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# Context and the role of policies to attract foreign R&D in Europe

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## **Abstract:**

This paper explores the effectiveness of policies in attracting the foreign R&D of MNEs to specific countries in Europe. We develop a macroeconomic investigation covering 29 European countries during the period between 1990 and 2012 in order to address: a) whether the provision of direct financial support for business R&D is effective for the attraction of foreign R&D; b) whether direct support is more effective than indirect support for this purpose; and c) whether the link between direct financial support for business R&D and the foreign R&D of MNEs is conditioned by the context within which the support is provided. The results of the analysis show that, first, the provision of direct financial support is generally effective for the attraction of foreign R&D by MNEs. Second, direct support for business R&D is more effective for this purpose than indirect support. Third, the provision of direct financial support for business R&D yields greater returns in contexts that are more socio-economically suitable for knowledge intensive, innovative activity.

**Keywords:** Foreign R&D, Multinational Enterprises (MNEs), direct and indirect support, knowledge flows, innovation, Europe.

**JEL codes:** E61; F23; O38; H25

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## **1. Introduction**

A shift is occurring in the spatial organization of multinational enterprises ('MNEs'). More specifically, MNEs are increasingly opting to 'decentralise' their research and development activities ("R&D") and perform a greater share of these knowledge-generating functions beyond the borders of their home markets, in developed and developing countries alike (Cantwell 1995; OECD, 2008a; Dachs et al., 2012; Iammarino and McCann; 2013).

From the perspective of host-countries, this shift is not inconsequential. The activities of foreign firms – R&D and otherwise – constitute an important source of knowledge and generate knowledge spillovers upon which domestic firms may capitalize, with the effect of enhancing productivity, growth and innovative capacity, yielding benefits for the economy more broadly (Cantwell, 1987; Blomström and Kokko, 1998; Todo et al., 2011; OECD, 2011).

Recognizing the potential benefits linked to hosting the foreign R&D of MNEs, policy makers have prioritized the attraction of foreign investment in R&D and knowledge intensive activities. In an effort to achieve this aim, countries have developed and implemented a variety of strategies and policies that range from the provision of subsidies and financial incentives for R&D to the establishment of agencies dedicated to attracting foreign activity (Guimén, 2009). Do these strategies work? Or are they a complete waste of public resources?

The overarching objective of this paper is to zero in on and evaluate the effectiveness of the different policy instruments implemented by European countries to attract the knowledge intensive activities of foreign firms. In particular, the research is concerned with the different 'direct' financial support instruments. The investigation is guided by three narrowly defined but related research questions: a) does the provision of direct financial support for business R&D attract or promote the foreign R&D of MNEs?; b) is direct financial support more effective than indirect financial support for this purpose?; and c) is the relationship between the provision of direct financial support for business R&D and the foreign R&D of MNEs conditioned by the context within which the support is provided?, and if so, how? The analysis is based on a macro-economic investigation of 29 European countries between 1990 and 2012.

Despite the rapid growth of policy tools targeting foreign direct investment in R&D by MNEs, there is, to our knowledge, a relative dearth of empirical studies evaluating and exploring the relationships and questions that lie at the heart of this research. The contribution of this research is therefore three-fold. *First*, it provides insight into the relationship between the provision of direct financial support for business R&D and the foreign R&D of MNEs, making use of the most up-to-date and comprehensive statistics available for a large sample of countries. *Second* and within the confines of data availability, it assesses the effectiveness of direct financial support in attracting the foreign R&D of MNEs relative to that of indirect measures. *Third*, and most importantly, the investigation adds nuance to the understanding of

direct financial support for business R&D through its examination of the extent to which the capacity of policies to attract foreign R&D investment is conditioned by the contexts within which it is employed. Insights provided with respect to this third contribution shed light on the socioeconomic and institutional conditions under which financial support instruments may be most usefully employed and ‘where’ and ‘when’ it may reasonably be expected that they will achieve their intended outcomes.

The empirical analysis suggests that the provision of direct financial support is generally effective for the attraction of foreign R&D by MNEs. It also reveals that while direct support for business R&D is of relevance to the attraction of MNEs’ foreign R&D, indirect support is not. Lastly, the relationship between direct financial support for business R&D and the attraction of the foreign R&D of MNEs is seemingly conditioned by the context within which it the support is provided. More specifically, the empirical analysis implies that the provision of direct financial support for business R&D is more effective in attracting the foreign R&D of MNEs in contexts that are more socio-economically suitable for knowledge intensive, innovative activity.

It is on the basis of these results that the policy insights provided by the paper are formed. Most notably, the evidence points to the need of policy makers to consider the deployment of direct financial support for business R&D as part of broader structural efforts aimed at attracting the foreign R&D of MNEs to European

countries. That said, the results indicate that support should not be deployed without adequate consideration of local contextual conditions. More concretely, policy makers in less developed or “innovation-averse” (Rodríguez-Pose, 1999) contexts should forgo financial support instruments in favour of efforts to address more fundamental, structural conditions, at least until the point at which they have succeeded in fostering a socioeconomic context that is more conducive to innovative activity and generally suitable for the hosting of the knowledge intensive activities of MNEs. Only then it becomes advisable for policy makers turn to financial instruments in an effort to attract foreign R&D.

The remainder of the paper proceeds as follows: *Section 2* develops the theoretical framework within which the research is situated. *Section 3* provides a taxonomic exploration of the provision of financial support across Europe. *Section 4* introduces the variables employed in the analysis. *Section 5* introduces the empirical methodology. *Section 6* addresses econometric concerns prior to presenting and providing a substantive discussion of the results of the empirical analysis. *Section 7* concludes by summarizing the analysis before presenting a series of preliminary policy implications and proposing avenues for future research.

## **2. Theoretical Framework**

Policy makers have at their disposal any number of strategies to promote investment in business R&D activities and functions (Czarnitzki and Lopes Bento,

2010; Izsak, et al., 2014). Among them is the provision of financial support. Financial support for business R&D stimulates R&D by responding to a central motivation of firms – profit maximization. By reducing the costs incurred by firms in the performance of R&D, a significant profit-/cost-related disincentive that is likely to inhibit private investment in R&D is alleviated, thereby increasing the propensity of firms to engage in R&D.

The use of public resources to subsidize or stimulate business R&D is increasingly common (*Section 3*). From the perspective of governments, the provision of financial support for business R&D is justified in two respects. The first justification derives from the well-established link between investment in R&D and innovation (Carvalho, 2011). Griliches' (1979) 'knowledge production function' posits that innovative activity (the 'output') is a function of a host of 'inputs'. The most important of these inputs, it is asserted, is "new economic knowledge", of which R&D is considered a significant source (Audretsch and Feldman, 2004, p. 2716). The logic, then, behind the provision of financial support for business R&D is that it stimulates the production of new knowledge and fosters innovative activity both of which contribute to economic growth and, in turn, to more broadly defined socioeconomic development (Solow, 1957; Romer 1990). The second related justification is that the prevalence of market failures associated with R&D may result in the undersupply of business R&D (Carvalho, 2011). That is, the high costs and uncertainty associated with performing R&D often discourages firms from allocating resources to R&D functions (Hall, 2002; Cerulli, 2012). This tendency for

underinvestment, and the potential consequences associated with it, suggests that a role may exist for government policies to foster private R&D as a means to correct for market failures.

Financial support for business R&D may be broadly classified as ‘directly’ or ‘indirectly’ provided (OECD, 2010, Carvalho, 2011). Directly and indirectly provided financial support constitute different means to achieve a single goal – to stimulate business R&D. In spite of this underlying primary objective, important differences exist between the two strategies.<sup>1</sup> The central difference relates to the mechanisms or instruments through which support is deployed. Direct financial support is delivered through “grants, loans and procurement [contracts]” (OECD, 2010, p.77). Indirect financial support, on the other hand, is delivered through various tax incentives (OECD, 2010; Carvalho, 2011). These incentives include: “R&D tax credits, R&D allowances, reductions in R&D workers’ wage taxes and social security contributions, and accelerated depreciation of R&D capital” (OECD, 2010, p.77).

*Direct financial support for business R&D is the main focus of this research.*

An extensive body of literature has considered the relationship between the provision of direct financial support for business R&D and economy-wide business R&D. Much of this literature is based upon empirical studies that have focused on a

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<sup>1</sup> One of, if not the most, profound difference between direct and indirect financial support is the degree of control that governments may have over the use of the support (Carvalho, 2011). It is understood that much less control may be retained over the use of indirect support which represents an increasingly serious concern for policy makers given the potential for “unintended effects” and negative externalities, especially with regard to their use by MNEs (OECD, 2014a, p. 22).



single country. These studies have not yielded a uniform conclusion (Zúñiga-Vicente et al., 2014). They have, however, provided ample evidence to suggest that direct financial support *can* be an effective tool to stimulate aggregate business R&D (Zúñiga-Vicente et al., 2014).

There are far fewer cross-country and macroeconomic investigations examining the relationship at the centre of this article (Montmartin and Herrera, 2014; Zúñiga-Vicente et al., 2014). And the few that do fail to reach the same conclusion. Of the four most relevant studies for the purpose of this analysis – Guellec and van Pottelsberghe de la Potterie (2000), Falk (2006), Thompson (2009), and Montmartin and Herrera (2014) – Guellec and van Pottelsberghe de la Potterie (2000) and Falk (2006) find evidence of a positive relationship between direct financial support and business R&D intensity, suggesting that direct support successfully stimulates business R&D.<sup>2</sup> Montmartin and Herrera (2014), by contrast, find no evidence of such a relationship. They, in fact, find a negative association between direct support and aggregate business R&D. They attribute at least part the discrepancy between their results and those of Guellec and van Pottelsberghe de la Potterie (2000) and Falk (2006) to the employment of “different relative measures for private R&D and for direct support” (Montmartin and Herrera, 2014, p. 18). These three studies also examine indirectly provided financial support with all investigations finding evidence of a positive relationship between said support and

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<sup>2</sup> Falk’s (2006) conclusions regarding the effect of direct support are less definitive than those of Guellec and van Pottelsberghe de la Potterie (2000). The positive relationship between direct financial support and aggregate R&D intensity is statistically significant in only one of Falk’s (2006) empirical models.

aggregate business R&D. In a similar vein, Thomson (2009) explores the relationship between host-country tax policy and the foreign R&D of MNEs, using a sample of 26 OECD countries between 1980 and 2006. He finds no evidence of a statistically significant relationship between R&D oriented tax policy and the R&D of foreign parties from which he concludes – albeit cautiously – that the provision of tax incentives (i.e. indirect financial support) does not attract foreign R&D. It is worth noting that while Thomson (2009) narrows the scope of study to focus singularly on the foreign R&D of MNE, he does so with reference to the provision of indirect financial support.

Hence, the preceding theoretical and empirical discussion marginally points to the idea that the provision of support for business R&D *may* contribute to incentivise foreign firms to elect to perform their R&D functions in one location over another – the prospect of minimising the costs incurred in the performance of R&D would, at the very, least pique the interest of a profit-oriented MNE. However, much of the evidence rests, as indicated above, on the study of indirect financial support. The relationship between direct financial support for business R&D and the R&D of MNEs therefore remains, to our knowledge, understudied from a systematic, cross-country, macroeconomic perspective. Recognising this gap in the literature, we have devised the following two research questions as points of departure for the empirical analysis of the link between specific country-based direct financial incentives and MNEs R&D investment:

The first research question asks whether the provision of direct financial support for business R&D can attract foreign R&D of MNEs. We anticipate that the provision of direct financial support for private R&D will entice MNEs to locate their R&D in those countries where the most attractive policy packages. The provision of financial support may afford MNEs the opportunity to minimize the financial costs incurred in the performance of R&D, thus enhancing the attractiveness of a given location.<sup>3</sup>

The second research question, represents a direct extension of the first. It acknowledges the often simultaneous provision of direct and indirect support and contemplates the extent to which the attractiveness of direct support for business R&D is dependent on the attractive effect of indirect support. It is anticipated, following Thomson (2009), that the provision of direct financial support for private R&D will have a stronger effect on the foreign R&D of MNEs than indirect support.

However, a firms' location decisions rests on a complex set of factors which go well beyond the provision of financial support by the state. R&D location decisions of MNEs are influenced by a wide range of factors, characteristics and conditions. Market size and other 'demand-side' factors affect the decision-making processes of MNEs (e.g. Kummerle, 1999; Kumar, 2001; Shimizutani and Todo,

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<sup>3</sup> Both domestic and foreign firms are often eligible to receive direct financial support for business R&D (OECD, 2011), as countries generally practice "non-discrimination vis-à-vis domestic firms [and foreign-owned companies]" (OECD, 2011, p. 69).

2008). Similarly, 'supply-side' factors, including, most notably, the availability of skilled-human capital and a territory's overall innovative capacity, more generally, are important considerations for MNEs when deciding where to locate critically important R&D functions (e.g. Florida, 1997; Kumar, 2001; Davis and Meyer, 2004; OECD, 2011; Crescenzi et al., 2014; Siedschlag et al., 2013; Thomson, 2013b). The documented importance of these locational factors gives rise to a fundamentally important question: *what is the relationship between these territorial characteristics and financial incentives that may entice MNEs?*

The prevailing view with respect to this question is that the provision of financial support is indeed of relevance to the location of MNE's foreign R&D, but that it may be a secondary or final consideration in the location decision-making process (OECD, 2011). That is, the provision of support only becomes a factor after more important location determinants – the “economic fundamentals” (OECD, 2011, p. 74) – have been assessed and deemed suitable. The said “economic fundamentals” include, but are by no means limited to those highlighted above. Moreover, it has been suggested that “government support [cannot] compensate for the negative effects [or absence] of other more important factors” (OECD, 2011, p.75). A suitable socio-economic context can thus be thought of as a ‘prerequisite’ to hosting MNEs R&D.

It may be inferred, then, that there are circumstances and contexts within which financial support will be ineffective, or certainly less effective in attracting the

foreign R&D of MNEs – i.e. where the ‘prerequisites’ are not met. Conversely, the provision of financial support may work synergistically with favourable territorial contexts to attract foreign R&D. That is, where socioeconomic and other conditions are suitable for the R&D of MNEs, the provision of financial support may prove to be the decisive factor in the decision about whether to locate or not in a specific territory and possibly a stimulus to investments and activity (OECD, 2011). Put simply, if the environment is such that it permits firms to perform R&D of an acceptable quality, the importance of cost and, by extension, the availability of financial support increases (OECD, 2011).

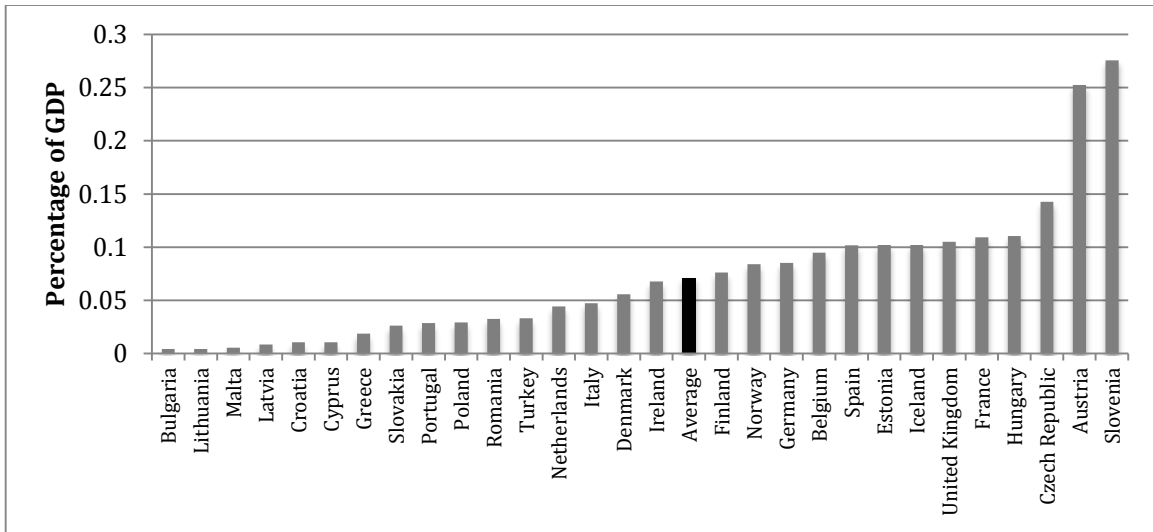
Our third research question therefore interrogates how the relationship between direct financial support for business R&D and the R&D of MNEs is conditioned by the context within which it is provided. It is anticipated that that the attractive effect of direct financial support for business R&D on the foreign R&D of MNEs will be greater in more developed contexts or ones whose socioeconomic and institutional conditions make them more conducive to knowledge-intensive, innovative activity in light of the prerequisite nature of “economic fundamentals” and the secondary importance of the provision of financial support to the location of MNEs’ foreign R&D.

### **3. Financial Support for Business R&D in Europe**

Financial support mechanisms are not employed uniformly across all countries – the socio-economic and political context, among other factors, influence the exact mix of R&D policies used (OECD, 2010; Carvalho 2011). Few countries, however, fail to provide some measure of support or subsidization to business R&D – an acknowledgement, perhaps, to its understood importance to aggregate knowledge-generation efforts. This widespread employment of financial support underscores the importance of a well-developed understanding of its effectiveness.

*Figure 1* illustrates the considerable variation in the employment of direct financial support for business R&D across European countries. There is no ubiquitous trend in the provision of such support across the countries considered in this empirical analysis. Relatively less wealthy countries appear at both ends of spectrum. In 2011, for example, Slovenia and the Czech Republic were among the most generous providers of direct financial support for business R&D, whereas Bulgaria and Lithuania provided the least support of the countries considered in the analysis. Similarly, the level of direct financial support provided to business R&D varied tremendously across relatively wealthier countries. Austria was second only to Slovenia in its provision of direct support for business R&D, while the Netherlands, Denmark and Ireland all fell below the average of the countries considered.

**Figure 1. Direct Financial Support for Business R&D, 2011**



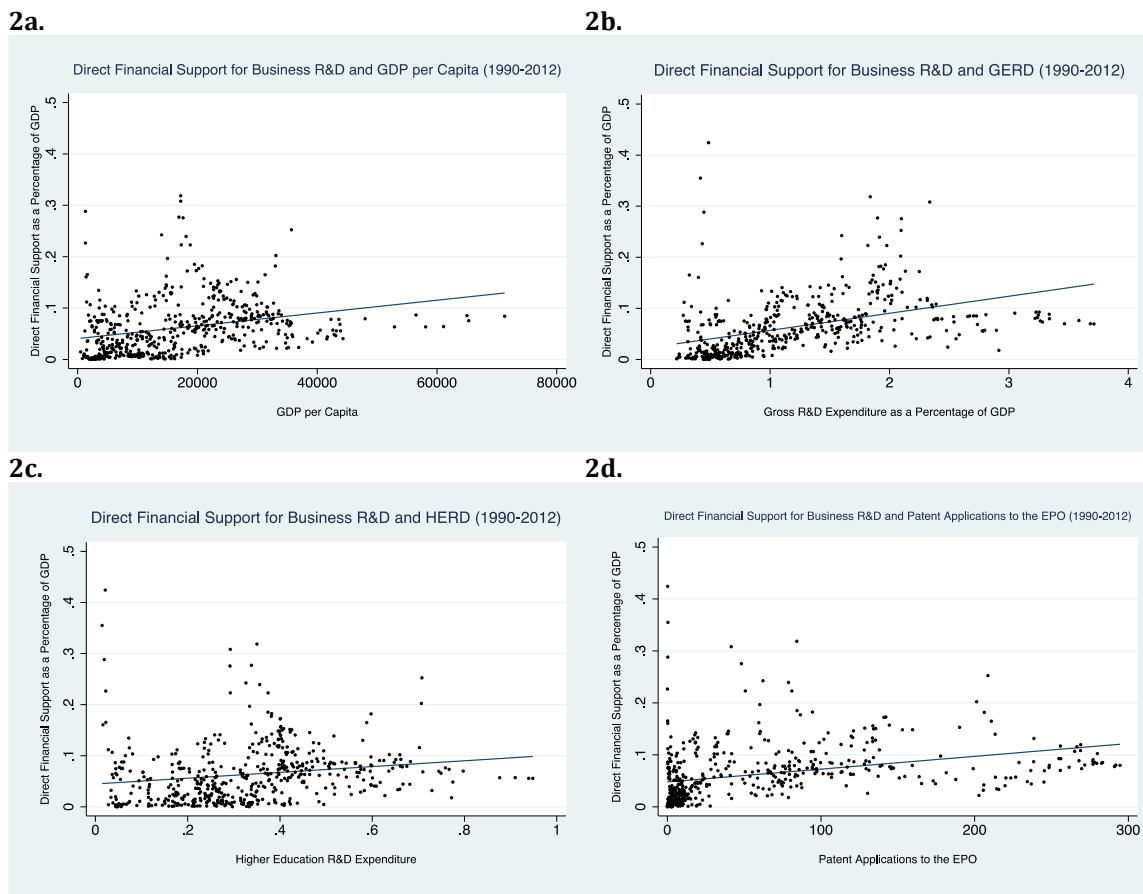
(Authors' elaboration, data from Eurostat)

*Figure 2a* depicts the relationship between the amount of direct financial support provided to firms for R&D and GDP per capita. The relatively neutral trend-line is indicative of the inferences drawn on the basis of *Figure 1* – more developed and less developed countries alike provide direct financial support to various extents in an effort to foster business R&D. Similarly, aggregate R&D expenditure (indicative of aggregate knowledge generation efforts); higher education R&D expenditure (indicative of the availability of suitably skilled human capital) and patent applications to the EPO (indicative of innovative capacity) are not robustly correlated with the provision of direct financial support for business R&D (*Figures 2b, 2c and 2d*).

In short, it appears that the level of financial support provided to firms for the performance of R&D is not necessarily commensurate with the level of wealth and development or the scientific and innovative capacity of European countries. It

cannot be definitely asserted, then, on the basis of these host-country characteristics, that a given country will provide more or less direct financial support to business R&D. Direct financial support is evidently provided across an array of countries each of which is characterized by unique contextual conditions. This raises critical questions about the way, and to extent to which, the context in which the financial support is provided influences its effectiveness.

**Figure 2. Direct Financial Support for Business R&D and (a) GDP per Capita; (b) GERD; (c) HERD; (d) Patent Applications to the EPO, 1990-2012**



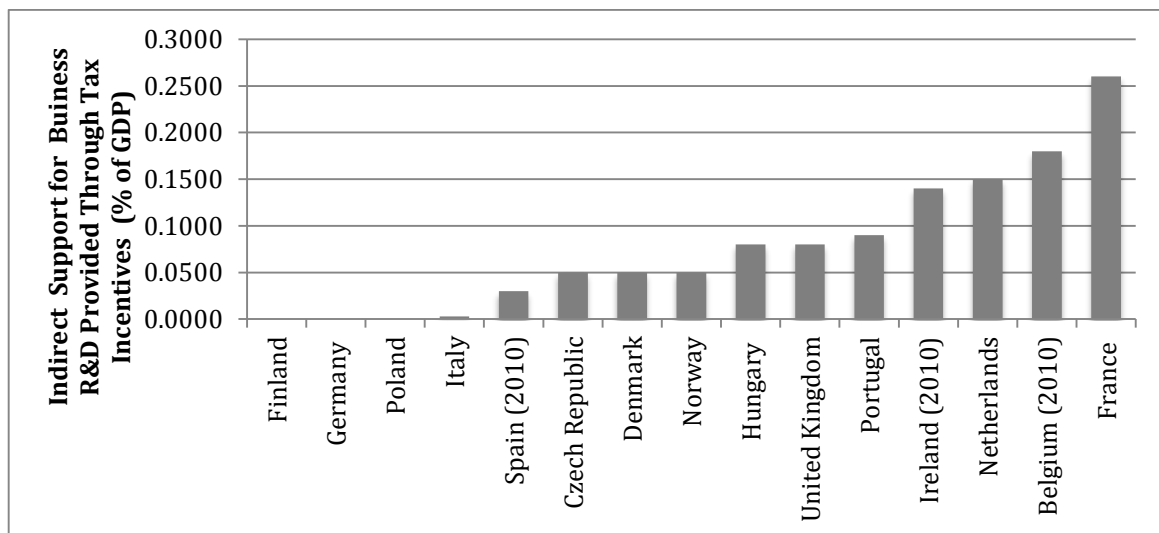
(Authors' elaboration, data from Eurostat)

Directly provided support is, as addressed, not the only type of financial support deployed by governments – indirectly provided financial support enjoys



widespread – and once again, variable – employment in the European context as well. Certain countries such as Germany and Finland do not offer indirect support and instead opt to stimulate business R&D largely through the provision of direct support (*Figure 3*). France, Belgium and the Netherlands, on the other hand, provide substantial support indirectly through tax incentives (*Figure 3*). More often than not, in spite of empirical evidence suggesting that direct and indirect support may be ‘substitutes’<sup>4</sup> (Guellec and van Pottelsberghe de la Potterie, 2000; Montmartin and Herrera, 2014), European countries provide the two types of support in tandem.

**Figure 3. Indirect Financial Support for Business R&D, 2011**



(Authors’ reproduction of figure from OECD (2013), data from OECD.)

#### 4. Data and Variables

##### 4.1. MNEs’ Foreign R&D: Business Enterprise R&D funded from Abroad

<sup>4</sup> This means that “the increased intensity of one [type of support] reduces the effect of the other” (Guellec and van Pottelsberghe de la Potterie, 2000, p.5)

The dependent variable employed in the empirical analysis is a measure of the foreign R&D of MNEs. Data concerning the foreign R&D of MNEs in European countries, and the activities of MNEs more generally is, unfortunately, sparse (Kleinbard, 2011). This research opts to use a proxy for the foreign R&D of MNEs: “business enterprise research and development financed from abroad” (henceforth referred to as ‘BERD from abroad’). BERD from abroad constitutes “direct [transfers] of resources [that] must be both intended and used for the performance of R&D” (Thomson, 2009, p. 13 paraphrasing OECD, 2002, p.114). BERD from abroad “comes mainly from other business enterprises” (OECD, 2013, p. 108) and when the interest MNEs have in protecting valuable knowledge and other ‘intangible’ assets and their related behaviour are considered (O’Donoghue and Croasdell, 2009), it is reasonable to assert, following Thomson (2009), that “a large share of [BERD from abroad] is likely to represent transfers between parent and affiliate firms” (p. 27). BERD from abroad may therefore be used as a proxy for where MNEs are electing to perform at least a portion of their foreign R&D and may be usefully employed to develop the indicative insights this study seeks to provide. The employment of BERD from abroad as a proxy for the foreign R&D of MNEs is further justified by its relative completeness for the countries and years of interest permitting inferences that contribute to more robust conclusions.

#### *4.2. Direct Financial Support for Business R&D: Business Enterprise R&D funded by the Government*

The ‘explanatory variable of interest’ is a measure of the financial support provided directly to firms for the performance of R&D. As addressed, direct financial support for business R&D is provided through a variety of mechanisms (*Section 2.1*). Following Guellec and van Pottelsberghe de la Potterie (2000) and Falk (2006) “business enterprise funded by the government” (henceforth referred to as ‘BERD by the government’) is employed as the ‘explanatory variable of interest’, as it captures the direct support provided to firms intended to stimulate business R&D – it is an aggregate measure that “[includes] contracts, loans, grants/subsidies” (OECD, 2010, p.77).

#### *4.3. Indirect Financial Support for Business R&D: The B-Index*

The second research question requires the inclusion of a measure of indirect support for business R&D. Following comparable previous empirical work, this research opts to use the ‘B-index’ as a proxy for indirect support. The ‘B-index’ is a composite measure originally developed by McFetridge and Warda (1983) that is indicative of the overall generosity of R&D related tax incentives that constitute the indirectly provided financial support for business R&D (OECD, 2009; 2013). Technically speaking, the B-index is defined as “[a measure of] the present value of before tax income necessary to cover the initial cost of R&D investment and to pay corporate income tax, so that it is profitable to perform research activities” (OECD,

2009, p.78).<sup>5</sup> The principle advantages associated with using the “B-index” are its simplicity, accessibility and international comparability (Warda, 2001), all characteristics that have lent it appeal, leading to its inclusion in recent empirical literature. The B-index is, however, a synthetic (p.78), composite measure meaning that the respective effectiveness of the various types of tax incentives a country may employ cannot be individually assessed (OECD, 2009). This aggregate nature of the B-index constitutes its most prominent constraint. This constraint however in no way impairs the achievement of the aims of this study. Another limitation of the B-index relates to its failure to capture other elements a country’s tax policy that may be of relevance to the performance of R&D, but are not explicitly R&D oriented (Warda, 2001). This study is explicitly focused on R&D-oriented policy and the B-index encapsulates the instruments and mechanisms we are concerned with.

The statistics for the B-index used in the empirical analysis were obtained from Thomson (2009; 2013a). Statistics for the ‘B-index’ from this source are, to our knowledge, the most comprehensive available. They are still, however, notably limited, available only for the years 1990-2006 for a smaller sample (16) of European countries. As such, empirical models including the B-index rely on a significantly smaller sample size than the other models estimated and thus inferences drawn must be approached with the appropriate measures of caution and an awareness of this limitation.

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<sup>5</sup> Please see Warda (2001) for a comprehensive discussion of the B-index and Thomson (2009) for a detailed explanation of the calculation of the B-index values employed in this research.

#### *4.4. Conditioning Variables: Traditional Determinants of the Location of MNEs' R&D*

The location of MNEs' foreign R&D, as addressed, is subject to an array of influences (Thursby and Thursby, 2006; OECD, 2011; Dachs et al. 2012).. 'Demand-side' factors, most notably, market size, have been highlighted as important (see, for example, Kummerle, 1999; Kumar, 2001; Shimizutani and Todo, 2008), however, it is becoming increasingly apparent that 'supply-side', socioeconomic factors are of considerable relevance (Florida, 1997). The availability of suitably skilled human capital, for example, is understood to be of paramount importance (see, for example, Florida, 1997; Kumar, 2001; Crescenzi et al. 2014; Belderbos et al. 2014). Similarly, the scientific, technological and innovative capacity of an environment has also been identified as a particularly relevant consideration (see, for example, Davis and Meyer, 2004; Crescenzi et al., 2014; Siedschlag et al., 2013; Thomson, 2013b).

Recognizing this, a selection of other prominent determinants is included in the empirical analysis. The principal motivation for the inclusion of the following variables is the development of interaction terms consisting of the aforementioned explanatory variable of interest and each of the following five variables that will permit an investigation into the third research question.

'GDP per capita' is included in the empirical analysis as an indicator of the overall level of economic development and also, by extension, the overall suitability of a context for R&D. 'Patent applications to the European Patent Office' ('EPO') is

included as an indicator of the overall innovative capacity of a country, an established determinant of the location of MNEs foreign R&D (see, for example, Crescenzi et al., 2014; Siedschlag et al., 2013). 'Higher education R&D expenditure' (henceforth referred to as 'HERD') enter the model as a proxy for the availability of suitably skilled human capital (as per Thomson, 2009), an important consideration for MNEs in their R&D location decisions (see, for example, Florida, 1997; Kumar, 2001). 'Aggregate (Gross) R&D expenditure' (henceforth referred to as 'GERD') is also used, as it is indicative of all other knowledge generation efforts and, in that sense, is connected to the overall conduciveness of a location to the hosting of knowledge-intensive, innovative activity. The 'ICRG Quality of Government Index' is included as a cursory indicator of the overall quality and functioning of the institutional context.

### ***5. Empirical Model***

Drawing inspiration from Guellec and van Pottelsberghe de la Potterie (2000), Falk (2006) and Thomson (2009), among others, we have developed a panel regression model to investigate the relationship between the provision of direct financial support for business R&D and the foreign R&D of MNEs where the foreign R&D of MNEs is function of the direct financial support for business R&D and a vector of other explanatory variables. The model is estimated using a 'two-way' (time and country) fixed-effects approach with robust standard errors.

The model assumes the following form:

$$berd\_abr_{it} = \alpha + \beta_1 berd\_gov_{it} + \theta_1 X_{it} + \eta_t + \mu_i + \varepsilon_{it} \quad (1)$$

where the dependent variable,  $berd\_abr_{it}$ , is BERD from abroad, our proxy for the foreign R&D of MNEs (*Section 3.1*); the explanatory variable of interest,  $berd\_gov_{it}$ , is the measure of direct financial support for business R&D and  $X_{it}$  is a vector of explanatory variables. The estimation results are summarized in *Tables 1, 2* and *3*.

The third research question concerning if (and how) the relationship between the provision of direct financial support for business R&D and the foreign R&D of MNEs is conditioned by the contextual characteristics of the country providing the support will be assessed through the inclusion of interaction terms. More specifically, five interaction terms have been developed each of which consists of the measure of direct support for business R&D (BERD by the government) and GDP per capita, patent applications to the European Patent Office, higher education R&D expenditure, aggregate R&D expenditure and the ICRG quality of government index, respectively. Estimations including these interactions terms are presented in *Table 3*.<sup>6</sup>

The dependent variable (BERD from abroad), the explanatory variable of interest (BERD by the government), higher education R&D expenditure and

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<sup>6</sup> All independent variables are centered on their means for the development of the interaction terms (Smith and Sasaki, 1979).

aggregate R&D expenditure are expressed as percentages of GDP (as per Falk, 2006). Patent Applications to the European Patent Office is expressed as 'per million inhabitants'.

All explanatory variables have been lagged one-year to minimize the potential simultaneity between the response variable and explanatory variables.

## **6. Results and Analysis**

### *6.1. Introduction to Results and Econometric Concerns*

Prior to reviewing the results of empirical analysis, two econometric concerns must be addressed. First, the results are based on the analysis of an unbalanced panel dataset due to the availability of statistics. Second, while all explanatory variables have been lagged by one year in an effort to address the potential simultaneity between the dependent variable and explanatory variables (as per Spies (2010) and Crescenzi et al. (2014)), inferring causality from the results must be done with caution. The aim of this research is to provide insights into the relationship between direct financial support for business R&D and the attraction of MNEs' foreign R&D that may be usefully supplemented by further research. Neither of these limitations inhibits or impairs the achievement of this goal. Within the limits of this study, the focus of the analysis remains on the 'direction' and significance of coefficients.



## 6.2. Estimation Results

**Table 1. Robust Estimation Results (full model, no interactions)**

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Constant	-0.0021 (0.0192)	-0.0448 (0.0163)	-0.0132 (0.0199)	-0.0141 (0.0184)	0.0134 (0.0191)	-0.1421*** (0.0150)	-0.0680** (0.0332)
Direct Financial Support for Business R&D	0.2079*** (0.0373)	0.2241*** (0.0444)	0.1787*** (0.0417)	0.1990*** (0.0392)	0.1953*** (0.0360)	0.4093*** (0.0580)	0.2417*** (0.0556)
GDP per Capita		5.30e-06*** (7.01e-07)					4.81e-06*** (8.26e-07)
R&D expenditure (GERD)			0.0192 (0.0141)				-0.0050 (0.0161)
Patent Applications to the EPO				0.0003** (0.0001)			0.00012 (0.00011)
Higher education (HERD)					0.0704** (0.0313)		0.0021 (0.0414)
Quality of Government (QoG)						0.2430*** (0.0215)	0.0170 (0.0377)
Country Fixed-Effects	Yes	Yes	Yes	Yes	Yes	No	Yes
Time Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	436	433	431	432	434	425	416
Adj. R-Squared	0.79	0.82	0.79	0.80	0.79	0.39	0.82
F-Statistic	7.33***	11.34***	6.98***	7.84***	7.23***	92.56***	9.98***

Robust S.E. in parentheses: \*, \*\*, \*\*\* denote significances at 10%, %5 and 1%, respectively.

Explanatory variables are lagged 1-year

Table 1 presents the results of the first set of estimations addressing the first research question. Of primary interest is the coefficient of the explanatory variable of interest: direct financial support for business R&D (BERD by the government). This coefficient is positive and statistically significant at the 0.01 level of significance across all estimations indicating a positive relationship between direct financial support for business R&D and BERD from abroad, the chosen proxy for the foreign R&D of MNEs.

The coefficients of the conditioning variables are consistent with both theory and previous empirical investigations. GDP per capita (indicative of overall level of economic development), aggregate R&D expenditure (indicative of aggregate knowledge generation efforts), higher education R&D expenditure (indicative of the availability of suitably skilled human capital), patent applications to the European Patent Office (indicative of innovative capacity) and the ICRG quality of government index (indicative of the institutional context) are found to be positively associated with BERD from abroad.<sup>7</sup>

**Table 2. Robust Estimation Results (reduced model)**

	(I)	(II)
Constant	0.0174 (0.0256)	0.0282 (0.0523)
Direct Financial Support for Business R&D	0.2252** (0.1030)	0.2208** (0.1055)
Indirect Financial Support for Business R&D ('B-Index')		-0.0102 (0.0472)
Country Fixed-Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Observations	184	184
Countries	16	16
Adj. R-Squared	0.85	0.85
F-Statistic	3.01***	2.83***

*Robust S.E. in parentheses: \*, \*\*, \*\*\* denote significances at 10%, %5 and 1%, respectively.*

*Explanatory variables are lagged 1-year*

The estimations summarized in *Table 2* are based on a smaller sample than those presented in *Table 1*. The smaller sample is a result of the inclusion of the B-index for which the statistics are limited. These estimations are directly relevant to

<sup>7</sup> Aggregate R&D expenditure is negatively associated with BERD from abroad in Regression VII contrary to expectation. The coefficient is, however, highly insignificant.

second research question. Consistent with the results of estimations that employ a larger sample (*Table 2*), the coefficient for directly provided financial support for business R&D is positive and statistically significant (in both estimations I and II). The coefficient for indirect financial support for business R&D, however, is not significant at any conventional level of significance, suggesting that while the provision of direct financial support for business R&D is associated with BERD from abroad, indirect support is not.

**Table 3. Robust Estimation Results (full model, interactions included)**

	(I)	(II)	(III)	(IV)	(V)
Constant	0.0574** (0.0187)	0.0061 (0.0198)	0.0137 (0.0192)	0.1816 (0.0203)	0.0688*** (0.0027)
Direct Financial Support for Business R&D	0.3033*** (0.0624)	0.1850*** (0.0419)	0.2454*** (0.5644)	0.2616*** (0.0666)	0.4815*** (0.0548)
GDP per Capita	5.36e-06*** (7.24e-07)				
R&D expenditure (GERD)		0.0191 (0.0141)			
Patent Applications to the EPO			0.0003*** (0.0001)		
Higher education (HERD)				0.0725** (0.0726)	
Quality of Government ('QoG')					0.2374** (0.0199)
Direct Financial Support for Private R&D*GDP per Capita	.00001** (5.91e-06)				
Direct Financial Support for Private R&D*GERD		0.1918** (0.0759)			
Direct Financial Support for Private R&D* EPO			0.0014 (0.0011)		
Direct Financial Support for Private R&D*HERD				0.4108 (.2737)	
Direct Financial Support for Private R&D*QoG					1.4041** (0.3181)
Country Fixed-Effects	Yes	Yes	Yes	Yes	No
Time Fixed-Effects	Yes	Yes	Yes	Yes	Yes
Observations	433	431	432	434	425
Countries	29	29	29	29	29
Adj. R-Squared	0.82	0.79	0.80	0.79	0.42
F-Statistic	10.04***	6.80***	7.53***	6.95***	67.26***

*Robust S.E. in parentheses: \*, \*\*, \*\*\* denote significances at 10%, %5 and 1%, respectively.  
Explanatory variables are lagged 1-year*

*Table 3* presents the results of the estimations that include the interaction terms developed to investigate the third and final research question. The focus here is on the interaction terms themselves, though it should be highlighted that the coefficients for the measure of direct financial support as well as all of the

conditioning variables are positive as would be expected on the basis of the estimation results presented in *Table 2*.

The three coefficients of the interaction terms consisting of direct financial support for business R&D and GDP per capita, aggregate R&D expenditure and quality of government, respectively, are positive and statistically significant. The coefficients of the interaction terms composed of the measure of direct financial support for business R&D and patent applications to the European Patent Office and higher education R&D expenditure, respectively, are also positive. These two coefficients, however, are not significant at any conventional level of significance. Substantive interpretations of these relationships are provided in the following section.

### *6.3. Discussion and Analysis*

The first research question asked whether the provision of direct financial support for business R&D could objectively be said to attract the foreign R&D of MNEs. It was hypothesized that the provision of direct financial support for business R&D should enhance the overall attractiveness of a location by affording firms the opportunity to minimize the costs incurred in the performance of R&D and thus a positive relationship would be observed between the measure of direct financial support and BERD from abroad, the proxy for the foreign R&D of MNEs (*Table 1*). Such a positive relationship is evident across all estimations of the model. There are

seemingly two plausible interpretations of this relationship that may be inferred from a synthesis of theoretical concepts, literature and the empirical analysis performed in this research.

The first, perhaps almost 'intuitive' explanation is derived from the conceptualization of the firm as a profit-oriented entity. As addressed, the provision of direct financial support for business R&D reduces the costs incurred by firms in the performance of R&D, alleviating a cost-related disincentive that discourages R&D. In short, the provision of financial support makes it less costly for firms to perform R&D allowing them to achieve that central aim of profit-maximization (through cost-minimization) while mitigating the risk associated with the cost of potential failure.

It may be inferred then, that the availability of direct financial support for business R&D, or more accurately, the opportunity to perform R&D at a lower cost enhances the attractiveness of a location offering this opportunity, thus attracting and promoting the foreign R&D of MNEs. This relationship between the direct financial support for business R&D and the foreign R&D of MNEs may be thought of as direct – it is the availability of support itself that attracts the MNE.

The second explanation is derived from the positive relationship between patent applications to the European Patent Office and BERD from abroad. Such a positive association suggests that countries with greater innovative capacity are

more attractive for the hosting of MNEs' foreign R&D. This observation is notably consistent with literature highlighting the relevance of host country innovative capacity to the foreign R&D of MNEs (Siedschlag, et al., 2013; Crescenzi et al., 2014).

Innovation, as addressed, is a product of a host of inputs, one of which is knowledge generated through R&D (Griliches, 1979; Audretsch and Feldman, 2004). Logically, increased R&D can and should yield increases in innovation. Direct financial support for business R&D has the capacity to stimulate *total* R&D. The provision of direct financial support should then yield increases in innovative output and capacity. It may be then deduced that the relationship between the provision of direct financial support for business R&D and the foreign R&D of MNEs is an indirect one. That is, it may be the case that the provision of direct financial support for business R&D is stimulating economy-wide business R&D resulting in increases in innovative output and the upgrading of the overall innovative capacity of a country. It is the increased innovative capacity that enhances the overall attractiveness of a given location to the foreign R&D of MNEs. The relationship between direct financial support for business R&D and the foreign R&D of MNEs may be described in some respects as indirect because though it is the financial support that ultimately attracts or promotes the foreign R&D of MNEs, it is the innovative capacity (resulting from increased aggregate R&D yielding an increase in innovative output and activity) of a country that provides a more welcoming socioeconomic context for the performance of R&D.

The second research question sought to establish whether the attractive effect of the provision of direct financial support for business R&D is greater than that of indirectly provided financial support. The results of the estimations including both directly and indirectly provided financial support for business R&D suggest that while direct support for business R&D may have an attractive effect on the foreign R&D of MNEs, the same cannot be said for indirect financial support – the estimations provide no evidence of a statistically significant relationship between the B-index and BERD from abroad (*Table 2*). This result is consistent with the empirical investigation of 26 OECD countries performed by Thomson (2009).

The third and final research question asked if the observed relationship between the provision of direct financial support for business R&D and the foreign R&D of MNEs is conditioned by the context within which the financial support is provided. Five interaction terms were developed, each of which consisted of the measure of direct financial support for business and R&D and one of the five aforementioned ‘conditioning variables’, to empirically investigate this question.

The positive, statistically significant coefficient for the interaction term consisting of the measure of direct financial support for business R&D and GDP per capita provides perhaps the most poignant insight into the how and the extent to which the relationship between directly provided financial support for business R&D and the foreign R&D of MNEs is conditioned by contextual conditions. It indicates that the effect on the foreign R&D of MNEs of direct financial support for



business R&D is greater in more economically developed contexts (*Table 3*). The coefficient of the interaction term composed of the measure of direct financial support for business R&D and aggregate R&D expenditure was also positive and statistically significant indicating that this support has a greater pull in countries that invest more substantially in R&D, and therefore present MNEs with a larger, more comprehensive knowledge base from which they can garner benefit. The third positive, statistically significant interaction term consisting of the measure of direct financial support for business R&D and the ICRG quality of government index indicates that the attractive effect of direct financial support for business R&D on the foreign R&D of MNEs is greater in countries with a high quality of governance and by extension sound, well-functioning institutions.

The interaction terms consisting of the measure of direct financial support and Patent Applications to the European Patent Office and higher education R&D expenditure, respectively, were both positive, however, neither was statistically significant. As such, definitive conclusions cannot be inferred from either. That said, they do provide insights that are consistent with the coefficients of the other three interactions terms, as well as theoretical expectations.

Taken together, the interaction terms suggest that the relationship between the provision of direct financial support for business R&D and contextual conditions is one of complementarity. The attractive effect on MNEs' foreign R&D of direct financial support is greater in contexts that are more socio-economically and

institutionally conducive to the performance of knowledge intensive economic activity. This is entirely consistent with expectations. Financial support is understood to be a ‘final consideration’ in the location decision of MNEs’ foreign R&D (OECD, 2011). More importantly, however, support alone cannot compensate for contextual conditions that are not conducive to R&D or the absence of “economic fundamentals” (OECD, 2011). A suitable context is effectively a necessary prerequisite for R&D. This would imply that support is only effective where contextual conditions are adequate for MNEs’ to perform R&D. When a suitable socioeconomic and institutional context exists (itself likely fostered by development engendered by hosted R&D), the support may further enhance the attractiveness of the location, working synergistically with favourable contextual characteristics.

## ***7. Conclusions and policy implications***

This research has investigated the relationship between direct financial support for business R&D and the foreign R&D of MNEs in European countries in order to improve our understanding of the effectiveness of these policies for the attraction of foreign R&D.

Three related research questions were developed. The first centred on whether the provision of direct financial support for business R&D played a role in attracting the foreign R&D of MNEs. The second question asked whether the attractive effect on foreign R&D is greater for directly or indirectly provided support. The third and final question examined whether between direct financial

support and business R&D is 'conditioned' by the socioeconomic and institutional context within which the support is provided.

The results of the analyses indicate that there is a positive, statistically significant relationship between direct financial support for business R&D and the foreign R&D of MNEs. Hence, the provision of financial support has an attractive effect on the foreign R&D of MNEs. This effect, however, is fundamentally related to direct financial support, as the empirical analysis yielded no evidence to suggest that the provision of indirect financial support for business R&D attracts the foreign R&D of MNEs. With regards to the final research question, the coefficients of the five interaction terms developed to assess how the relationship between direct financial support for business R&D and the foreign R&D of MNEs is conditioned by contextual factors suggest that the provision of support may have a more profound attractive effect on the foreign R&D of MNEs in more developed contexts that are more suitable for the performance of knowledge-intensive, innovative activity.

In sum, the empirical evidence suggests the provision of direct financial support for business R&D can have a notable effect on the attraction of the foreign R&D of MNEs. The effect is seemingly greater in certain contexts suggesting that direct support works synergistically with more favourable host-country conditions.

The aforementioned conclusions point in the direction of various potential policy implications. The most immediate policy effect relates to the justification of

the use of public resources to support and lever off of business R&D more generally. Empirical studies show reason to think that direct support for business R&D may indeed be an effective means to stimulate total business R&D (*Section 2*). The relationship between direct support for business R&D and the foreign R&D of MNEs' observed in this research effectively adds an additional order of justification to the employment of direct support for business R&D. That is, the empirical evidence cautiously suggests that the provision of direct support for business R&D may attract the foreign R&D of MNEs, which literature indicates should at the very least be on the radar of policy makers. This second order of justification is quite important. The use of public resources to support any private activity may be, to put it lightly, contentious and subject to extensive and probing scrutiny (OECD, 2011).

It also may be concluded that policy makers in European countries – and perhaps also beyond them – would be remiss to not at the very least explore the provision of direct financial support for business R&D as a means to attract the foreign R&D activities of MNEs. That is, the results of the empirical analysis provide sufficient cause to suggest that direct financial support for business R&D has an attractive effect on the foreign R&D of MNEs that likely operates through two, possibly mutually reinforcing channels. This particular policy instrument may represent an efficient and effective way for governments and policy makers to entice MNEs to locate at least a portion of their higher-value adding activities in the jurisdictions for which they are responsible and eventually reap the economic growth- and development-related benefits associated with managing to do so.

Even more precisely, the results suggest that the attractive effect that the provision of direct financial support for business R&D has on the foreign R&D of MNEs is conditioned, at least to a degree by the contextual conditions in of the territory in which it is employed. The implications of this for policy makers are two-fold. First, this observation implies that direct financial support for business R&D should not be deployed without adequate consideration of context, or an evaluation of whether the returns to and outcomes of that use of public resources may be optimal in a given setting. Second, it implies that the provision of direct financial support for business R&D should be (appropriately) integrated into broader strategies to attract foreign knowledge intensive and innovative activities.

It would be reasonable in light of the finding that direct financial support instruments may be more effective in the attraction of foreign R&D in socioeconomic and institutional contexts that are *ex ante* more suitable for the performance of knowledge intensive activity, to suggest that financial support instruments should feature more prominently in the strategic approaches of more developed, innovative economies. That said, contextual conditions should not be neglected as they are, as addressed, effectively a prerequisite for the hosting of the foreign R&D of MNEs. Consequently, efforts to condition as well as upgrade the innovative environment should still be made.

In less developed, less innovative contexts on the other hand, the role for direct financial support for business R&D may be, or perhaps should be, much narrower in scope and more directly integrated into comprehensive development strategies. The inference that financial incentives cannot compensate for the absence of “economic fundamentals” would imply that policy makers in less favourable contexts would be better served by directing the bulk of their resources to efforts to address more fundamental, structural contextual conditions and cultivate an environment within which MNEs may operate efficiently and profitably. Once they have succeeded in creating a context that is capable of hosting, and attractive to, the knowledge intensive activities of MNEs, policy makers might then consider integrating direct financial support for business R&D into their strategies to increase the appeal of their respective countries to the foreign R&D activities of MNEs.

While our paper has provided what we consider to be interesting food for thought, there are still a number of limitations which have been exposed throughout this paper. Some avenues for further research may be derived from these limitations. The departure point for continued research would be the development of a larger, more complete, balanced data set. Doing so would present the opportunity to validate our conclusions. More advanced econometric techniques – dynamic modelling techniques, or instrumental variables, for example – should also be considered in an effort to better tease out causal relationships. The results of doing so could be usefully compared to the results of this empirical work.

Further research should also consider the use of disaggregated data. The measure of the provision of 'direct' financial support to private R&D employed is an aggregate statistic that includes a number of specific policy tools. Disaggregated statistics for 'direct' financial support to private R&D would afford the opportunity to observe the effects of more specific policy tools (i.e. the effect of a grant versus a loan). The employment of data disaggregated by sector or industry for the foreign R&D of MNEs would also add value to the literature as doing so would allow one to observe the relationships of interest across various sectors or industries.

## Appendix

**Table A1: Descriptive Statistics (Full Dataset)**

	Mean	Maximum	Minimum	Std. Deviation
BERD from Abroad (% of GDP)	0.0732	0.4398	0.00002	0.0811
Direct Support for Business R&D (% of GDP)	0.0632	0.4242	0.00005	0.0569
GDP per Capita	17280.3	77500.0	400.0	12328.6
HERD (% of GDP)	0.3356	0.9481	0.0146	0.1804
GERD (% of GDP)	0.8747	2.9674	0.0893	0.5907
Patent Applications to EPO (per mil. Inhabitants)	59.52	294.60	0.01	75.16
Quality of Government Index	0.7747	1.00	0.3889	0.1616

Years included: 1990-2012

Countries Included: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Turkey, United Kingdom

*Note:* Descriptive statistics include all years for all regions

**Table A2: Descriptive Statistics (Reduced Dataset with B-Index)**

	Mean	Maximum	Minimum	Std. Deviation
BERD from Abroad (% of GDP)	0.0770	0.2423	0.0017	0.0719
Direct Support for Business R&D (% of GDP)	0.0759	0.3185	0.0023	0.0511
Indirect Support for Business R&D ('B-index')	0.9622	1.0800	0.5700	0.1107

Years included: 1990-2006

Countries Included: Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, United Kingdom

*Note:* Descriptive statistics include all years for all regions



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