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ARTICLES

FIRM SIZE AND INNOVATIVE PERFORMANCE: A META-ANALYSIS ACROSS OF 25 YEARS OF EVIDENCE

*Federico Bachmann**, *Rodrigo Ezequiel Kataishi***

* Universidad Nacional de Mar del Plata, Mar del Plata, Buenos Aires, Argentina. E-mail: federico.bachmann@gmail.com

** Universidad Nacional de Tierra del Fuego, Ushuaia, Tierra del Fuego, Argentina. E-mail: rkataishi@gmail.com

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ABSTRACT

This study conducts a comprehensive meta-regression analysis to examine the relationship between firm size and innovative performance, utilizing 95 empirical studies published between 1993 and 2017. By incorporating 655 econometric estimations from these studies, we aim to identify key factors contributing to the heterogeneity observed in the empirical literature. Our findings confirm a positive average effect of firm size on innovative performance, reinforcing the theoretical expectation that larger firms tend to be more innovative due to economies of scale and greater resource availability. However, this relationship is moderated by various contextual and methodological factors that affect results, such as the measures used for firm size and innovation, the type of innovation considered (product or process), and the geographic context (developed or developing countries). This study contributes to the literature by presenting one of the most comprehensive meta-analyses on this topic to date, introducing new moderator variables, and offering deeper insights into the sources of heterogeneity. The results not only reinforce the most common hypotheses on the size-innovation relationship but also provide a nuanced understanding of the variations in empirical results. By highlighting the importance of measurement choices and firm characteristics in understanding the firm size–innovation nexus, this study offers valuable guidance for future research, enabling a more refined approach to investigating this complex relationship.

Keywords: Firm size; Innovation; Meta-regression analysis; R&D investment; Innovation measurement

1. Introduction

Innovation studies at the firm level have made significant strides in integrating the logics of technological change, competition, and industrial organization. Over the past several decades, a substantial body of empirical and theoretical research has contributed to this approach, resulting in a deeper understanding of the complexity of innovation. This understanding extends beyond individual firms to encompass sectoral and regional aggregated levels, providing a comprehensive perspective on innovation dynamics.

Empirical research on innovation has been strengthened through the widespread implementation of National Innovation Surveys since the early 1990s. These surveys have undergone continuous updates and improvements, incorporating insights from influential manuals such as the Frascati Manual (OECD, 1963), the Oslo Manual (OECD, 1992), and the Bogotá Manual (JARAMILLO; LUGONES; SALAZAR, 2001). These key contributions have facilitated the use of comparable evidence on industrial innovative activity, allowing for cross-temporal and cross-national analysis. The availability of such comprehensive data has greatly enhanced our understanding of innovation processes and outcomes across different industries and countries.

The literature recognizes that drivers that foster innovation, such as formal training, capital investments, and institutional collaborations, are critical for achieving innovative success (CASSIMAN; VEUGELERS, 2006). In spite of this, the evidence on the innovative performance (IP) of industrial firms remains varied, and the relationship between firm size and innovation is still a subject of extensive examination. Some studies support a positive relationship, emphasizing the advantages larger firms have in terms of resources and capabilities (GALBRAITH, 1952; MANSFIELD, 1963; SCHERER; ROSS, 1990; COHEN; LEVINTHAL, 1989). In contrast, others suggest a negative relationship, highlighting the agility and entrepreneurial spirit of smaller firms (ACS; AUDRETSCH, 1988; TEPLOV; ALBATS; PODMETINA, 2019; PARRILLI; BALAVAC; RADICIC, 2020).

This variability and heterogeneity regarding the relationship between innovative performance and firm size have been extensively highlighted in different works (BECHEIKH; LANDRY; AMARA, 2006; HALL; MAIRESSE, 2006; SANTOS *et al.*, 2015). However, academic consensus largely favors the idea of a positive relationship between IP and firm size, particularly in light of the role played by research and development (R&D), technological capacities, and learning efforts (COHEN, 2010; DAMANPOUR, 2010; KNOTT; VIEREGGER, 2020).

Empirical results can vary due to differences in data, measurement choices, or analytical methods. This paper introduces a Meta-Regression Analysis (MRA) approach to explain such phenomena, focusing on the evaluation of key empirical findings considering the specific features of each study. MRA is a quantitative method that synthesizes accumulated empirical evidence, such as regression model results or statistical data from existing academic literature (STANLEY; DOUCOULIAGOS, 2012; UGUR *et al.*, 2015). This method allows for the identification of patterns and the quantification of average effects while accounting for heterogeneity across studies.

In this study, we analyze 655 comparable econometric results found in 95 articles in the field of the economics of innovation, all published between 1993 and 2017. These studies, all built upon econometric evidence, provide various inquiries into the relationship between firm size and innovative performance.

The primary objective of this paper is to identify key factors contributing to the observed variability in empirical evidence regarding the relationship between innovative performance (IP) and firm size. Specifically, we aim to test two hypotheses: H1 posits that firm size is positively related to innovative performance due to economies of scale in R&D investment and greater resource availability. H2 suggests that the relationship between firm size and innovative performance is moderated by contextual and methodological factors, such as measurement choices, type of innovation, and geographic context, which contribute to the heterogeneity observed in empirical results. To test these hypotheses, we provide meta-regression estimations derived from existing research that analyzes how product and process innovations relate to firm size and other explanatory variables.

Our results confirm a positive and statistically significant relationship between firm size and innovative performance, in spite of the observed heterogeneity derived from the analyzed literature. We argue that this heterogeneity can be partially explained by firms' characteristics and empirical strategies developed by researchers, particularly in the way in which IP and size are measured (GRAZZI; PIETROBELLI, 2016; STANLEY; JARRELL, 2005; BACHMANN *et al.*, 2021).

This study contributes to the literature by providing a comprehensive meta-analysis of the relationship between firm size and innovative performance. By incorporating a broader range of studies and effect sizes, and by introducing new moderator variables, this research offers fresh insights into the complex dynamics of firm size and innovation. Our analysis not only consolidates existing findings but also illuminates potential avenues for future research in exploring the determinants of divergent results in this area of study.

The rest of the paper is organized as follows. Section 2 provides the theoretical framework for innovation and presents our hypotheses. Methodology is detailed in Section 3, including the data collection process and the meta-regression analysis approach. Section 4 presents a description of the data and econometric results. Finally, Section 5 discusses the implications, and Section 6 concludes.

2. Theoretical framework

Technological change has long been recognized as a crucial driver of economic development (YOUNG, 1928; SCHUMPETER, 1934, 1942; NELSON; WINTER, 1982). In this context, technology is seen as a result of accumulated knowledge that enhances efficiency in firms' activities (ANTONELLI; SCELLATO, 2013; MONTOBBIO; KATAISHI, 2014). Innovation, defined as the introduction of new products or processes, is expected to have positive impacts on competitive performance and productivity (MORRIS, 2018). Empirical evidence supports a clear relationship between technological progress and economic performance at the firm level (BOWEN; ROSTAMI; STEEL, 2010; ROSENBUSCH; BRINCKMANN; BAUSCH, 2011; ROUSSEAU *et al.*, 2016; SANTOS *et al.*, 2015), sectoral level (KATZ; STUMPO, 2001; LALL, 2000; MALERBA; ORSENIGO, 1997; MALERBA, 2003), and national level (LUNDVALL, 1992; MALERBA, 2003; CASSIOLATO *et al.*, 2013).

The theoretical foundation for understanding innovation at the firm level can be traced back to Schumpeter (1934, 1942), who emphasized the role of entrepreneurs and innovation as engines of economic growth. In his 1942 work, Schumpeter shifted the focus from individual entrepreneurs to R&D investments within corporations, highlighting how organized efforts in research and development drive technological advancements and economic progress. However, it is important to note that Schumpeter's influence primarily pertains to market structure and entrepreneurial roles in innovation, whereas the specific focus on firm size in innovation research was introduced by Galbraith (1952). This perspective underscores the importance of institutional structures and corporate strategies in fostering innovation. Galbraith (1952) further expanded this line of thought by highlighting the significance of firm size in innovation, arguing that larger firms possess advantages due to their ability to finance and manage large-scale R&D projects. According to this perspective, economies of scale in R&D and the capacity to absorb risks make large firms more innovative (MANSFIELD, 1963; SCHERER; ROSS, 1990).

This argument for a positive relationship between firm size and innovative performance is further elaborated through several theoretical considerations. Firstly, larger firms can spread the fixed costs of R&D over a greater output and have more diversified portfolios, allowing them to exploit economies of scale and scope in innovation activities (GALBRAITH, 1952; SCHERER; ROSS, 1990). Secondly, big firms possess greater financial resources, enabling them to invest more in R&D and innovation projects (COHEN; LEVINTHAL, 1989). Mediating factors such as organizational structure and decision-making processes also play a crucial role in determining how firm size impacts innovative performance. Larger firms may have more complex hierarchical structures, which can either facilitate or hinder innovation depending on the efficiency of their internal processes. Additionally, the technological life cycle of products can influence the innovation strategies of firms. In the early stages of a technology's development, smaller firms may lead with radical innovations, while larger firms might dominate in later stages with incremental improvements and scaling. The continuity or discontinuity of technical change also affects whether larger or smaller firms have the upper hand in driving innovation within different sectors.

Furthermore, larger firms have a higher probability of acquiring patents, absorbing smaller firms, and appropriating innovation rents, which enhances their innovative capabilities and market positioning (HALL; ZIEDONIS, 2001). The ability to attract and retain highly qualified human resources is another critical factor. Big firms often offer better compensation and possess stronger reputations, making them more attractive to top talent. The quality of human resources is strongly associated with the types of technologies and investments firms pursue, thereby reinforcing the link between firm size and innovation (CASSIOLATO; LASTRES, 2000; KATAISHI; BRIXNER, 2023). Moreover, large firms benefit from complementary assets, including sophisticated marketing channels, established customer bases, and extensive distribution networks, which facilitate the successful commercialization of new products and processes. The integration of complementary assets ensures that innovations are not only developed but also effectively brought to market, thereby maximizing their economic impact (TEECE, 1986). Additionally, sectoral and geographical factors further contextualize the relationship between firm size and innovative performance. In high-tech sectors, larger firms may have the resources to invest in cutting-edge technologies, whereas in traditional sectors, smaller firms might excel in niche innovations. Similarly, firms in developed countries may face different competitive and regulatory environments compared to those in developing countries, influencing their innovation capabilities and strategies. All of these factors contribute to larger firms having higher absorptive capacity, allowing them to recognize, assimilate, and apply external knowledge more effectively than smaller firms (COHEN; LEVINTHAL, 1989; ZAHRA; NIELSEN, 2002; AUDRETSCH; LEHMANN, 2005).

Building upon these theoretical foundations, empirical studies have found that firm size positively influences innovative performance, particularly when innovation is measured by inputs such as R&D expenditure or patents (CAMISÓN *et al.*, 2002; DAMANPOUR, 2010; KNOTT; VIEREGGER, 2020; BACHMANN; KATAISHI, 2020). This position is supported by a robust body of research that consistently demonstrates the advantages larger firms possess in fostering innovation through resource allocation, strategic investments, and capacity for knowledge absorption.

Contrarily, other theoretical perspectives argue for a negative relationship between firm size and innovative performance. Larger firms may suffer from bureaucratic rigidity, slowing decision-making processes and reducing flexibility, which can hinder innovation (ROTHWELL; ZEGVELD, 1982; CRETINI; ROBERT, 2022). In contrast, small and medium-sized enterprises (SMEs) may be more agile and responsive to market changes, allowing them to innovate more rapidly in niche markets (FORÉS; CAMISÓN, 2016). SMEs may favor radical innovation, while larger firms prioritize incremental improvements, with both firm types demonstrating a preference for knowledge at different stages of maturity (ACS; AUDRETSCH, 1988).

Additionally, evidence suggests that the link between firm size and innovation is more nuanced and context-specific than previously believed (LAFORET, 2013). This complexity is illustrated by a minority of findings indicating that in specific scenarios, smaller enterprises demonstrate higher rates of innovation, especially when measured by outcomes like the introduction of new products (ROTHWELL; ZEGVELD, 1982; ACS; AUDRETSCH, 1988;). It's worth noting, however, that these observations often pertain to specialized sectors and emerging technologies, rather than widely adopted innovations (NOTEBOOM, 1994).

Following this path, some studies suggest that the relationship between firm size and innovative performance is non-linear or moderated by other factors. Technological regimes, market structure, and competition can influence the incentives for firms of different sizes to innovate (DOSI, 1982; MALERBA; ORSENIGO, 1997; DAMANPOUR, 2010), while participation in networks, clusters, and alliances can affect innovation outcomes irrespective of firm size (DEBRESSON, 1989; KATAISHI; MORERO, 2020).

Firm size measurement can be operationalized using various indicators, including, but not limited to, the number of employees, sales revenue, and total assets. Each measure captures different aspects of firm size, potentially influencing its relationship with innovation. For instance, the number of employees often reflects the scale of operations and workforce size, while sales revenue typically indicates market size and financial capacity. Similarly, innovative performance is measured using diverse approaches, such as input and output indicators. Common innovation inputs include R&D expenditure and the number of R&D personnel, representing the financial and human capital devoted to innovation activities. Innovation outputs frequently encompass patents granted, new product introductions, and innovation sales, reflecting the tangible outcomes of innovation efforts. For example, R&D expenditure is often positively associated with firm size as larger firms can allocate more resources to extensive research and development initiatives. In contrast, patents and product innovation may exhibit a negative association with firm size in certain contexts, as smaller firms might be more agile in developing and commercializing innovative products due to their flexibility and focus on niche markets. These measurement choices may lead to varying results, as input measures tend to show stronger relationships with firm size due to larger firms' greater resources, while output measures might capture the effectiveness of innovation processes, potentially favoring smaller firms in some contexts (NOTEBOOM, 1994; MALERBA, 2003; BACHMANN; KATAISHI, 2020). It's important to note that these examples represent common approaches, but the range of measurement methods in the literature is extensive and evolving (BECHEIKH *et al.*, 2006; CRETINI; ROBERT, 2022).

Based on the theoretical perspectives discussed, we formulate two main hypotheses. The first hypothesis posits that firm size is positively related to innovative performance due to recurrently stressed explanatory factors, such as economies of scale in R&D investment, greater resource availability, enhanced ability to acquire patents, absorb smaller firms, appropriate innovation rents, and the capacity to attract and retain highly qualified human resources. The second hypothesis suggests that the relationship between firm size and innovative performance is moderated by contextual and methodological factors, including industry characteristics, technological regimes, market competition, measurement choices, and econometric specifications, thereby contributing to the heterogeneity observed in empirical studies. These hypotheses guide our meta-regression analysis, aiming to uncover the underlying factors that contribute to the variability in empirical findings regarding the firm size–innovation nexus.

3. Data and methods

MRA technique enables systematic summaries based on quantitative (econometric) empirical evidence (NELSON; KENNEDY, 2009). This method relies on statistical information provided by scientific sources (papers, books, working papers) looking for answers to three main questions: What is the average (or "genuine") effect size? Can we identify sources of heterogeneity beyond sample error in the evidence? Thus, the population is composed of papers that study IP-size relations making use of (one or several) econometric models from 1993 until 2017. To promote replicability, all analyses were conducted using the open-source programming language R (version 4.1). The code used for these analyses is publicly available, allowing researchers to reproduce our findings[1]. To achieve a representative sample, this research implemented a wide search followed by a data filter, excluding papers that didn't implement econometric exercises relating IP with firm size

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[1] BACHMANN and KATAISHI (2024)

(qualitative studies, inverse effect-size studies). Besides structural information (such as number of observations), the data also contains information regarding the IP-size estimator, standard errors, and other papers features, such as region, date, and other model specifications (DIMOS; PUGH, 2016; ROUSSEAU *et al.*, 2016). The analysis period from 1993 to 2017 was chosen to capture over two decades of empirical research on firm size and innovative performance, reflecting significant developments in innovation theory and econometric methodologies.

3.1 Meta-Regression Analysis

Meta-Regression Analysis (MRA) is a specialized technique that enables the scrutiny of statistically significant effect sizes, which are metrics that quantify the association between two variables and their distribution within a population (NELSON; KENNEDY, 2009). One of the key features of MRA is the use of Partial Correlation Coefficients (PCC). These are considered homogeneous effect sizes derived from primary regression coefficients. Importantly, PCCs lack a measurement unit, but they are valuable for indicating both the magnitude and direction of statistical associations (DIMOS; PUGH, 2016; STANLEY; DOUCOULIAGOS, 2012). The PCC and its standard error are mathematically defined as follows:

$$PCC = \frac{t}{\sqrt{t^2 + df}} \tag{1}$$

$$s.e.(PCC) = \sqrt{\frac{(1 - PCC)^2}{df}} \tag{2}$$

Where t is the statistical value of the significance test and df are the estimate's degrees of freedom (ALOE; THOMPSON, 2013; DIMOS; PUGH, 2016). PCCs are typically assumed to be unbiased and normally distributed, with mean β_0 and variance vi (VIECHTBAUER, 2010). As so, estimation of the average effect size is given by:

$$PCC_i = \beta_0 + e_i \quad i=1,\ldots,n \tag{3}$$

Here, PCC is the effect size on each paper *i,* β_0 is the average effect size and ei~$N(0; v_i)$ is the error term. This approach aggregates each result considered in the analysis, where every effect size refers to a single population parameter and is called homogeneous effect model[2]. If equation [3] is heteroscedastic, an error correction through Weighted Least Squares (WLS) is required. In this paper we use the inverse of PCC variance ($w_i=1/v_i$) as a weighing strategy, which gives higher relevance to regression estimates that show more precision (RICE; HIGGINS; LUMLEY, 2018).

Heterogeneity of effect sizes is measured by a Q test, which is essentially a chi-squared test with the null H_0: $PCC1=\ldots=PCCn$ (VIECHTBAUER, 2007). The rejection of the null hypothesis provides evidence of heterogeneity (that goes beyond sampling error). Homogeneous effect sizes rarely apply in social sciences, because effect sizes can usually differ from a single average result. In this case, the unobservable u_i is added to the model (HIGGINS; THOMPSON; SPIEGELHALTER, 2009; RHODES, 2012) to take that effect into account. Consequently, we get $PCC_i \sim 0(\beta 0; \tau^2+v_i)$ with τ^2 representing the variance between papers or its heterogeneity level. This leads to the heterogeneous effects model[3]:

$$PCC_i = \beta_i + e_i = \beta_0 + u_i + e_i \tag{4}$$

Where $u_i \sim N(0; \tau^2)$ and $e_i \sim N(0; v_i)$ are the additive error terms that assume $\mathrm{Cov}(e_i; u_i) = 0$. Since total variance is defined as τ^2+v_i, average effect estimation weighting stands as $w_i=1/(\tau^2+v_i)$.

Equations [3] and [4] are the simplest, univariate models in MRA. However, moderator variables (also called Z matrix) may be added to explain heterogeneity in the same fashion as conventional regression

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2 This model is referred to in the literature as fixed-effect-size (FES). In order to avoid further confusion this paper uses Rhodes' (2012) nomenclature which distinguishes between homogeneous and heterogeneous effect sizes.

3 This model is referred to in the literature as random-effect-size (RES).

analysis does (STANLEY; DOUCOULIAGOS, 2012). Taking that into account, Multivariate MRA model is defined as:

$$PCC_i = \beta_0 + \gamma_1 Z_{1i} + \ldots + \gamma_g Z_{gi} + u_i + e_i \quad g=1,\ldots,G \tag{5}$$

Usually, papers can report more than one effect size and may include different models and results. In this case, *PCCs* cannot be assumed as independent, because they can be correlated within each paper. Hence, data acquires a hierarchical or multilevel structure, with observed effects grouped into clusters representing each paper -and their multiple estimators- *(*NELSON; KENNEDY, 2009; STANLEY; DOUCOULIAGOS, 2012; VIECHTBAUER, 2007). Regression models that better reflect this structure allow the coefficients to vary randomly among clusters. Considering such effect, intra-study correlation leads to the following expression:

$$PCC_{ij} = \beta_0 + \gamma_1 Z_{1ij} + \ldots + \gamma_g Z_{gij} + u_j + e_{ij} \quad j=1,\ldots, J \tag{6}$$

Where *i is* the *i-th* effect in j-th cluster. Random intercept for each paper is given by $\beta_0 + u_{j.}$ Intra-paper effects are tested through the LM test under the null hypothesis that effect sizes are independent of each other (BALTAGI; LI, 1990).

The model displayed in [6] is analogous to those frequently used in unbalanced panel data structures analysis, where each paper is considered as an individual with several observations, in addition to an unobservable component u_i (STANLEY; DOUCOULIAGOS, 2017). If u_i and the explanatory variables are correlated, random effects coefficients will be biased and inconsistent. In this case, the unobservables are extracted from the error term through usual fixed effects panel estimation. Another option is to add an identification dummy for each cluster or paper (this approach is called least squares dummy variable - LSDV) in order to capture the unobservable effect. To decide whether fixed or random effects estimators are accurate, a traditional Hausman test (WOOLDRIDGE, 2002) can be applied to MRA results.

3.2 Sample and moderator variables

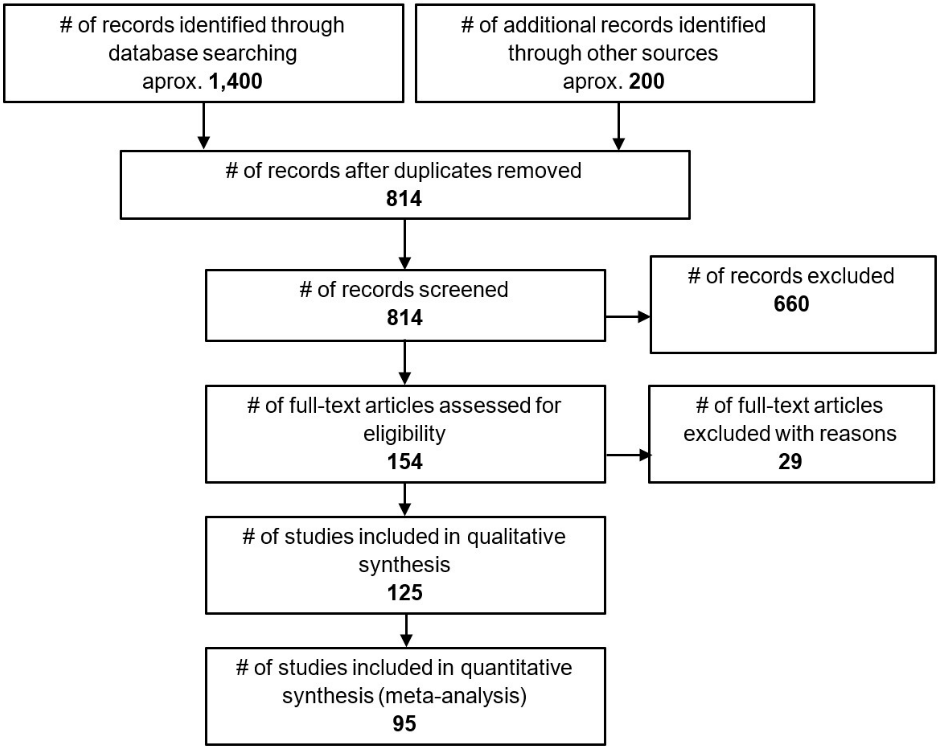
The target population consists of quantitative academic articles that investigate the sources of Innovative Performance (IP) at the firm level. Keywords and inclusion criteria were developed based on contributions from Becheikh, Landry and Amara (2006) and Cohen (2010). Consequently, the main sample includes 95 articles that meet the following criteria: i) are published between 1993 and 2017; ii) are written in English; iii) analyze the firm level; iv) are oriented towards the manufacturing sector; v) have econometric models that take into account IP; vi) consider IP as a dependent variable; vii) are related to technological innovation topics; viii) have a continuous operationalization of firm size; ix) are extracted from journals ranked in *Citescore*.

The empirical articles considered in the sample come from several sources: American Economic Association database (ECONLIT), JSTOR, SCOPUS, SSRN, SciELO, Bielefeld Academic Search Engine (BASE), and the specialized journal *Technovation*. Finally, Google Scholar was consulted to attend for geographical representativeness.

Figure 1 depicts the PRISMA flow diagram illustrating the identification phase of the study. From approximately 1,600 pieces of evidence, selection process ended up with 95 articles reporting a total of 655 econometric estimations[4]. The sample covers diverse countries, regions, sectors and econometric strategies. These features constitute the moderator variables utilized to carry out the multivariate MRA. Typically, moderators refer to geographical origin of data, (type and number of) variables included in the analysis and econometric specifications (STANLEY; DOUCOULIAGOS, 2012). Table 1 displays the variables explaining heterogeneity in current MRA. Moderator variables were selected based on their theoretical relevance to the firm size–innovation relationship, as they capture key contextual and methodological factors that could

[4] The list of articles together with key features is presented in the Annex.

FIGURE 1
PRISMA flow diagram.



Source: authors.

influence empirical findings. Table 1 displays the variables explaining heterogeneity in current MRA. The analysis period from 1993 to 2017 was selected to encompass over two decades of empirical research, capturing significant developments in innovation theory and econometric methodologies.

4. MRA results

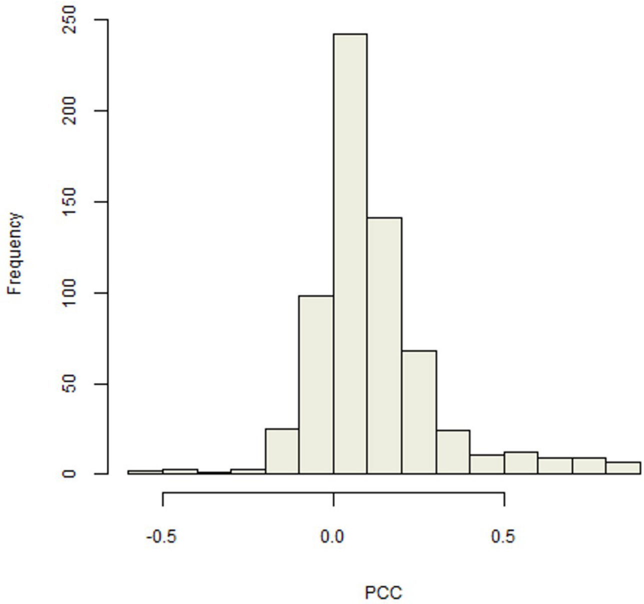
With respect to the MRA results, Figures 2 and 3 provide an initial overview of the data analysis. The PCC histogram in Figure 2 reveals both positive and negative effects, with positive effects being notably more prevalent, constituting approximately 77% of the sample. Figure 3

Table 1
Moderator variables

Variable	Operational definition	Mean (SE)
developed (*Z*)	Dummy: 1 for developed countries' data.	0.81 (0.38)
cross_section (*Z* or *K*)	Dummy: 1 if data is cross sectional, 0 if panel.	0.51 (0.50)
innovative_firms (*Z*)	Dummy: 1 if firms are exclusively innovative.	0.26 (0.44)
prod_proc (*Z* or *K*)	Dummy: 1 for product and process innovation.	0.65 (0.47)
product (*Z* or *K*)	Dummy: 1 for product innovation only.	0.23 (0.42)
process (*Z* or *K*)	Dummy: 1 for process innovation only.	0.11 (0.31)
IP_innov (*Z* or *K*)	Dummy: 1 if IP is measured as "the firm innovates or not".	0.38 (0.48)
IP_invest (*Z* or *K*)	Dummy: 1 if IP is measured as "the firm invests or not".	0.05 (0.23)
IP_patent (*Z* or *K*)	Dummy: 1 if IP is measured by # of patents.	0.27 (0.44)
IP_budget (*Z* or *K*)	Dummy: 1 if IP is measured by R&D budget.	0.18 (0.39)
IP_sales (*Z* or *K*)	Dummy: 1 if IP is measured by innovative sales.	0.09 (0.29)
industry_control (*Z* or *K*)	Dummy: 1 if sectoral controls are included.	0.18 (0.38)
one_sector (*Z* or *K*)	Dummy: 1 for one-sector studies.	0.67 (0.46)
no_control (*Z* or *K*)	Dummy: 1 if sectoral controls are not included.	0.14 (0.35)
size (*K*)	Dummy: 1 if sales, 0 if employees.	0.25 (0.43)
control (*K*)	Dummy: 1 if size is control, 0 if independent variable.	0.60 (0.49)
v_i	PCC_i variance	0.002 (0.006)
ID_Article	*j=1,…,95*	--

displays a funnel plot that shows a quasi-symmetrical distribution. Similarly, positive effects dominate and become more precise as they increase, clustering toward the positive side of the axis. In contrast, negative effects are less precise in general, and display greater variability, which can be theoretically explained by the differing mechanisms through which firm size impacts innovation, as larger firms benefit from economies of scale while smaller firms may exhibit greater agility (GALBRAITH, 1952; ROTHWELL; ZEGVELD, 1982).

FIGURE 2
PCC histogram.

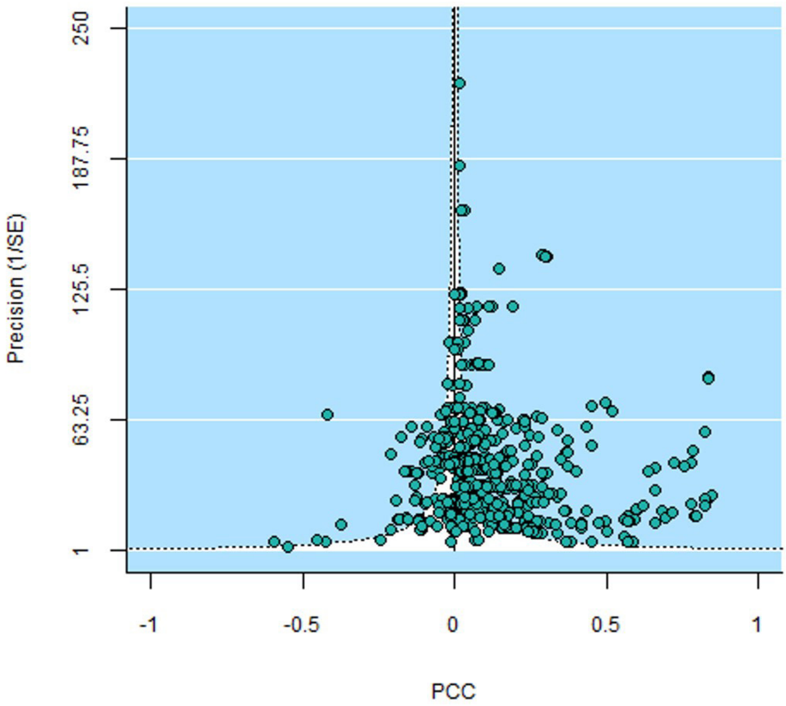


Source: authors.

The MRA conducted in this study utilizes five different econometric models. In our univariate meta-regression analysis (MRA), several key observations are made. First, there is a positive average effect on firm size and Innovative Performance (IP), aligning with previous meta-analyses such as those by Camisón et al. (2002) and Damanpour (2010). This supports the theoretical perspective that larger firms can leverage their resources to drive innovation (Galbraith, 1952; Mansfield, 1963). Second, the Partial Correlation Coefficient (PCC) is notably centered around a value of 0.13. Lastly, there is evidence of heterogeneity that goes beyond sample error, as demonstrated by the p-value of the Q test being less than 0.01 in every case. This heterogeneity underscores the importance of contextual and methodological factors in shaping the relationship between firm size and innovation, as posited in our theoretical framework.

Table 2 presents the estimations for both homogeneous (models 1 and 3) and heterogeneous size effects, using both random (model 4)

FIGURE 3
PCC funnel plot.



Source: authors.

and fixed cluster effects (model 5). The LM test indicates cluster effects within papers, which are correlated with variance as per the Hausman test. Therefore, our conclusions are primarily based on model 5 (FE-LSDV). While the FE-LSDV model accounts for 72% of the observed variability, its R^2 value is not sufficiently high for a direct comparison with random effects models. As Verbeek (2004) notes, fixed effects models or LSDV typically have higher R^2 values due to the inclusion of dummy variables. This highlights the complexity of modeling the firm size–innovation relationship, where accounting for unobserved heterogeneity is crucial for accurate effect estimation.

Table 3 shows the multivariate MRA results for LSDV and WLS models. In these models, the intercept is not the average effect but represents the value of PCC when all explanatory variables are set to zero. Consistent with our theoretical framework, the sources of heterogeneity

TABLE 2
Univariate MRA

	1	2	3	4	5
	FES (no cluster effect)	**RES (no cluster effect)**	**FES (Pooled OLS)**	**RES (random effects)**	**RES (FE-LSDV)**
Intercept	0.101 (0.002)***	0.11 (0.023)***	0.079 (0.006)***	0.121 (0.017)***	0.13 (0.071)*
Variance (v_i)	-0.98 (2.386)	-5.293 (6.153)	-14.962 (6.751)**	-3.395 (2.264)	-4.804 (2.437)**
n	95	95	655	655	655
Heterogeneity Q test	P-val<0.0001	P-val<0.0001	P-val<0.0001	P-val<0.0001	P-val<0.0001
Asymmetry test (v_i)	z=-0.41 P-val=0.68	z=-0.86 P-val=0.389	t=2.216 P-val=0.027	z=-1.498 P-val=0.133	t=-1.971 P-val=0.049
LM test (cluster effect)	--	--	--	χ^2=360.95. (df=1). P-val<0.001	
Hausman test	--	--	--	χ^2=2.927. (df=1). P-val=0.087	

***0, **0.01, *0.05, Source: authors.

include methodological dimensions (such as data structure, variable operationalization, and industry controls) and firm characteristics (like country development status, technological trajectory, and type of innovation). This aligns with previous findings (CAMISÓN *et al.*, 2002; DAMANPOUR, 2010), suggesting that these factors play a significant role in moderating the firm size–innovation relationship.

When it comes to the characteristics of firms or the data used in the studies, the geographic origin of the firms in the samples introduces a level of variation. Specifically, studies that use data from developed countries tend to show a more pronounced effect of firm size on Innovative Performance (IP) compared to studies that use data from other countries. This can be explained by the fact that developed countries have stronger statistical systems, which provide not only more accurate evidence but also allow for the inclusion of more variables in the models. Additionally, the availability of panel data is determinant. Consistently, cross-sectional evidence (typically

TABLE 3
Multivariate MRA

	Heterogeneous effects (LSDV)	Heterogeneous effects (random effects)
intercept	0.046 (0.155)	0.068 (0.053)
developed	0.177 (0.086)**	-0.015 (0.042)
cross_section	-0.123 (0.053)**	-0.057 (0.028)**
innovative_firms	-0.045 (0.023)*	-0.013 (0.02)
product	0.042 (0.025)*	-0.007 (0.021)
process	0.045 (0.026)*	-0.002 (0.024)
IP_invest	0.102 (0.025)***	0.067 (0.024)***
IP_budget	0.178 (0.029)***	0.11 (0.026)***
IP_patents	0.114 (0.035)***	0.101 (0.03)***
IP_sales	0.037 (0.029)	-0.02 (0.026)
industry_control	0.087 (0.033)**	0.058 (0.028)**
one_sector	-0.125 (0.162)	0.108 (0.053)**
size	0.098 (0.028)***	0.092 (0.024)***
control	-0.031 (0.087)	-0.014 (0.031)
size*vi	-6.893 (6.581)	-8.623 (5.619)
control*vi	-23.881 (8.247)***	-14.651 (7.181)**
variance (v_i)	4.765 (5.829)	3.881 (5.104)
n	650	650
Heterogeneity Q test	P-val<0.0001	P-val<0.0001
LM test (cluster effect)	χ^2=31.171 (df=1). P-val<0.001	χ^2=771.92 (df=1). P-val<0.001
Hausman test	χ^2=67.849 (df=16). P-val<0.001	

***0, **0.01, *0.05, Source: authors.

found in studies from developing countries) shows a weaker link between firm size and IP. The use of panel data structures allows for the tracking of cumulative effects over time, capturing the development of a firm's capabilities along an evolutionary path (DIMOS; PUGH, 2016; NELSON; WINTER, 1982). This issue is an important source of heterogeneity in several MRA studies and applications (FELD; HECKEMEYER, 2011; Havránková, 2015). The observed variation underscores the importance of considering both methodological and contextual moderators in understanding the firm size–innovation relationship. This aligns with our theoretical framework, which posits that factors such as data structure and geographical context significantly influence empirical findings.

5. Implications

Evidence indicates that among innovative firms, the effect size related to firm size is weaker. While firm size is crucial for distinguishing between innovators and non-innovators, this distinction becomes less pronounced when comparing firms that have already engaged in innovation and meet a minimum threshold of capabilities. In this context, a firm's prior trajectory serves as a moderating factor. A company's innovation history significantly shapes how its size impacts innovative performance, emphasizing the critical role of accumulated capabilities and established routines. The persistence observed in innovative processes, which enhances technological capabilities and consequently improves innovative performance, underscores this point (HALL; MAIRESSE, 2006). These findings highlight the significance of multiple virtuous cycles linking innovation to better performance, and then back to further innovation (BOWEN *et al.*, 2010; KNOTT; VIEREGGER, 2020). As organizations incorporate innovative practices into their operations, the impact of firm size on innovation performance generally diminishes (UGUR *et al.*, 2015). This phenomenon underscores how internal processes and continuous innovation practices can outweigh the impact of firm size in sustaining innovative performance.

Although the distinction between product and process innovation in studies helps explain observed differences, its significance is moderate. For both process and product innovation, larger firms typically show higher innovative performance. However, research suggests that product innovation may have stronger effects in Small and Medium-sized Enterprises (SMEs), even though they innovate less often. This shows that while larger firms have more resources for innovation, SMEs can achieve important innovations through flexibility and focus on specific markets. Effect sizes increase when product and process innovation are analyzed separately. This finding partly supports discussions in the conceptual review about the interconnected relationships between product development, firm size, and overall firm performance. It also shows the importance of looking at different types of innovation separately when studying how firm size relates to innovation, as each type may interact differently with company characteristics.

Another key feature that affects results is how IP is measured in each study. Effect sizes show higher values when innovation is measured through inputs (investment, R&D budget, and patents) in contrast to considering it as an output (product innovation or sales derived from innovation). Despite arguments regarding big firms' financial advantages to innovate (CAMISÓN *et al.*, 2002; COHEN, 2010), when innovation is considered as an output, weaker effects are obtained, suggesting that capabilities are critical to innovative performance (NELSON; WINTER, 1982; COHEN; LEVINTHAL, 1989). This result complements previous findings, showing that once innovative processes are ongoing, size is not as relevant to achieving economic profit, but its relevance is critical to capabilities construction and accumulation (DAMANPOUR, 2010).

Technological differences across industries are also key moderators in this relationship. The meta-regression analysis reveals that the inclusion of sectoral controls leads to stronger correlations between firm size and IP. These results hold for studies including only one or multiple sectors. Methodological influences, such as firm size measurements and control variables in each study, are considered both as main effects and interaction effects within our models. These two groups of variables are able to partially explain the correlation between PCC and its variance, indicating that both contextual and methodological factors contribute to the observed heterogeneity in the firm size–innovation relationship.

With respect to the firm size effect, results show a positive coefficient that links IP and size, especially when the former is measured with financial indicators. In other words, results support that financial capabilities are related to process innovation in big firms (DAMANPOUR, 2010; GRAZZI; PIETROBELLI, 2016). This type of measurement accurately captures firms' economic constraints and, therefore, the financial advantages of large enterprises. Interaction between sales and variance is not statistically significant, which implies that this metric does not lead to more precision in the effects analyzed.

Lastly, when firm size is included as a control variable, it does not constitute a source of heterogeneity. Nevertheless, negative coefficients on the interaction between control variables and their variance imply that stronger size effects are more precise within estimations that include size as a control. A possible explanation for this may lie in the characteristics of this group of models, which are related to panel data and larger samples.

Two key findings emerge from the multivariate Meta-Regression Analysis (MRA). First, it confirms the existence of a positive size effect on average, strongly supporting H1. This reinforces the long-standing notion that larger firms generally demonstrate higher innovative performance. Secondly, the analysis reveals that heterogeneity in this relationship is significantly explained by both contextual features and methodological influences, robustly supporting H2. This underscores the complexity of the firm size-innovation relationship, highlighting that it's not a simple, uniform correlation but one that varies depending on industry context, measurement methods, and other factors. These results not only validate our hypotheses but also provide a nuanced understanding of how firm size interacts with innovation across different settings. They emphasize the need for a multifaceted approach when examining this relationship, considering both the overarching trend and the specific contexts that can modify it. This comprehensive view offers valuable insights for both researchers designing future studies and practitioners seeking to understand and leverage the relationship between firm size and innovative performance in various business environments.

Altogether, econometric estimations seem to indicate that the average effect is based upon a direct relationship between size and innovative efforts. Bigger firms possess larger resources to invest, providing them with more opportunities to successfully achieve innovations. Nevertheless, there is a gap between technological improvements and their introduction into the market, which defines a successful innovation. For smaller firms, capabilities are achieved partly through transitioning along an innovative path that allows them to embody innovative routines, thereby enhancing their innovation drivers. This highlights the importance of internal capabilities and innovation processes in sustaining innovative performance beyond mere size advantages.

6. Conclusions

The presented meta-analysis, encompassing 95 empirical studies from 1993 to 2017, offers a comprehensive examination of the relationship between firm size and innovative performance. Our findings corroborate the prevailing academic consensus, confirming a positive average effect size that underscores the robustness of the link between organizational scale and innovation capacity. However, this relationship is not monolithic and varies depending on different contextual factors and methodological approaches, highlighting the need for a deeper theoretical understanding of the underlying mechanisms.

Our results reveal that the strength of the size-innovation relationship is moderated by a range of variables, including the geographic context of firms (developed versus developing countries), industry sectors, and the specific types of innovation under scrutiny (product versus process). Notably, the operationalization of both firm size and innovative performance emerges as a critical factor in explaining the observed heterogeneity in effect sizes. Input-based measures of innovation, such as R&D expenditure and patent applications, demonstrate stronger correlations with firm size compared to output-based metrics like new product introductions or innovation-derived sales. This distinction underlines the direct link between organizational scale and the capacity to invest in innovation, while simultaneously highlights the complex nature of translating these investments into market-ready innovations, as supported by resource-based and absorptive capacity theories.

The analysis further reveals a non-linear aspect to the size-innovation relationship. Among firms already engaged in innovative activities, the effect of size diminishes, suggesting that the accumulation of innovation capabilities and the integration of innovative routines into standard operations play a more significant role than mere organizational scale. This finding emphasizes the importance of path dependency and learning processes in shaping a firm's innovative trajectory, aligning with theories that stress the role of dynamic capabilities in sustaining innovation over time.

Methodological considerations, including data structure (panel versus cross-sectional) and the inclusion of sectoral controls, significantly influence the observed relationships. These findings underscore the critical importance of research design in studies examining the firm size-innovation nexus and call for careful consideration of methodological choices in future investigations. Theoretical models that account for these methodological variations are essential to fully capture the dynamic nature of the size-innovation relationship.

While larger firms generally demonstrate higher innovative performance, our analysis also highlights the significant innovation potential of Small and Medium-sized Enterprises (SMEs), particularly in product innovation and niche market contexts. This nuanced understanding challenges simplistic notions of size advantage and points to the complex interplay between organizational scale, market positioning, and innovation strategies. It suggests that SMEs may leverage their agility and specialized focus to achieve significant innovations despite limited resources, thus contributing to a more balanced theoretical perspective on firm size and innovation.

The study's findings have important implications for both theory and practice. They suggest that while firm size remains a significant factor in innovative performance, its impact is moderated by a complex interplay of internal capabilities, external context, and methodological considerations. From a theoretical standpoint, this underscores the necessity of integrating multiple theoretical lenses, such as the resource-based view and institutional theory, to understand the multifaceted nature of innovation dynamics. For policymakers and practitioners, this implies that fostering innovation requires a multifaceted approach that goes beyond simple size-based considerations. Policies aimed at enhancing innovation should consider firm-specific capabilities, industry characteristics, and the broader economic context to effectively support both large and small firms.

Several limitations of this study warrant mention and provide directions for future research. First, the analysis period (1993-2017) may not capture the most recent developments in innovation dynamics, particularly in rapidly evolving fields such as digital transformation and open innovation. Future studies should explore more recent data to address this limitation. Second, the predominance of quantitative studies in our sample may overlook valuable insights from qualitative research. Integrating mixed-method approaches in future meta-analyses could provide a more holistic understanding of the size-innovation relationship. Additionally, incorporating theoretical frameworks into meta-regression models could enhance the explanatory power of the analysis and bridge the gap between empirical findings and theoretical propositions.

Additionally, the relative scarcity of data from developing countries in our sample limits the generalizability of our findings across diverse economic contexts. Future research should prioritize the inclusion of studies from a broader range of geographical and economic settings to enhance our understanding of how the size-innovation relationship manifests across different developmental contexts. This would contribute to a more inclusive and globally relevant theoretical framework that accounts for diverse economic environments.

This meta-analysis provides a comprehensive overview of the relationship between firm size and innovative performance. While confirming the general positive association, it highlights the complex, context-dependent nature of this relationship. The study emphasizes the need for future research to adopt more sophisticated, multidimensional approaches to capturing both firm size and innovative performance. Moreover, it calls for greater attention to the mediating factors and organizational processes that link size to innovation outcomes, thereby advancing theoretical understanding beyond empirical regularities. As the landscape of innovation theory and practice continues to evolve, ongoing research in this field remains crucial for advancing our understanding of the drivers of innovation in organizations of all sizes.

References

ACS, Z. J.; AUDRETSCH, D. B. Innovation and firm size in manufacturing. *Technovation*, Oxford, v. 7, n. 3, p. 197-210, 1988.

ALOE, A. M.; THOMPSON, C. G. The synthesis of partial effect sizes. *Journal of the Society for Social Work and Research*, Washington, v. 4, n. 4, p. 390-405, 2013.

ANTONELLI, C.; SCELLATO, G. Complexity and technological change: knowledge interactions and firm level total factor productivity. *Journal of Evolutionary Economics*, Heidelberg, v. 23, p. 77-96, 2013.

AUDRETSCH, D. B.; LEHMANN, E. E. Does the knowledge spillover theory of entrepreneurship hold for regions? *Research Policy*, Amsterdam, v. 34, n. 8, p. 1191-1202, 2005.

BACHMANN, F.; KATAISHI, R. *El análisis de meta regresión (AMR) aplicado a la relación entre desempeño innovador y tamaño de la firma:* Un abordaje epistemológico sobre nuevas metodologías en economía. Madrid: Asociación Civil Red Pymes Mercosur, 2020.

BACHMANN, F.; KATAISHI, R. *MRA innovation size Bachmann Kataishi 2024 RBI public script Source Code*. 2024. Available from: <https://github.com/rkataishi/codeanddata/blob/main/MRAinnovationsizeBachmannKataishi2024RBIpublicscript.R>. Access in: 11 Oct 2023.

BACHMANN, F.; LISERAS, N.; GRAÑA, F. M. Desempeño innovador y tamaño de la firma: heterogeneidad y sesgo de publicación abordados desde un análisis de meta-regresión. *Innovar,* Bogotá, v. 31, n. 81, p. 75-99, 2021.

BALTAGI, B. H.; LI, Q. A Lagrange multiplier test for the error components model with incomplete panels. *Econometric Reviews,* New York, v. 9, n. 1, p. 103-107, 1990.

BECHEIKH, N.; LANDRY, R.; AMARA, N. Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993–2003. *Technovation*, Oxford, v. 26, n. 5–6, p. 644-664, 2006.

BOWEN, F. E.; ROSTAMI, M.; STEEL, P. Timing is everything: A meta-analysis of the relationships between organizational performance and innovation. *Journal of Business Research*, New York v. 63, n. 11, p. 1179-1185, 2010.

CAMISÓN, C. et al. *Meta-análisis de la relación entre tamaño de empresa e innovación*. Castellón: Instituto Valenciano de Investigaciones Económicas, 2002.

CASSIMAN, B.; VEUGELERS, R. In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science*, Hanover, v. 52, n. 1, p. 68-82, 2006.

CASSIOLATO, J. E. et al. FDI and national systems of innovation: lessons from the experience of BRICS. In: CASSIOLATO, J. *et al. (Org.). Transnational corporations and local innovation*. India: Routledge, 2013. p. 67. http://doi.org/10.4324/9780367818562

CASSIOLATO, J. E.; LASTRES, H. M. M. Local systems of innovation in Mercosur countries. *Industry and Innovation*, London, v. 7, n. 1, p. 33-53, 2000.

COHEN, W. M. Fifty years of empirical studies of innovative activity and performance. In: HALL, B.H; ROSENBERG, N. (Ed.). *Handbook of the Economics of Innovation*. Berkeley: Elsevier, 2010. p. 129-213. http://doi.org/10.1016/S0169-7218(10)01004-X.

COHEN, W. M.; LEVINTHAL, D. A. Innovation and learning: the two faces of R & D. *Economic Journal*, London, v. 99, n. 397, p. 569-596, 1989. http://doi.org/10.2307/2233763.

CRETINI, I. O.; ROBERT, V. Firm size, foreign capital and modes of innovation: an analysis of manufacturing firms in Argentina. *Revista Brasileira de Inovação*, São Paulo, v. 21, p. e022006, 2022.

DAMANPOUR, F. An integration of research findings of effects of firm size and market competition on product and process innovations. *British Journal of Management*, Oxford, v. 21, n. 4, p. 996-1010, 2010.

DEBRESSON, C. Breeding innovation clusters: a source of dynamic development. *World Development*, Oxford, v. 17, n. 1, p. 1-16, 1989.

DIMOS, C.; PUGH, G. The effectiveness of R&D subsidies: a meta-regression analysis of the evaluation literature. *Research Policy, Amsterdam*, v. 45, n. 4, p. 797-815, 2016.

DOSI, G. Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. *Research Policy, Amsterdam*, v. 11, n. 3, p. 147-162, 1982. http://doi.org/10.1016/0048-7333(82)90016-6.

FELD, L. P.; HECKEMEYER, J. H. FDI and taxation: a meta-study. *Journal of Economic Surveys*, Oxford, v. 25, n. 2, p. 233-272, 2011.

FORÉS, B.; CAMISÓN, C. Does incremental and radical innovation performance depend on different types of knowledge accumulation capabilities and organizational size? *Journal of Business Research*, New York, v. 69, n. 2, p. 831-848, 2016.

GALBRAITH, J. K. *American Capitalism: the concept of countervailing power*. New York: Houghton Mifflin, 1952.

GRAZZI, M.; PIETROBELLI, C. *Firm innovation and productivity in Latin America and the Caribbean: the engine of economic development.* Washington, DC: Springer, 2016.

HALL, B. H.; MAIRESSE, J. Empirical studies of innovation in the knowledge-driven economy. *Economics of Innovation and New Technology,* Abingdon, v. 15, n. 4–5, p. 289-299, 2006.

HALL, B. H.; ZIEDONIS, R. H. The patent paradox revisited: an empirical study of patenting in the US semiconductor industry, 1979-1995. *Rand Journal of Economics*, Santa Monica, v. 32, p. 101-128, 2001.

HAVRÁNKOVÁ, Z. *Six essays on meta-regression analysis*. 2015. Dissertation (Doctoral) - Charles University in Prague, Prague, 2015.

HIGGINS, J. P. T.; THOMPSON, S. G.; SPIEGELHALTER, D. J. A re-evaluation of random-effects meta-analysis. *Journal of the Royal Statistical Society. Series A, (Statistics in Society)*, London, v. 172, n. 1, p. 137-159, 2009.

JARAMILLO, H.; LUGONES, G.; SALAZAR, M. *Normalización de Indicadores de Innovación Tecnológica en América Latina y el Caribe:* Manual de Bogotá. Bogotá: Colciencias, 2001.

KATAISHI, R.; BRIXNER, C. Entre lo exógeno y lo exótico: las periferias, los supuestos económicos sobre Ciencia, Tecnología e Innovación y sus implicancias para el desarrollo tecno-productivo. *Ensayos de Economía*, Bogotá, v. 33, n. 62, p. 77-99, 2023.

KATAISHI, R.; MORERO, H. Taxonomies, technological opportunities, and global value chains in developing countries: a literature review and a conceptual approach proposal. *Investigación y Desarrollo*, Buenos Aires, v. 28, n. 2, p. 168-220, 2020.

KATZ, J.; STUMPO, G. Regímenes competitivos sectoriales, productividad y competitividad internacional. *Revista de la CEPAL*, Santiago, v. 75, p. 137-158, 2001.

KNOTT, A. M.; VIEREGGER, C. Reconciling the firm size and innovation puzzle. *Organization Science*, Maryland, v. 31, n. 2, p. 477-488, 2020.

LAFORET, S. Organizational innovation outcomes in SMEs: effects of age, size, and sector. *Journal of World Business*, Amsterdã, v. 48, n. 4, p. 490-502, 2013.

LALL, S. The Technological structure and performance of developing country manufactured exports, 1985-98. *Oxford Development Studies*, Oxford, v. 28, n. 3, p. 337-369, 2000.

LUNDVALL, B. A. *National systems of innovation:* towards a theory of innovation and interactive learning. London: Pinter, 1992. vol. 242.

MALERBA, F. Sectoral systems and innovation and technology policy. *Revista Brasileira de Inovação*, Campinas, v. 2, n. 2, p. 329-375, 2003.

MALERBA, F.; ORSENIGO, L. Technological regimes and sectoral patterns of innovative activities. *Industrial and Corporate Change*, Oxford, v. 6, n. 1, p. 83-118, 1997.

MANSFIELD, E. Size of firm, market structure, and innovation. *Journal of Political Economy*, Chicago, v. 71, n. 6, p. 556-576, 1963.

MONTOBBIO, F.; KATAISHI, R. The international dissemination of technological knowledge. In: ANTONELLI C.; LINK A.N. (Eds.). *Routledge handbook of the economics of knowledge*. London: Taylor & Francis, 2014. p. 165-189

MORRIS, D. M. Innovation and productivity among heterogeneous firms. *Research Policy*, Amsterdã, v. 47, n. 10, p. 1918-1932, 2018.

NELSON, J. P.; KENNEDY, P. E. The use (and abuse) of meta-analysis in environmental and natural resource economics: An assessment. *Environmental and Resource Economics*, Amsterdã, v. 42, n. 3, p. 345-377, 2009.

NELSON, R. R.; WINTER, S. G. *An evolutionary theory of economic change*. Cambridge: Harvard University Press, 1982.

NOTEBOOM, B. Innovation and diffusion in small firms: theory and evidence. *Small Business Economics*, Dordrecht, v. 6, p. 327-347, 1994.

OECD. *Frascati Manual:* the measurement of scientific and technical activities. Paris: OECD, 1963.

OECD. *Oslo Manual:* proposed guidelines for collecting and interpreting technological innovation data. Paris: OECD, 1992.

PARRILLI, M. D.; BALAVAC, M.; RADICIC, D. Business innovation modes and their impact on innovation outputs: Regional variations and the nature of innovation across EU regions. *Research Policy,* Amsterdã, v. 49, n. 8, p. 104047, 2020.

RHODES, W. Meta-analysis: an introduction using regression models. *Evaluation Review,* Los Angeles, v. 36, n. 1, p. 24-71, 2012.

RICE, K.; HIGGINS, J. P. T.; LUMLEY, T. A re-evaluation of fixed effect(s) meta-analysis. *Journal of the Royal Statistical Society. Series A, (Statistics in Society),* London, v. 181, n. 1, p. 205-227, 2018.

ROSENBUSCH, N.; BRINCKMANN, J.; BAUSCH, A. Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs. *Journal of Business Venturing,* v. 26, n. 4, p. 441-457, 2011.

ROTHWELL, R.; ZEGVELD, W. *Innovation and the small and medium sized firm:* University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship. Lincoln, United Kingdom: Frances Pinter Publishers, 1982.

ROUSSEAU, M. B. et al. Innovation, firm performance, and appropriation: A meta-analysis. *International Journal of Innovation Management,* Singapore, v. 20, n. 03, p. 1650033, 2016.

SANTOS, J. H. D. A. et al. Searching for a path: A bibliometric study on innovation and technological capabilities. *International Journal of Innovation*, London, v. 3, n. 2, p. 54-66, 2015.

SCHERER, F. M.; ROSS, D. *Industrial market structure and economic performance (3rd ed.).* Boston: Houghton Mifflin, 1990.

SCHUMPETER, J. A. *Capitalism, socialism and democracy.* New York: Harper & Brothers, 1942.

SCHUMPETER, J. A. *The theory of economic development.* Cambridge: Harvard University Press, 1934.

STANLEY, T. D.; DOUCOULIAGOS, H. *Meta-regression analysis in economics and business.* New York: Routledge, 2012.

STANLEY, T. D.; DOUCOULIAGOS, H. Neither fixed nor random: weighted least squares meta-regression. *Research Synthesis Methods,* Hoboken, v. 8, n. 1, p. 19-42, 2017.

STANLEY, T. D.; JARRELL, S. B. Meta-regression analysis: a quantitative method of literature surveys. *Journal of Economic Surveys*, Oxford, v. 19, n. 3, p. 299-308, 2005. http://doi.org/10.1111/j.0950-0804.2005.00249.x.

TEECE, D. J. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy,* Amsterdam, v. 15, n. 6, p. 285-305, 1986.

TEPLOV, R.; ALBATS, E.; PODMETINA, D. What does open innovation mean? Business versus academic perceptions. *International Journal of Innovation Management,* Singapore, v. 23, n. 01, p. 1950002, 2019.

UGUR, M. et al. R&D and productivity in OECD firms and industries: a hierarchical meta-regression analysis. *Research Policy,* Amsterdam, v. 45, n. 10, p. 2069-2086, 2015.

VERBEEK, H. M. W. *Verification of WF-nets.* 2004. Thesis (Phd) - Industrial Engineering and Innovation Sciences. Technische Universiteit Eindhoven, Eindhoven, 2004.

VIECHTBAUER, W. Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software,* San Francisco, v. 36, n. 3, p. 1-48, 2010. http://doi.org/10.18637/jss.v036.i03.

VIECHTBAUER, W. Hypothesis tests for population heterogeneity in meta-analysis. *British Journal of Mathematical & Statistical Psychology,* Oxford, v. 60, n. 1, p. 29-60, 2007.

WOOLDRIDGE, J. M. *Econometric analysis of cross section and panel data*. Cambridge: MIT Press, 2002.

YOUNG, A. Increasing returns and economic progress. *Economic Journal,* London v. 38, n. 152, p. 527-542, 1928.

ZAHRA, S. A.; NIELSEN, A. P. Sources of capabilities, integration and technology commercialization. *Strategic Management Journal,* Haboken, v. 23, n. 5, p. 377-398, 2002. http://doi.org/10.1002/smj.229.

Author's contribution:

A. Literature review and problematization: Rodrigo Ezequiel Kataishi and Federico Bachmann

B. Data collection and statistical analysis: Rodrigo Ezequiel Kataishi and Federico Bachmann

C. Preparation of figures and tables: Federico Bachmann

D. Manuscript development: Rodrigo Ezequiel Kataishi and Federico Bachmann

E. Bibliography selection: Rodrigo Ezequiel Kataishi and Federico Bachmann

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ANNEX 1
Table 1A
Studies included in MRA

ARTICLES - CE	Number of estimations	Country	Period	Sample size	Innovation measurement	Size measure	Main size effect
Aboal and Garda (2016)	10	Uruguay	2004-2009	1328	IA; Obtained Results	Employees	Positive
Ahuja (2000)	11	International	1982-1992	996	Obtained Results	Employees	Positive
Ahuja and Katila (2001)	6	International	1980-1991	598	Obtained Results	Employees	Positive
Allred and Park (2007)	5	Developed economies	1990-2000	1081	Invested resources	Sales	Positive
Almeida et al. (2011)	10	USA and Europe	1990-2003	971	Obtained Results	Employees	Positive
Arvanitis (2008)	2	Switzerland	1997-1999	595	Obtained Results	Employees	Positive
Aschhoff and Schmidt (2008)	8	Germany	2001-2004	699	Obtained Results	Employees	Null
Audretsch (1995)	7	United States	1975-1982	374	Obtained Results	Sales	Negative; Null
Baptista and Swann (1998)	11	United Kingdom	1975-1982	1984	Obtained Results	Sales	Positive
Barasa et al. (2017)	11	Kenya, Tanzania and Uganda	2010-2012	1541	Obtained Results	Employees	Null
Bartoloni and Baussola (2001)	1	Italy	1990-1992	13334	Obtained Results	Employees	Positive
Battisti et al. (2015)	16	Europe	2002-2004	173	Obtained Results	Employees	Positive; Null
Becheikh (2013)	1	Egypt	2009	2132	Obtained Results	Employees	Positive
Belderbos (2001)	2	Japan	1990-1993	194	Obtained Results	Sales	Positive

Table 1A
Continuation...

ARTICLES - CE	Number of estimations	Country	Period	Sample size	Innovation measurement	Size measure	Main size effect
Benavente (2006)	15	Chile	1997-1998	197	IA; Invested resources; Obtained Results	Employees	Null
Beugelsdijk and Cornet (2002)	6	Germany	1996	1510	Obtained Results	Employees	Negative
Bishop and Wiseman (1999)	3	United Kingdom	1996	320	IA; Obtained Results	Employees	Positive
Blundell et al. . (1999)	9	United Kingdom	1972-1982	2943	Obtained Results	Sales	Positive
Bratti and Felice (2012)	7	Italy	2001-2003	1635	Obtained Results	Employees	Null
Cassiman and Veugelers (2006)	15	Belgium	1993	269	IA; Obtained Results	Sales	Various
Cefis (2010)	13	Germany	1998-2002	4604	IA	Employees	Negative; Null
Cefis and Marsili (2015)	8	Netherlands	1994-2002	513	Obtained Results	Employees	Null
Classen et al. (2014)	4	Germany	2006	1067	IA; Invested resources; Obtained Results	Employees	Positive
Clausen (2009)	8	Norway	1999-2001	1019	Invested resources	Employees	Positive; Null
Clausen and Pohjola (2013)	6	Norway	1998-2006	1644	Obtained Results	Employees	Various
Cockburn and Henderson (1994)	3	USA and Europe	1993	171	Invested resources	Sales	Null
Conte and Vivarelli (2014)	13	Italy	2002	2247	Invested resources; Obtained Results	Employees	Various
Corsino et al. (2011)	4	International	1999-2004	564	Obtained Results	Employees	Positive

Table 1A
Continuation...

ARTICLES - CE	Number of estimations	Country	Period	Sample size	Innovation measurement	Size measure	Main size effect
Crespi et al. (2016)	21	Argentina	1998-2004	2083	Invested resources	Sales	Positive
De Propris (2000)	1	United Kingdom	1994-1996	270	Obtained Results	Employees	Null
Dhingra (2013)	8	Thailand	2003-2006	413	Obtained Results	ambos	Null
Doran and Jordan (2016)	9	Ireland	2004-2006	591	Obtained Results	Employees	Positive
Doran and O'leary (2016)	4	Ireland	2006-2008	522	Obtained Results	Employees	Null
Eriksson et al. (2014)	8	China	2011	564	IA; Obtained Results	Employees	Positive
Fassio (2015)	3	Germany, Spain and Italy	2002-2004	2126	Invested resources	Sales	Negative
Fitjar et al. (2013)	4	Norway	2010	1602	Obtained Results	Employees	Positive
Fontana and Gueronzi (2008)	1	Europe	2000	486	Obtained Results	Employees	Positive
Francois et al. . (2002)	4	France	1990-1996	3906	Obtained Results	Employees	Positive
Freel (2003)	8	United Kingdom	2001	90	Obtained Results	Employees	Positive
Fritsch and Meschede (2001)	5	Germany	1995	627	Invested resources	Employees	Null
Fu et al. (2018)	5	Ghana	2010-2013	501	Obtained Results	Employees	Null
Ganotakis and Love (2011)	2	United Kingdom	2004	314	Obtained Results	Employees	Positive
Ganter and Hecker (2013)	8	Germany	2002-2008	984	Obtained Results	Employees	Null
Gelabert et al. (2009)	7	Spain	2000-2005	4008	Invested resources	Employees	Null
Goedhuys and Veugelers (2012)	4	Brazil	2000-2002	1563	Obtained Results	Employees	Null
González et al. (2016)	2	Spain	2001-2011	9462	Obtained Results	Employees	Null

Table 1A
Continuation...

ARTICLES - CE	Number of estimations	Country	Period	Sample size	Innovation measurement	Size measure	Main size effect
Greve (2003)	8	Japan	1971-1996	147	Invested resources; Obtained Results	Employees	Positive
Hall and Ziedonis (2001)	6	United States	1979-1995	164	Obtained Results	Employees	Positive
Hao and Jaffe (1993)	13	International	1973-1988	321	Invested resources	Sales	Positive
Harris et al. (2003)	4	Australia	1995-1998	11271	Obtained Results	Employees	Positive
Herstad et al.. (2015)	15	Norway	2006-2008	1230	IA; Obtained Results	Employees	Null
Herstad and Sandven (2014)	4	Norway	2008-2010	616	Obtained Results	Employees	Null
Himmelberg and Peterson (1994)	13	International	1983-1987	368	Invested resources	Sales	Positive
Hitt et al. (1997)	2	International	1988-1990	293	Invested resources	Sales	Positive
Honig-Haftel and Martin (1993)	8	United States	1983-1988	28	Obtained Results	Employees	Positive
Kampik and Dachs (2011)	4	Europe	2002-2004	1718	Invested resources; Obtained Results	Employees	Positive
Kang and Kang (2010)	3	South Korea	2005	1353	Obtained Results	Employees	Positive
Keupp and Gassmann (2013)	4	Switzerland	1990-2008	1476	Obtained Results	Employees	Null
Kochhar and David (1996)	4	NASDAQ	1989	99	Obtained Results	Sales	Positive
Leiblein and Madsen (2009)	5	International	1990-1999	2599	Obtained Results	Sales	Null
Lerner and Wulf (2007)	4	International	1987-1997	177	Obtained Results	Sales	Positive
Liu and Buck (2007)	3	China	1997-2002	126	Obtained Results	Employees	Positive

Table 1A
Continuation...

ARTICLES - CE	Number of estimations	Country	Period	Sample size	Innovation measurement	Size measure	Main size effect
Love et al. (1996)	4	Scotland	1992	318	IA; Obtained Results	Employees	Null
Love and Ashcroft (1999)	3	Scotland	1993	304	Obtained Results	Employees	Positive
Love and Roper (1999)	4	United Kingdom	1995	576	Obtained Results	Employees	Positive
Love and Roper (2002)	4	United Kingdom, Ireland and Germany	1991-1994	684	Obtained Results	Employees	Negative; Null
Macpherson (1998)	1	United States	1989-1993	129	Obtained Results	Employees	Null
Malerba et al. (1997)	2	European Union	1984	164	Obtained Results	Employees	Null
Maré et al. (2014)	5	New Zealand	2000-2008	13722	Obtained Results	Employees	Positive
Marín and Petralia (2018)	12	Argentina and Brazil	1998-2003	4787	Obtained Results	Employees	Null
Martínez Ros (1999)	7	Spain	1990-1993	8000	Obtained Results	Employees	Positive
Mothe et al. (2015a)	3	Luxembourg	2004-2006	568	Obtained Results	Employees	Null
Mothe et al. (2015b)	3	France	2006-2008	2673	Obtained Results	Employees	Negative
Negassi (2004)	7	France	1990-1996	1234	Obtained Results	Sales	Positive
Nieto et al. (2015)	3	Spain	1998-2007	15173	Invested resources; Obtained Results	Employees	Null
Nooteboom et al. (2007)	8	International	1986-1997	762	Obtained Results	Sales	Positive
Raymond et al. (2010)	8	Netherlands	1994-2000	1764	Obtained Results	Employees	Positive
Reichstein et al. (2008)	12	United Kingdom	1998-2000	376	Obtained Results	Employees	Null

Table 1A
Continuation...

ARTICLES - CE	Number of estimations	Country	Period	Sample size	Innovation measurement	Size measure	Main size effect
Reichstein and Salter (2006)	4	United Kingdom	2001	2885	Obtained Results	Employees	Positive
Roper and Hewitt-Dundas (2015)	15	Ireland	1991-2008	2040	Obtained Results	Employees	Positive; Null
Sakakibara and Branstetter (1999)	6	Japan	1983-1994	3423	Invested resources; Obtained Results	Sales	Positive
Salomon and Shaver (2005)	24	Spain	1990-1997	3471	Obtained Results	Employees	Null
Segarra Blasco et al. (2008)	2	Catalonia	2002-2004	1332	IA	Employees	Positive
Shefer and Frenkel (2005)	2	Israel	1994	179	Invested resources	Sales	Negative; Null
Sorensen and Stuart (2000)	36	Asia, Japan, EU and USA	1986-1992	3349	Obtained Results	ambos	Various
Srholec (2010)	6	Czech Republic	1999-2001	1809	Obtained Results	Employees	Positive
Stuart (1999)	10	International	1986-1992	2685	Invested resources; Obtained Results	Sales	Positive
Tavassoli and Karlsson (2015)	6	Sweden	2002-2012	1722	Obtained Results	Employees	Positive; Null
Tello (2015)	18	Peru	2002-2007	294	IA; Obtained Results	Employees	Positive
Van Beers and Sadowski (2003)	5	Netherlands	1994-1996	1459	Obtained Results	Employees	Positive
Van Beveren and Vandenbussche (2010)	3	Belgium	1998-2004	189	Obtained Results	Employees	Null

Table 1A
Continuation...

ARTICLES - CE	Number of estimations	Country	Period	Sample size	Innovation measurement	Size measure	Main size effect
Van Leeuwen and Klomp (2006)	8	Netherlands	1994-1996	1926	IA; Invested resources; Obtained Results	Employees	Negative
Veugelers and Cassiman (2005)	1	Belgium	1990-1992	504	Obtained Results	Employees	Positive
Worter (2007)	1	Switzerland	1999-2005	2777	IA	Employees	Negative
Zoghi et al. (2010)	3	Canada	1999-2003	15433	Obtained Results	Employees	Positive

Note: last column summarises the main results in each article. Significantly positive and negative effects are labelled as "positive" and "negative" respectively, while non-significant are "null"; extremely heterogeneous evidence is classified as "various". Source: authors.

References of Studies included in MRA

Aboal, D., & Garda, P. (2016). Technological and non-technological innovation and productivity in services vis-à-vis manufacturing sectors. Economics of Innovation and New Technology, 25(5), 435–454. https://doi.org/10.1080/10438599.2015.1073478

Ahuja, G. (2000). Collaboration Networks, Structural Holes, and Innovation: A Longitudinal Study. Administrative Science Quarterly, 45(3), 425. https://doi.org/10.2307/2667105

Ahuja, G., & Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. Strategic Management Journal, 22(3), 197–220. https://doi.org/10.1002/smj.157

Allred, B. B., & Park, W. G. (2007). Patent rights and innovative activity: Evidence from national and firm-level data. Journal of International Business Studies, 38(6), 878–900. https://doi.org/10.1057/palgrave.jibs.8400306

Almeida, P., Hohberger, J., & Parada, P. (2011). Individual scientific collaborations and firm-level innovation. Industrial and Corporate Change, 20(6), 1571–1599. https://doi.org/10.1093/icc/dtr030

Aristizabal-Ramirez, M., Botero-Franco, M. C., & Canavire-Bacarreza, G. (2017). Does Financial Development Promote Innovation in Developing Economies? An Empirical Analysis. Review of Development Economics, 21(3), 475–496. https://doi.org/10.1111/rode.12314

Arvanitis, S. (2008). Explaining innovative activity in service industries: Micro data evidence for Switzerland. Economics of Innovation and New Technology, 17(3), 209–225. https://doi.org/10.1080/10438590601004220

Aschhoff, B., & Schmidt, T. (2008). Empirical Evidence on the Success of R&D Cooperation—Happy Together? Review of Industrial Organization, 33(1), 41–62. https://doi.org/10.1007/s11151-008-9179-7

Audretsch, D. B. (1995). Firm profitability, growth, and innovation. Review of Industrial Organization, 10(5), 579–588. https://doi.org/10.1007/BF01026883

Bachmann, F., Liseras, N., & Graña, F. M. (2016, septiembre 28). Análisis de los determinantes de la innovación bajo un enfoque sistémico. Presentado en XXI Reunión Anual de la Red PyMEs-MERCOSUR, Tandil, Argentina.

Baptista, R., & Swann, P. (1998). Do firms in clusters innovate more? Research Policy, 27(5), 525–540. https://doi.org/10.1016/S0048-7333(98)00065-1

Barasa, L., Knoben, J., Vermeulen, P., Kimuyu, P., & Kinyanjui, B. (2017). Institutions, resources and innovation in East Africa: A firm level approach. Research Policy, 46(1), 280–291. https://doi.org/10.1016/j.respol.2016.11.008

Barge-Gil, A. (2013). Open Strategies and Innovation Performance. Industry & Innovation, 20(7), 585–610. https://doi.org/10.1080/13662716.2013.849455

Bartoloni, E., & Baussola, M. (2001). The Determinants of Technology Adoption in Italian Manufacturing Industries. Review of Industrial Organization, 19(3), 305–328. https://doi.org/10.1023/A:1011881516500

Battisti, G., Gallego, J., Rubalcaba, L., & Windrum, P. (2015). Open innovation in services: Knowledge sources, intellectual property rights and internationalization. Economics of Innovation and New Technology, 24(3), 223–247. https://doi.org/10.1080/10438599.2014.924745

Becheikh, N. (2013). The Impact of Knowledge Acquisition and Absorptive Capacity on Technological Innovations in Developing Countries: Evidence From Egyptian Small and Medium-Sized Enterprises. Journal of African Business, 14(3), 127–140. https://doi.org/10.1080/15228916.2013.843997

Belderbos, R. (2001). Overseas innovations by Japanese firms: An analysis of patent and subsidiary data. Research Policy, 30(2), 313–332. https://doi.org/10.1016/S0048-7333(99)00120-1

Benavente, J. M. (2006). The role of research and innovation in promoting productivity in Chile. Economics of Innovation and New Technology, 15(4–5), 301–315. https://doi.org/10.1080/10438590500512794

Beugelsdijk, S., & Cornet, M. (2002). "A Far Friend is Worth More than a Good Neighbour": Proximity and Innovation in a Small Country. Journal of Management and Governance, 6(2), 169–188. https://doi.org/10.1023/A:1015775321949

Bishop, P., & Wiseman, N. (1999). External ownership and innovation in the United Kingdom. Applied Economics, 31(4), 443–450. https://doi.org/10.1080/000368499324156

Blundell, R., Griffiths, R., & Van Reenen, J. (1999). Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms. Review of Economic Studies, 66(3), 529–554. https://doi.org/10.1111/1467-937X.00097

Bond, S., Harhoff, D., & Van Reenen, J. (1999). Investment, R&D, and financial constraints in Britain and Germany. Institute of Fiscal Studies. Londres.

Cabral, J., & Traill, W. B. (2001). Determinants of a firm's likelihood to innovate and intensity of innovation in the Brazilian food industry. Journal on Chain and Network Science, 1(1), 33–48. https://doi.org/10.3920/JCNS2001.x004

Capron, H., & Cincera, M. (2004, noviembre). Industry/University S&T Transfers: What Can We Learn from Belgian Cis-2 Data? CEPR Discussion Paper No. 4685. CEPR.

Cassiman, B., & Veugelers, R. (2002). Complementarity in the Innovation Strategy: Internal R&D, External Technology Acquisition, and Cooperation in R&D. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.303562

Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. Management Science, 52(1), 68–82.

Crespi, G., Giuliodori, D., Giuliodori, R., & Rodriguez, A. (2016). The effectiveness of tax incentives for R&D+i in developing countries: The case of Argentina. Research Policy, 45(10), 2023–2035. https://doi.org/10.1016/j.respol.2016.07.006

Cefis, E. (2010). The impact of M&A on technology sourcing strategies. Economics of Innovation and New Technology, 19(1), 27–51. https://doi.org/10.1080/10438590903016385

Cefis, E., & Marsili, O. (2015). Crossing the innovation threshold through mergers and acquisitions. Research Policy, 44(3), 698–710. https://doi.org/10.1016/j.respol.2014.10.010

Classen, N., Carree, M., Van Gils, A., & Peters, B. (2014). Innovation in family and non-family SMEs: An exploratory analysis. Small Business Economics, 42(3), 595–609. https://doi.org/10.1007/s11187-013-9490-z

Clausen, T. H. (2009). Do subsidies have positive impacts on R&D and innovation activities at the firm level? Structural Change and Economic Dynamics, 20(4), 239–253. https://doi.org/10.1016/j.strueco.2009.09.004

Clausen, T. H., & Pohjola, M. (2013). Persistence of product innovation: Comparing breakthrough and incremental product innovation. Technology Analysis & Strategic Management, 25(4), 369–385. https://doi.org/10.1080/09537325.2013.774344

Cockburn, I., & Henderson, R. (1994). Racing to invest? The dynamics of competition in ethical drug discovery. Journal of Economics & Management Strategy, 3(3), 481–519. https://doi.org/10.1111/j.1430-9134.1994.00481.x

Conte, A., & Vivarelli, M. (2014). Succeeding in innovation: Key insights on the role of R&D and technological acquisition drawn from company data. Empirical Economics, 47(4), 1317–1340. https://doi.org/10.1007/s00181-013-0779-1

Corsino, M., Espa, G., & Micciolo, R. (2011). R&D, firm size and incremental product innovation. Economics of Innovation and New Technology, 20(5), 423–443. https://doi.org/10.1080/10438599.2011.562354

Crepon, B., Duguet, E., & Mairessec, J. (1998). Research, innovation and productivity: An econometric analysis at the firm level. Economics of Innovation and New Technology, 7(2), 115–158. https://doi.org/10.1080/10438599800000031

Crespi, G., Giuliodori, D., Giuliodori, R., & Rodriguez, A. (2016). The effectiveness of tax incentives for R&D+i in developing countries: The case of Argentina. Research Policy, 45(10), 2023–2035. https://doi.org/10.1016/j.respol.2016.07.006

Czarnitzki, D., & Kraft, K. (2005). License expenditures of incumbents and potential entrants: An empirical analysis of firm behavior. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.732303

Damijan, J. P., Kostevc, Č., & Rojec, M. (2011). Innovation and firms' productivity growth in Slovenia: Sensitivity of results to sectoral heterogeneity and to estimation method. En P. Nijkamp & I. Siedschlag (Eds.), Innovation, Growth and Competitiveness (pp. 165–193). https://doi.org/10.1007/978-3-642-14965-8_8

De Propris, L. (2000). Innovation and inter-firm co-operation: The case of the West Midlands. Economics of Innovation and New Technology, 9(5), 421–446. https://doi.org/10.1080/10438590000000017

Dhingra, S. (2013). Trading away wide brands for cheap brands. American Economic Review, 103(6), 2554–2584. https://doi.org/10.1257/aer.103.6.2554

Doran, J., & Jordan, D. (2016). Cross-sectoral differences in the drivers of innovation: Evidence from the Irish Community Innovation Survey. Journal of Economic Studies, 43(5), 719–748. https://doi.org/10.1108/JES-10-2014-0171

Doran, J., & O'Leary, E. (2016). The innovation performance of Irish and foreign-owned firms: The roles of R&D and networking. The World Economy, 39(9), 1384–1398. https://doi.org/10.1111/twec.12378

Elshamy, H. (2015). The impact of firm size on innovative activity: An analysis based on Egyptian firm data. International Journal of Business and Technopreneurship, 5(3), 397–406.

Eriksson, T., Qin, Z., & Wang, W. (2014). Firm-level innovation activity, employee turnover and HRM practices—Evidence from Chinese firms. China Economic Review, 30, 583–597. https://doi.org/10.1016/j.chieco.2014.02.005

Fassio, C. (2015). How similar is innovation in German, Italian and Spanish medium-technology sectors? Implications for the sectoral systems of innovation and distance-to-the-frontier perspectives. Industry and Innovation, 22(2), 102–125. https://doi.org/10.1080/13662716.2015.1033160

Fitjar, R. D., & Rodríguez-Pose, A. (2015). Networking, context and firm-level innovation: Cooperation through the regional filter in Norway. Geoforum, 63, 25–35. https://doi.org/10.1016/j.geoforum.2015.05.010

Fontana, R., & Guerzoni, M. (2008). Incentives and uncertainty: An empirical analysis of the impact of demand on innovation. Cambridge Journal of Economics, 32(6), 927–946. https://doi.org/10.1093/cje/ben021

Foster, L., Grim, C., & Zolas, N. J. (2016). A portrait of firms that invest in R&D. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2845982

François, J. P., Favre, F., & Negassi, S. (2002). Competence and organization: Two drivers of innovation. Economics of Innovation and New Technology, 11(3), 249–270. https://doi.org/10.1080/10438590210906

Freel, M. S. (2003). Sectoral patterns of small firm innovation, networking and proximity. Research Policy, 32(5), 751–770. https://doi.org/10.1016/S0048-7333(02)00084-7

Fritsch, M., & Meschede, M. (2001). Product innovation, process innovation, and size. Review of Industrial Organization, 19(3), 335–350. https://doi.org/10.1023/A:1011856020135

Fu, X., Mohnen, P., & Zanello, G. (2018). Innovation and productivity in formal and informal firms in Ghana. Technological Forecasting and Social Change, 131, 315–325. https://doi.org/10.1016/j.techfore.2017.08.009

Ganau, R., & Di María, E. (2014, agosto 26). Determinants of technological innovation in SMEs. Firm-level factors, agglomeration economies and the role of KIBS providers. Presentado en St. Petersburg, Russia.

Ganotakis, P., & Love, J. H. (2011). R&D, product innovation, and exporting: Evidence from UK new technology-based firms. Oxford Economic Papers, 63(2), 279–306. https://doi.org/10.1093/oep/gpq027

Ganter, A., & Hecker, A. (2013). Persistence of innovation: Discriminating between types of innovation and sources of state dependence. Research Policy, 42(8), 1431–1445. https://doi.org/10.1016/j.respol.2013.04.001

Gelabert, L., Fosfuri, A., & Tribó, J. A. (2009). Does the effect of public support for R&D depend on the degree of appropriability? The Journal of Industrial Economics, 57(4), 736–767. https://doi.org/10.1111/j.1467-6451.2009.00396.x

Goedhuys, M., & Veugelers, R. (2012). Innovation strategies, process and product innovations and growth: Firm-level evidence from Brazil. Structural Change and Economic Dynamics, 23(4), 516–529. https://doi.org/10.1016/j.strueco.2011.01.004

González, X., Miles-Touya, D., & Pazó, C. (2016). R&D, worker training and innovation: Firm-level evidence. Industry and Innovation, 23(8), 694–712. https://doi.org/10.1080/13662716.2016.1206463

Greve, H. R. (2003). A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding. Academy of Management Journal, 46(6), 685–702. https://doi.org/10.5465/30040661

Gussoni, M., & Mangani, A. (2012). L'impatto del supporto pubblico sulla spesa in R&S: L'influenza della cooperazione e dell'appropriabilità dei risultati. L'industria, (2), 237–254. https://doi.org/10.1430/37674

Hall, B. H., & Ziedonis, R. H. (2001). The patent paradox revisited: An empirical study of patenting in the U.S. semiconductor industry, 1979–1995. The RAND Journal of Economics, 32(1), 101. https://doi.org/10.2307/2696400

Hall, B., Jaffe, A., & Trajtenberg, M. (2001). The NBER patent citation data file: Lessons, insights and methodological tools (Núm. w8498). Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w8498

Hao, K. Y., & Jaffe, A. B. (1993). Effect of liquidity on firms' R&D spending. Economics of Innovation and New Technology, 2(4), 275–282. https://doi.org/10.1080/10438599300000008

Harris, M. N., Rogers, M., & Siouclis, A. (2003). Modelling firm innovation using panel probit estimators. Applied Economics Letters, 10(11), 683–686. https://doi.org/10.1080/1350485032000138999

Herstad, S. J., & Sandven, T. (2014). Marked for life? On researcher involvement at infancy and the innovative capabilities of survivor firms. Applied Economics Letters, 21(17), 1210–1213. https://doi.org/10.1080/13504851.2014.920464

Herstad, S. J., Sandven, T., & Ebersberger, B. (2015). Recruitment, knowledge integration and modes of innovation. Research Policy, 44(1), 138–153. https://doi.org/10.1016/j.respol.2014.06.007

Himmelberg, H., & Peterson, B. (1994). R&D and internal finance: A panel study of small firms in high-tech industries. The Review of Economics and Statistics, 76(1), 38–51.

Hitt, M. A., Hoskisson, R. E., & Kim, H. (1997). International diversification: Effects on innovation and firm performance in product-diversified firms. Academy of Management Journal, 40(4), 767–798. https://doi.org/10.5465/256948

Hoelz Pinto, A. M., & Lage de Souza, F. (2015). Competition and innovation in the Caribbean. En Dohnert, S., Crespi, G., & Maffioli, A. (Eds.), Exploring Firm-Level Innovation and Productivity in Developing Countries: The Perspective of Caribbean Small States. Washington, DC: Inter-American Development Bank.

Honig-Haftel, S., & Martin, L. R. (1993). The effectiveness of reward systems on innovative output: An empirical analysis. Small Business Economics, 5(4), 261–269. https://doi.org/10.1007/BF01516247

Janz, N., Lööf, H., & Peters, B. (2003). Firm-level innovation and productivity—Is there a common story across countries? SSRN Electronic Journal. https://doi.org/10.2139/ssrn.416444

Kampik, F., & Dachs, B. (2011). The innovative performance of German multinationals abroad: Evidence from the European community innovation survey. Industrial and Corporate Change, 20(2), 661–681. https://doi.org/10.1093/icc/dtr008

Kang, K. H., & Kang, J. (2010). Does partner type matter in R&D collaboration for product innovation? Technology Analysis & Strategic Management, 22(8), 945–959. https://doi.org/10.1080/09537325.2010.520473

Keupp, M. M., & Gassmann, O. (2013). Resource constraints as triggers of radical innovation: Longitudinal evidence from the manufacturing sector. Research Policy, 42(8), 1457–1468. https://doi.org/10.1016/j.respol.2013.04.006

Knott, A. M., & Vieregger, C. (2016). Reconciling the firm size and innovation puzzle. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2756232

Kochhar, R., & David, P. (1996). Institutional investors and firm innovation: A test of competing hypotheses. Strategic Management Journal, 17(1), 73–84. https://doi.org/10.1002/(SICI)1097-0266(199601)

Leiblein, M. J., & Madsen, T. L. (2009). Unbundling competitive heterogeneity: Incentive structures and capability influences on technological innovation. Strategic Management Journal, 30(7), 711–735. https://doi.org/10.1002/smj.746

Lerner, J., & Wulf, J. (2007). Innovation and incentives: Evidence from corporate R&D. Review of Economics and Statistics, 89(4), 634–644. https://doi.org/10.1162/rest.89.4.634

Liu, X., & Buck, T. (2007). Innovation performance and channels for international technology spillovers: Evidence from Chinese high-tech industries. Research Policy, 36(3), 355–366. https://doi.org/10.1016/j.respol.2006.12.003

López, A., & Orlicki, E. (2006). ¿Quién patenta en la Argentina? Un análisis econométrico para el sector manufacturero. En Sistemas de Propiedad Intelectual y Gestión Tecnológica en Economías Abiertas: Una Visión Estratégica para América Latina y el Caribe. Santiago de Chile: OMPICEPAL.

Losada-Otárola, M., & Zuluaga, J. C. (2013). Derramamientos sectoriales de conocimiento e innovación en la industria manufacturera colombiana: Un análisis multinivel. Innovar, 23(47), 19–32.

Love, J. H., & Ashcroft, B. (1999). Market versus corporate structure in plant-level innovation performance. Small Business Economics, 13(2), 97–109.

Love, J. H., & Roper, S. (1999). The determinants of innovation: R&D, technology transfer and networking effects. Review of Industrial Organization, 15(1), 43–64.

Love, J. H., Ashcroft, B., & Dunlop, S. (1996). Corporate structure, ownership and the likelihood of innovation. Applied Economics, 28(6), 737–746. https://doi.org/10.1080/000368496328489

Machikita, T., Miyahara, S., Tsuji, M., & Ueki, Y. (2009). Linked versus non-linked firms in innovation: The effect of economies of network in East Asia. En K. Limskul (Ed.), Development of Regional Production and Logistic Networks in East Asia.

MacPherson, A. D. (1998). Academic-industry linkages and small firm innovation: Evidence from the scientific instruments sector. Entrepreneurship & Regional Development, 10(4), 261–276. https://doi.org/10.1080/08985629800000015

Malerba, F., Orsenigo, L., & Peretto, P. (1997). Persistence of innovative activities, sectoral patterns of innovation and international technological specialization. International Journal of Industrial Organization, 15(6), 801–826. https://doi.org/10.1016/S0167-7187(97)00012-X

Maré, D. C., Fabling, R., & Stillman, S. (2014). Innovation and the local workforce: Innovation and local workforce. Papers in Regional Science, 93(1), 183–201. https://doi.org/10.1111/j.1435-5957.2012.00479.x

Marín, A., Liseras, N., Calá, C. D., & Graña, F. M. (2017). Oportunidades de innovación divergentes: ¿es el territorio importante? Pymes, Innovación y Desarrollo, 5(1), 2–23.

Marín, A., & Petralia, S. (2018). Sources and contexts of inter-industry differences in technological opportunities: The cases of Argentina and Brazil. Innovation and Development, 8, 29–57. https://doi.org/10.1080/2157930x.2018.1429191

Martinez-Ros, E. (1999). Explaining the decisions to carry out product and process innovations. The Journal of High Technology Management Research, 10(2), 223–242. https://doi.org/10.1016/S1047-8310(99)00016-4

Morris, D. (2015). Access to financing and innovation in Caribbean firms. En S. Dohnert, G. Crespi, & A. Maffioli (Eds.), Exploring Firm-Level Innovation and Productivity in Developing Countries: The Perspective of Caribbean Small States. Washington, DC: Inter-American Development Bank.

Mothe, C., Nguyen-Thi, U. T., & Nguyen-Van, P. (2015a). Assessing complementarity in organizational innovations for technological innovation: The role of knowledge management practices. Applied Economics, 47(29), 3040–3058. https://doi.org/10.1080/00036846.2015.1011320

Mothe, C., Nguyen-Thi, U. T., & Nguyen-Van, P. (2015b). Complementarities in organizational innovation practices: Evidence from French industrial firms. Economics of Innovation and New Technology, 24(6), 569–595. https://doi.org/10.1080/10438599.2014.949416

Negassi, S. (2004). R&D co-operation and innovation: A microeconometric study on French firms. Research Policy, 33(3), 365–384. https://doi.org/10.1016/j.respol.2003.09.010

Nieto, M. J., Santamaria, L., & Fernandez, Z. (2015). Understanding the innovation behavior of family firms. Journal of Small Business Management, 53(2), 382–399. https://doi.org/10.1111/jsbm.12075

Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V., & van den Oord, A. (2007). Optimal cognitive distance and absorptive capacity. Research Policy, 36(7), 1016–1034. https://doi.org/10.1016/j.respol.2007.04.003

Pradhan, J. P. (2003). Liberalization, firm size and R&D performance: A firm level study of Indian pharmaceutical industry. Journal of Indian School of Political Economy, 14(4), 647–666.

Raymond, W., Mohnen, P., Palm, F., & van der Loeff, S. S. (2010). Persistence of innovation in Dutch manufacturing: Is it spurious? Review of Economics and Statistics, 92(3), 495–504. https://doi.org/10.1162/REST_a_00004

Reichstein, T., & Salter, A. (2006). Investigating the sources of process innovation among UK manufacturing firms. Industrial and Corporate Change, 15(4), 653–682. https://doi.org/10.1093/icc/dtl014

Reichstein, T., Salter, A. J., & Gann, D. M. (2008). Break on through: Sources and determinants of product and process innovation among UK construction firms. Industry & Innovation, 15(6), 601–625. https://doi.org/10.1080/13662710802565198

Roper, S., & Hewitt-Dundas, N. (2015). Knowledge stocks, knowledge flows and innovation: Evidence from matched patents and innovation panel data. Research Policy, 44(7), 1327–1340. https://doi.org/10.1016/j.respol.2015.03.003

Roper, S., & Love, J. H. (2002). Innovation and export performance: Evidence from the UK and German manufacturing plants. Research Policy, 31(7), 1087–1102. https://doi.org/10.1016/S0048-7333(01)00175-5

Rouvinen, P. (2004). Is technology policy practised as it is preached? Finnish evidence. Finnish Economic Papers, 17(2), 51–61.

Sadowski, B. M., & Sadowski-Rasters, G. (2006). On the innovativeness of foreign affiliates: Evidence from companies in The Netherlands. Research Policy, 35(3), 447–462. https://doi.org/10.1016/j.respol.2006.01.003

Sakakibara, M., & Branstetter, L. (1999). Do stronger patents induce more innovation? Evidence from the 1988 Japanese patent law reforms. NBER Working Paper No. 7066. https://doi.org/10.3386/w7066

Salomon, R. M., & Shaver, J. M. (2005). Learning by exporting: New insights from examining firm innovation. Journal of Economics & Management Strategy, 14(2), 431–460. https://doi.org/10.1111/j.1530-9134.2005.00047.x

Segarra-Blasco, A., Garcia-Quevedo, J., & Teruel-Carrizosa, M. (2008). Barriers to innovation and public policy in Catalonia. International Entrepreneurship and Management Journal, 4(4), 431–451. https://doi.org/10.1007/s11365-008-0086-z

Sharma, S. (2007). Financial development and innovation in small firms (World Bank Policy Research Working Paper No. 4350). Washington, DC: World Bank. https://doi.org/10.1596/1813-9450-4350

Shefer, D., & Frenkel, A. (2005). R&D, firm size and innovation: An empirical analysis. Technovation, 25(1), 25–32. https://doi.org/10.1016/S0166-4972(03)00152-4

Sorensen, J. B., & Stuart, T. E. (2000). Aging, obsolescence, and organizational innovation. Administrative Science Quarterly, 45(1), 81. https://doi.org/10.2307/2666980

Srholec, M. (2010). A multilevel approach to geography of innovation. Regional Studies, 44(9), 1207–1220. https://doi.org/10.1080/00343400903365094

Stuart, T. (1999). A structural perspective on organizational innovation. Industrial and Corporate Change, 8(4), 745–775. https://doi.org/10.1093/icc/8.4.745

Tavassoli, S., & Karlsson, C. (2015). Persistence of various types of innovation analyzed and explained. Research Policy, 44(10), 1887–1901. https://doi.org/10.1016/j.respol.2015.06.001

Tello, M. D. (2015). Firms' innovation, public financial support, and total factor productivity: The case of manufactures in Peru. Review of Development Economics, 19(2), 358–374. https://doi.org/10.1111/rode.12147

Tether, B. S., & Bascavusoglu-Moreau, E. (2012). A different path to growth? Service innovation and performance amongst UK manufacturers. Centre for Business Research, University of Cambridge.

Van Beers, C., & Sadowski, B. M. (2003). On the relationship between acquisitions, divestitures and innovations: An explorative study. Journal of Industry, Competition and Trade, 3(1/2), 131–143. https://doi.org/10.1023/A:1025486722201

Van Beveren, I., & Vandenbussche, H. (2010). Product and process innovation and firms' decision to export. Journal of Economic Policy Reform, 13(1), 3–24. https://doi.org/10.1080/17487870903546267

Van Leeuwen, G., & Klomp, L. (2006). On the contribution of innovation to multi-factor productivity growth. Economics of Innovation and New Technology, 15(4–5), 367–390. https://doi.org/10.1080/10438590500512927

Veugelers, R., & Cassiman, B. (2005). R&D cooperation between firms and universities: Some empirical evidence from Belgian manufacturing. International Journal of Industrial Organization, 23(5–6), 355–379. https://doi.org/10.1016/j.ijindorg.2005.01.008

Wörter, M. (2007). Driving forces for research and development strategies: An empirical analysis based on firm-level panel data. SSRN Electronic Journal. https://doi.org/10.3929/ethz-a-005510829

Zoghi, C., Mohr, R. D., & Meyer, P. B. (2010). Workplace organization and innovation. Canadian Journal of Economics/Revue Canadienne d'économique, 43(2), 622–639. https://doi.org/10.1111/j.1540-5982.2010.01586.x

Zuluaga Jiménez, J. C., Sánchez Manchola, I. D., & Barrios Aguirre, F. (2012). Ambiente regional y desempeño innovador de las firmas. Una propuesta de análisis multinivel. Estudios Gerenciales, 169–189. https://doi.org/10.18046/j.estger.2012.1484