UNIVERSITÀ CATTOLICA del Sacro Cuore

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The role of business visits in fostering R&D investment

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Working Paper n. 49 - June 2025

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PROGETTO DI RICERCA DI RILEVANTE INTERESSE NAZIONALE 2022

Innovation and labor market dynamics

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Abstract

Labor mobility is considered a powerful channel to acquire external knowledge and trigger complementarities in the innovation and R&D investment strategies; however, the extant literature has focused on either scientists' mobility or migration of high-skilled workers, while virtually no attention has been devoted to the possible role of short-term business visits.
Using a unique and novel database originating a country/sector unbalanced panel over the period 1998-2019 (for a total of 8,316 longitudinal observations), this paper aims to fill this gap by testing the impact of BVs on R&D investment.
Results from GMM-SYS estimates show that short-term mobility positively and significantly affects R&D investments; moreover, our findings indicate - as expected - that the beneficial impact of BVs is particularly significant in less innovative countries and in less innovative industries.
These outcomes justify some form of support for BVs within the portfolio of the effective innovation policies, both at the national and local level.

Keywords: Business visits; labor mobility; knowledge transfer; R&D investments

JEL classification: O31, J61

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1. Introduction

Innovation policy can be summarised as the set of strategies and measures implemented by governments to promote and support innovation for the purpose of enhancing economies' productivity and growth through technological advancement (Schot and Steinmuller, 2018). Its relevance has grown over time, as the notion that scientific and technical knowledge has moved away from its original characterization as a global public good whose availability and transferability across the globe makes its spatial location less relevant for accessing its benefits. Under such approach (often adopted by the mainstream international economics, based on the Heckscher-Ohlin-Stolper-Samuelson framework), low-income countries were predicted not only to access knowledge developed in high-income countries without hurdles, but also to be able to use it, grow faster and 'catch up' with their high-income counterparts. Historically, this has often not occurred, as experience has shown that scientific knowledge is typically localised and 'sticky' (*i.e.* geographically contained to where investments in research are made, see Heimeriks and Boschma, 2014), tacit (*i.e.* not coded, but embodied in individuals, see Polanyi, 1966), path-dependent (David, 1975, Arthur, 1994) and its transfer is conditional on the presence of 'absorptive capacity' (Cohen and Levinthal, 1989 and 1990) within knowledge recipients, *i.e.* prior experience in research activities and adequate social capabilities in the knowledge transfer's destination place (see Abramowitz, 1986; Lee, 2016, 2019 and 2024).

Of course, as new challenges emerge alongside the limitations of the prevailing reference model - as is currently the case with the United Nations' SDGs[1]- the theoretical frames underpinning innovation policy naturally evolve. Yet, adapting the reference model may at times underplay elements that appear to have little consequence until an unexpected shock may reveal otherwise.

One such example is the Covid-19 pandemic, which, for a time, has reduced to almost nil physical interactions between people in several countries. As well-known sources of innovation like relations between producers and suppliers, and producers and final customers, also occur through people's interactions, will lower innovation activity follow fewer interactions due to the pandemic? It is probably too early to observe such so recent dynamics in official statistics, but existing empirical evidence supports the hypothesis that work-related mobility contributes to generate and transmit productive knowledge, even when it occurs over short periods of time, as in the case of business visits (from now on: BVs). The relevant literature (see next section) notes that short-term business visits are neither side effects of international trade and investment flows nor 'consumption' items, as accounted for in company books. Can they instead be viewed, at least in part, as a trigger factor in fostering investment in knowledge production activities, such as R&D investments? Or as a strategic choice to access fundamental external knowledge able to increase the expected profitability of R&D expenditures, especially by organisations, regions and countries constrained by geography and resources availability? If so, could some incentives for BVs be included in innovation policies?

[1] In more recent times, innovation policy has been asked to take a more proactive and experimental stance to shed light on the transformative changes required to address the social and environmental challenges contained in the United Nations' Sustainable Development Goals.

Indeed, on the one hand, the extant (rare) literature on BVs has investigated their (indirect) impact on productivity and economic growth, but not (with one exception, see next section) their direct effect on innovation activities (such as R&D investments). On the other hand, previous literature has clearly underlined that innovation is characterized by complementarities and super-additive effects (Milgrom and Roberts, 1990 and 1995) which can be considered to be the inner rationale of formal cooperative R&D (Veugelers, 1997; Cassiman and Veugelers, 2002; Piga and Vivarelli, 2003 and 2004) and 'open innovation' (Chesbrough, 2003; Chesbrough et al. 2006). Under the same approach, labor mobility can be considered as an investment in accessing information and competences as it is a powerful channel to acquire external knowledge and trigger complementarities in the innovation and R&D investment strategies (Braunerhjelm et al., 2020). Nevertheless, previous research has devoted much attention to long-term labor mobility - both in terms of scientists' mobility (Geuna, 2015; Verginer and Riccaboni, 2021; Lissoni and Miguelez, 2024) and migration of high-skilled workers (Breschi and Lissoni, 2009; Bosetti et al., 2015; Lissoni, 2018; Fassio et al., 2019) - but virtually no attention has been paid to the possible role of short-term BVs in enhancing knowledge and productivity.

We aim to fill these gaps with the present study, whose purpose is to empirically test - in a cross-country sectoral econometric framework - the effect of BVs on R&D investments by combining R&D data from the OECD with novel information from a proprietary database collecting international business visits expenditures worldwide. As better qualified in Section 3, in this study BVs are defined as work-related labour movements lasting less than 3 months, involving no change of residence and hence generally not capped by immigration authorities. Furthermore, we will try to assess whether BVs are particularly crucial in countries that are not within the club of the R&D worldwide champions (the hypothesis being that this channel of knowledge transfer might be particularly important for countries that - although characterized by an adequate absorptive capacity – most need outside knowledge).

As a preview of the findings (see Section 4 for a detailed discussion), our results highlight that BVs do raise R&D investments, with an elasticity of about 4-5% and that this effect is particularly significant for countries that are not R&D-leaders. However, in the current policy debate BVs are still considered as consumable expenditures rather than an activity more akin to an investment in accessing and generating productive knowledge. Therefore, we argue for a reconsideration of short-term labor mobility as an explicit target of innovation policy under the prior that its recognition will prompt the development of suitable national and regional incentives to promote its occurrence (see Section 5).

The rest of the paper is organised as follows. Section 2 provides a review of the relevant literature, ahead of the summary of data and methodology (Section 3). The results are discussed in Section 4, while Section 5 offers key concluding remarks and policy considerations.

2. The literature

The extant literature within the domain of the economics of innovation extensively highlights the role of external knowledge (Section 2.1), but is extremely limited as far as the role of BVs is concerned (Section 2.2).

2.1 The importance of external knowledge

Innovation literature and innovation policy have evolved considerably over time. Initially, they were largely focused on promoting internal research and development (R&D) within national boundaries, with an emphasis on supporting specific industries, companies ("national champions") or technologies deemed critical for national competitiveness. This approach was rooted in the belief that governments could play a crucial role in driving innovation by funding basic research, providing subsidies for R&D activities, and protecting intellectual property rights (Nelson, 1959).

However, as the understanding of innovation processes evolved, so did the approaches to their design and implementation. The emergence of the National Innovation Systems (NIS) framework in the late 20th century marked a significant shift in the conceptualisation of innovation policy, as it emphasised the importance of interactions between the actors of an innovation system (firms, universities, research institutions, and government agencies) in generating new products and processes. In particular, it recognised that innovation is not a linear process but rather a complex, interactive, and systemic phenomenon[2] that requires coordination and collaboration across different agents. Moreover, internal and external knowledge generate complementarities that in turn originate super-additive effects in terms of innovative performance (Freeman, 1987; Lundvall, 1992; Nelson, 1993).

The development of innovation systems at the national, regional (Cooke et al., 1997), and sectoral (Malerba, 2002) level encapsulates the tenet that scientific and technological knowledge is cumulative and path-dependent (David, 1975; Arthur, 1988), contains important tacit elements, and does not freely or automatically travel over geographical and cultural distances. Instead, it is 'sticky' (von Hippel, 1994), and typically exists both outside and within the successful innovator (e.g. March and Simon, 1958; Mansfield, 1968; Rosenberg and Steinmuller, 1988).

However, an organisation's ability to recognise and absorb this external knowledge, and gain an edge over competitors as a consequence, depends on its 'absorptive capacity' (Cohen and Levinthal, 1989 and 1990) and on its 'dynamic' capabilities (Teece et al., 1997): a set of skills, knowledge, and competencies that organisations develop and accumulate over time. By interacting, each organisation learns new information, problems and solutions, which can be linked to its existing knowledge stock. In turn, these novel linkages

[2] The interdisciplinary and multi-faceted nature of innovation policy has continued to date, encompassing a wide range of policy instruments and strategies that cover both supply-side (e.g. R&D funding, tax incentives, and support for education and skills development), and demand-side incentives (e.g. public procurement, standards, and regulations targeting innovative products and services) (e.g. Edler & Georghiou, 2007; Mazzucato, 2018).

expand problem-solving capabilities and skills within individuals and organisations, raising their efficient absorption of new information (Cohen and Levinthal, 1989; Teece et al., 1997), and their creativity (Shalley et al., 2004) and learning capabilities (McCombs, 1991).

Given that outside knowledge is on the one hand path-dependent and localized and on the other hand crucial as a key complement to internal knowledge, in the last two decades the innovation literature has focused on knowledge transfer as a key driver of innovation. In particular, the literature has been mainly devoted to investigate four channels through which knowledge transfer may occur.

1) Spillovers: although companies pursue appropriability through different means (from patents to secrecy), knowledge spillovers are recognized as an important externality that can be of great benefit for all economic agents (either companies or countries) that are endowed by an adequate absorptive capacity (Jaffe et al., 2000; Filatotchev et al., 2011). Indeed, endogenous growth theory (Lucas, 1988; Romer, 1994) considers knowledge spillovers as the ultimate drivers of economic growth.
2) Cooperative R&D: since R&D and innovation are cumulative processes characterised by path-dependence and strong complementarities, cooperative R&D is considered a key strategy for acquiring external knowledge and for enhancing the value from the internal one (Colombo and Garrone, 1996). Indeed, cooperation in R&D is sometimes a *conditio-sine-qua-non* to pursue large, very expensive and uncertain R&D investments[3].
3) Long-term labor mobility: the mobility of both scientists and high-skilled workers has been proved to be crucial in knowledge and technology transfer and in fostering innovation and competitiveness both at the micro and macro level (Edler et al., 2011; Fassio et al., 2019; Lissoni and Miguelez, 2024).
4) Open innovation: the large literature initiated by the seminal contribution of Henry Chesbrough (2003) points to the fact that both the linear model of innovation and its extended versions that take into account spillovers, R&D cooperation and long-term labor mobility, are not sufficient to give full account of innovation activity that is more and more dependent on the external environment and its inputs, signals and feedbacks (Obradović et al, 2021).

2.2 The importance of short-term business visits

While all the perspectives briefly outlined above underline the role of external knowledge in fostering firms' and countries' innovation activity, virtually no attention has been devoted to short-term labor mobility (namely BVs) as a possible channel of knowledge transfer (particularly tacit knowledge). To our knowledge, BVs have been rarely studied and never explicitly considered as a feasible and deserving tool of innovation policy.

[3] This is the rationale why national and international antitrust policies always allow - and sometimes promote - R&D joint ventures (provided they are not translated into a collusion in the final markets).

This is rather surprising, since knowledge is not evenly spread out geographically and labor mobility addresses the strategic need to access it. This can be achieved by either relocating to specific areas (von Hippel, 1987; Florida, 2002;-Howells, 2002; Bathelt et al., 2004; Torre and Rallet, 2005) or by interacting, often in person[4], with individuals who possess valuable, embodied knowledge (Polanyi, 1966; Franco and Filson, 2000; Zellner, 2003; Dahl and Pedersen, 2004; Bathelt and Schuldt, 2008).

While the gaps in the literature and in the policy debate may appear surprising from a theoretical point of view, the same are unsurprising from an empirical viewpoint, given the practical difficulty in developing a comprehensive metric and the challenge of accessing data capturing all the activities carried out by organisations to access external knowledge. With particular reference to BVs, innovation surveys - the primary source of innovation statistics - do not include short-term mobility as a possible source contributing to product or process innovations. Conversely, short-term movements are included in the United Nations' (UN, 1998) definition of 'international visits'[5], however leading to excessively aggregated data[6]. Information from passenger surveys and tourism statistics is also too generic to provide details about the activities carried out beyond major airport destinations, average length of stay, and expenditure. While primary data from in-depth interviews are very informative and support the idea that mobility is mainly aimed to promote knowledge exchanges (Tani, 2014), the empirical results available are usually based on too few observations to be broadly applicable. Lastly, financial statistics from public and private databases, such as Dun & Bradstreet[7], do not separate short-term mobility expenses from other general costs within company accounts, making it impossible to single out BVs (see also Piva et al., 2023).

Given these serious limitations, the extant (and scarce) empirical literature focusing on testing the impact of BVs has made recourse to proxies for short-term mobility, such as tourists (Andersen and Dalgaard, 2011), friends and relatives (Hovhannisyan and Keller, 2015) or migration flows (Rogers, 1995; Dowrick and Tani, 2011) as well as commercial proprietary data (Tani, 2014; Piva et al. 2018 and 2023). However, each of these

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[4] Face-to-face interaction is the most effective form of communication because it forces participants to quickly decide whether to trust each other. If mutual trust is established, it leads to increased mutual understanding and cooperative behavior, as the transaction costs and uncertainty associated with sharing knowledge decrease. This, in turn, facilitates exchanges of know-how and experiences (Hansen, 1999; Amin and Cohendet, 2004), promotes learning, and creates 'social capital' and networks (Dosi et al., 2020).

[5] An *international visitor* is defined by the UN as "any person who travels to a country other than that in which he/she has his/her usual residence but outside his/her usual environment for a period not exceeding 12 months and whose main purpose of visit is other than the exercise of an activity remunerated from within the country visited" (UN, 1998 - para. 29). The category of international visitors includes tourists (overnight visitors) and same-day visitors (also known as "excursionists") (UN, 1998 - para. 30).

[6] Data on international visits are gathered following a well-established convention to classify movements between two countries according to the length of stay (UN, 1998): namely, movements are classified as 'visits' if they involve a change in the 'usual residence' for less than 12 months and no payment is received from the host country, or defined as 'migrations' if they last for over one year. In turn, migration is split into 'long-term' if there is a change of usual residence longer than 12 months and 'short-term' when the change of residence lasts between 3 and 12 months. Moreover, 'Temporary migration' is also used at times to single out particular categories of stays that grant employment rights and last a number of years (typically up to four). However, these are reclassified as visits or migrations in international statistics depending on their length of stay. This classification - here briefly summarized - tends to be followed by most of national statistical offices, although this is not always the case, making particularly complicated to obtain consistent historical series (e.g. Salt et al., 1994; OECD, 2008). Finally, as some visits allow recipients to subsequently apply for permanent visa, since 2006 the OECD (SOPEMI reports) has reclassified a certain amount of visits as permanent movements if the underlying entry visa is characterized by: 1) no expiry date; 2) being renewed indefinitely; 3) allowing recipients to apply for permanent residence in the host country.

[7] Dun & Bradstreet is a US-based private corporation that offers credit and financial information (including accounts), on more than 300 million businesses around the world: https://www.dnb.com/.

studies exhibits significant drawbacks.

Andersen and Dalgaard (2011) used travel data for 72 countries over two years (120 observations in total) sourced from the World Tourism Organization to link international arrivals plus departures to total factor productivity (TFP) and showed that travel intensity accounts for almost 50% of the variation in aggregate TFP. Dowrick and Tani (2011) used cross-sectoral data within one country (Australia) measuring the specific number of business visits, as reported by arrival and departure cards over the period 1991-2005 (143 observations). In their short-term panel estimations, they found that a 10% rise in the gross flows of BVs in an industry increases multifactor productivity in that industry by about 0.1%. They also find that the productivity effect of outgoing BV is about double those of incoming BV (0.2% vs. 0.1%). Piva et al. (2018) used proprietary data from the Global Business Travel Association, covering on average 16 sectors in 10 countries during the period 1998-2011 (2,262 observations). Their fixed-effect results suggested that mobility through BVs was indeed an effective mechanism to improve labour productivity, the estimated elasticity (0.053) being about half as large as investing in R&D (a prime mechanism to foster productivity as commonly supported by researchers and policy-makers alike). In a follow-on study, enriched by an expanded dataset (unbalanced panel of 3,574 observations) and specifications to include trade as a channel of knowledge diffusion and the possibility of decreasing returns in BV intensity and productivity performance, Piva et al. (2023) confirm that higher BVs are associated with a 0.02 rise in labour productivity (fixed effect estimates).

However, most of the previous studies explicitly dealing with BVs were devoted to assessing their possible (indirect) impact on productivity growth and ultimately competitiveness and economic growth rather than investigating the possible positive effect of BVs on innovation activity.[8] To our knowledge, the sole antecedents in this respect are the studies by Hovhannisyan and Keller (2015 and 2019). Both studies use patent data to construct the dependent variable and passenger survey data collected at US airports for indicators of outflows (2015: US residents to 34 countries) and inflows (2019: share of inflows from EU NUTS 2 regions) of business visitors, respectively. The association between business visit outflows from the US and US-filed patents by inventors based in the visited countries turns out to be 0.02[9], while that between the share of business visit inflows from EU regions to the US and the corresponding region's share of EU-filed patent applications results equal to 0.03-0.045. Though not accounting for visits' length of stay, the studies reveal that outflows and inflows of business visitors have asymmetric effects on patents, which are stronger for visitors' origin than for their visited places of destination, echoing what observed by Dowrick and Tani (2011) in the case of multifactor productivity. Indeed, both studies highlight that visiting (*i.e.* outflow visits geared on the same country as in the case of European researchers applying for patents in Europe after a visit to the US) is far more effective than being visited.

[8] The expected positive sign in the relationship between BVs and R&D activities is rooted in the role played by BVs in enhancing the recipient absorptive capacity and in fostering the innovative complementarities discussed in the previous sections.
[9] In other words, 10% increase in business visitors is associated with a 0.2% increase in US patents from the visited country of destination.

However, to use patents as a proxy of innovation activities potentially affected by short-term BVs is not immune to drawbacks. Indeed, it is more likely that the knowledge acquired through BVs affects R&D decisions, given the complementarities between internal and external knowledge highlighted in the previous sections. Moreover, patents require years to be prepared, applied and granted, while R&D investments belong to innovative strategies which can be adopted as a direct consequence of the information, knowledge and opportunities acquired through BVs.

In what follows, we put forward an empirical test of the direct impact of BVs onto R&D investments in a country/sector framework, spanning from 1998 to 2019.

3. Data and methodology

To measure BVs, we use a specialized commercial database originally created by the National Business Travel Association (NBTA) (see also Piva et al., 2018 and Piva et al. 2023) to forecast trends in international short-term mobility post-9/11 as, after the event, travel to the USA significantly decreased, causing concern among NBTA members (primarily global air carriers) about future travel demand. This database was assembled using travel service statistics from each country's national input-output tables and sources such as various Ministries for Tourism, airline ticket sales, and the International Air Transport Association (IATA). Data were collected at the sectoral-level for a large number of countries worldwide. The database was later further enriched as the NBTA evolved into the Global Business Travel Association (GBTA), with an expanded number of members coverage worldwide. The GBTA's database is constructed using the same principle applied to an input-output table, whereby BVs are measured as expenditures in monetary values for each 'buying' industry. This has at least two advantages. First, contrary to some of the previous works, this indicator measures the value and not the number of passengers or trips[10] - hence it represents the aggregate expenditure associated with BVs for a given sector/country/year and its evolution over the period covered. Second, they refer to overall short-term expenditures, national and international, where the international component, due to collecting procedures, is typically dominant. The database, which reports BV expenditures and the value of output is, unsurprisingly, commercially sensitive as it is used by airlines to forecast and decide their load capacity in each country or regional market. The access to this novel and unique database was made possible through GBTA's agreement to share their information at a discount and financial support from the University of New South Wales awarded to one of the authors.

Our empirical strategy - in a cross-country sectoral framework - is based on the merger of three datasets: the NBTA/GBTA database for BVs described above and the publicly available OECD-ANBERD and OECD-STAN databases for economic variables, including R&D investments. The industry classification for both datasets is ISIC Rev.4.

[10] This means that a longer travel by a top manager is valued more than a shorter travel by a middle-level manager.

The final sample is an unbalanced (due to OECD missing values) panel covering 30 industries (manufacturing and services) for 25 countries in the 1998-2019 timespan, with a total of 8,316 longitudinal observations. All the monetary series have been corrected for purchasing power parities, expressing, at the end, values in constant prices and PPP 2010 US dollars.

In order to consider the well-known dynamic and path-dependent dimension of R&D investments[11], we set up a specification in a Dynamic Panel Data (DPD) framework (1):

$$lnRD_{ijt} = \alpha lnRD_{ijt-1} + \beta_1 lnBVC_{ijt} + \beta_2 lnE_{ijt} + \beta_3 TRADE_{jt} + \ Dummies + \nu_{ijt} \qquad (1)$$

with:

i (sector) = 1,…, 30;   j (country) = 1,…, 25;   t (time) = 1998,…, 2019;   ln = natural logarithm

The annual R&D investments at the sectoral level is, therefore, framed within a dynamic specification. The measure of our key impact variable is the entire business visits capital (BVC) obtained from the original BVs flows through the Perpetual Inventory Method (PIM)[12]. Controls are E (the total number of employees per sector) which accounts for the size of the industry, and TRADE intensity ($\frac{(Import+Export)}{GDP} * 100$)[13], to account for international exposure[14] (indeed, this alternative channel of technology transfer might drive innovative investments potentially replacing the role of short-term mobility of workers; see Acharya and Keller, 2009; Brancati et al., 2024).

BVs are measured as stocks rather than flows since it is the cumulated acquired knowledge which may affect the current R&D decisions, rather than the sole contemporaneous flow. Indeed, both tangible and intangible capitals are generally measured in terms of stocks in the relevant innovation literature (see Hall and Mairesse, 1995; Parisi, et al., 2006; Ortega et al., 2014). Moreover, using BVs stock allows emphasizing learning and cumulative patterns related to short-term mobility and so considering the mobility effort a longer and more effective source of innovation. Finally, since stocks incorporate the accumulated investments in the past, the risk of endogeneity is significantly mitigated.

[11] See the seminal contributions of Arthur (1988 and 1994) and David (1975 and 1985) and what discussed in the previous Sections 1 and 2. The path-dependent nature of R&D investments calls for the inclusion of the lagged dependent variable as in eq.1.

[12] $BVC_0 = \frac{BVs_0}{(g+\delta)}$; $BVC_t = BVC_{t-1}(1-\delta) + BVs_t$ where BVC is the capital (stock); BVs measure the investment flow; δ is the depreciation rate of 15% (as BVs - seen as a channel of knowledge acquisition - should have a fast degree of obsolescence, similar in principle to the standard discount rate for R&D proposed by Hall, 2007 and Hall et al., 2009); finally, g is computed as an "ex post" 3-year compound growth rate (see Piva et al., 2023).

[13] Obtained from the World Bank open data source.

[14] This data is only available at the country-year level and so it is repeated for all industries in a given country in a given year.

The sample composition by countries is presented in Table 1.

Table 1: Sample composition by countries

Country	**Observations**
Australia	283
Austria	477
Belgium	493
Canada	431
Chile	63
Czechia	516
Denmark	232
Finland	412
France	332
Germany	472
Greece	164
Hungary	324
Ireland	205
Italy	510
Japan	319
Korea	494
Mexico	432
Netherlands	129
Norway	353
Portugal	399
Slovakia	147
Spain	440
Sweden	210
United Kingdom	105
United States	374
Total	**8,316**

In order to explore possible heterogeneity across nations, we identify two groups of countries according to their innovation intensity ($\frac{R\&D}{GDP}$) at the macro level: the top 5 leader innovators (Korea, Sweden, Japan, US and Germany[15]) and non-leader innovators (the remaining 25 countries).

[15] The top 5 R&D performers of our sample were identified based on the 2019 R&D intensity value, considering that 2019 is the most recent year of the time-span of our analysis.

The sectoral composition of the sample is presented in Table 2.

Table 2: Sample composition by industries

Industries	High (H) Low (L)	ISIC Rev. 4	Observations
Agriculture, forestry and fishing	L	01-03	375
Food products; beverages	L	10-11	79
Tobacco products	L	12	69
Textiles	L	13	217
Wearing apparel	L	14	195
Leather and related products, footwear	L	15	210
Wood and products of wood and cork, except furniture; articles of straw and plaiting materials	L	16	344
Paper and paper products	L	17	341
Printing and reproduction of recorded media	L	18	331
Coke and refined petroleum products	L	19	279
Chemicals and chemical products; pharmaceuticals, medicinal chemical and botanical products	H	20-21	323
Rubber and plastics products; other non-metallic mineral products	H	22-23	353
Basic metals	H	24	370
Fabricated metal products, except machinery and equipment	L	25	373
Computer, electronic and optical products	H	26	346
Electrical equipment	H	27	347
Machinery and equipment n.e.c.	H	28	360
Motor vehicles, trailers and semi-trailers; other transport equipment	H	29-30	369
Furniture; other manufacturing; repair and installation of machinery and equipment	H	31-33	362
Construction	L	41-43	384
Accommodation and food service activities	L	55-56	266
Publishing activities	L	58	172
Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	L	59-60	149
Telecommunications	L	61	239
Computer programming, consultancy and related activities; information service activities	H	62-63	215
Financial and insurance activities	L	64-66	334
Real estate activities	L	68	258
Professional, scientific and technical activities	H	69-75	256
Administrative and support service activities	L	77-82	233
Arts, entertainment and recreation	L	90-93	167
Total			**8,316**

Note: 'High' R&D intensity industries (H) include manufacturing and non-manufacturing industries in (High R&D intensity + Medium-high R&D intensity + Medium R&D) intensity groups based on OECD taxonomy, while 'Low' (L) include manufacturing and non-manufacturing industries in (Medium-low R&D intensity + Low R&D intensity) groups (see Galindo-Rueda and Verger, 2016).

The large number of industries, albeit with an unbalanced dimension, provides a comprehensive picture of the economic structure of the countries analysed. This allows us to take into consideration another possible source of heterogeneity, namely the different innovation propensity across the different industries (Arbelo, et al., 2024). Therefore, following the OECD taxonomy (Galindo-Rueda and Verger, 2016), we cluster industries labelling them 'High R&D intensity industries' if they belong to the High R&D intensity + Medium-high R&D intensity + Medium R&D intensity groups, while 'Low R&D intensity industries' belong to the Medium-low R&D intensity and Low R&D intensity groups.

Table 3 presents descriptive statistics and correlation matrix for the whole sample. As can be seen, a positive, statistically significant and relatively high in magnitude correlation between BVs and R&D emerges from this very preliminary test.

Table 3: Descriptive statistics and correlation matrix

	Mean	**ln(RD)**	**ln(BVC)**	**ln(E)**
ln(RD)	4.30			
ln(BVC)	6.42	0.532*		
ln(E)	4.73	0.341*	0.627*	
TRADE	0.79	-0.204*	-0.202*	0.347*

Notes:
- Employees are expressed in thousands of persons engaged, monetary variables are expressed in millions of constant PPP 2010 US dollars.
- * Significant at 95%

4. Results

As far as the econometric methodology is concerned, the DPD specification requires GMM-family estimators to generate unbiased estimates. In particular, given the very high AR(1) correlation of our dependent variable (R&D, equal to 0.97), we opted for a GMM-SYS as the best unbiased estimator (see Blundell and Bond 1998; Pellegrino et al., 2019; Damioli et al., 2021).

In Tables 4 and 5 our attention will focus on GMM-SYS estimated coefficients, where the lagged R&D is treated as endogenous[16], although POLS and FE estimates are also reported[17] as controls.

[16] A number of Hansen tests were run to assess the potential endogeneity of other regressors. Results provided evidence of their exogeneity. Indeed, the BVC variable is a stock already considering - by construction - BVs flows in previous years.
[17] POLS is affected by upward bias in estimating the lagged dependent variable, meanwhile a downward bias is characterizing the case of the FE estimator. As it can be seen in Tables 4 and 5, the GMM-SYS estimator of the lagged dependent variable is always within these upper and lower bounds, as required.

In Table 4 (column 3) the dependent variable is confirmed to be strongly persistent and auto-correlated with a highly significant coefficient of about 0.9. Our variable of interest, BVC, turns out to have a positive and very significant impact on R&D, with an elasticity equal to 4.4%. Employment, as size control variable, has an expected positive and significant effect on R&D, while TRADE does not seem to affect in a significant way the innovative investments at the sectoral level[18]. With regard to the standard GMM diagnoses, the AR(1) and AR(2) tests and the non-significant Hansen test reassure us on the proper choice of the instruments matrix (see Bond 2002).

Our key result - using the whole available sample - supports our hypothesis that short-term mobility (i.e. ideas circulation and face-to-face interactions), positively affects innovative investments. In addition, digging into the sample composition and considering the two groups of leader and non-leader R&D countries, we test the same relationship for the sole non-leader innovative countries (column 6) to evaluate if this channel might play a stronger role in countries that are further away from the innovation frontier. Here the hypothesis is that weaker countries in terms of domestic knowledge generation (those with lower R&D/GDP ratios) may benefit more from the knowledge transfer associated with BVs in comparison with innovative leaders . The results indicate that this is the case, as the beneficial impact of BVC is primarily due to its effect in less innovative countries (elasticity increasing to 4.7%). This implies that the free exchange of ideas and people could be essential for their innovative performance.

[18] This outcome may be due to the imperfect measure we have at disposal, that is the national figure repeated at the industry level (see above).

Table 4: Dependent variable: ln(RD)

	(1) WHOLE SAMPLE OLS	(2) WHOLE SAMPLE FE	(3) WHOLE SAMPLE GMM-SYS	(4) NON-LEADER INNOVATORS POLS	(5) NON-LEADER INNOVATORS FE	(6) NON-LEADER INNOVATORS GMM-SYS
Lagged ln(RD)	0.979***	0.687***	0.904***	0.976***	0.680***	0.874***
ln(BVC)	0.009**	0.019*	0.044***	0.010***	0.015	0.047***
ln(E)	0.011**	0.043***	0.016***	0.015*	0.035**	0.027*
TRADE	0.045	0.029	0.002	0.041	0.004	0.037
Constant	-0.034	1.221***	-0.280	0.093	1.216***	0.052
Time-dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country-dummies	Yes	-	Yes	Yes	-	Yes
Time-dummies Wald test (p-value)	3.93***	9.30***	4.79***	3.39***	10.10***	5.24***
Country-dummies Wald test (p value)	2.42***	-	0.96	2.10***	-	1.13
Hausman test		1426.95***			1152.94***	
Adj. R^2	0.97			0.96		
R^2 within		0.60			0.61	
AR(1)			-7.84***			-7.13***
AR(2)			0.64			-0.49
Hansen test			222.18			205.25
Number groups	604			488		
Number obs.	8,316			6,447		

Notes:
- In columns (4), (5), (6), the top RD/GDP performers in 2019 were excluded (Korea, Sweden, Japan, US, Germany)
- * Significant at 90%; ** Significant at 95%; *** Significant at 99%

As a complementary exercise, we run the same estimation focusing on the top 5 R&D investors (Table 5). As obvious (column 3), the persistence of R&D is higher in leader innovative countries (96%), implying that in these countries industries are keener to invest in R&D in a stable manner. Turning our attention to our key impact variable, the BVC, although positive, is no longer statistically significant. Our interpretation is that BVs as a channel of knowledge acquisition is not so important in those countries that can rely on an excellent, established, and continuous production of domestic knowledge (while it turns out to be essential for all the other countries that are not within the club of the R&D champions worldwide, see Table 4, column 6).

As the diverse industrial structure of economies could influence the observed differences and shape the outcomes, we classify industries as either 'High' or 'Low' innovative (based on the OECD classification - see Table 2) to discover and qualify potential differences in our results. We present the results in Table 6.

The GMM-SYS estimates reveal that BVC has the highest and most significant impact on R&D investments in 'High' R&D industries in non-leader countries (column 2). This suggests that external knowledge transfer can be crucial in boosting R&D in industries that are more inclined towards innovation but are situated in non-leader countries. In addition, 'Low' industries, in both leader and non-leader innovator countries (columns 3 and 4, respectively), benefit from the mobility of people, with an elasticity of about 3-4%. To summarize, high-tech industries in leader countries do not seem to need BVs as a source of viable knowledge; BVs are instead crucial in non-leader countries and low-tech industries. However, while weaker situations benefit more from BVs in general, the most significant and larger coefficient is detected in the high-tech industries in the non-leader countries, reminding us of the key role of the absorptive capacity (see previous sections).

Table 5: Dependent variable: ln(RD) in Leader Innovators (Korea, Sweden, Japan, US, Germany)

	(1) LEADER INNOVATORS POLS	(2) LEADER INNOVATORS FE	(3) LEADER INNOVATORS GMM-SYS
Lagged ln(RD)	0.987***	0.700***	0.955***
ln(BVC)	0.007	-0.012	0.023
ln(E)	-0.001	0.404***	0.001
TRADE	-0.081	0.033	-0.428
Constant	0.112	-0.318	0.047
Time-dummies	Yes	Yes	Yes
Country-dummies	Yes	-	Yes
Time-dummies Wald test (p-value)	1.32	3.96***	1.78**
Country-dummies Wald test (p-value)	3.05**	-	2.18*
Hausman test		310.56***	
Adj. R^2	0.98		
R^2 within		0.64	
AR(1)			-3.34***
AR(2)			1.59
Hansen test			101.18
Number groups	116		
Number obs.	1,869		

Notes:
- To avoid over-identification (see Roodman, 2009), number of instruments is 115 in columns (3)
- * Significant at 90%; ** Significant at 95%; *** Significant at 99%

Table 6: Dependent variable: ln(RD); GMM-SYS estimations

	(1) LEADER INNOVATORS "High" R&D intensity	(2) NON-LEADER INNOVATORS "High" R&D intensity	(3) LEADER INNOVATORS "Low" R&D intensity	(4) NON-LEADER INNOVATORS "Low" R&D intensity
Lagged ln(RD)	0.941***	0.878***	0.902***	0.905***
ln(BVC)	0.016	0.062***	0.045**	0.034**
ln(E)	0.038	0.049**	-0.013	0.016
TRADE	0.17	0.037	-0.015	0.074
Constant	0.152	-0.074	0.349	-0.134
Time-dummies	Yes	Yes	Yes	Yes
Country-dummies	Yes	Yes	Yes	Yes
Time-dummies Wald test (p-value)	3.55***	3.24***	2.42***	3.12***
Country-dummies Wald test (p-value)	0.99	1.42	1.47	1.18
AR(1)	-3.50**	-3.06***	-3.03***	-6.99***
AR(2)	0.69	0.28	1.58	-0.92
Hansen test	22.86	135.80	46.11	135.52
Number obs.	782		1,087	

Notes:
- In columns (1), (3) the top RD/GDP performers in 2019 were excluded (Korea, Sweden, Japan, US, Germany).
-"High"R&D intensity industries include manufacturing and non-manufacturing industries in (High R&D intensity + Medium-high R&D intensity + Medium R&D intensity) groups based on OECD taxonomy, while "Low" include manufacturing and non-manufacturing industries in (Medium-low R&D intensity + Low R&D intensity) groups (see Galindo-Rueda and Verger, 2016).
- To avoid over-identification (see Roodman, 2009), number of instruments is 100 in columns (1) and (3) and 173 in columns (2) and (4).
- * Significant at 90%; ** Significant at 95%; *** Significant at 99%

5. Conclusions and policy implications

At present, both the academic debate and innovation policy recognise and support the provision of incentives for developing R&D cooperation and spillover internalization through the activities identified by the literature discussed above: namely, fostering certain forms of interactions such as formal and informal collaborations with private or government-sponsored research centres like universities, laboratories or other agencies and arrangements aiming knowledge transfer like M&A activity, licensing, R&D joint-ventures. However, innovation policy remains silent on the role of business visits: namely, short-term, face-to-face work-related interactions, understood as a vehicle to generate new knowledge and enhance absorptive capacity.

The relevant literature has shown that short-term BVs are far from being mere 'consumption' items - but can be a rather important driver of productivity growth. Going beyond this perspective, in this paper we have investigated whether BVs can be viewed as a trigger factor in fostering investments in knowledge production activities, such as R&D investments. Indeed, BVs can be considered as a strategic choice to access fundamental external knowledge, which is in turn able to increase the expected profitability of in-house R&D expenditures, given the crucial role of super-additive complementarities in knowledge generation (see Section 2). Moreover, this channel for acquiring external knowledge may be particularly relevant for those organisations, regions and countries which are constrained by geographical, economic and technological disadvantages.

The findings discussed in Section 4 support our hypothesis that short-term mobility positively and significantly affects internal R&D investments. Moreover, they indicate that the beneficial impact of BVs is primarily due to its effect in less innovative countries, revealing that the free exchange of ideas and people could be essential for their innovative performance (while the effect fades away within the club of the global R&D champions); finally, industries matter: sectors characterized by a lower R&D intensity (in both leader and non-leader innovator countries), benefit more from BVs. While this evidence allows us to conclude that weaker situations (both from a geographical and a sectoral point of view) benefit more from BVs, it is also worthy to highlight that the larger impact of BVs is actually detected in the high-tech industries in the non-leader countries, reminding us of the key role of the absorptive capacity cumulated in relatively lagging countries.

Overall, the theoretical discussion, the hypotheses and the empirical outcomes put forward in the present study call for including BVs into the portfolio of effective innovation policies and address how such activity can be incentivised with targeted initiatives. Far from being consumable expenditures, BVs should be considered as an investment in knowledge and encouraged through specific tools of innovation policy, both at the national and local level, as well as adequate auditing measures to limit the possibility of abusing their possible reconsideration as a valuable investment.

This study is not immune from important limitations both in terms of available data and adopted methodology. In particular, new firm-level data would be necessary to further test the relationship between BVs and R&D decision, directly at the company level through proper micro-econometric methodologies. Furthermore, if the inclusion of BVs into the innovation policy discussion called for here were ever implemented, an analysis would be necessary to properly assess their ex-post effectiveness.

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