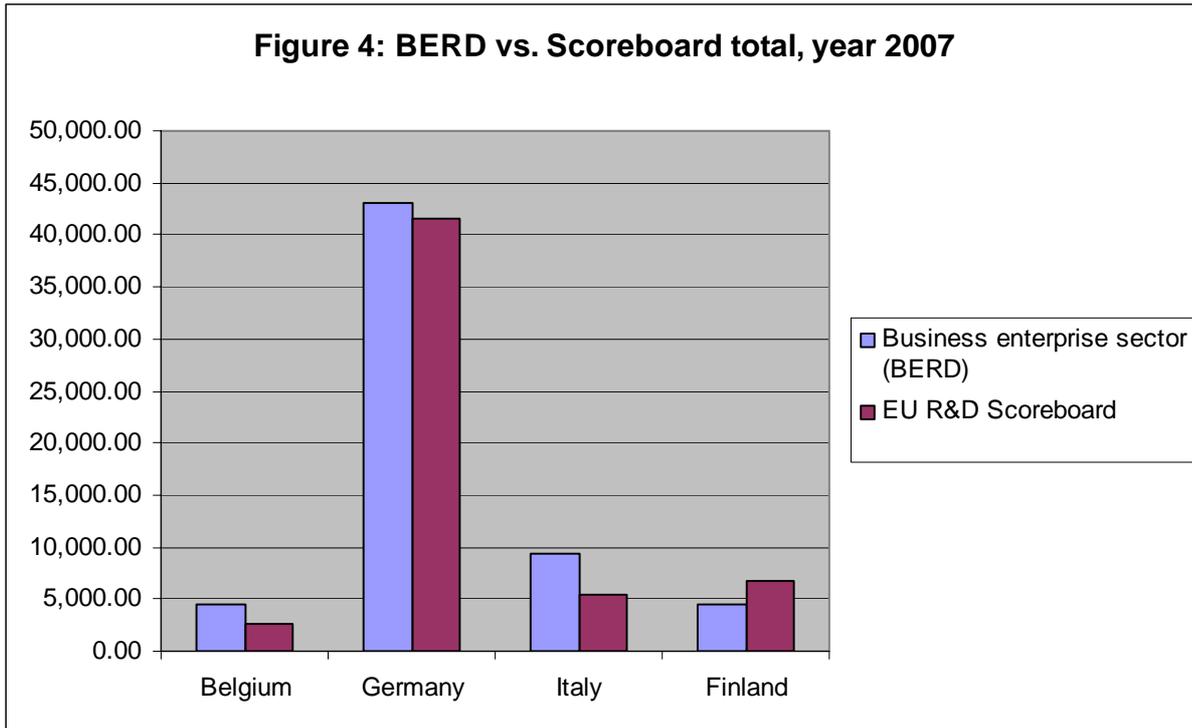
- Total number of subsidiaries involved in R&D nationally and belonging to the 100 companies, where possible divided by country of origin;
- Total R&D performed nationally by the 100 companies, where possible divided by country of origin;
- R&D performed with own funds nationally by the 100 companies, where possible divided by country of origin;
- If available, R&D performed abroad by national companies, where possible divided by location.

Relationship between BERD and Scoreboard total national values

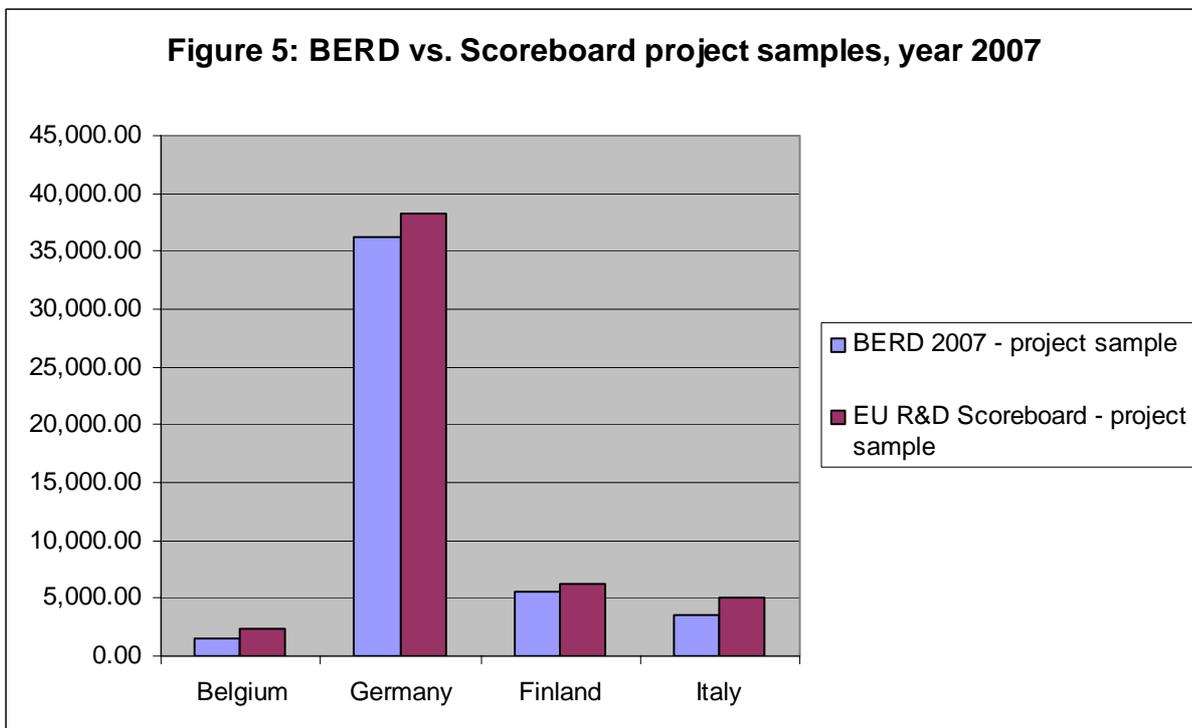
Together with a strong improvement in the methodology, the extended analysis allowed us to individualise a preliminary quantification of the overlap between BERD and Scoreboard values, as well as the cross-country R&D Investment for the countries involved in this study.

Firstly, as with the pilot exercise and confirmed by the extended analysis, the inverted relationship between BERD and Scoreboard total values at the national level was seen. That is, while for total values the BERD is usually higher than the Scoreboard, in our analysis it was the other way round. For the samples identified, the Scoreboard total R&D investment is always higher than the BERD value for the same companies.

In other words, it seems not to be true that the Scoreboard covers only a part of the national totals (i.e. when the residual part is attributable to companies outside the Scoreboard); however, it is apparently true that BERD (which is the R&D performed nationally) covers only a part of multinational companies' worldwide R&D. The reconstruction of the total ownership composition of Scoreboard companies, therefore, appears to be necessary to measure such phenomena. A quantification of this, for the reference year 2007, is shown in the following figures 4 and 5.



Source: European Commission, JRC – IPTS, 2010.



Note: as project sample we refer to the 100 companies as identified in section 5.

Source: European Commission JRC – IPTS, 2010.

In figure 4, the total R&D in the Scoreboard is higher than the BERD only for Finland. This is probably due to the specificity of the country, with few multinational companies having a large part of their R&D in subsidiaries abroad. The same might happen in any country, but the weight of the top Finnish national R&D performer (Nokia) is probably higher than that of its counterparts in the other countries.

Regarding the analysis of top R&D performers only, figure 5 shows how Scoreboard values are always higher. This is not surprising, given that the Scoreboard's aim is to report the totality of companies' R&D activity. On the other hand, our assessment of companies' worldwide R&D from BERD surveys, being a data sum aimed only at measuring the national R&D total, is obviously expected to be lower, though not necessarily. In fact, it might not include a part of the companies' worldwide total, which BERD partners are not able to individualise through their surveys. In any case, the two sets of data present very similar values.

Once this relationship between BERD and Scoreboard samples is individualised, it is possible to consider the Scoreboard total as the denominator value: that is the total R&D controlled by top performers worldwide. In accordance with this, and as the two sets of values in figure 5 are quite close, we calculated the following indicators (see figure 6):

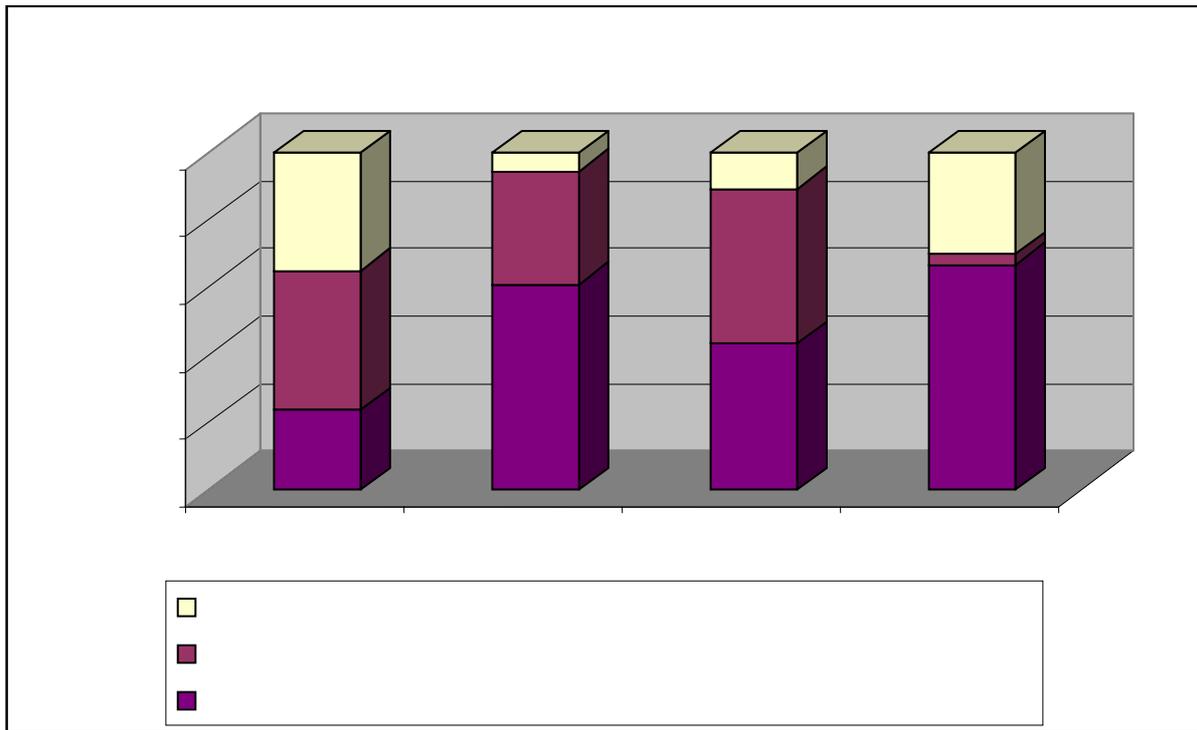
- The percentage of R&D performed by the 100 companies in their home country;
- The percentage of R&D performed by the 100 companies outside their home country;
- The residual percentage for which there is no overlap¹⁶.

Though there might be a high variability of sample composition from year to year – for instance, in the case of Italy, for the reference year 2006 the overlap between BERD and Scoreboard was around 80%, while for the reference year 2007 it was only 70% - in general terms, our matching strategy provides a good degree of overlap.

An additional point regards the "source of funding" differences. It is usually believed that a major discrepancy between BERD and Scoreboard values reflects the exclusion of external sources of funding from the Scoreboard total. As already explained in the methodological session, Scoreboard only includes "cash investment funded by the company". Even if this figure varies considerably from year to year, the double-check with BERD meso-data in our analysis shows that for our sample the R&D investment is mainly performed by Scoreboard companies with own funds. That is, since BERD surveys measure – according to the Frascati Manual – the disaggregation of total R&D by source of

¹⁶ This is mainly due, in our idea, to the underestimation of the Outward R&D. The improvement of this estimation is an unavoidable step for a complete overlapping of the two values and the main aim of this project.

funding, the total R&D performed by companies with own funds could be extrapolated. As shown in the following table 2, the difference between this new aggregate from BERD surveys and the Scoreboard total is very little.



Note: as project sample we refer to the 100 companies as identified in section 5.

Source: European Commission JRC – IPTS, 2010.

Table 2 – percentage of R&D financed by sample companies themselves

	15 top Scoreboard companies from Belgium	50 top Scoreboard companies from Germany	20 top Scoreboard companies from Finland	15 top Scoreboard companies from Italy
BERD 2007 - project sample				
Percentage of R&D performed on the national territory, with own funds	96,4%	98,9%	96,9%	80,9%

Source: European Commission JRC – IPTS, 2010.

The explanation of the different value for Italy is due to the exclusion of public grants to companies in this figure. In other words, in the Italian case, public grants are considered as public funding and not as companies’ own funds.

Assessment of cross-countries R&D Investment by Scoreboard companies

As regards the assessment of cross-country R&D flows, the confidentiality issue still has to be considered as the main problem. As with the exercise performed in the OECD project, we asked the

four BERD producers involved in the project to provide their estimate on the geographical implementation of R&D by the sample companies. These estimates are reported in table 3¹⁷.

Table 3 – percentage of cross-country R&D

Year of reference: 2007	15 top Scoreboard groups from Belgium	50 top Scoreboard groups from Germany	20 top Scoreboard groups from Finland	15 top Scoreboard groups from Italy
R&D executed in Belgium	37%	-	0%	-
R&D executed in Finland	0%	-	49%	-
R&D executed in Germany	14%	65%	10%	2%
R&D executed in Italy	1%	-	1%	96%
R&D executed in other EU-27 countries	23%	-	21%	-
R&D executed in the US	22%	-	11%	-
R&D executed in the rest of the world	3%	35%	9%	3%
Total (from National Statistics)	100%	100%	100%	100%

Source: European Commission JRC – IPTS, 2010.

As already stated, the assessment of Outward R&D Investment by the single BERD producers suffers from the main limitation intrinsic to the R&D survey: the aim is to produce a value for the R&D performed nationally and not worldwide. A double-check can be done by comparing two values conceptually related to the same sample: that is, Outward from country X to country Y (according to the country X estimate) compared to Inward in country Y from country X (according to the country Y estimate).

Unfortunately, in our project, this is not always possible. In the case of Germany, the Outward value cannot be disaggregated by country of destination; in the case of Italy, the country of destination is not always explicitly declared. As it is not compulsory, the Outward R&D question appears to be less reliable than the others. Furthermore, we performed a comparison between these two sets of aggregate data and report them in table 4. Looking at this table, it is clear that variability may come from both sides: in some cases, the Inward value might be higher because of the limitations to the Outward question, which we have already recalled; while in other cases, the Outward value might be higher because of the difference in defining the country of the parent company.

¹⁷ The 100% refers to total R&D from R&D surveys, therefore to the first two colours (red and violet) in figure 6.

Table 4 – comparison of Inward and Outward estimations

Outward country	Inward country	description
Belgium	Finland	equal (zero)
Belgium	Germany	Outward > Inward
Belgium	Italy	Inward > Outward
Finland	Belgium	Outward > Inward
Finland	Germany	Outward > Inward
Finland	Italy	Outward > Inward
Germany	Belgium	not available
Germany	Finland	not available
Germany	Italy	not available
Italy	Belgium	not available
Italy	Finland	not available
Italy	Germany	Inward > Outward

Source: European Commission JRC – IPTS, 2010.

The only way to overcome this limitation, in our opinion, is to define an additional step. The BERD producers from the countries involved might provide EUROSTAT with even more disaggregated data for a sample of companies (eventually, the 100 Scoreboard companies selected in this exercise). The feasibility of a "one shot" micro-data comparison might also be explored.

6. Project workshop in Luxembourg

On the 5th of May 2010, a workshop on the project took place in Luxembourg, at EUROSTAT¹⁸. The main aim was to present the results shown in the previous sections, together with the discussion of further possible steps.

The first discussion point was about the "ownership composition" topic. Suggestions were made regarding to the use of FATS statistics. National experts related to this had two main doubts: the possible discrepancy between the ownership definition in the FATS statistics as opposed to R&D Survey ones; and the difficulty in merging micro-data from surveys with different approaches.

As regards the discrepancy, some participants in the workshop explained how the country of ownership in FATS surveys is always the ultimate owner, while in R&D surveys the direct controller is often reported. This might mean that the ultimate owner logic is interesting for the organisational attribution of the company (e.g. ultimate owner in Cayman Islands), but not for the individualisation of

¹⁸ I wish to thank all the participants, in particular our colleagues from EUROSTAT who hosted the workshop, namely: Mr Veijo Ritola (Section head), Ms Reni Petkova, Mr Hakan Wilen and Ms Angeles Hermosa. Then there were colleagues from the national statistics offices: Mr Giulio Perani (ISTAT, Italy), Mr Andreas Kladroba (Stifterverband, Germany), Mr Tero Luhtala (Statistics Finland). Finally I wish to thank Ms Agnieszka Maria Skonieczna (DG RTD) for attending the workshop and providing useful comments.

the real industrial motivations for it. On the other hand, it was argued that, having individualised the entire network of subsidiaries with this project, it may be possible to distinguish these two sides.

As regards the difference in defining R&D, there was full agreement that R&D data resulting from a dedicated survey are more accurate than FATS ones. In any case, it was also pointed out that the majority of Member States produce R&D Inward FATS data directly from R&D surveys.

A second point of discussion was about the funding of business R&D. It was argued that for the analysis of R&D internationalisation, it is very important to know not only the location where R&D is performed, but also the location of the funder of this activity. That is, total R&D data from all affiliates in the multinational enterprises are not enough for tracking the international R&D flows of these companies, but additional breakdown by source of funds is also highly demanding. It was also agreed that this was simply not feasible in this project. Assessing the “ownership composition” of Scoreboard groups has been done, while the funding problem might be included in a further step. Access to micro data, anyway, would then be needed.

Another point raised was about how to capture companies' extramural expenditure. There was general agreement that it would be impossible to individualise the country of destination, because such information is missing in the R&D survey.

Finally, it was agreed that the present report gives a clear insight into the relationship between BERD and Scoreboard values. The participants suggested the need to make more effort to identify a different strategy for exchanging meso-data. It was proposed that, ideally, a possible follow-up from the results of this report would be led by EUROSTAT. However, EUROSTAT has declared that it is not in the position, for the time being, to undertake such a task. In particular, direct involvement and contribution to further development by EUROSTAT is not possible for two major reasons:

- other ongoing activities of higher priority (e.g. development of European Research Area indicators);
- the confidentiality problem: some Member States may not be in the position of providing micro data on a voluntary basis; the further distribution of data collected may be not available for analytical purposes for JRC or other interested bodies.

7. Conclusions

In these times of a global and knowledge-based economy, one of the most important policy needs is to find out how geographical locations attract and retain private investment, in particular those related to knowledge-intensive activities. The current project on the measurement of corporate R&D

internationalisation was developed with the aim of providing a methodological step forward in this field. In particular, it was aimed at answering two main questions:

- Is there a methodological strategy to assess the degree of corporate R&D internationalisation in the EU, not only at the country level (as in BERD statistics) but also for top EU R&D investors?
- Is there a methodological strategy to trace the cross-country and/or sectoral flows of R&D within this selected sample of top R&D investors?

Using available BERD statistics, such an assessment cannot be undertaken. On the one hand, R&D data at a national level (those provided by EUROSTAT or OECD) provide only a proxy of the foreign involvement in national R&D expenditure. This is because data from national R&D surveys are produced to estimate the R&D performed nationally, with no regard to the individualisation of the actual R&D performers. On the other hand, rankings like the EU Industrial R&D Investment Scoreboard provide the names of these top R&D investors, but cannot provide a disaggregation of their global R&D investment by country or economic area.

With the current project, we proposed a novel methodology to measure such geographical execution of corporate R&D investment, using data from national BERD surveys and from the Scoreboard in a complementary way. Therefore it represents an alternative to a new *ad hoc* collection of information, for example to survey the top R&D investors only. Such new collections of data (see, for example: European Commission, 2009b) is an expensive pursuit and their results are often not easy to be generalised.

In our analysis, we have instead used existing data in a novel way. To use BERD and Scoreboard data for a sample of companies resident in four EU countries (Belgium, Finland, Germany and Italy) in a complementary way, the collaboration with the BERD producers from these countries was unavoidable.

The positive results showed in the report have led us to propose the following conclusions:

- BERD and Scoreboard values, though addressing slightly different concepts, are comparable and can be used complementarily.
- Data regarding the top EU R&D investors (that is companies appearing in the Scoreboard rankings and those active in the internationalisation of R&D) can be considered as the starting point for such complementary use.
- Starting from the top R&D investors' global values and adding aggregate values from national R&D statistics provides novel insights into the internationalisation of R&D, at least for the four EU countries involved.

In addition, the project provided a positive, although preliminary, assessment of intra-EU cross-country R&D flows. We believe that such a strategy can be further developed to obtain a clear picture of the geographical location of R&D investment by the top performers in the future. Given that the suggested coordination by EUROSTAT, within the framework presented, seems not to be feasible at the moment, alternative strategies must be investigated. In particular, after the development of the Euro-Group Register at EUROSTAT, covering the top companies operating in the EU, a new broader activity for a meso-data exchange could be proposed.

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Abstract

The report summarises the main results of a research activity aimed at testing a novel approach for the measurement of EU business R&D internationalisation. Such approach is based on the complementary use of two different sources of data: on the one hand, statistical data from private R&D expenditure taken from national surveys (BERD); on the other hand, data collected from companies' annual reports and accounts (as in the EU Industrial R&D Investment Scoreboard). The main objectives of the study were: i) to explore the methodological rationale for comparing the two sets of data; ii) to test the robustness of the novel methodology through an analysis applied to four EU countries (Belgium, Finland, Germany and Italy); iii) to provide indications of possible further research and follow up activities.

The main results from the project are as follows:

- BERD and Scoreboard values, though addressing slightly different concepts, are comparable and can be used in a complementary way.
- Data regarding top EU R&D performers (that is, companies included in Scoreboard rankings who are the active part of the R&D internationalisation process) have to be considered from the starting point of such complementary use, instead of as final data at the country level resulting from official statistics.
- Using top R&D performers' global values and adding aggregate values from national R&D statistics allows novel insights on the R&D internationalisation process to be given, at least for the four EU countries involved.
- Further research could rely on the forthcoming Euro-Group Register under development at EUROSTAT, to obtain a clear view of intra-EU cross-country R&D flows.

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