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A proposal for developing new indicators on the internationalisation of R&D by matching micro-data from national R&D surveys

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Aim of the paper

The paper provides methodological suggestions for the use of R&D survey data to measure R&D internationalisation. A well established empirical literature has pointed out the main issues about this phenomenon, both at micro and at national level of analysis, raising the need for improved statistics on this subject.

In order to fill this need by producing cross-country statistics, international efforts (including the ongoing OECD *R&D globalisation project*) are being undertaken by collecting, at a pilot level, macro and meso-data from different countries. We suggest that a further step might be represented by undertaking bilateral or multilateral matching of micro-data from national R&D surveys. We argue that R&D survey data may provide relevant evidence to address research issues discussed in current literature, such as the nature of existing relationships among different National Innovation Systems (NIS) or the motivations of R&D outsourcing/off-shoring strategies by Multinational Enterprises (MNEs).

1. Theoretical background

Economic literature is increasingly interested in the analysis of R&D internationalisation activities undertaken by business enterprises. Among scholars it is widely diffused the perception that R&D diffusion processes are highly hierarchical, mainly based on one-way transfer of knowledge generated in MNEs home countries. Since the late 1970s, some pioneering studies (Ronstadt, 1976; Lall, 1979; Mansfield, Teece and Romeo, 1979) have targeted R&D internationalisation as a key driver for economic growth. In those studies, R&D was still intended as a highly centralised activity; therefore, the MNE was seen as “a polyp with its brain in the home country and tentacles in the host countries” (Archibugi and Michie, 1995).

Lately, in the mid 1990s, some theoretical contributions have provided useful taxonomies to compare the different business strategies fostering the globalisation of R&D. We mainly refer to: Archibugi and Michie (1995), Dunning and Narula (1995) and Kuemmerle (1996, 1997). The first contribution argued that the so-called *globalisation of technology* is composed by three sub-phenomena: the global *exploitation* of technology, the global *technology collaboration* and the global *generation* of technology, the latter being referable “to a single actor only: the multinational corporation”. This sentence is fully consistent with the figures on world 2002 R&D expenditure: 69% of world’s business R&D was undertaken by “the 700 largest R&D spending firms of the world – of which at least 98% are Transnational Corporations” (UNCTAD, 2005).

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Two other studies have provided a different taxonomy, distinguishing between the main activities related to R&D Foreign Direct Investment (FDI): *asset exploiting* (Dunning and Narula, 1995) or *Home Base Exploiting* (HBE, Kuemmerle, 1996) on one side, *strategic asset augmenting* (Dunning and Narula, 1995) or *Home Base Augmenting* (HBA, Kuemmerle, 1996) on the other side. Respectively, “firms internationalise their R&D to improve the way in which existing assets are utilized” or “to improve existing assets or to acquire (and internalise) or create completely new technological assets through foreign-located R&D” (Narula and Zanfei, 2004).

Following those contributions, recent empirical studies have mainly investigated the following topics:

- at firm (group) level:
 - o the trade-off between Home and Host location advantages as a motivation for MNEs R&D FDI (Kuemmerle, 1999; Patel and Vega, 1999; Le Bas and Sierra, 2002);
 - o the trade-off between Internationalisation and Diversification in MNEs (Le Bas and Patel, 2005);
- at national level:
 - o the impact of R&D internationalisation on countries’ specialisation and diversification (Cantwell and Janne, 2000; Criscuolo et al., 2002);
 - o a potential process of “hollowing out” of national capabilities because of R&D internationalisation (Criscuolo and Patel, 2003).

2. Current indicators on R&D internationalisation

These scientific contributions have largely shaped the demand, by analysts and policy-makers, for statistics and indicators measuring the globalisation processes. Most of their needs have been incorporated in the OECD’s *Handbook on Economic Globalisation Indicators*, firstly released in 2005. Among several “globalisation issues” related to the relevant literature in the field, the *Handbook* focuses also on R&D internationalisation, having been largely influenced by questions emerged during the 2002 revision process of the *Frascati Manual*.

As a result, some areas which were neglected in the past are now covered by statistical production: R&D expenditure flows to/from abroad and R&D activities performed by foreign-controlled affiliates, on the inward side, and by affiliates abroad of domestic MNEs, on the outward side.

In particular, the *Handbook on Economic Globalisation* recommends the production, at national level, of the following indicators on MNEs R&D activities:

- R&D expenditure by foreign-controlled affiliates, absolute value and share of total business R&D expenditure (*Inward R&D – expenditure*);
- Number of researchers in foreign-controlled affiliates, absolute value and share of total researchers (*Inward R&D – employees*);
- Share of business R&D expenditure financed from abroad (*R&D Inflows*);
- R&D expenditure by affiliates abroad as a share of domestic R&D expenditure in the compiling country (*Outward R&D*).

The ability of countries to comply with these recommendations and to regularly produce these indicators is largely influenced by the methodology adopted in carrying out their business R&D surveys. For instance, the Italian R&D survey, having adopted a census approach rather than a sample one, is assumed to be particularly effective in individuating the amount of R&D performed by affiliates of foreign-controlled MNEs (*Inward R&D*).

3. *The prospects for international collaboration in R&D statistics*

The growing need for statistics on the economic globalisation can be seen as a major challenge for national and international statistical systems. A comprehensive set of statistical indicators on the economic globalisation processes is now available from the OECD². It includes indicators on international trade and FDI, as well as data on the activities of foreign affiliates (also their S&T activities) in several countries. The European context is less developed and is mostly related – in addition to the traditional trade and FDI statistics - to the development of a set of foreign affiliates statistics, including both economic and R&D data (FATS domain).

Further developments of statistical activities by international agencies in the field of globalisation could take place along two distinct lines of action:

- fostering the flow of foreign affiliates data from member countries;
- developing new data collection exercises at international level.

Anyway, the implementation of a Europe-wide survey may be affected by serious methodological and technical problems ranging from the correct identification of the statistical units, to the management of non-responses or to the need of reducing other potential non-sampling errors. Shortly, it could be an expensive effort with a low probability to be very successful.

Thus, it is not surprisingly that OECD and Eurostat are still largely relying on data collected at national level. As to the specific R&D domain, the OECD *R&D globalisation project* provides a very good example about potentialities and limits of a systematic collection of national statistics on the R&D performed by foreign affiliates and by foreign affiliates of nationally-based MNEs.

On the one hand, an international project exploiting the information collected through the national business R&D surveys, could open the way to an intensive use of information – including meso and micro-data – usually neglected because of:

- the need of protecting data confidentiality,
- the lack of demand from national users,
- poor methodological guidelines and definitions,
- problems with the comparability with other countries' data.

In fact, the OECD project is attracting a large interest on both the policy and the research sides mainly because it provides a strong methodological base to compare for the first time data on R&D internationalisation from different countries.

On the other hand, what it is still critical with this approach are the obstacles to access confidential data. This is a main shortcoming for the OECD project, since some inconsistencies between data from different countries (and sometimes from different statistical or administrative data sources in the same country) can be addressed only checking the original micro-data or, at least, data with a restricted access for confidentiality concerns.

After the presentation of some preliminary finding of their *R&D globalisation project*³, the OECD researchers responsible for it have addressed to national data producers some key questions about the future of the project:

- *What are the difficulties in identifying foreign-controlled affiliates and in measuring data concerning affiliates performing R&D abroad? Can exchange of practices, and perhaps bilateral exchange of otherwise confidential information, help in improving the coverage of this population?*

² OECD Economic Globalisation Indicators 2005.

³ “Note on R&D internationalisation: a pilot exercise undertaken by the NESTI Task Force”, paper presented by Alessandra Colecchia at the 2006 NESTI Meeting in Berlin (29-31 May 2006), DSTI/EAS/STP/NESTI(2006)22.

- *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?*

What is behind these questions is a possible development of 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 possibility is currently explored through the “ISTAT R&D internationalisation project”⁴; its preliminary findings and methodological suggestions are presented in the following paragraph.

4. A proposal for developing new indicators on the internationalisation of R&D

While the production of new indicators at the group level mainly suffer the methodological problems raised, the task of defining a set of indicators on the internationalisation of R&D at country level can be based on a largely consolidated experience. In the framework of the ISTAT project, novel indicators are currently being provided. Besides testing the feasibility of producing them, the ISTAT project is going to develop a consistent framework where these indicators could provide an overall assessment of the degree of internationalisation of a national R&D system in terms of “propensity” to invest in R&D abroad, “permeability” to foreign R&D investments and ability to “penetrate” in selected R&D systems abroad. Finally, some specific indicators will be aimed at measuring the degree of “integration” between two national R&D systems (table 1).

Table 1. Indicators on the internationalisation of R&D	
<i>International R&D Propensity</i>	a. Overall Propensity (O Pro)* b. Country Propensity (C Pro)* c. Sector/Country Propensity (SC Pro)
<i>International R&D Permeability</i>	a. Overall Permeability (O Per)* b. Sectoral Permeability (S Per) c. Country Permeability (C Per) d. Sector/Country Permeability (SC Per)
<i>International R&D Penetration</i>	a. Simple Country Penetration (SC Pen) b. Relative Country Penetration (RC Pen)
<i>International R&D Integration</i>	a. Bilateral Integration (B Int) b. Sectoral Bilateral Integration (SB Int)
* Indicators recommended by the OECD <i>Handbook on Economic Globalisation</i>	

⁴ Since January 2006, ISTAT has been undertaking a national project aimed at improving its ability to produce relevant indicators on the internationalisation of the Italian R&D system. In this perspective, ISTAT has also contributed to the OECD *R&D globalisation project* producing pilot statistics on foreign affiliates R&D (expenditure and personnel), as well as collecting preliminary estimates on outward FATS R&D expenditure and personnel.

With the aim of complementing this analysis, as well as to test the coverage of the preliminary estimates on the internationalisation of the Italian R&D system, ISTAT has contacted the institutions responsible for R&D statistics in some OECD countries in order to assess the chances for sharing quantitative and qualitative information on bilateral flows of R&D.

Some collaborations have been undertaken – on a purely experimental basis – with Wissenschaftsstatistik GmbH im Stifterverband für die Deutsche Wissenschaft for Germany, the Office fédéral de la statistique for Switzerland, the Office for National Statistics for the UK and the Federal Office SPP “Politique scientifique” for Belgium.

Several activities have been carried out to check the interest by other countries of implementing:

- exchange of meta-data on the national R&D surveys, including information not regularly reported to the OECD’s *Sources and Methods* database;
- exchange of macro-data not regularly published by the surveying institutions.

In the following paragraphs we provide an extended explanation of such indicators.

4.1. International R&D Propensity

General definition: from the compiling country perspective, the International R&D Propensity ratios can be defined as the measure of the relevance of its R&D activities (affiliates/expenditure/personnel) abroad. Given the two possible denominators (domestic vs. foreign total R&D activities), we distinguish among the following ratios.

4.1.a. Overall Propensity

Definition: the Overall Propensity is calculated as the rate of R&D activities owned by domestic firms abroad on total domestic business R&D activities (similarly to the first Outward investment ratio in the *Handbook of Economic Globalisation*).

Purpose: the Overall Propensity estimates the attitude of the national R&D system to expand internationally. Such indicator is equal to 0 if domestic firms do not perform R&D abroad; it is lower than 1 if activities in the home country are higher than abroad; it is equal to 1 if business R&D activities are equally divided at home and abroad; it is higher than 1 if foreign activities are higher than domestic ones.

Formula and data required:

$$O Pr o = \frac{\text{Outward R \& D}}{\text{Domestic R \& D}}$$

Where:

Outward R&D = intramural R&D expenditure/personnel in foreign subsidiaries of domestic firms.

Domestic R&D = intramural R&D expenditure/personnel of domestic firms.

Data source: national business R&D survey providing Outward information.

4.1.b. Country Propensity

Definition: the Country Propensity is calculated as the rate of R&D activities owned by domestic firms in country X on total R&D activities owned by domestic firms abroad.

Purpose: the Country Propensity estimates the relevance of single countries of destination, independently from the amount of Outward R&D. Therefore, it can be defined as the Geographical Breakdown of the Overall Propensity. Such indicator is equal to 0 if no domestic firm owns R&D activities in country X; it is equal to 1 if country X is the only foreign country in which domestic firms perform R&D.

Formula and data required:

$$C Pr o = \frac{\text{R \& D in country X}}{\text{Outward R \& D}}$$

Where:

R&D in country X = intramural R&D expenditure/personnel of subsidiaries resident in country X and owned by domestic firms.

Outward R&D = intramural R&D expenditure/personnel in total foreign subsidiaries of domestic firms.

Data source: national business R&D survey providing Outward information.

4.1.c. Sector/Country Propensity

Definition: the Sector/Country Propensity can be defined as the rate of R&D activities owned by domestic firms in sector Y of country X on total R&D activities owned by domestic firms in sector Y abroad.

Purpose: the Sector/Country Propensity estimates the relevance of single countries of destination, with particular attention to their sectoral specialisation. It might be useful to individuate if a foreign country is attractive in general or for a sector specificity. Such indicator is equal to 0 if no domestic firm owns R&D activities in sector Y of country X; it is equal to 1 if country X is the only foreign country in which domestic firms perform R&D with regards to sector Y.

Formula and data required:

$$SCPr_o = \frac{R \ \& \ D \ \text{in sector Y of country X}}{R \ \& \ D \ \text{in sector Y abroad}}$$

Where:

R&D in sector Y of country X = intramural R&D expenditure/personnel of subsidiaries active in sector Y, resident in country X and owned by domestic firms.

R&D in sector Y abroad = intramural R&D expenditure/personnel of subsidiaries active in sector Y, resident abroad and owned by domestic firms.

Data source: national business R&D survey providing Outward information (eventually matched with macro and macro-confidential data coming from foreign national surveys).

4.2. International R&D Permeability

General definition: from the compiling country perspective, the International R&D Permeability ratios can be defined as the measure of the relevance of foreign-owned R&D activities (affiliates/expenditure/personnel) in it. With regards to different possible breakdowns (geographical and sectoral), we distinguish among the following ratios.

4.2.a. Overall Permeability

Definition: the Overall Permeability is calculated as the rate of domestic R&D activities owned by foreign parent companies on total domestic business R&D activities (similarly to the first Inward investment ratio in the *Handbook of Economic Globalisation*).

Purpose: the Overall Permeability estimates the attitude of the national R&D system to receive foreign R&D-related investment. Such indicator is equal to 0 if no foreign firm owns R&D activities in the compiling country; it is equal to 1 if domestic R&D activities are totally owned by foreign firms.

Formula and data required:

$$OPer = \frac{\text{Inward R \& D}}{\text{Domestic R \& D}}$$

Where:

Inward R&D = intramural R&D expenditure/personnel of domestic firms owned by foreign parent companies.

Domestic R&D = intramural R&D expenditure/personnel of total domestic firms.

Data source: national business R&D survey providing detailed Inward information.

4.2.b. Sectoral Permeability

Definition: the Sectoral Permeability is calculated as the rate of domestic R&D activities in sector Y owned by foreign parent companies on total domestic R&D activities in sector Y.

Purpose: the Sectoral Permeability estimates the attitude of a domestic sectoral system to receive foreign R&D-related investment. Such indicator is equal to 0 if no foreign firm owns R&D activities in that specific sector of country X; it is equal to 1 if domestic R&D activities in sector Y are totally owned by foreign firms.

Formula and data required:

$$SPer = \frac{\text{Inward R \& D in sector Y}}{\text{Total R \& D in sector Y}}$$

Where:

Inward R&D in sector Y = intramural R&D expenditure/personnel of domestic firms active in sector Y and owned by foreign parent companies.

Total R&D in sector Y = intramural R&D expenditure/personnel of firms active in sector Y.

Data source: national business R&D survey providing detailed Inward information.

4.2.c. Country Permeability

Definition: the Country Permeability is calculated as the rate of domestic R&D activities owned by parent companies resident in country X on total domestic business R&D activities.

Purpose: the Country Permeability estimates the attitude of the national R&D system to receive foreign R&D-related investment having a specific origin. Such indicator is equal to 0 if no firm from country X owns R&D activities in the compiling country; it is equal to 1 if domestic R&D activities are totally owned by firms from country X.

Formula and data required:

$$CPer = \frac{\text{Inward R \& D from country X}}{\text{Domestic R \& D}}$$

Where:

Inward R&D from country X = intramural R&D expenditure/personnel of domestic firms owned by parent companies resident in country X.

Domestic R&D = intramural R&D expenditure/personnel of total domestic firms.

Data source: national business R&D survey providing detailed Inward information.

4.2.d. Sector/Country Permeability

Definition: the Sector/Country Permeability is calculated as the rate of domestic R&D activities in sector Y owned by parent companies resident in country X on total domestic R&D activities in sector Y.

Purpose: the Sector/Country Permeability estimates the attitude of a domestic sectoral system to receive foreign R&D-related investment having a specific origin. Such indicator is equal to 0 if no firm from country X owns R&D activities in that specific sector of country X; it is equal to 1 if domestic R&D activities in sector Y are totally owned by firms from country X.

Formula and data required:

$$SCPer = \frac{\text{Inward R \& D in sector Y from country X}}{\text{Total R \& D in sector Y}}$$

Where:

Inward R&D in sector Y from country X = intramural R&D expenditure/personnel of domestic firms active in sector Y and owned by parent companies resident in country X.

Total R&D in sector Y = intramural R&D expenditure/personnel of firms active in sector Y.

Data source: national business R&D survey providing detailed Inward information.

4.3 International R&D Penetration

General definition: the International R&D Penetration ratios can be defined as the measure of the differences among the countries of origin of foreign R&D. With regards to different possible weights, we distinguish among the following ratios.

4.3.a. Simple Country Penetration

Definition: the Simple Country Penetration is calculated as the rate of R&D activities owned by parent companies resident in country X on total Inward R&D activities. Therefore it represents the geographical distribution of Inward Investment.

Purpose: the Simple Country Penetration estimates the capability of single foreign countries to enter the compiling country R&D system. Such indicator is equal to 0 if no firm from country X owns R&D activities in the compiling country; it is equal to 1 if all foreign R&D activities are owned by firms from country X.

Formula and data required:

$$SCP_{Pen} = \frac{\text{Inward R \& D from country X}}{\text{Inward R \& D}}$$

Where:

Inward R&D from country X = intramural R&D expenditure/personnel of domestic firms owned by parent companies resident in country X.

Inward R&D = intramural R&D expenditure/personnel of domestic firms owned by foreign parent companies.

Data source: national business R&D survey providing detailed Inward information.

4.3.b. Relative Country Penetration

Definition: the Relative Country Penetration is calculated as the rate of R&D activities owned by parent companies resident in country X on R&D activities owned by parent companies resident in the top investor country.

Purpose: the Relative Country Penetration estimates the capability of single foreign countries to enter the compiling country R&D system, taking into account the same capability of other countries entering the same system. In particular, such indicator allows to operate a direct comparison by using the top foreign investor value at the denominator. The Relative Country Penetration is equal to 0 if no firm from country X owns R&D activities in the compiling country (as in the previous indicator); it is equal to 1 if country X is the top foreign investor country in the domestic R&D system.

Formula and data required:

$$RCP_{Pen} = \frac{\text{Inward R \& D from country X}}{\text{Inward R \& D from the top investor country}}$$

Where:

Inward R&D from country X = intramural R&D expenditure/personnel of domestic firms owned by parent companies resident in country X.

Inward R&D from the top investor country = intramural R&D expenditure/personnel of domestic firms owned by parent companies resident in the top investor country.

Data source: national business R&D survey providing detailed Inward information.

4.4 International R&D Integration

General definition: differently from the previous ones, Integration indicators can be calculated after an international exchange of data: macro and macro-confidential data from different national surveys are necessary to assess the relevance of cross-investment.

4.4.a. Bilateral Integration

Definition: the Bilateral Integration ratio is calculated as the rate of the reciprocal R&D activities in countries A and B, weighted by their total foreign R&D investment, on the sum of the reciprocal R&D activities in countries A and B, weighted by the sum of their total foreign R&D investment.

Purpose: the Bilateral Integration estimates the relevance of the interdependence between two national systems, with respects to the relevance of all the other systems investing in the two countries. The Bilateral Integration is equal to 0 if at least one of the two countries does not invest in the other; it is equal to 1 if both countries are the only foreign investor countries in the other.

Formula and data required:

$$BInt = \frac{\frac{A \text{ in } B}{\text{Inward } B} * \frac{B \text{ in } A}{\text{Inward } A}}{\frac{A \text{ in } B + B \text{ in } A}{\text{Inward } B + \text{Inward } A}}$$

Where:

A in B = intramural R&D expenditure/personnel of firms resident in country B and owned by parent companies resident in country A.

B in A = intramural R&D expenditure/personnel of firms resident in country A and owned by parent companies resident in country B.

Inward B = intramural R&D expenditure/personnel of firms resident in country B and owned by foreign parent companies.

Inward A = intramural R&D expenditure/personnel of firms resident in country A and owned by foreign parent companies.

Data source: national business R&D surveys of country A and country B, both providing detailed Inward information.

4.4.b. Sectoral Bilateral Integration

Definition: the Sectoral Bilateral Integration ratio is calculated as the Bilateral Integration, with regards to specific sectors of activity for both countries A and B.

Purpose: the Sectoral Bilateral Integration estimates the relevance of the interdependence between two sectoral systems of two countries, with respects to the relevance of all the other countries investing in the two systems. The Sectoral Bilateral Integration is equal to 0 if at least one of the two countries does not invest in a specific sector of the other country; it is equal to 1 if both countries are the only foreign investor countries in that specific sector of the partner.

Formula and data required:

$$SBInt = \frac{\frac{A \text{ in } Yb}{\text{Inward } Yb} * \frac{B \text{ in } Ya}{\text{Inward } Ya}}{\frac{A \text{ in } Yb + B \text{ in } Ya}{\text{Inward } Yb + \text{Inward } Ya}}$$

Where:

A in Yb = intramural R&D expenditure/personnel of firms of sector Y in country B and owned by parent companies resident in country A.

B in Ya = intramural R&D expenditure/personnel of firms of sector Y in country A and owned by parent companies resident in country B.

Inward Y_b = intramural R&D expenditure/personnel of firms of sector Y in country B and owned by foreign parent companies.

Inward Y_a = intramural R&D expenditure/personnel of firms of sector Y in country A and owned by foreign parent companies.

Data source: macro and macro-confidential data coming from national business R&D surveys of country A and country B, both providing detailed Inward information.

5. A brief discussion on the indicators

As discussed in the first paragraph, economic literature has been focusing on some particular aspects of the R&D internationalisation process. The indicators presented in the previous paragraph aim at giving answers to some of those research questions. Some of the indicators considered in the ISTAT project have been calculated – even though for testing purposes only - and the results are presented in Table 2. That represents only a preliminary sample; more evidence could be collected and analysed in relation to the future availability of additional R&D data from partner countries.

In particular, indicators on *Overall propensity* (OPro) and *Overall permeability* (OPer) are quite straightforward and are already available in the OECD databases (at least for countries estimating the R&D expenditure by foreign affiliates in the country and by home-controlled foreign affiliates abroad). While no partner countries have produced data for calculating OPro to compare with Italy, OPer has been produced for five countries showing quite different national attitudes towards foreign R&D investments.

On the “propensity” side some additional information is provided on the relative interest of Italian MNEs to invest in a country rather than in another one (*Country propensity*, CPro). Data for four European partner countries show that Italian MNEs could be interested to perform R&D more in Germany than in other countries. To detail this indicator at sectoral level the availability of micro-data from one or more foreign country would be needed. The feasibility of calculating this indicator will be tested in the future.

On the “permeability” side, the level of acceptability in Italy of R&D investments from other countries is measured (*Country permeability*, CPer). German R&D investments seem slightly more acceptable than others for the Italian R&D system.

A similar indicator has been developed at sector level (*Sector permeability*, SPer): such indicator might be used, for example, to confirm that the chemical industry (including the pharmaceutical industry) in Italy is much more open to foreign R&D investments than the textile industry. A more complex indicator combining sectoral and country “permeability” (*Sector/country permeability*, SCPer) has been calculated, though only with reference to Germany as investor country and the textile and chemical industries as sectors. Using it, one could find a synthetic measure for the fact that in Italy the chemical industry is more attractive for German enterprises than the textile industry.

Assuming that a “competition” would exist among countries to enter into foreign national R&D systems - similarly to what happens in the global trade market - the degree of “penetration” of enterprises from country X to country Y will provide a measure of competitive success. ISTAT is currently testing two indicators: *Simple country penetration* (SCPen) and *Relative country penetration* (RCPen). While SCPen shows that Germany is more successful than UK or Belgium to invest in the Italian R&D system (as it is the UK, compared to Germany, with regard to the Swedish R&D system), RCPen provides the additional information that the Netherlands, as top investor country in the Italian R&D system, is outperforming the US by a factor of two, and Germany by a factor of five, as to the ability to invest on R&D in Italy.

Table 2. Selected indicators on Italian R&D internationalisation, year 2003		
<i>Indicator</i>	<i>Country</i>	<i>Value</i>
Overall Propensity Outward R&D / Domestic R&D	Italy	0,028
Country Propensity R&D in country X / Outward R&D	Italy to Belgium to Germany to Switzerland to UK	0,006 0,197 0,074 0,052
Sector/Country Propensity R&D in sector Y of country X / R&D in sector Y abroad		<i>needs multilateral matching</i>
Overall Permeability Inward R&D / Domestic R&D	Italy Belgium Germany UK US	0,321 0,571 0,252 0,450 0,145
Sectoral Permeability Inward R&D in sector Y / Total R&D in sector Y	Italy NACE 17 (Textile industry) NACE 24 (Chemical industry)	0,154 0,589
Country Permeability Inward R&D from country X / Domestic R&D	Italy from Belgium from France from Germany from the UK Sweden from Belgium from Germany from the UK	0,011 0,025 0,034 0,027 0,001 0,006 0,181
Sector/Country Permeability Inward R&D in sector Y from country X / Total R&D in sector Y	Italy Nace 17 from Germany Nace 24 from Germany	0 0,024
Simple Country Penetration Inward R&D from country X / Inward R&D	From Belgium to Italy From Belgium to Sweden From Germany to Italy From Germany to Sweden From the UK to Italy From the UK to Sweden	0,036 0,002 0,105 0,012 0,086 0,399
Relative Country Penetration Inward R&D from country X / Inward R&D from the top investor country	Italy from the Netherlands from the US from Germany	1 0,523 0,277
Bilateral Integration	Italy-Germany Italy-UK Italy-Sweden UK-Sweden UK-US	0,039 0,012 0,003 0,013 0,377
Sectoral Bilateral Integration	Italy-Germany: Nace 24 Italy-Germany: Nace 29 (Machinery industry)	0,012 0,067

The final group of indicators under testing deals with bilateral integration of national R&D systems. Two main indicators have been developed comparing, respectively, the integration between countries in general (*Bilateral integration*, BInt) and the integration between countries at sectoral level (*Sectoral bilateral integration*, SBInt). These are key indicators in a project mainly aimed at stimulating the bilateral co-operation in R&D statistical production. Data already available from the OECD allow for producing the basic bilateral indicator for several couples of countries. Some interesting evidence is emerging from this indicator: the Italian R&D system is more “integrated” with the German system than with the British one; the R&D systems of the US and the UK are very highly integrated; Sweden performs quite low in R&D integration with Italy and even with the UK.

Finally, a larger availability of data – namely, a sectoral breakdown of foreign affiliates R&D expenditure data – would make it possible to produce more detailed indicators on bilateral sectoral integration. For instance, evidence from Italy and Germany shows a higher degree of R&D integration in the machinery sector than in the chemical sector. This outcome is, obviously, independent from the relevance of the German R&D investments for the chemical R&D in Italy, drawing the attention of the users more on the high level of reciprocal investments in a specific field of R&D, than on the level of “penetration” of a national R&D system into another.

6. Conclusions

The growing demand for indicators on the internationalisation of R&D activities should lead to a better exploitation of the results of business R&D surveys in order to produce indicators at both country and enterprise level. With such aim, we have tried to recall the main questions raised in literature and to give them a synthetic answer through novel indicators, at least at country level. Further efforts are then needed to obtain *cross-country* information at micro (group) level, which is of main interest, as shown by the extensive coverage of the *EU industrial R&D investment Scoreboard*.

According to this idea, the ISTAT *R&D internationalisation project* can be seen as a pilot experience to test the results of an intensive use of R&D survey data. The ISTAT exercise has moved from the basic assumption that if national R&D data will be shared (on either a bilateral, or multilateral context) among producers, the options for improving the statistical production in the field of R&D internationalisation will increase dramatically.

Several difficulties have to be still addressed before R&D surveys would become a major source of data for statistics on internationalisation. It has also to be stressed that the integration of several administrative and statistical sources will have to be planned moving towards a “statistical system” producing data on the internationalisation of R&D. In any case, we consider such activity as the main challenge to individuate the real extent of *cross-country* investment in R&D.

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