

## **The cross border R&D activity of Italian business firms**

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### *Abstract*

Using data from the ISTAT-RS1 Survey we explore inward and outward R&D activities of different categories of firms resident in Italy in 2001-2010. From this perspective we provide detailed evidence of the role played by this country in the global creation and transmission of technology. First, foreign owned multinationals are the most active in cross-border transactions of knowledge but hold a low and decreasing share in national R&D expenditure. This trend reveals on the one hand that the Italian economy is a poorer and poorer attractor of high value added investments from abroad; and on the other hand that national companies, and particularly local SMEs not belonging to international groups, have significantly increased their R&D efforts over the past decade. Second, although outward expenditures of Italian companies increased substantially, R&D performed abroad remains a minor component of business research activities, and is due to a small number of firms investing in a few destination countries. We argue that this paucity of outward R&D activity might hinder both “asset exploiting” and “asset seeking” strategies of Italian firms. Third, we find a strong positive correlation between outward R&D and other innovative activities, including domestic research and R&D commissioned to foreign affiliates. By contrast, in the case of foreign owned firms active in Italy, we find that outward R&D is negatively correlated with intra-group technical cooperation.

JEL: F10, F23, O33

*Keywords: R&D internationalisation; corporate R&D; R&D flows.*

## **1. Introduction**

An extensive and growing literature has emphasized two main stylised facts on the internationalization of innovative activities. First, outward R&D has grown considerably over the past decades, a phenomenon that affected firms of most nationalities, although this has historically occurred with a lower intensity and at a slower pace than the internationalisation of production. Second, foreign owned R&D has also increased in nearly all countries, and in many cases it has reached a remarkable share of national R&D budgets (UNCTAD 2005, OECD 2011, Dachs et al. 2014). In both cases striking variations can be observed across countries and sectors, but there is a general agreement that these trends reflect a profound change in the global organization of innovative activities (Cantwell 1995, Zanfei 2000, Narula and Zanfei 2005).

The importance and implications of both inward and outward R&D for innovation, productivity and growth have been widely acknowledged in extant literature (see Dachs et al 2014, ch.1 for a recent review). However, severe data constraints have most frequently impeded to examine outward and inward R&D FDI jointly and in comparative terms from an empirical point of view. The two sets of data are most often collected through separate surveys, under the responsibility of different institutions or distinct offices of the same institution. Inward R&D is available at the aggregate and sectoral level and by the home country of the foreign owned investors for most European countries, with national statistical offices offering these data in greater details than OECD and Eurostat. Outward R&D data are much less available, especially when R&D expenditures are considered: statistical offices generally have harder times collecting them as they typically address the firm population located within a country. Altogether, this may result into different samples for each survey and creates serious problems in comparisons between inward and outward R&D activities (Colecchia 2007, Zahradnik and Urban 2014).

This state of affairs is indeed very unsatisfactory. In fact, by analysing either inward or outward R&D flows alone, rather than considering them jointly, one can only have a partial understanding of the role of a country in the cross-border generation and transfer of technology. Important channels of knowledge creation and assimilation would be out of consideration, and others would be arbitrarily emphasized. By contrast, to the extent that both inward and outward FDI are examined but inconsistent data are used, there is no way to examine their relative importance, evaluate their complementarities and hence assess their impact on economic growth in comparative terms.

These data limitations have had important implications on the analysis of the links between internationalization, innovation and economic performance. Some studies have attempted to take into account the differential role of inward and outward FDI, and have highlighted that the former

are generally associated with lower innovation and technology transfer than the latter (e.g. van Pottelsberghe de la Potterie and Lichtenberg 2001, Filippetti et al. 2011). Nevertheless, the available data did not allow to identify inward and outward R&D so that authors were obliged to make inference based on broader indicators of international production.

A further constraint to empirical analysis of R&D internationalisation has to do with the lack of disaggregated data. Microdata are seldom available, due to confidentiality reasons, as both inward and outward R&D investment decisions are often concentrated in a few easily recognizable large firms. When available, firm level data on R&D of internationalised firms may not be consistent with data on R&D activities conducted by non-internationalised firms. Firm level as well as detailed sectoral disaggregations of R&D data need be considered with special care in the case of inward expenditure, particularly in smaller countries where a few subsidiaries account for a major share of R&D expenditure of foreign owned firms.

The scarcity of reliable micro data on the foreign components of R&D activities determines *inter alia* an unclear perception of the role played by different firm categories in performing innovative activities in a given country. This backdrop in empirical analysis mirrors into a relatively low consideration of heterogeneity within industries in mainstream economics. Some contributions in international trade literature have recently acknowledged the role of intra-industry variety and have given increasing attention to differences in performances between multinationals, exporters, importers, two-way traders, as opposed to non internationalized firms (Helpman et al. 2004, Melitz 2004, Girma et al. 2005, Castellani and Zanfei 2006, Aristei et al. 2013, Damijan et al. 2013). However, the links between firm diversity and R&D performance still need be explored in greater details.

This paper contributes to filling both the analytical gaps highlighted above with specific reference to the Italian case. On the one hand, we attempt to provide a comprehensive assessment of the role played by this country in the cross-border generation and transfer of knowledge by evaluating the absolute and relative importance of inward as well as outward R&D performed over the past decade. On the other hand, we shed some light on the variety of players involved in R&D activities in Italy, including foreign owned companies, national enterprises belonging to a group, and national independent firms. To do so, we exploit in unprecedented detailed way the micro-data from the business R&D surveys carried out by ISTAT on a panel of over 13,000 firms active in Italy in 2001-2010. The ISTAT R&D survey has a census approach, it is addressed at all the potential R&D performers active in Italy and it is compulsory and anonymous. The cross border R&D activities are caught in a twofold way: a flag signals when a firm is foreign owned (thus identifying inward R&D

activities); a specific question inquires about R&D activities performed by foreign subsidiaries of the firm active in Italy (thus identifying outward R&D activities). All the variables are double checked by ISTAT using additional sources, including administrative data.

We will show that both aspects at centre stage in this paper – the relative intensity of inward and outward R&D components of Italy’s innovative activities, and the heterogeneity of players involved – reflect to some extent the specificities of the Italian patterns of specialization and the characteristics of its national innovation system (De Benedictis 2005, Boschma and Iammarino 2009, Nuvolari and Vasta 2012).

First, Italy’s specialization in traditional, low technology and specialized supplier industries and its weak presence in scale intensive and science based sectors translate into a relatively low profile of both inward and outward R&D activities. This confirms and further highlights what has been observed in many other countries for which data are available with some comparability, i.e. both inward and outward R&D activities are concentrated in a handful of performers, which represent the most dynamic component of national innovation systems (Dachs et al. 2014). What we will highlight to be specific of the Italian case is that this dynamic heart of the national innovation system is particularly weak and has been shrinking over the past decade. From this perspective, our study provides a worrisome picture: Italy appears to play a minor and diminishing role in a global scenario of growing globalization of technology. In fact, we will show that foreign owned component of R&D is decreasing, and outward R&D activities – which are measured directly in terms of actual expenditures performed abroad – are still a tiny, albeit growing, share of gross national R&D.

Second, Italy’s highly fragmented market structure characterised by a lack of large firms and by an extreme proliferation of medium, small and micro-sized enterprises implies a high heterogeneity of players involved in innovative activities (Hall et al. 2009, Bottazzi et al. 2002). We will exploit the richness of the ISTAT micro-data to highlight the role played by different categories of firms in domestic and cross-border R&D. We consider it particularly appropriate in the Italian case to distinguish not only foreign owned from national owned firms, but also, within the latter category, independent firms from companies belonging to groups of firms. As documented in a number of studies, the development of business groups has traditionally characterised the top layer of Italian capitalism (Colajanni 1991, Barca and Trento 1997), but also involves a wide variety of firm categories, including medium sized enterprises. In fact, the so-called “Italian Mittelstand” can compensate for the lack of economies of scales and scope by joining both horizontal and vertical groups, and exploit the flexibility of this governance structure to adapt to changing market and

technological conditions (Colli and Vasta 2010). A few studies have highlighted that this form of corporate governance is associated with higher efficiency at the firm level. This correlation is stronger in the case of internationalised groups, especially when active in high tech industries, and persists when controlling for the size of companies (Zeli 2002). It thus appears that it is the involvement of firms in more or less complex nexuses of transactions, rather than their size per se, that drives economic performance.

Nevertheless, to the best of our knowledge there is no direct evidence on how group belonging is associated with *R&D activity* in the Italian case<sup>1</sup>. This paper will shed some light on this relatively under-explored aspect of innovative activities in this country. We shall illustrate that business groups, and particularly parent companies and a few national subsidiaries belonging to these groups, account for about 75% of gross national R&D and are responsible for almost all of the country's outward R&D. One should also note, however, that independent companies have substantially increased their efforts to perform institutionalized R&D and more than doubled their expenditures over the past decade. Hence, a key component of the Italian economy, represented by SMEs not belonging to groups, appear to have made important investments to improve their innovative performances. However, the latter are not active in the cross-border creation, absorption and transmission of knowledge, which in turn remains under the control of a low (and diminishing) number of firms.

The remainder of this paper is structured as follows: in section 2, we review the evidence on inward and outward innovative activities, highlighting the role played by Italy in cross country comparisons; in section 3, we provide some new and detailed evidence on Italian cross border R&D; in section 4, we focus on the concentration and heterogeneity of outward R&D performers; finally, in section 5 we provide some concluding remarks.

## **2. Extant evidence on inward and outward innovative activities**

The outward expansion of MNEs' innovative activities has received increasing attention over the past decades, and has been examined mainly by using patent data. Cantwell (1995) has adopted a historical perspective and highlighted different phases of large firms' foreign inventive activities, involving a few Western nations in the first half of the 1900s (the US and some European countries, such as the Netherlands, Switzerland and the UK) and a more extensive number of home countries starting from the 1970s and 1980s in particular. In spite of a severe lack of data on outward

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<sup>1</sup> Studies on the correlation between group belonging and innovation are available for emerging countries. See Hobday (1995) for East Asian countries, and Mahmood and Mitchell (2004) for Korea and Taiwan in particular.

innovative activities and of R&D expenditure in particular, several studies have highlighted that foreign innovative activities carried out by multinationals have further accelerated in the final decades of the 1900s and at the beginning of the subsequent century (Hedge and Hicks, 2008; Dunning and Lundan, 2009, UNCTAD 2005, OECD 2011, Dachs et al. 2014).

Based on an extensive dataset on the activities of large MNEs referring to 30 countries, UNCTAD (2005) has estimated that on average the share of total R&D performed by foreign affiliates has increased from less than 10% to more than 16% in 1993-2002. Zaharadnik (2014) shows that the intensity of research activities abroad has increased in the case of nearly all countries for which outward BERD data are available in 2003-2007, although it must be noted that evidence is limited to a few nations and no official information is available in this respect for emerging countries and even for some highly industrialised countries like France and the UK.

Evidence on inward R&D is relatively more abundant than in the case of outward flows, even though data are missing or not reliable enough for some important countries and aggregates of nations. Indeed, no official statistics exist on R&D expenditures of foreign owned firms for the whole EU, just for each member countries, so that aggregate data can only be estimated on a continental basis. Moreover, there is a considerable mismatch between inward BERD in China and outward BERD to China originating from main investing countries.

The top locations for R&D investment decisions of the largest R&D spenders monitored by UNCTAD (2005) are the US and the UK, followed by China and by some of the most advanced industrialised and industrialising countries (France, Japan, India, Canada, Germany and Singapore). Foreign R&D had reached on average 15.9% of national R&D budget the top 23 recipient countries in 2003, with an average growth of 4,3 percentage points since 1995. Overall, there is a large variation of inward R&D intensity across countries, ranging from over 80% in the case of Malta to less than 5% in Japan, Bulgaria and Latvia, and this heterogeneity persist, as recorded by OECD and Eurostat statistics in more recent years. In a number of small countries (Ireland, Belgium, Austria, and Singapore), foreign R&D intensity approaches 60% of total R&D or is even higher, but this share exceeds 40% in many large countries as well, including Brazil, Sweden, Canada and the UK. In more recent years, data highlight an increase of intensity in the majority of countries in 2003-2007, with most countries exhibiting a slow increase, and the most striking growth rates occurring in relatively small countries (Zaharadnik 2014).

Comparative analyses of national patterns of cross-border innovative activities seldom include data on Italy. When they do, this country appears to play a marginal role both as home and as recipient of R&D FDIs, although the available data are often contradictory. Evidence based on patent data is

more extensive and broadly consistent with this scenario of relatively weak innovative performance of Italy.

Let us review extant studies on the Italian case from the outward perspective first. Using data on the top performers in terms of patenting abroad over a long historical period, Cantwell (1995) shows that not only Italy exhibits a lower degree of foreign patenting, as compared to the other large European countries; it also experiences a decrease in foreign patenting between the period 1920-1939 (29%) and the period 1969-1990 (14%), while the European average goes up from 12% to 27%.

Focusing on a shorter period (1981-1986), Pavitt and Patel (1991) find that large firms from almost all European countries have a low propensity to perform innovative activities abroad. However, in their calculations Italy is characterised by the lowest value among European countries and the second lowest among most industrialised countries: 2.2% of US patents by large firms operating abroad on national total, with only Japan exhibiting a lower share (0.6%).

Using more recent data (1996-2000) with the same methodology, Criscuolo and Patel (2003) find an increase in the percentage of foreign patenting by Italian firms (+14.6%) as compared to the 1985-1990 period. However, Italy is still ranking last among the main European countries in terms of large companies patenting abroad.

Dachs and Pyka (2010) report that Italian firms account for 7.9% of total EPO patent applications in 2000-2005, as opposed to 43.4% for Germany and 15.1% for France.

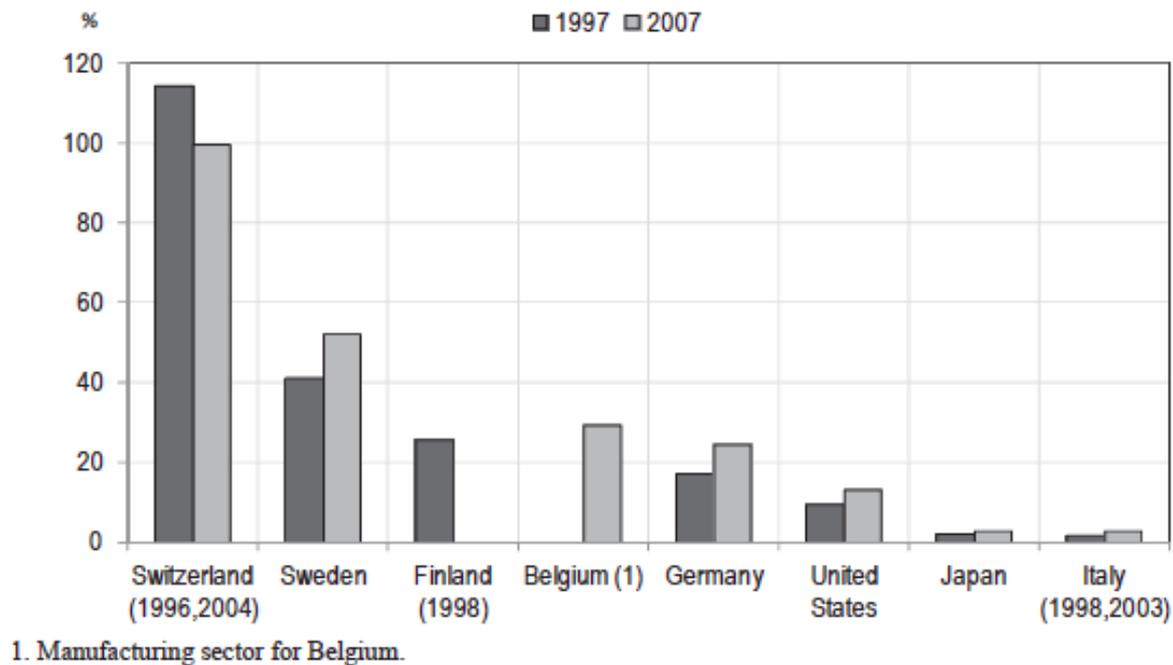
A slightly different picture is provided by Le Bas and Sierra (2002): in their paper, Italian firms' foreign patenting accounts for 44.4% of their total patents, leading a second tier group of countries (France, Sweden and the UK), with only Swiss and Dutch firms performing better. However, their study is focused on a sample of the 345 MNCs with the greatest patenting activity in Europe: only 5 of these MNCs are Italian, and such a limited sample might be biased. It might indeed be a signal of an Italian peculiarity: the internationalisation of technology is not a frequent case among Italian firms *but* the few top Italian MNCs are good performers in global technological activities.

Using fDImarkets data supplied by Financial Times, Mariotti and Mutinelli (2012 pp.14-22) calculate that R&D investment of foreign firms represent 3.4% of total inward investment projects recorded in Italy over the 2009-2012, and that this share has been diminishing over time (it was 5.5% in 2003-2009). They also show that Italy has a specialization index (derived from standard Balassa indicators expressed in terms of investment project shares) below 1, relative to other Western European countries, revealing a lower attractiveness in this field, and this attractiveness appears to be decreasing sharply in the examined period (specialisation index from 0,99 in 2003-

2008 to 0,65 in 2009-2012). R&D investment projects of foreign affiliates of Italian firms represent an even lower albeit increasing share of total outward investment projects: 1.6% in 2003-2008, 2.3% in 2009-2012. The specialisation index in this case is also below 1, and lower than in the case of inward R&D investment projects, albeit growing over time (from 0,38 to 0,54). While these data might roughly reflect inward and outward R&D trends in Italy, they do not permit to quantify the actual intensity of these activities, as they are merely based on the number of projects and no reliable data on their values are available from this source.

The scanty official statistics on outward R&D FDIs show that business R&D expenditures of Italian affiliates abroad, as a percentage of expenditure at home, were almost zero, while other EU countries (Germany, Sweden and Finland) had more than 20% and Switzerland almost 100% (see figure 1). The Italian share has slightly increased in 2007, but at a lower rate than in the case of other European investing countries (OECD 2011, p.19).

**Figure 1 – Business R&D expenditure by affiliates abroad as a percentage of domestic R&D in selected countries**



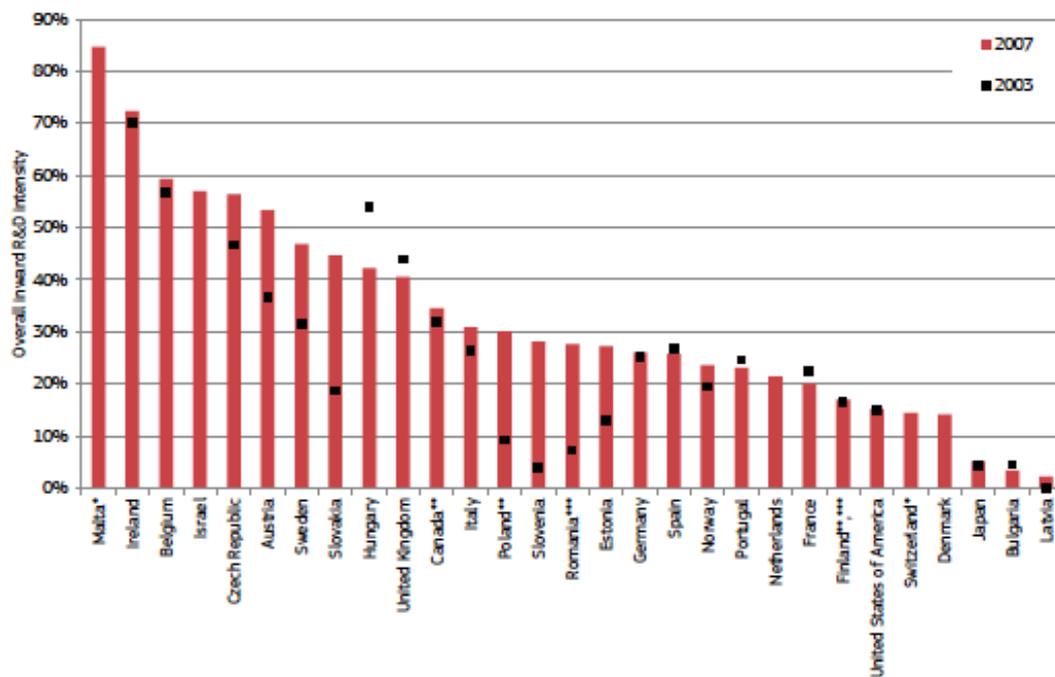
Source: OECD, 2011

As for inward R&D, Italy was ranking 10<sup>th</sup> among the actual locations of the largest R&D spenders worldwide, according to the survey conducted by UNCTAD (2005). With a percentage of about 10% of responses, it showed lower attractiveness compared to some large countries (ranging from advanced countries such as the US and the UK, to emerging ones as China and India), but still

higher than other technologically advanced countries such as the Scandinavian ones or Switzerland. However, when considering another question of that survey aimed to identify the *most attractive* foreign R&D location, Italy slipped back to less than 5% of positive responses. This can be interpreted as revealing expectations of low gains from R&D investments in Italy.

Using official statistics and international data sources, recent works by the OECD (2008, 2011), by the European Commission (2012) and by Dachs et al. (2014) allow to better quantify the share of affiliates under foreign control in total business R&D has been oscillating between 25 and 30% over the past decade. While this is in line with the percentage observed for other large EU countries such as Germany and Spain, it is lower than the average values in Europe (see figure 2). Moreover, one should note that percentage values are rather misleading in this case, as the level of R&D expenditures of domestic firms in Italy is itself lower than in most EU countries.

**Figure 2 – Share of business R&D expenditures under foreign control, 2003 and 2007**



Note: No 2003 data for Malta, Israel, Netherlands, Switzerland and Denmark; \* 2008 instead of 2007; \*\* 2006 instead of 2007; \*\*\* 2004 instead of 2003

Source: European Commission, 2012

Both OECD and European Commission figures are based on the Italian Statistical Institute (ISTAT) data on the activities of foreign affiliates (the FATS survey<sup>2</sup>). These data confirm a (slight) decrease

<sup>2</sup>The FATS survey provides statistics on the activities of foreign affiliates in each country, including among several other variables also R&D expenditures. These are double checked using the R&D survey itself. However, foreign ownership is assessed by OECD in accordance to the country of the Ultimate Owner along the companies' chain of

in the attractiveness of Italy as a location of foreign R&D: the portion of national R&D performed by affiliates of foreign companies was 25.9% in 2004, 24.6% in 2008 and 24.4% in 2010 (ISTAT-FATS Survey data)<sup>3</sup>. On the other side, official data on outward R&D investment of Italian companies have been collected by ISTAT through the Outward FATS survey for the first time for year 2010, but are currently unpublished.

A proxy for the evolution of global R&D activities of large Italian firms can be drawn from the EU Industrial R&D Investment Scoreboard, published annually by the European Commission since 2004 and including the ranking of top EU and non-EU R&D performers globally. Although Scoreboard data do not offer any direct information on the internationalisation of R&D, they still provide insights on the relative weight of Italian MNCs *vis-à-vis* their international competitors in terms of their global R&D activities (see table 1).

**Table 1 – Share of firms and their global R&D investment for selected countries, years 2003-2007-2010**

	Percentage of firms in the Scoreboard			Global R&D investment in the Scoreboard		
	2003	2007	2010	2003	2007	2010
UK firms	30%	29%	24%	17%	17%	16%
German firms	20%	19%	21%	37%	33%	34%
French firms	13%	11%	13%	19%	20%	18%
Italian firms	3%	5%	6%	4%	4%	5%
Other EU firms	34%	36%	36%	23%	26%	27%

Source: European Commission, 2004, 2008 and 2011

Table 1 shows that the number of Italian firms entering the Scoreboard has grown over the examined period, and they are responsible of a rather stable share of global R&D investments. To a closer look, however, three considerations arise:

- As illustrated by Le Bas and Sierra (2002), some Italian MNCs are in fact top performers of global R&D.

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control. This might lead to small discrepancies in the Inward figures, as the R&D survey identifies instead the foreign owner at the first level of control (direct owner).

<sup>3</sup> Data from the Official Survey on foreign affiliates in Italy, carried out by ISTAT in 2005–2006 have been used by Driffield, Love and Menghinello (2009) to assess the actual transfer of knowledge to local firms in Italy. Qualitative questions on knowledge transfer were introduced following OECD recommendations to increase the stock of available information on MNE behaviour. Aggregated figures were disseminated by ISTAT in February 2007, while micro-data were made available for research purposes shortly after.

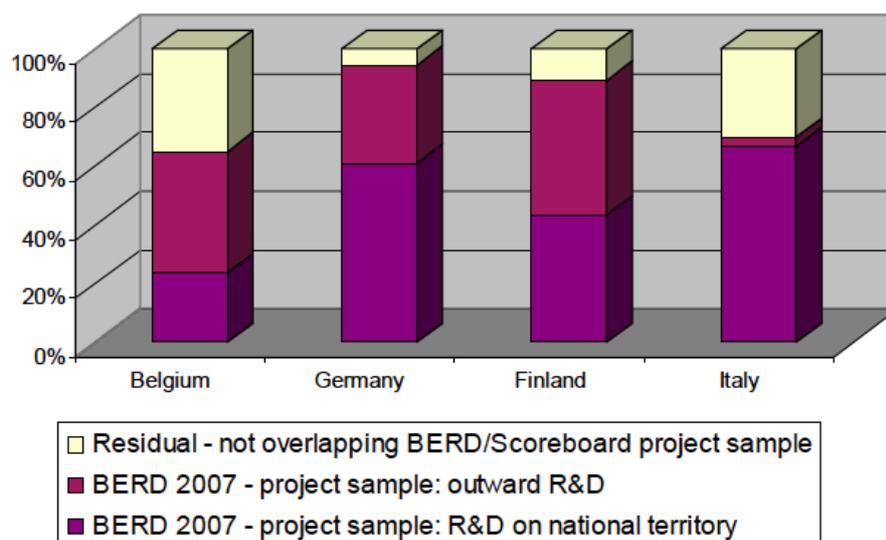
- Data produced by both the OECD (2008) and the ISTAT FATS show that Italy's share of global R&D investments is rather low, especially when compared to the other core EU countries.
- As reported in the EU R&D Scoreboard, foreign R&D investments as a percentage of overall R&D investment of large firms has been rather stable over the 2003-2010 period, and this applies also for Italy (European Commission 2011).

A major limitation of the evidence we have just illustrated is that it captures only the top of the iceberg. In fact it relies on available information on the innovative activity of the world's largest R&D spenders and patent holders. While this might capture the bulk of global R&D, which indeed reflects the investment strategies of the top multinational firms, it would be largely mistaken to use these data to infer patterns of R&D internationalisation across EU countries, and in the Italian case in particular.

An attempt to overcome the drawbacks of extant statistics has been made by ISTAT which carries out a first, comprehensive survey to collect data on all types of R&D activity conducted by all categories of firms active in Italy (from now on: ISTAT-RS1). This survey, which will be more thoroughly exploited in subsequent sections of this paper, has been partially used in a few occasions as part of wider projects aiming to compare the Italian case with other EU countries. The first one has been the OECD pilot project on the internationalisation of R&D (see Colecchia, 2007). Within this project, eight countries (including Italy) provided the OECD with aggregate data on R&D expenditure and personnel, classified by country of origin and destination. Results highlighted the difficulty in finding a consistence between the value of Inward R&D in country X from country Y and the corresponding Outward R&D from Y to X. However, the attempt was considered positive and full of insights worth investigating.

Thereafter, another project by the European Commission JRC-IPTS has involved Italy as well as Belgium, Finland and Germany. Results of this project demonstrated the feasibility of a micro-matching strategy: a sample of 100 top global R&D performers in the EU R&D Scoreboard, having the headquarters in one of the four countries, has been anonymously linked to micro-data from the respective national surveys on business R&D (Cozza, 2010). By so doing it was possible to assess how much R&D was performed by sample firms in any of the other countries involved and, consequently, how much in the rest of the world. This feasibility study has led to a more comprehensive assessment of outward R&D expenditures, and allowed to compare them with R&D expenditures conducted within national boundaries of the four countries (see figure 3).

**Figure 3 – Business R&D expenditure (BERD) overlapping with Scoreboard total, sample of companies from Belgium, Finland, Germany and Italy, year 2007**



Source: Cozza, 2010

Both the OECD and the EC-JRC projects have exploited the R&D survey information on group belonging and multinationality of R&D performers, and double checked these data via the national statistical archives or FATS survey. These studies generally confirm that the share of R&D activities conducted abroad by Italian firms is remarkably lower than in the case of the other countries under observation. However, neither of these projects permits to compare R&D activities across different categories of firms active in Italy.

To summarise, previous studies highlighted that most countries have experienced an increasing globalisation of innovative activities of their business firms. This has been shown mostly in terms of cross-border patenting activities, and less in terms of R&D investments, due to severe data limitations, especially in the case of outward R&D FDI. Whenever data are available, outward R&D FDI are hardly comparable with inward R&D FDI, and this creates problems in the actual assessment of the role of a given country in the cross-border generation and transmission of knowledge. Italy makes no exception in this scenario. The recent FATS surveys conducted by the Italian Statistical Institute (ISTAT) according to OECD standard methodologies have improved the availability of data on inward R&D, while outward FATS survey carried out in 2010 are not published yet, and information yielded can be expected to be partially inconsistent with inward data. The ISTAT-RS1 survey on R&D activities conducted by business firms both within and outside national boundaries has opened up new possibilities that have been only partially exploited.

The latter dataset has been tested against similar data-sources developed by other EU countries with specific reference to outward R&D, with some comparisons with R&D performed within national borders. However ISTAT-RS1 has not been exploited to fully compare inward and outward R&D, nor to evaluate the innovative performance of different categories of firms active in Italy.

### **3. The different dimensions of Italian cross border R&D: evidence from the Italian R&D survey**

#### *3.1. An overview on the categories of R&D performers*

To better compare inward and outward R&D activities conducted by firms resident in Italy we will make a more in depth use of the ISTAT-RS1 survey mentioned in section 2. This survey is based on census data collected by ISTAT referring to a 2001-2010 unbalanced panel of R&D performers active in Italy (39,152 observations, corresponding to 13,675 firms performing R&D at least in one year). For the purposes of this paper, R&D performed in Italy has been separated into three categories: R&D performed by national groups, R&D performed by Italian firms not in a group, and R&D performed by foreign owned firms. The latter corresponds to inward R&D FDIs.

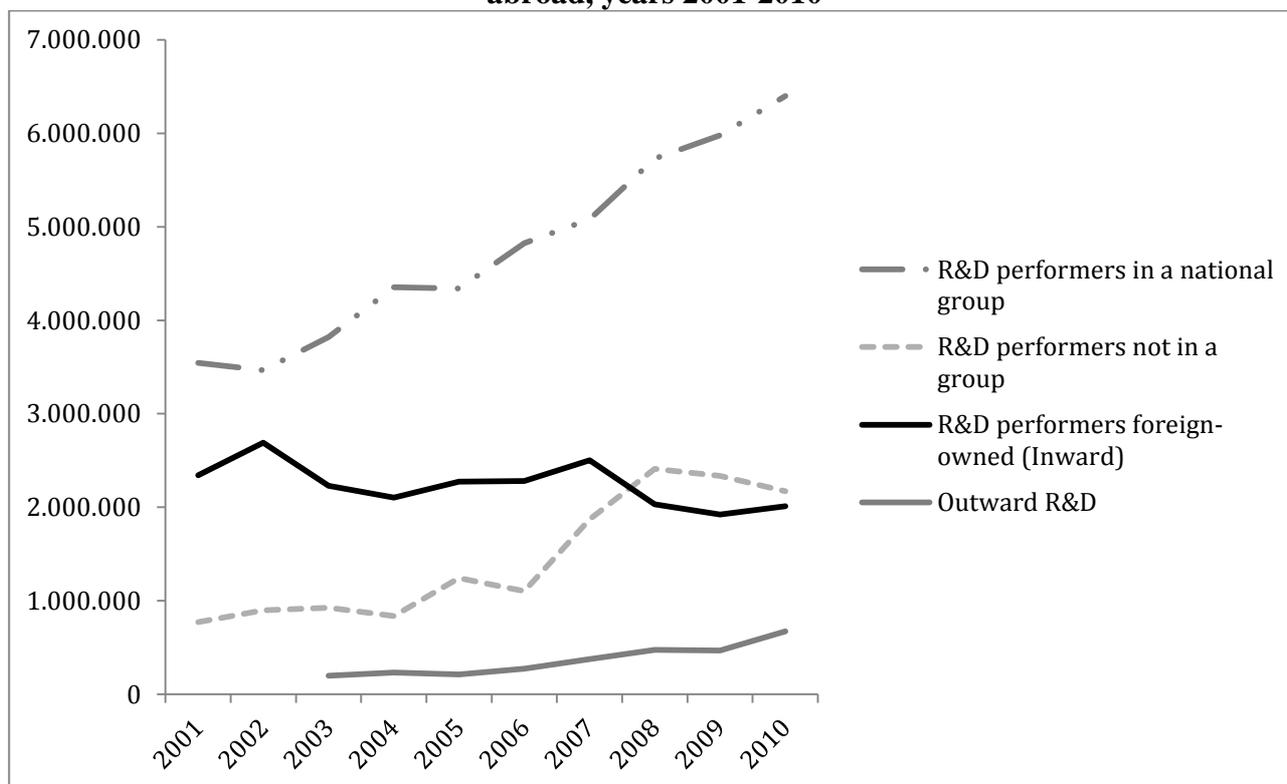
ISTAT-RS1 also collects information on outward R&D, defined as the research expenditure of foreign subsidiaries of a sub-set of the above mentioned R&D performers in Italy (namely, 720 observations corresponding to 269 firms with foreign subsidiaries performing R&D at least in one year over the 2003-2010 period)<sup>4</sup>.

Over the last decade, the composition of R&D performed in Italy has undergone a remarkable change (figure 4): inward R&D has declined both in absolute and relative terms and ends up representing the lowest share of all R&D investors, while the national component has increased substantially. The category of firms that exhibits the fastest growth of R&D budget is the one of national firms not belonging to a group. In other words, small sized firms which are most often not organised in a group and represent the bulk of the Italian economy, have substantially increased their efforts to innovate. Nevertheless, independent firms do not possess, by definition, any R&D subsidiaries abroad. Hence their R&D, albeit growing, is confined within national boundaries. Moreover, it is national firms belonging to a group that maintain by far the largest share of R&D performed in Italy.

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<sup>4</sup> A limitation of these data is that the question on outward R&D is compiled only if the respondent has R&D activities in Italy, potentially excluding firms that perform R&D only abroad. Random controls based on other sources allow us to believe that cases of the latter case is not a frequent one.

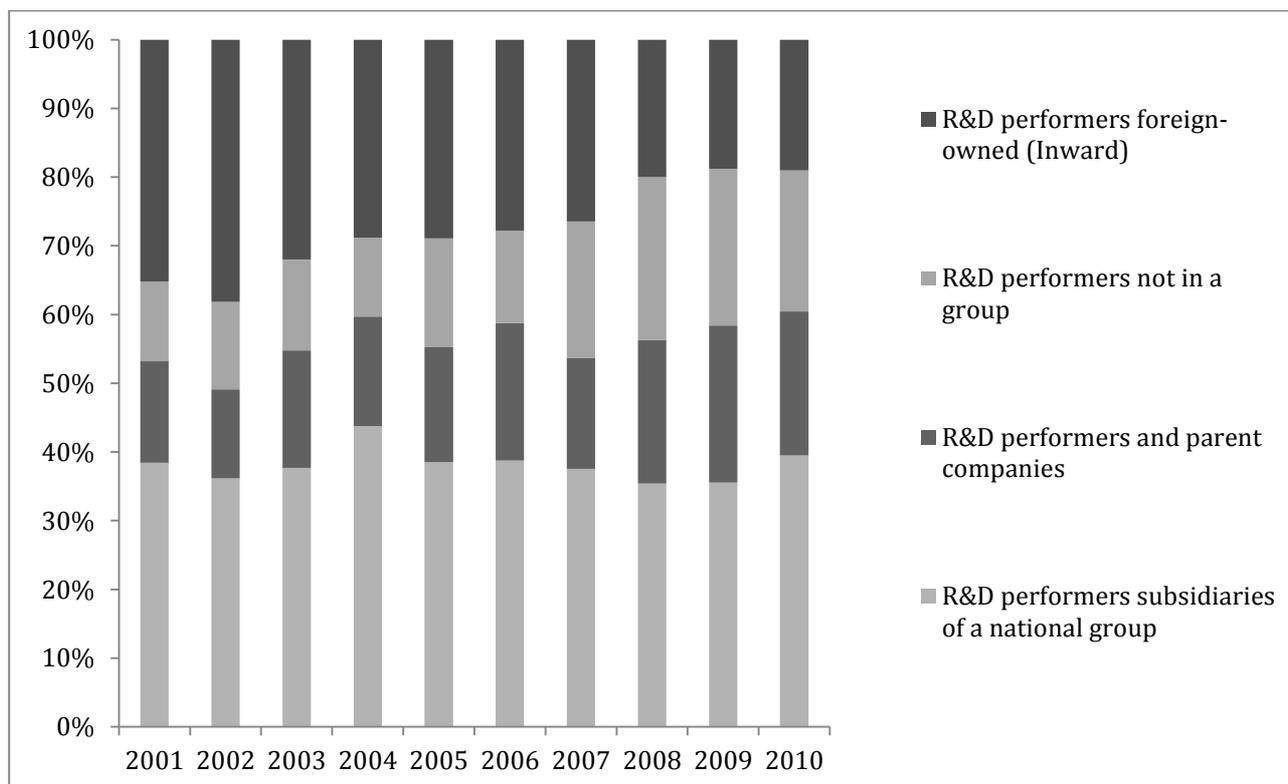
**Figure 4 – Trends in business R&D expenditure (in thousand euros at current prices) performed in Italy by different types of firms and Outward R&D performed by Italian firms abroad, years 2001-2010**



Source: elaborations on ISTAT-RS1 survey

Figure 5 allows to further distinguishing two subsets within the category of firms belonging to a national group, i.e. parent companies and national subsidiaries. Both subsets of firms have significantly increased their budget of R&D. Indeed, over the entire period, subsidiaries of national firms have been the most relevant category and in 2010 their R&D expenditure approximates 4 billion euros, that is twice as much as each of the other categories.

**Figure 5 – Trends in business R&D (% distribution of absolute values) performed in Italy by different types of firms, years 2001-2010**



Source: elaborations on ISTAT-RS1 survey

The data also allow to explore how R&D activities performed by each category of investors are organised. In fact, we can distinguish:

- **R&D inflows**, that is the percentage of R&D performed in Italy but funded by a foreign firm in the same group;
- **R&D outflows**, that is the percentage of extra-muros R&D commissioned to foreign affiliates of the same group and funded by a firm active in Italy;
- **R&D international cooperation**, that is the percentage of Italian firms cooperating in R&D with a foreign firm belonging to the same group, thus representing a proxy for intra-group technology transfer.

Table 2 below highlights *inter alia* that foreign owned R&D performers are not only responsible for the largest share of R&D inflows (which is not surprising), but are also largely and increasingly involved in R&D outflows, and are major players in international R&D cooperation as well.

**Table 2 – Share of R&D inflows, R&D outflows and R&D international cooperation on total R&D, by category of performers, years 2001 and 2010**

<i>Category</i>	R&D inflows		R&D outflows		R&D international cooperation	
	<i>2001</i>	<i>2010</i>	<i>2001</i>	<i>2010</i>	<i>2001</i>	<i>2010</i>
<b>All R&amp;D performers belonging to a group</b>	<b>3%</b>	<b>9%</b>	<b>16%</b>	<b>19%</b>	<b>4%</b>	<b>2%</b>
R&D performers and parent companies	0%	1%	13%	10%	4%	2%
R&D performers subsidiaries of a national group	1%	6%	23%	18%	5%	3%
R&D performers foreign owned	6%	23%	14%	26%	21%	18%

Source: elaborations on ISTAT-RS1 survey

These data help draw a more precise picture of the cross-border organisation of Italy's innovative activities: R&D activities of foreign owned multinationals active in Italy are largely and increasingly financed by foreign parties of the same group; moreover they are the most active in cross-border knowledge exchanges, which take the form of both R&D outflows and international technical collaborations. There are several possible interpretations for this evidence. On the one hand, the high and increasing inward and outward R&D flows in which foreign owned performers are involved could signal that the latter are further reducing the local content of their R&D activities in Italy. This could reveal that the attractiveness of Italy as a recipient of value added activities is further diminishing. On the other hand, one might suggest that foreign owned firms are re-organising their R&D activities based in Italy by means of stronger knowledge intensive networks involving other foreign parties. This envisages less of a dismal scenario, to the extent that Italy maintains a non-marginal role in the governance of such networks. This is subject matter for further analyses based on R&D Survey data.

As regards R&D inflows, we have already highlighted that foreign owned firms are, quite unsurprisingly, the most involved in this specific type of innovative activity. What is more interesting to note is that national groups are characterised by almost no R&D inflows. In other words, both parent companies and national subsidiaries of Italian companies are responsible for a very minor fraction of R&D that is financed by foreign parties. This negligible engagement of Italian firms in inward R&D flows, combined with their relatively low involvement in both outward R&D and international R&D cooperation, is rather clear evidence of the low level of integration of these firms in global networks of research.

To summarise, ISTAT-RS1 data help us depict more precisely the role of Italy as a weak player in the global creation and transmission of knowledge. First, the absolute and relative value of foreign owned R&D is low and decreasing: Italy is less and less attractive for knowledge intensive investors and this per se reduces the possibilities of gaining access to foreign sources of technology. Second, despite of their decreasing share of national R&D, foreign owned R&D performers are the only ones that are able to get involved in significant, and increasing, cross-border inflows and outflows of R&D, as well as in technological cooperative ventures. Third, national companies appear to have a very limited capacity to engage in global inflows and outflows of knowledge.

### 3.2. A focus on Inward and Outward R&D

The continuous decline of inward R&D, shown in figure 4, is largely due to the disinvestment of companies from advanced countries (table 3). Two main trends emerge over the examined period:

- Foreign R&D coming from some of the most advanced countries (especially the US, the Netherlands, Germany and France) has decreased in absolute values over the 2001-2009 period;
- Also in the cases where the absolute value has increased (e.g. for Switzerland), there is a decrease in the average R&D investment per firm over the very last years.

**Table 3 – Inward R&D by source country, in thousand euros at current prices, selected years**

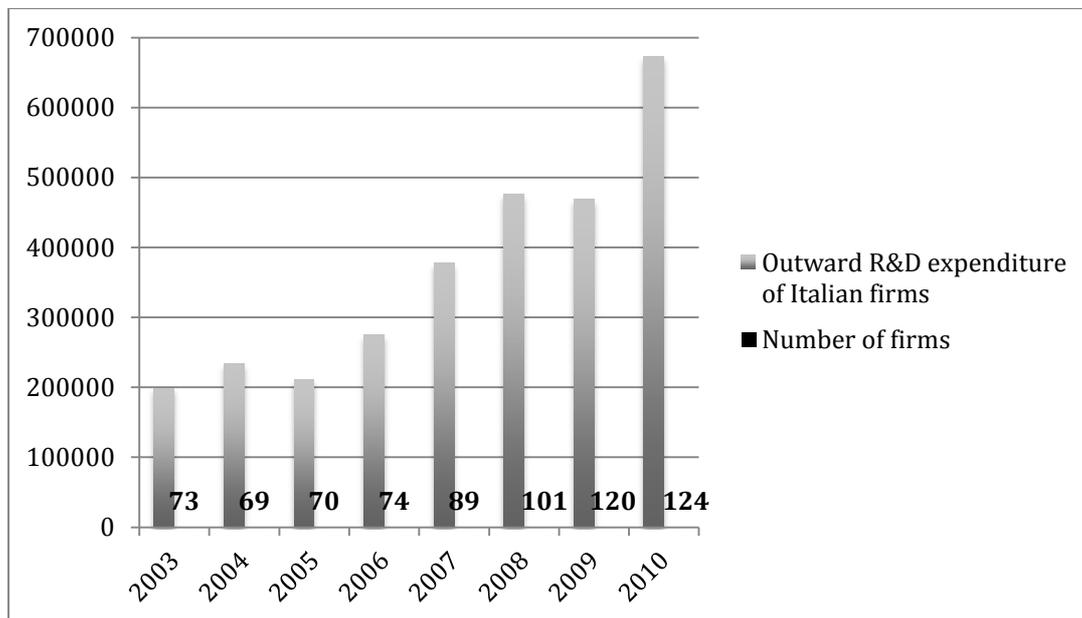
Country	2001			2005			2009		
	Expenditure	Firms	Average	Expenditure	Firms	Average	Expenditure	Firms	Average
Netherlands	1,081,518	25	<b>43,261</b>	614,194	16	<b>38,387</b>	733,492	29	<b>25,293</b>
USA	424,882	68	<b>6,248</b>	379,052	73	<b>5,192</b>	287,575	78	<b>3,687</b>
UK	155,324	21	<b>7,396</b>	207,371	16	<b>12,961</b>	200,168	17	<b>11,775</b>
Germany	217,860	38	<b>5,733</b>	324,727	61	<b>5,323</b>	170,655	44	<b>3,879</b>
Switzerland	56,834	19	<b>2,991</b>	174,343	15	<b>11,623</b>	183,053	26	<b>7,041</b>
France	187,970	33	<b>5,696</b>	198,791	34	<b>5,847</b>	135,486	46	<b>2,945</b>
Japan	56,979	11	<b>5,180</b>	18,966	7	<b>2,709</b>	67,417	22	<b>3,064</b>
Other EU countries	106,482	51	<b>2,088</b>	300,390	65	<b>4,621</b>	216,617	87	<b>2,490</b>
Rest of World	51,480	11	<b>5,056</b>	54,983	12	<b>4,582</b>	16,673	43	<b>388</b>
<b>All countries</b>	<b>2,339,329</b>	<b>277</b>	<b>8,445</b>	<b>2,272,817</b>	<b>299</b>	<b>7,601</b>	<b>2,011,136</b>	<b>392</b>	<b>5,130</b>

Source: elaborations on ISTAT-RS1 survey

Another key point in the table is the absence of valuable R&D investment from emerging countries (Rest of World), whose technological involvement has been recently increasing at an accelerated pace (see, among others, Chen et al. 2012). All of these trends contribute to the picture of a marginal role played by Italy in attracting top foreign R&D performers. Overall, foreign MNCs operating in Italy appear to be decreasing their engagement in R&D. Especially large investors seem to be lacking, or at least the size of their investments is rather low. Therefore, these figures on inward R&D confirm and further qualify the evidence put forward in literature and in official statistics.

Let us now turn to outward R&D. As we have noted already in section 3.1, R&D performed by foreign subsidiaries of Italian firms has significantly increased in 2003-2010, and exhibits a growth rate three times as high as the overall R&D performed in Italy. This is true both in terms of number of outward investing firms and of expenditure (figure 6).

**Figure 6 – Outward R&D expenditure (in thousand euros at current prices) of Italian firms, years 2003-2010**



Source: elaborations on ISTAT-RS1 survey

As shown in table 4, outward R&D has grown at the remarkable (compound) rate of 19% per year over the 2003-10 period and the pace has been even faster in the case of many target countries, including the US, some European countries and several emerging countries too. However, the bulk

of outward R&D appears to be concentrated in a few countries, with the sum of the first four (Brazil, Germany, France and the US) accounting in 2010 for more than two thirds of total outward R&D expenditure (467 million euros out of 673 million euros total).

**Table 4 – Outward R&D expenditure by target country, in thousand euros at current prices, years 2003-2010**

Country	2003	2004	2005	2006	2007	2008	2009	2010	CAGR
Brazil	1,829	5,886	8,565	13,911	15,697	20,194	75,904	177,493	92%
Germany	39,159	42,901	44,717	69,282	107,916	120,663	121,137	135,660	19%
France	56,301	70,181	56,980	57,908	73,118	85,652	72,157	81,846	5%
US	19,622	29,825	28,126	39,025	57,354	85,975	62,215	72,714	21%
Switzerland	14,789	15,851	9,723	10,614	28,088	37,606	38,296	41,897	16%
UK	10,391	9,900	11,136	16,395	12,979	13,643	13,960	38,781	21%
Spain	13,127	12,742	16,721	19,159	24,680	28,302	28,711	30,407	13%
India	320	479	702	697	2,639	2,382	2,009	16,143	75%
Other EU countries	23,014	25,793	16,572	26,016	31,988	28,015	29,646	39,013	8%
Rest of the World	20,276	19,685	17,779	22,412	23,575	54,243	24,268	39,232	10%
<b>Total Outward R&amp;D</b>	<b>198,828</b>	<b>233,243</b>	<b>211,021</b>	<b>275,419</b>	<b>378,034</b>	<b>476,675</b>	<b>468,303</b>	<b>673,186</b>	<b>19%</b>

Source: elaborations on ISTAT-RS1 survey

Of course, starting from very low values, destination countries such as Brazil<sup>5</sup> and India exhibit much higher growth rates as compared to most advanced countries. Furthermore, investments in some of the destination countries are undertaken by a low number of firms, some of which perform large R&D projects, leading in 2010 to a very unbalanced distribution of average R&D per firm (table 5). For instance, the average outward R&D of firms investing in Brazil is from five to ten times higher than that towards other target countries; and the 7 firms investing in India have exhibit approximately the same average R&D expenditure as the 31 ones investing in the US.

<sup>5</sup> It has to be recalled that Brazil is a target country, both for manufacturing and services, of some very large Italian MNCs.

**Table 5 – Outward R&D expenditure (in thousand euros at current prices), number of performers and average expenditure, by target country, year 2010**

Country	Outward R&D expenditure	Number of outward R&D performers	Average outward R&D per firm
Brazil	177,493	8	22,187
Germany	135,660	28	4,845
France	81,846	28	2,923
US	72,714	31	2,346
Switzerland	41,897	10	4,190
UK	38,781	9	4,309
Spain	30,407	17	1,789
India	16,143	7	2,306

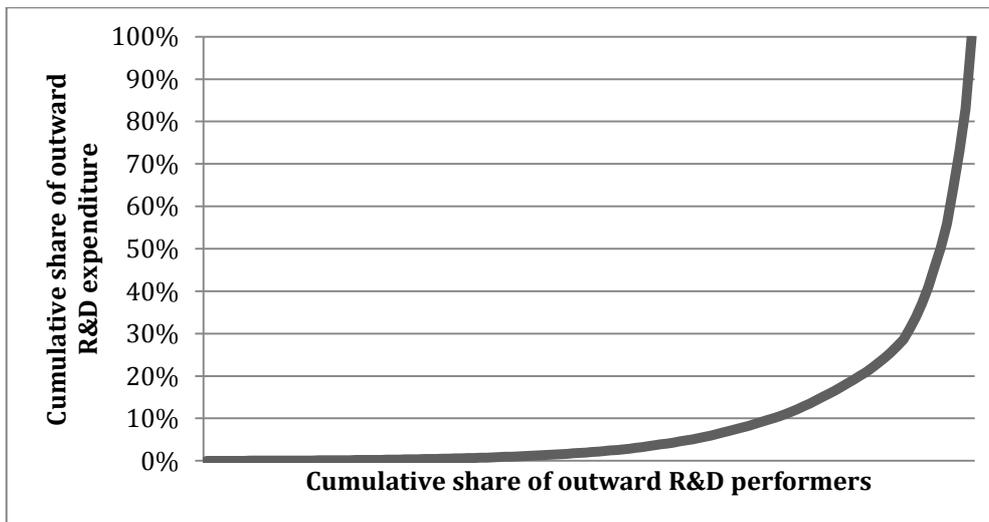
Source: elaborations on ISTAT-RS1 survey

It thus appears that outward R&D is largely a matter of few companies investing in a limited number of target countries. In the following section we shall further explore the patterns of outward R&D, examine the distribution of investments by category of performers, and illustrate correlations with other R&D activities of Italian firms.

#### 4. Concentration and heterogeneity of outward R&D performers

As shown in figure 7, there is a high concentration of outward R&D investors in year 2010: the top five outward investors account for 50% of total outward R&D, while the top ten firms control more than two thirds.

**Figure 7 – Lorenz curve on outward R&D performers and expenditure, year 2010**



Source: elaborations on ISTAT-RS1 survey

A few more details need be highlighted. First, *outward investors represent a relatively small share of R&D performers in Italy*: the percentage of firms engaged in R&D abroad is on average well below 10% of total R&D investors active in Italy, with only 123 firms with outward R&D in year 2010. It should be noted that the largest portion of firms with outward R&D activities are indeed parent companies of Italian groups (58 firms in year 2010). In fact *there are three times as many outward investors among parent companies of Italian groups as there are in the other categories of firms*: in 2010, 9% of parent companies are involved in R&D activities abroad, whereas the share drops to 3% in the case of national subsidiaries of Italian groups, and in the case of foreign owned firms.

Second, *outward R&D amounts to a very minor share of Gross National R&D*<sup>6</sup>. As shown in table 6, R&D performed abroad is on average 6% of GNERD. It is only in the case of parent companies and of national subsidiaries of Italian groups that this share is important, and reaches 22-23% of their gross R&D expenditure.

Third and finally, *concentration of Gross National R&D expenditures is highest in the category of foreign owned firms, followed by parent companies of national groups involved in outward R&D*. Concentration is lower but still significant in the case of national subsidiaries with outward R&D activities; and it is lowest in the case of firms with no outward R&D activities (table 6).

**Table 6 – Gross National Expenditure on R&D at current prices, by category, year 2010**

Category	GNERD		HHI	in Italy	abroad
Subsidiaries of Italian groups without outward activities	3,129,245	28%	372	100%	-
Italian firms not belonging to a group	2,170,501	19%	110	100%	-
<b>Subsidiaries of foreign firms (inward)</b>	2,025,214	18%	3,007	99%	1%
<i>Italian parent companies with outward activities</i>	1,588,735	<b>14%</b>	2,155	78%	22%
<i>Subsidiaries of Italian groups with outward activities</i>	1,363,109	<b>12%</b>	1,362	77%	23%
Italian parent companies without outward activities	972,604	9%	136	100%	-
<b>Total</b>	<b>11,249,408</b>	<b>100%</b>		<b>94%</b>	<b>6%</b>

Source: elaborations on ISTAT-RS1 survey

<sup>6</sup> GNERD (Gross National Expenditure on R&D) is obtained “by adding the domestically financed intramural expenditures [...] and the R&D performed abroad” (OECD, 2002:121).

The data we have illustrated have the merit of delivering a detailed and precise picture of outward R&D activities based on direct measures and calculated on all R&D performers in Italy. These descriptive statistics substantially confirm the image emerged from previous studies on the role of Italy in the cross-border creation and transfer of knowledge, while shedding light on some further important aspects. They highlight that only a tiny minority of R&D performers are in the position to carry out R&D abroad, and even fewer firms within this minority concentrate a substantial part of outward R&D expenditure. This is further evidence that the “oligopolistic heart” of Italy’s innovation system is fragile, and its ability to extend its networks beyond the national boundaries is very limited. Such a feeble outward reach implies that Italian firms are less capable of exploiting knowledge they are already endowed with, thus hindering the so called “asset exploiting” strategies; and that Italian investors have a weaker access to foreign sources of technology, hence undermining their “asset seeking” strategies (Narula and Zanfei 2005).

To draw a more comprehensive picture, one would need to evaluate whether and to what extent outward R&D investments can co-exist with other innovation activities, including domestic R&D, R&D outflows and technological cooperation with other units belonging to the same group.

To test the association between outward R&D and other research activities we run a random effect OLS regression model, using an unbalanced panel data of Outward R&D investors over the 2003-2010 period. The dependent variable is the natural logarithm of Outward R&D, broken down by category of investor. Firm size and sectors are also controlled for. Results are shown in table 7.

Results show that outward R&D are a positively and significantly correlated with R&D in Italy, for all categories. Also R&D outflows are positively associated with outward R&D for all categories of firms, except for Italian parent companies. Therefore, both domestic R&D activities and R&D outflows appear to co-exist with R&D performed abroad. While this correlation cannot be interpreted as a causal relation, nor as a straightforward complementarity effect<sup>7</sup>, this result is broadly consistent with the widely held view that *there is a two way link between domestic and foreign R&D*. On the one hand, research at home may provide new ideas, products and processes whose exploitation in foreign markets might justify further R&D conducted abroad. On the other hand, R&D performed abroad creates knowledge that may feed back to research labs at home and provide more incentives to R&D investments in Italy. Given the high correlation between R&D outflows and outward R&D one cannot exclude that extra-muros R&D commissioned to foreign

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<sup>7</sup> Testing causal links and complementarities is beyond the scope of this paper, as we are more interested in exploring how outward R&D decisions are taken by different firm categories, conditional to firm characteristics and other R&D strategies. By adopting this simplified correlation method, one cannot exclude that both domestic and foreign R&D are associated with unobservable firm characteristics in a correlated way. This leads us to a very careful interpretation of results.

affiliates generates new opportunities for creating new foreign research labs or expanding R&D facilities abroad.

**Table 7 – Factors explaining the probability of performing Outward R&D**

	Overall	Category 1 (Italian parent companies)	Category 2 (subsidiaries of Italian groups))	Category 3 (foreign subsidiaries)
VARIABLES	Ln outward	Ln outward	Ln outward	Ln outward
Ln R&D in Italy	0.537*** (0.048)	0.536*** (0.065)	0.598*** (0.083)	0.311*** (0.118)
Ln outflow	0.047** (0.018)	0.005 (0.024)	0.079** (0.036)	0.159*** (0.041)
Cooperation	-0.228** (0.106)	-0.174 (0.135)	-0.192 (0.234)	-0.634** (0.249)
Medium size	0.486* (0.249)	0.485 (0.337)	0.529 (0.467)	1.111 (0.759)
Large size	0.641** (0.260)	0.623* (0.339)	0.627 (0.502)	1.258 (0.833)
Manufacturing	-0.189 (0.211)	-0.319 (0.264)	-0.139 (0.416)	-0.091 (0.597)
Constant	1.623*** (0.384)	1.847*** (0.499)	1.200* (0.713)	2.305** (1.071)
Observations	673	395	196	82

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Outward R&D is instead negatively correlated with R&D cooperation with foreign firms in the same group, although the estimated coefficients are significant only for foreign subsidiaries. This might be revealing of the fact that foreign owned firms active in Italy are not completely free to take decisions concerning R&D activities in other locations, and are more likely to give up R&D investment projects abroad if they can rely on intra-group exchanges of knowledge.

## 5. Conclusions

Using data from ISTAT-RS1 Survey we have shown that R&D in Italy is overwhelmingly carried out within the national boundaries (94% of GNERD is conducted in Italy) and increasingly involves firms that have no connections with foreign sources of knowledge. In fact, over the past decade a large and growing fraction of R&D has been undertaken by firms not organised into groups,

especially SMEs. These firms appear to be more and more engaged in R&D activities as a way to compensate for their structural weakness, and to improve their economic performance. Nevertheless, they have limited or no ability to gain access to international knowledge networks.

The key players of cross-border R&D activities are foreign owned firms and parent companies of firms belonging to national groups, which are most active in exchanging technology with foreign parties and in R&D FDIs. We have pointed out that foreign MNCs play the most important role in both outflows and inflows of R&D and in technological cooperation. However, their share in national R&D expenditure is decreasing and this signals that the Italian economy is a poorer and poorer attractor of high value added investments from abroad. As regards Outward R&D, we have shown that only a few R&D performers are in the position to carry out R&D abroad, and even fewer firms within this minority concentrate a substantial part of outward R&D expenditure. These firms can be found especially in the category of parent companies of Italian groups. We have argued that this paucity of outward R&D activity might hinder both “asset exploiting” and “asset seeking” strategies of Italian firms. A more positive trend observed is the increasing – albeit weak – involvement of national subsidiaries belonging to Italian groups in outward R&D activities, which might be a promising development for the future.

We have found a clear correlation between Outward R&D and domestic research activities carried out by the different categories of firms under observation. We have suggested that these results are consistent with a two-way link between domestic and foreign R&D. In fact, while research at home may provide new ideas, products and processes whose exploitation in foreign markets justifies further R&D conducted abroad; R&D performed abroad creates knowledge that may feed back to research labs at home. We have also found evidence that outward R&D FDIs are associated with higher extra-muros R&D commissioned to foreign affiliates, which might signal that the two R&D strategies can feed on one another. While these correlations should be interpreted cautiously and no causal links have been ascertained, it appears that a poor outward R&D performance as the one observed for Italy is most likely to be associated with both low R&D at home, and with unsubstantial cross-border knowledge transactions.

Italy thus appears to be a weak player in the global creation and transmission of technology. This scenario is indeed characterised by a few top performers that concentrate most of the country’s cross-border innovation and are able to exploit complementarities between domestic and foreign sources of knowledge. However, this dynamic heart of Italy’s innovation system appears to be narrow and shrinking over time. If not reversed, this trend is most likely to contribute to a long term impoverishment of this country’s economic performance.

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