POSTGRADO ECONOMÍA Y NEGOCIOS
UNIVERSIDAD DE CHILE

"Productivity Slowdown in EMEs: Can R&D investment be blamed?"

TESIS PARA OPTAR AL GRADO DE MAGÍSTER EN ECONOMÍA

Alumno: Felipe Rojas Muñoz
Profesor Guía: José De Gregorio

Santiago, junio de 2024

Agradecimientos

A Camila, gracias por el apoyo y motivación durante todos estos años.
A mis padres, gracias por todo el soporte y la confianza.
A mis profesores y mentores, José De Gregorio, Eduardo Engel,
Jaime Ruiz-Tagle, Andrés Fernández y David Coble.

Productivity Slowdown in EMEs: Can R&D investment be blamed?

Felipe Rojas Muñoz*
Advisor: José De Gregorio

March, 2024

Abstract

This paper tests the hypothesis that productivity slowdown in EMEs may be caused by low R&D investment, estimating both investment levels and return rates of R&D for a wide panel of firms in EMEs. I use financial statement data to get an unbalanced panel of 13,246 public listed companies in 38 countries between 1980 and 2019. I find that firms in EMEs have been increasing their investment rates in R&D over the last decades (3.6%), although not reaching AEs levels yet (8.0%). Firms' borrowing constraints might explain this persistent difference. R&D investment return in EMEs is positive, significant and robustly higher than physical capital return, reaching an average of 37.6%. This result holds robust among different specifications, and country and firms splits. Given increasing investment levels and high returns, these findings draw special attention to the not-so-clear channel from R&D investment to actual productivity gains for the whole economy, reinforcing the relevance of spillovers in knowledge capital.

*frojasmu@fen.uchile.cl

1 Introduction

Global productivity slowdown is not a new phenomenon. Over the past decades, the productivity has been growing at a slower rate, either measured as a macro level TFP or as a micro level added-value-per-worker. This has been widely observed in advanced economies (Decker et al. (2017); Gordon (2016)), but also in middle income countries (Andrews et al., 2016), and has been amplified after the global financial crisis (Adler et al., 2017). Given the yet open productivity gap between advanced and emerging market economies, this issue is even more relevant for the latter group. De Gregorio (2018) finds that this phenomenon has been even worse for EMEs, where productivity has been growing slower than in the US, thus widening the gap.

There are several reasons why this slowdown might be taking place. As a pessimistic perspective, Gordon (2012) argues that the IT revolution that took place worldwide decades ago has run its course and other new technologies will take time to make a significant impact. On the other hand, some authors argue that a low investment by firms in knowledge-based capital (KBC) such as R&D might be a pivotal reason behind the productivity slowdown (OECD, 2013). Adler et al. (2017) argue that lower investment is related to weaker corporate balance sheets given tighter financial conditions. Other authors have found that, although R&D investment in EMEs has steadily grown in the last years, it is still far away from advanced economies' levels (Luintel and Khan, 2017).

A particular problem for companies investing in R&D is a borrowing constraint, which has been widely studied and proved (Mulkay et al. (2001); Aghion et al. (2010)). Hall and Lerner (2009) argue that banks and other debtholders prefer to use physical assets to secure loans, thus disencouraging the financing of R&D projects (or R&D-intensive firms) since the assets created by these investments are often intangible. This often forces companies to finance their investments with their own resources. The authors propose solutions to this problem, such as preferential tax treatment, or guarantees loan, to somehow overcome the risen cost of capital.

Another crucial decision by firms when deciding how much to invest in R&D projects is the expected return of it. Any profit-maximizing firm model will draw the conclusion that the firm will allocate resources in investments that are expected to be more profitable (after correcting for uncertainty). Goñi and Maloney (2017) formalize and prove that, since EMEs' firms are further away from the technological frontier compared to firms in AEs, the R&D investment of the former group should have a much higher return. However, they highlight some crucial requirements for investment to be profitable, such as country human capital level and institutionality.

A positive R&D investment return by a certain firm would also signal that the investment in KBC is actually improving the performance of that firm, through many channels such as cost reduction, development of new products or more productive workers. However, at the aggregate level, high investment and high returns by firms would not necessarily translate to productivity gains for the rest of the economy. Van Ark et al. (2008) analyze the channel from R&D investment to an actual improvement in productivity for a diverse group of countries in Europe (both low and high income). They find that countries with a smaller manufacturing sector, lack of institutionality, rigid labor markets and less competitive markets have a less clear transition from R&D investment to productivity growth. Ortega-Argilés et al. (2014) find that European firms have a relative lower capacity to translate corporate R&D expenditure into productivity gains, compared to firms in the US. Hall et al. (2010) also highlight the role of institutionality and a skilled workforce for enhancing R&D spillover effects between firms. At the end, cross-country differences in productivity can be partly attributed to spillover effects, where knowledge diffuses beyond its place of creation and creates wider benefits (OECD, 2013).

Having discussed the (not-always-clear) relationship between productivity, investments and return in R&D, the objective of this paper is to determine both the investment levels (and some of its determinants) and the returns for R&D by firms in EMEs over the last decades. Having these numbers may shed some light on at least three explanations to the problem of productivity slowdown: *1)* R&D investments levels by firms are low, which explains much of the problem, *2)* investment levels are high, but low returns are causing that firms cannot translate their investment into productivity gains, or *3)* both investment levels and returns by firms are high, meaning countries' structural problems are inhibiting productivity improvements and spillovers.

To do so, I will use financial statement data of public listed companies.[1] First, it is a long panel that follows companies for several years. This is crucial to capture the dynamic nature of the investment, since it is unlikely that the latest investment in R&D increases the knowledge capital stock immediately, because of the lag from expenditure to innovation, but also from innovation

[1] Even though some studies have used this kind of datasets (Hall and Mairesse, 2009), it was not for analyzing firms in EMEs.

to commercialization. Second, these datasets are highly detailed and include firm-level valuable information such as investment expenditures, number of employees, annual sales, and assets stocks. Lastly, this data is exhaustive since it has information of virtually every public listed company in a given country. Additional details about the advantages and disadvantages of using this kind of datasets are further discussed in Section 2.

The literature in this topic has mainly focused on advanced economies, either because of the availability of data or because the R&D investment was more relevant in industrial economies. When turning to emerging-market economies, the analyses have been performed using either aggregated R&D data for cross-country analysis or micro-level survey data for an individual country, as summarized in Hall et al. (2010). The main problem with firm-level survey databases is that most of them are not panel surveys following the same companies over the time, and if they do, the time series of R&D expenditures are still too short.

Another problem when comparing cross-country firm-level R&D expenditures in EMEs is the lack of standardization between surveys and consistency over time. Even though most of them tries to follow common conventions as in the Frascati Manual (OECD, 2015), the definition of R&D expenditure is still wide and includes a variety of dimensions to take into account. For instance, the expenditure can focus on different stages of the production, such as the improvement of internal processes or the development of new products, and some surveys may report only partial information or the whole aggregate R&D expenditure. Also, what surveys may label as "productive" sector may include public firms and non-profit organizations that may not be suitable for certain analyses.

The work by Lederman and Saenz (2005) offers a compilation of national surveys until 2000 that uses a consistent definition of R&D expenditures across them. However, it fails in properly dividing R&D into private and public expenditures, but rather into productive and non-productive sectors. And so, cross-country analyses such as the one in Goñi and Maloney (2017) end up using an aggregated R&D series rather than firm-level series.

There are numerous studies that measure the impact of financial restrictions on R&D investment, although the vast majority analyzing individual countries, and mostly AEs. Mulkay et al. (2001) compare France and USA analyzing 500 large firms from each country, between 1982-1993, finding that the cash flow is indeed important for financing both physical capital and R&D projects in USA, although not for French firms. Bond et al. (2010) analyzes public listed companies in the UK since 1985 finding a negligible effect of financial restrictions on the R&D investment for the average firm, although a strong pattern where firms that choose to do R&D are often "deep-pocket" (less financially constrained) firms. Aghion et al. (2010) finds that the average level of R&D investment decreases with sales volatility when the firm is more credit constrained, when analyzing a large panel of about 13,000 firms in France between 1993 and 2004.

Regarding R&D returns, there is a significant heterogeneity among the results, which is mostly due to the sample of firms that the study analyzes (different countries, periods and industries) rather than econometric differences. A pioneer study by Lichtenberg and Siegel (1991) analyzes 2000 US firms between 1972 and 1981 and find a return of 29%. For Japan, Kwon and Inui (2003) get a lower return, 16%, when analyzing 3830 manufacturing Japanese firms between 1995 and 1998. More recently, for the UK, Rogers (2010) distinguishes between manufacturing and non-manufacturing firms within a panel of 719 companies in 1989-2000, getting a return between 40% and 58% for the first group and between 53% and 108% for the latter group. In Chile, a recent study by Benavente and Calvo (2019) analyzes 486 firms between 2009 and 2014, finding a return of 30%.

Among cross-country analyses, Griffith et al. (2004) analyze 12 OECD countries between 1974 and 1990, although they do not use firm-level data, but industry-level aggregated R&D expenditure. They find returns that span between 47% and 67%. The closest approach to a cross-country analysis using firm-level data is the one in Goñi and Maloney (2017), that uses a extended version of the database by Lederman and Saenz (2005). However, as discussed, the paper ends up using aggregated R&D data since the database does not distinguish between private and public (by government companies, etc.) expenditures. Their analysis is performed using an unbalanced panel of 70 countries over 5 decades, between 1960 and 2010, finding returns between 20% and 50% for AEs and between 10% and striking 150% for EMEs.

The contribution of this study is, first, to fill a gap in the literature of cross-country analysis using firm-level data to estimate both investment trends and returns for R&D investment. But also, to be able to link these return rates to the phenomenon of productivity slowdown in EMEs, by assessing whether it is due to low investment rates in KBC (or relative low investment compared to AEs), low returns on the investment, or neither of those.

To do so, I will analyze both the investment rates and return rates for several splits at firm-level and country-level metrics, due to the heterogeneity of firms, industries and countries. For the investment determinants, I will also analyze the role of borrowing restrictions to finance R&D projects. Regarding the estimation of the return rates, I will use a standard production function model widely used in the literature and a two-stage least squares approach to address endogeneity, using both common instruments (outcome lags) and novel ones that the database allows to compute (country-industry R&D and physical capital expenditure averages).

I find that firms in EMEs have been steadily increasing their investment rates in R&D over the last decades, although still falling behind than companies in AEs, reaching 3.6% and 8.0% of their annual sales in the latest years, respectively. This is the same phenomenon that other authors have found when looking at relative productivity growth. Also, borrowing constraints do matter when financing R&D expenditure (more than physical capital expenditure), thus making firms more dependant on their own financial resources. The return rates of the investment have also increased in EMEs, reaching an average of 37.6%. This return rate is higher than physical capital return (16.0%), and also higher than the R&D return in AEs (27.1%). Also, firms in high-tech industries and less financially open countries are the ones experiencing the largest returns in the sample (53.3% and 44.2%, respectively). Lastly, I find that tax incentive programs do not seem to have any significant impact neither on the investment levels nor the return rates.

The rest of the paper is structured as follows. Section 2 details the database I use, focusing on the advantages and the validity of the sample. Section 3 analyzes the investment rates for various subsamples of firms, and assesses the role of financial constraints in R&D expenditure. Section 4 explains the model and the econometric approach for estimating the return rates, and gives the main results. Lastly, Section 5 concludes.

2 Data

I will analyze financial statement data of public listed companies in 38 emerging-market economies between 1980 and 2019.[2] Refinitiv Worldscope will be the main data source. In this dataset, the definition of annual R&D expenditures by companies is consistent across years and countries, and

[2]This is a broad set of countries, including those that were categorized as EMEs between 1980-2000, but are classified as high income countries now. See Appendix A.1 for details.

follows the guidelines by the OECD's Frascati Manual (OECD, 2015). It is an aggregated variable than includes both process R&D and product R&D, among other expenditures.[3]

To get country-level data, that will later be used to split the sample, I will rely on usual databases such as World Bank's WDI and Penn World Tables (Feenstra et al., 2015). Another useful database for the analysis is the OECD's R&D tax incentives dataset, that provides country-level preferential tax treatment to firms' expenditures on R&D, not only for OECD country members.[4] Additionally, I will also assess the financial account openness of each firm's country, using the usual index by Chinn and Ito (2006).

Table 1 details the sample of firms that I will be working with. It compares the full sample of companies in those 38 EMEs with the sample of firms that report R&D expenditure in at least one year.[5] Even though the sample size shrinks considerable, the final sample is still adequate, having an unbalanced panel of 13,246 companies with an average of 7.1 years of data per firm (and actually more than half of the firms in the sample having over 7 years of data). On the other hand, there is no evidence of sample bias that suggest that companies that are not investing in R&D are the ones that are underreporting their expenditures (i.e. instead of reporting 0 expenditure, they might report no data), since more than 10% of observations are actually R&D expenditure = 0.

Despite the advantages of being a long and detailed panel, an evident inconvenient of using this kind of datasets is that public listed companies are not representative of the entire economy. The performance of listed companies may not accurately reflect what smaller businesses are doing. On the other hand, many influential companies are privately held and do not trade on public exchanges. However, looking at public listed companies is still a valid approach (as Hall and Mairesse (2009) argue) since they represent a considerable share of any country labor, assets and innovation expenditures. Furthermore, public companies with large (or moderate) R&D budgets may be at the forefront of technological advancements, providing insights into the country innovation landscape.

[3]The complete definition is: *Research and Development Expense represents all direct and indirect costs related to the creation and development of new processes, techniques, applications and products with commercial possibilities* (Refinitiv, 2020).

[4]The procedure to compute the preferential tax treatment is the following: calculate the Effective Average Tax rate (EATR) or the cost of capital for a comparable investment to which R&D tax incentives do not apply. Then, by taking the difference between the two EATRs (R&D and non-R&D investment), it is possible to gauge the preferential tax treatment offered to R&D in a given jurisdiction.

[5]A more restrictive sample would be to consider firms that report R&D data at least k years consecutively. Appendix A.3 compiles the main results of the paper using the sample of firms reporting data at least 5 years consecutively (8,093 firms), yielding no significant differences.

	Full Sample	Firms with R&D data
Observations	406,765	93,555
Firms	29,450	13,246
Years covered	1980-2019	1980-2019
Avg. years per firm	13.8	7.1
Countries covered	38	38
Low-tech Firms	21,084	7,056
Mid-tech Firms	4,969	3,405
High-tech Firms	3,397	2,785

Note: *Full Sample* contains every firm in 38 EMEs. *Firms with R&D data* refers to the sample of firms reporting R&D expenditure data in at least one year. I use common industry tech-level classification, such as the one in Hall (2010). The full list of number of firms and observations per country and industry can be found in Appendix A.1 and A.2.

Table 1: Final sample details

Table 2 presents summary statistics of key variables for firms with R&D data.[6] Every accounting variable is winsorized at the top and bottom 1% to reduce the effects of outliers. It stands out that the R&D expenditure (both the level and the ratio compared to annual sales) presents a right-skewed distribution, with many firms not investing in R&D and some firms spending sizable amounts. Another key takeaway is that the median firm invests in R&D one sixth of what it spends in physical capital.

Variable	**Mean**	**SD**	**P25**	**Median**	**P75**	**Obs.**	**Firms**
R&D expenditure (million USD)	8.8	21.2	0.1	1.2	5.8	93,555	13,246
Capital expenditure (million USD)	34.2	173.03	1.1	6.2	28.5	120,029	13,235
R&D expenditure / Sales	0.030	0.120	0.001	0.008	0.033	92,222	13,102
Capital expenditure / Sales	0.110	0.211	0.018	0.048	0.114	117,696	13,154
Cash Flow / Assets	0.061	0.190	0.027	0.073	0.134	108,459	13,190
Sales Growth	0.175	0.492	-0.038	0.100	0.266	109,299	13,111
Labor Growth	0.066	0.265	-0.050	0.015	0.118	101,909	11,275

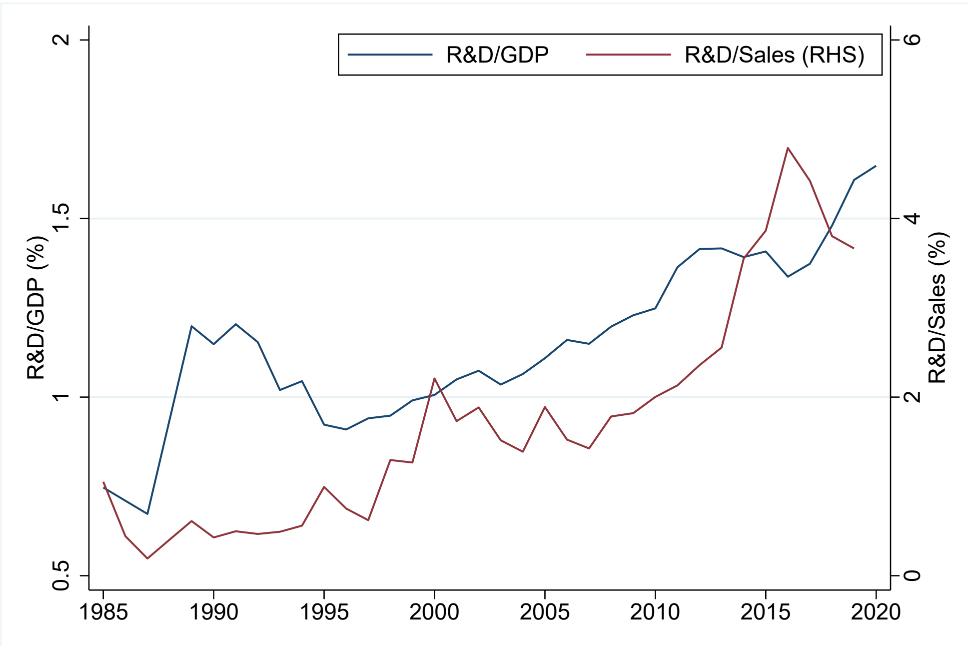
Note: The table shows summary statistics for the sample of firms with R&D data in EMEs between 1980 and 2019. Sales growth and labor growth is the % increase from one year to the next.

Table 2: Summary Statistics of R&D sample

Another useful analysis should be the comparison between the R&D expenditure of these companies, and the rest of the country R&D expenditure. Figure 1 shows, for the 38 EMEs analyzed,

[6] The same table for the full sample of firms in EMEs in the dataset, can be found in Appendix A.4. No significant differences were found between the two samples.

the average of firm-level R&D expenditure over annual sales, compared to the average of country-level R&D expenditure over GDP, using OECD data. Despite public listed companies spend around two and a half times more in R&D than the rest of the country, both series show a clear upward trend and a high correlation ($\rho = 0.71$). This clarifies that even though public listed companies may not be representative of the rest of the firms, their R&D expenditures move to the same direction that the rest of the country.



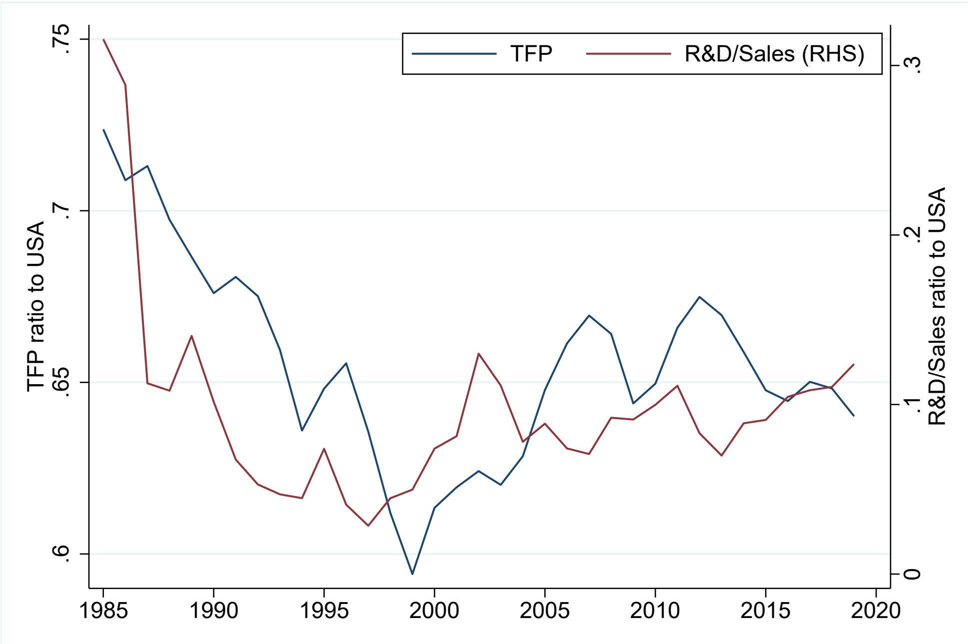
Note: The R&D/Sales series depicts simple averages across firms in 38 EMEs. The R&D/GDP series shows simple averages across 38 EMEs. Source: OECD and author's calculations using Refinitiv Worldscope.

Figure 1: R&D/GDP and R&D intensity in EMEs

Despite companies in EMEs are increasing their expenditures on innovation, they are doing it at a slower rate than AEs. Figure 2 shows the same firm-level R&D expenditure series as before, but scaling it over the same series for the US. The upward trend showed before, now became a clear downward trend and a stagnation over the last years. Additionally, I compare this ratio to the average (across countries) Total Factor Productivity (TFP) ratio to the US, using PWT 10.01 (Feenstra et al., 2015). Both series seem to co-move, and the correlation between the 1-year-lagged R&D expenditure ratio and the TFP ratio is striking, $\rho_{t-1} = 0.83$.[7] This shows a possible relation

[7]The correlation between the TFP ratio and the contemporaneous R&D expenditure, the 2-years-lagged and the 3-years-lagged are also high: $\rho_t = 0.82$, $\rho_{t-2} = 0.81$, $\rho_{t-3} = 0.79$.

(not causation) between the productivity growth slowdown for EMEs and the R&D expenditure by firms in such countries, compared to the US.



Note: The R&D/Sales series depicts simple averages across firms in 38 EMEs, compared to USA. The TFP series shows simple averages across 38 EMEs, compared to USA. Source: PWT 10.01 and author's calculations using Refinitiv Worldscope.

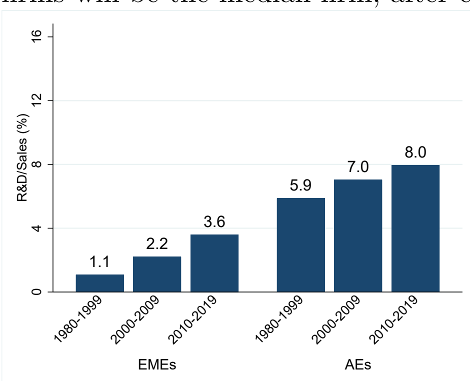
Figure 2: TFP and R&D intensity in EMEs compared to USA

3 Investment rates

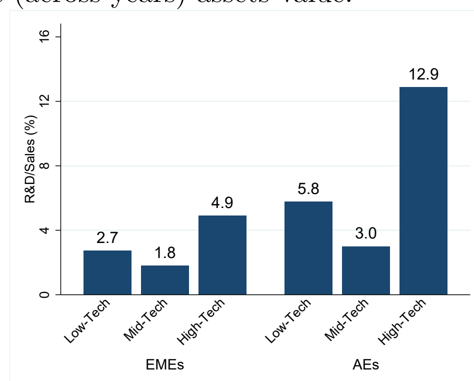
This section digs deeper on the analysis of the R&D investment rates by firms in EMEs. The variable used for this purpose is annual R&D investment over annual sales (or *R&D intensity*), which is a ratio of how much a firm invests compared to its income. First, I will analyze the R&D over sales ratio for various splits of firms and countries, to take into account the heterogeneity of firms in the sample. Then, I will deepen the analysis of the funding sources that firms rely on when financing this kind of investment. Whether it depends on internal or external resources will provide an insight on the existence of borrowing constraints.

3.1 R&D intensity

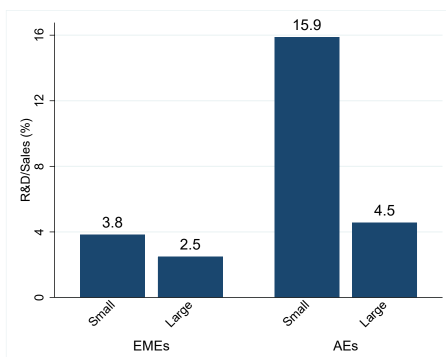
Figure 3 compares R&D intensity of firms in EMEs and AEs. I split the sample by decades, firm's tech-level and firm's size. First, splitting by decades is crucial since it allows us to see the trend of the investment, but also it is necessary since business decades ago may have different incentives to invest in R&D. Second, splitting by the technological level of the industry of the firm addresses the bias that AEs may have more technological firms than EMEs. Lastly, classifying firms by size allows to assess whether larger firms take advantage of their access to capital or economies of scale. It is worth noting that public listed companies are already *large*, compared to the rest of the firms in the economy. However, among this group of firms, there is still a heterogeneity that needs to be addressed. I will use assets value as a measure of firm size. The threshold between small and large firms will be the median firm, after calculating their average (across years) assets value.[8]



(a) Split by decades



(b) Split by tech level



(c) Split by firm size

Note: The figures depict averages of firm-level annual R&D expenditure over sales, for each split and group of countries. *Tech-level* split is performed using definitions in Hall (2010), while *firm size* split is done by checking the median firm in terms of averaged (across years) assets value.

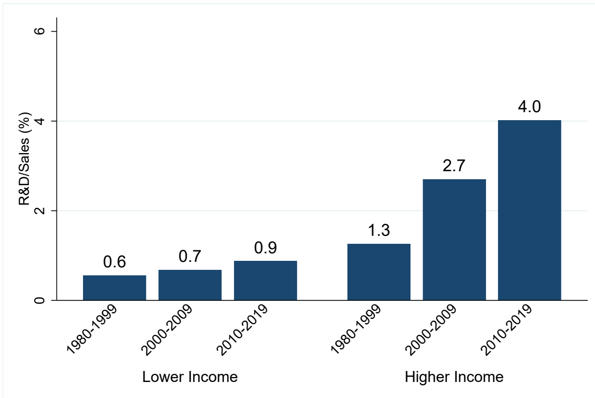
Figure 3: R&D/Sales - EMEs and AEs comparison

This shows that in recent decades, there has been a notable increase in R&D investment by firms, both in EMEs and AEs, reaching 3.6% and 8.0% respectively between 2010 and 2019. It is worth noting, however, that the investment ratio is consistently higher in AEs than in EMEs,

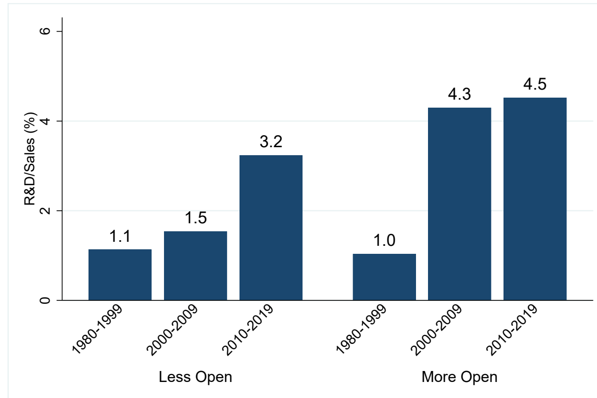
[8]Other measures of firm size for the split, such as annual sales, draw similar results, although with more discrepancy between small and large firms.

despite of the persistent growth in R&D by firms in EMEs. Particularly striking is the outstanding investment ratio seen among high-tech firms in AEs (12.9%), although in EMEs the investment is also high compared to mid and low-tech companies. Another interesting takeaway can be seen in the firm size split, with small firms in both EMEs and AEs exhibiting a propensity to invest more in R&D compared to larger firms.

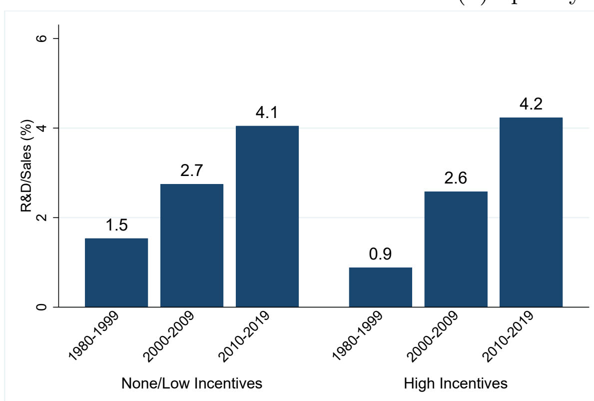
Figure 4 analyzes the heterogeneity of countries in EMEs in more depth. It shows the trend of R&D investment ratio by firms for different splits of countries (by using countries' metrics that may affect R&D investment), to assess whether there is a difference in the upward trend seen in Figure 3, Panel a). First, I categorize countries by their income level, using WDI data. I group lower-middle and low income in the *Lower income* group, and upper-middle and high income in the *Higher income* group. Second, to address a possible channel where companies that easily get financing abroad may have a higher investment, I split countries based on their financial account openness. The median country, using Chinn and Ito (2006) index, will serve as threshold to classify countries. Lastly, to assess the effectiveness of public policy towards R&D investment, I split countries whether there is a significant preferential tax treatment for R&D investment (5% or more) or not, using OECD's tax incentive database.



(a) Split by Income Level



(b) Split by Financial Openness



(c) Split by Tax Incentives

Note: The figures depict averages of firm-level annual R&D expenditure over sales, for each split and decade in EMEs. *Income level* split is performed using WDI. *Financial openness* split is done using the median country (after averaging across years) with Chinn and Ito (2006) index. *Tax incentives* split is done using OECD's tax incentive database (countries with tax incentives under 5% is categorized as *None/Low*).

Figure 4: R&D/Sales Trend - Country Splits - EMEs

This analysis shows interesting insights. First, firms in higher income countries are the ones whose R&D investment ratio have grown steadily, reaching 4.0% in the last analyzed period. On the other hand, firms in lower income countries have not shown any significant progress during the last decades. Second, firms in more financially open countries exhibit higher levels of R&D investment than those in more closed economies. Despite of the usual correlation between income and financial openness, panel (b) shows an even higher growth in the R&D ratio, growing from 1.0% to 4.5% in some decades. Since financially open countries typically have well-developed financial markets and institutions, firms have greater access to capital through various channels such as bank loans and private equity, which is particularly important for financing R&D projects (Hall and Lerner, 2009). Lastly, the impact of tax incentives on R&D investment appears limited, since the difference between countries with high and low incentives is negligible. A plausible explanation for this ineffectiveness is a crowding-out effect where tax incentives for R&D may inadvertently subsidize activities that companies would have undertaken regardless of the incentives. OECD (2023) find that this effect is particularly higher for larger firms, which happens to be the case in the sample analyzed.

3.2 Investment funding sources

This section formally assesses the importance of financial constraints for firms investing in R&D. I will follow an empirical approach on the standard investment regressions pioneered by Fazzari et al. (1988) (and later extended by Baker et al. (2003), among others). With some variations, these regressions relate a firm's investment to its growth opportunities, usually measured by its average Tobin's Q, and its availability of internal resources, traditionally captured by its cash flow and intended to capture the importance of financial constraints. I will adapt that framework to capture the role of financial constraints and/or growth opportunities towards the investment in R&D:

$$\frac{R_{i,c,t}}{Y_{i,c,t}} = \alpha + \beta_1 Q_{i,c,t-1} + \beta_2 \frac{CF_{i,c,t}}{Assets_{i,c,t}} + \beta_3 \frac{\Delta Debt_{i,c,t}}{Assets_{i,c,t}} + X_{i,t} + \Theta_{c,t} + \varepsilon_{i,c,t} \tag{1}$$

Where the measure of investment for firm i in country c in year t is the ratio of R&D investment ($R_{i,c,t}$) over the annual sales ($Y_{i,c,t}$). For the measure of growth opportunities, I will use the firm's lagged value of average Tobin's Q ($Q_{i,c,t-1}$).[9] On the other hand, the ratio of cash flows ($CF_{i,c,t}$) over assets ($Assets_{i,c,t}$) measures the availability of internal resources, aiming to capture the relevance of financial constraints. Lastly, the ratio of total debt growth ($\Delta Debt_{i,c,t}$) over assets measures the debt issuance (short term and long term) as an alternative source of funding. Additional control variables, such as firm size and profitability are included in $X_{i,t}$. Country-year fixed effects are also included to control for unobserved firm characteristics.

Table 3 shows the results of the regression, in EMEs, for R&D investment, and also for physical capital investment, for comparison. Both sources of funding (cash flow ratio and debt issuance ratio)

[9] I rely on computing the average Tobin's Q rather than the marginal Q, since the latter is unobservable. I follow the specification by Fazzari et al. (1988): Q = (Mkt Value of Common Equity + (Total Assets - Book Value of Common Equity))/Total Assets.

appears positive and significant. The discrepancy between R&D and physical capital arises when looking at the magnitudes of each coefficient. The cash flow ratio coefficient is three times larger, and the debt issuance ratio coefficient is roughly half for R&D than that for physical capital. For instance, in average, a 10% increase in the CF/Assets ratio would increase the R&D investment ratio by 1.46%, and the physical capital investment by 0.56%. On the other hand, the same increase of 10% in the ΔDebt/Assets ratio would increase the R&D investment ratio by 0.8%, and the physical capital investment by 1.27%. This suggests that firms rely more on their own resources when financing R&D projects than they do when financing physical capital investment. At the same time, debt issuance has a stronger correlation with capital expenditure than R&D expenditure. This analysis illustrates that the phenomena of borrowing constraints when financing R&D projects is also relevant for publicly listed companies in EMEs.

Table 4 performs the same analysis for the sample of firms in advanced economies. It stands out that Tobin's Q coefficient, both for R&D and Capex, is higher in AEs than in EMEs. This implies that the market-perceived growth opportunities is more relevant for investment in these firms. Also, while the effect of CF/Assets is similar for Capex, it is slightly lower for R&D investment. At the same time, ΔDebt/Assets' coefficient is larger in both kind of investments. This means that firms in AEs tends to rely on their own resources for R&D investment in a lesser extent, while debt issuance is still a strong source of funding. Overall, one can say that firms both in AEs and EMEs suffer the problem of borrowing constraints, albeit it is stronger in firms in EMEs.

Dependent variable:	R_t/Y_t			$Capex_t/Y_t$		
	(1)	(2)	(3)	(4)	(5)	(6)
Q_{t-1}	0.0166^{*}	0.0105^{**}	0.0163^{**}	0.0171^{**}	0.0169^{***}	0.0172^{***}
	(0.00949)	(0.00468)	(0.00736)	(0.00737)	(0.00619)	(0.00627)
$CF_t/Assets_t$	0.146^{***}		0.145^{***}	0.0485^{***}		0.0555^{***}
	(0.0465)		(0.0471)	(0.00561)		(0.00574)
$\Delta Debt_t/Assets_t$		0.0521^{***}	0.0802^{***}		0.117^{***}	0.127^{***}
		(0.0190)	(0.0176)		(0.00583)	(0.00599)
Country-year F.E.	✓	✓	✓	✓	✓	✓
Observations	72,963	72,936	72,555	82,262	82,466	82262

Note: Standard errors in parentheses, clustered at firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Only firms, in EMEs, with at least one year of R&D data are included in the sample of the regressions. Every specification includes a constant, country-year fixed effects and two control variables: firm's $log(assets_t)$ and ROA_t.

Table 3: R&D and Capital Investment Source Funding - EMEs

Dependent variable:	R_t/Y_t			$Capex_t/Y_t$		
	(1)	(2)	(3)	(4)	(5)	(6)
Q_{t-1}	0.0251^{***}	0.0212^{***}	0.0286^{***}	0.0232^{**}	0.0223^{***}	0.0169^{***}
	(0.00792)	(0.00521)	(0.00242)	(0.00952)	(0.00502)	(0.00619)
$CF_t/Assets_t$	0.0955^{***}		0.112^{***}	0.0672^{***}		0.0596^{***}
	(0.0287)		(0.0454)	(0.00896)		(0.00475)
$\Delta Debt_t/Assets_t$		0.113^{***}	0.120^{***}		0.174^{***}	0.192^{***}
		(0.0233)	(0.0185)		(0.00481)	(0.00820)
Country-year F.E.	✓	✓	✓	✓	✓	✓
Observations	198,718	200,165	197,574	193,569	194,190	193,569

Note: Standard errors in parentheses, clustered at firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Only firms, in AEs, with at least one year of R&D data are included in the sample of the regressions. Every specification includes a constant, country-year fixed effects and two control variables: firm's $log(assets_t)$ and ROA_t.

Table 4: R&D and Capital Investment Source Funding - AEs

4 Return rates

While the previous section showed some insights to understand the trends in R&D investment by firms in EMEs, this section focuses on the outcome of that investment: the return. When measuring the returns, literature has divided according to at least three dimensions (Hall et al., 2010). First, whether the estimation is on private returns (looking only the profitability of the firm) or social returns (measuring also spillovers and externalities). Second, the econometric approach varies among different studies. While some authors estimate a production function, others focus on the costs function of the firm. Lastly, depending on the scope of the paper, some authors measure the return of certain R&D expenditures, namely process R&D or product R&D. Given the nature of the R&D variable used in this study (and the abundance of benchmarks to compare the results to), I will estimate the private returns, using a production function, and using the most comprehensive definition of R&D investment.

4.1 Theoretical Model

According to the usual framework in the literature, following Charles and Williams (1997) and Hall et al. (2010), a firm i (in country m) in year t, produces its output (Y_{it}) following an augmented Cobb-Douglas technology type using physical capital (C_{it}), labor (L_{it}) and knowledge capital (K_{it}):

$$Y_{it} = A_{imt} L_{it}^{\alpha} C_{it}^{\beta} K_{it}^{\gamma} e^{u_{it}} \tag{2}$$

Where A_{imt} represents the technical progress, that can be separated between a firm-specific effect and a country-time effect: $A_{imt} = A'_i \cdot A'_{mt}$. Firms' productivity shocks are represented by u_{it}. I will assume that u_{it} are i.i.d.[10] Also, I will assume that shocks are firm-specific, and do not have any industry-wide component.

[10]These kind of shocks are assumed in many studies (Hall and Mairesse (1995); Wakelin (2001); Foray et al. (2007)). However, other authors (Griffith et al. (2006); Rogers (2010); Benavente and Calvo (2019)) use a more flexible specification that allows productivity shocks to have certain persistence. Nonetheless, some authors that use both models do not find significant differences in their estimation (Griffith et al. (2004); Bond et al. (2003)). I use a serial correlation test proposed by Wooldridge (2002) to test the absence of autocorrelation of u_{it}, after allowing for heteroskedasticity clustering at the firm-level. This yields a p-value of 13%, thus not rejecting the null hypothesis of no first-order autocorrelation.

Next, I will take logs and the first difference. Defining $\Delta a_{mt} \equiv \lambda_{mt}$:

$$y_{it} = a_i + a_{mt} + \alpha l_{it} + \beta c_{it} + \gamma k_{it} + u_{it}$$
$$\Delta y_{it} = \lambda_{mt} + \alpha \Delta l_{it} + \beta \Delta c_{it} + \gamma \Delta k_{it} + \Delta u_{it} \tag{3}$$

Where lower case letters represent logarithms. The main problem with estimating the previous equation is that Δk, which is approximately the growth rate $\frac{\Delta K}{K}$, requires an appropriate measure of an intangible asset. To overcome this problem, the literature relies on a subtle transformation. Using the definition of the elasticity as the product between the marginal productivity and the ratio of K over Y ($\gamma = \frac{\partial Y}{\partial K}\frac{K}{Y}$):

$$\gamma \cdot \Delta k = \frac{\partial Y}{\partial K}\frac{K}{Y} \cdot \frac{\Delta K}{K} = \rho_{K} \frac{\Delta K}{Y}$$

Besides losing the level of K, this transformation has the purpose of incorporating the marginal productivity (ρ_{K}) into the equation that will be estimated, rather than the elasticity (γ). The marginal productivity estimation will be used as the measure of the return rate. In order to compare both R&D return and physical capital return, I will also use this transformation for the latter ($\beta \Delta c = \rho_{C} \frac{\Delta C}{Y}$). And so, (3) becomes:

$$\Delta y_{it} = \lambda_{mt} + \alpha \Delta l_{it} + \rho_{C} \frac{\Delta C_{it}}{Y_{it}} + \rho_{K} \frac{\Delta K_{it}}{Y_{it}} + \Delta u_{it} \tag{4}$$

Note that ΔC_{it} can be easily measured, as the net physical capital formation (or the net investment in physical capital). However, ΔK_{it} is not observed yet. One can use the traditional formation of capital $\Delta K_t = R_t - \delta_K K_{t-1}$, (where R_t is R&D investment) and follow Charles and Williams (1997), Griffith et al. (2004) and Goñi and Maloney (2017) to assume that the depreciation of the knowledge capital is negligible ($\delta_K \approx 0$). This is a good approximation since it is an intangible asset that is durable and does not necessarily diminish over time. However, such traditional formation of capital would not take into account the long term nature of R&D investment. As discussed, it may take years between the investment and the actual innovation (due to learning process) depending on the complexity of the innovation. Because of this, lags of R&D expenditures ($R_{i,t-\tau}$) must be incorporated in the formation of the knowledge capital. A formal expression that allows for the possibility that *i)* current investment may not increase current stock one-to-one $\left(\frac{\partial \Delta K_t}{\partial R_t} < 1\right)$, *ii)* current investment actually decreases current stock $\left(\frac{\partial \Delta K_t}{\partial R_t} < 0\right)$, and *iii)* current knowledge stock may be affected by past investment $\left(\frac{\partial \Delta K_t}{\partial R_{t-\tau}} \neq 0\right)$, could be:

$$\Delta K_t = \omega_0 R_t + \sum_{\tau=1}^{T} \omega_\tau R_{t-\tau} = \sum_{\tau=0}^{T} \omega_\tau R_{t-\tau} \tag{5}$$

It is crucial to understand that is is not that the lagged investment would affect the output in a later year directly. It is always the stock of knowledge capital in t that affects production in t. The crucial assumption here is that the lagged investment would affect the knowledge capital in a later year, and through that, the production in a later year. This distinction is relevant for the case of physical capital. Note that I am not including any variable of physical capital investment (neither contemporaneous nor lagged), but the actual net growth of physical capital (ΔC).

Replacing (5) in (4):

$$\Delta y_{it} = \lambda_{mt} + \alpha \Delta l_{it} + \rho_C \frac{\Delta C_{it}}{Y_{it}} + \rho_K \left[\omega_0 \frac{R_{it}}{Y_{it}} + \sum_{\tau=1}^{T} \omega_\tau \frac{R_{i,t-\tau}}{Y_{it}} \right] + \Delta u_{it} \tag{6}$$

Note that in the previous equation, ρ_K cannot be estimated. However, the parameter of interest now is not ρ_K, but actually the sum of the coefficients of both contemporaneous and lagged investment in R&D ($\sum_{\tau=0}^{T} \rho_K \omega_\tau$). Following Benavente and Calvo (2019), this parameter is a measure of a "mid-run" return of these activities. In other words, it does not matter whether the impact of R&D investment on output is negative contemporaneously or positive in the following years, but the return in net terms.[11]

The final tweak to (6) is to address the endogeneity between any investment decision (both capital and R&D stock) and the productivity of the firm and other characteristics that are captured in u_{it}. For example, a firm may spend more in such investments only the years it got a great performance (in terms of Y_{it}), and thus the estimate of the investment return would be upward biased. Formally, the investment endogeneity takes the form $E(R_{it} u_{it}) \neq 0$ and $E(\Delta C_{it} u_{it}) \neq 0$. Note that the first lag of R&D investment is also endogenous in the model, since $E(R_{i,t-1} \Delta u_{it}) = E(R_{i,t-1}(u_{it} - u_{i,t-1})) \neq 0$. To overcome this issue, I will include four instrumental variables on

[11] Note that, for instance, $\rho_K \omega_0 < 0$ would not imply that the contemporaneous knowledge capital is decreasing the output, but actually, that contemporaneous investment in knowledge capital is (temporary) decreasing the knowledge capital and, through that channel, decreasing the output.

both the contemporaneous and lagged R&D investment rate ($\frac{R_{it}}{Y_{it}}$ and $\frac{R_{i,t-1}}{Y_{it}}$), and the net physical capital investment rate ($\frac{\Delta C_{it}}{Y_{it}}$). The first instrument, common to every endogenous variable, is an output lag in levels ($Y_{i,t-\tau}$). Using lags (in level) as instruments in an equation in difference have been vastly used in the literature (Hall et al., 2010). The rationale behind it is straightforward: firm's past performance is not a predictor of today's performance[12], while it may affect today's R&D investment by reducing financial constraints or lowering financial costs. Griffith et al. (2006) argue that only one lag dated $t-2$ is enough, and so I will include $Y_{i,t-2}$ as the first instrument. The rest of the instruments can be computed due to the advantages of the dataset. They are country-industry averages of both the contemporaneous and lagged R&D investment $\overline{R}_{j,m,t}$ and $\overline{R}_{j,m,t-1}$, and the net physical capital investment $\overline{\Delta C}_{j,m,t}$. These variables are expected to be highly correlated with the firm-level investment, at the same time that they are not correlated with a firm-specific performance (firms are affected by firm-specific shocks rather than industry-wide shocks). These four instruments will be proved to be valid as exogenous and relevant in a two-stage least squares (2SLS) approach.

After addressing the endogeneity problem, the equation in (6) becomes:

$$\Delta y_{it} = \lambda_{mt} + \alpha \Delta l_{it} + \rho_C \widehat{\frac{\Delta C_{it}}{Y_{it}}} + \rho_K \omega_0 \widehat{\frac{R_{it}}{Y_{it}}} + \rho_K \omega_1 \widehat{\frac{R_{i,t-1}}{Y_{it}}} + \sum_{\tau=2}^{T} \rho_K \omega_\tau \frac{R_{i,t-\tau}}{Y_{it}} + \Delta u_{it} \tag{7}$$

Where $\widehat{\frac{\Delta C_{it}}{Y_{it}}}$, $\widehat{\frac{R_{it}}{Y_{it}}}$ and $\widehat{\frac{R_{i,t-1}}{Y_{it}}}$ come after a first stage regression using Y_{t-2}, $\overline{R}_{j,m,t}$, $\overline{R}_{j,m,t-1}$ and $\overline{\Delta C}_{j,m,t}$ as exogenous instruments. Y_{it} will be measured as annual sales, L_{it} as number of employees, C_{it} as PP&E stock and R_{it} as R&D expenditure. All variables are measured in constant 2018 U.S. dollars.

4.2 Return Rates Estimation

Table 5 shows the results of the main regression (7) for firms in EMEs. For comparison, it displays two sets of specifications: OLS and two-stage least squares (2SLS), where a 1st stage regression is run on $\frac{\Delta C_{it}}{Y_{it}}$, $\frac{R_{it}}{Y_{it}}$ and $\frac{R_{i,t-1}}{Y_{it}}$. Every specification corrects the standard errors for heteroskedasticity and clusters them at the firm level to control for serial correlation. I include specifications with different sets of lags, to assess the relevance of lags in the estimation. Hall et al. (2010) recommend

[12] Since $\Delta u_{it} = u_{it} - u_{i,t-1}$, the orthogonality condition holds, $E(Y_{it-j}\Delta u_{it}) = 0$, for $j >= 2$.

to include 2 or 3 lags for the average firm or R&D project, after examining different studies that analyzes different industries and countries. In Appendix A.5, an extended version of Table 5 can be found, including up to 5 lags. There is no apparent difference after the third lag, thus the preferred specification will be the one including 3 lags. Besides the estimation for every coefficient, the table exhibits the estimation for the parameter of interest (*R&D return (sum)*), which is the sum of the coefficients of both current and lagged R&D investment (recall this parameter is a measure of a "mid-run" return of these activities). For this estimator, I perform a joint hypothesis test (where the null hypothesis is that the estimator is 0) to assess its significance. To assess the validity of the instruments in each regression, the table displays both the p-value of the Sargan-Hansen's overidentification test (to assess the exogeneity of the instruments) and the Cragg-Donald F statistic of the 1st stage regression (to assess the relevance of the instruments).

R&D investment return is positive, significant and robustly higher than physical capital return among the specifications that includes lags, reaching 37.6% in the preferred specification. This means that, on average, every dollar spent in R&D yields a mid-run return of 0.376 dollars per year. Note that the contemporaneous R&D investment actually has a negative impact in the output (-37.8%), while the lagged R&D investment terms tend to be positive thus making the investment profitable at the mid-run. This investment maturity effect is widely acknowledged in the literature as part of a learning process by firms when investing in a knowledge-based capital. It is also remarkable that R&D investment return is more than double the physical capital return, 16.0%.

For comparison purposes, Table 6 shows the same analysis, but for firms in AEs. R&D return in these firms is also positive, significant and robustly higher than physical capital. However, the return is lower than firms in EMEs, 27.1%. This profitability difference has been anticipated and documented by Goñi and Maloney (2017) stating that companies in EMEs are further away from the technological frontier compared to firms in AEs. Lastly, it is worth noting that physical capital return is roughly the same for firms in AEs and in EMEs (16.5%).

Dependent variable:			Δy_t			
	OLS			2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Δl_t	0.319***	0.390***	0.386***	0.277	0.402***	0.442***
$\frac{\Delta C_t}{Y_t}$	0.152***	0.164***	0.167***	0.542	0.142**	0.160**
$\frac{R_t}{Y_t}$	-0.0624***	-0.301***	-0.271***	-0.897	-0.403**	-0.378***
$\frac{R_{t-1}}{Y_t}$		0.0231	0.0825***		0.0922**	0.0718
$\frac{R_{t-2}}{Y_t}$		0.579***	0.284***		0.699***	0.703***
$\frac{R_{t-3}}{Y_t}$			0.186***			-0.0212*
Capital return	15.2%***	16.4%***	16.7%***	54.2%	14.2%**	16.0%**
R&D return (sum)	-6.2%***	30.1%***	28.2%***	-89.7%	38.8%**	37.6%***
Sargan-Hansen p-value	-	-	-	0.28	0.34	0.29
Cragg-Donald F statistic	-	-	-	1.24	20.2	21.4
Observations	53,309	41,043	34,410	53,309	41,043	34,408

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample contains firms in 38 EMEs between 1980 and 2019. Every regression includes country-year fixed effects and clusters the standard errors at firm level. The *R&D return (sum)* term is the sum of contemporaneous and lagged $\frac{R_{t-j}}{Y_t}$ ratios' coefficients, while its significance comes after a joint hypothesis test (H_0: sum = 0). On 2SLS specifications, a 1st stage is regressed on the variables $\frac{\Delta C_t}{Y_t}$, $\frac{R_{t-1}}{Y_t}$ and $\frac{R_t}{Y_t}$ using four instruments: a country-industry average of both contemporaneous and lagged R&D investment ($\overline{R}_{j,m,t}$, $\overline{R}_{j,m,t-1}$), and capital growth ($\overline{\Delta C}_{j,m,t}$), and the 2-periods lagged sales ($Y_{i,t-2}$). These specifications display the p-value of the Sargan-Hansen test and the Cragg-Donald F statistic of the 1st stage regression.

Table 5: R&D Returns - Baseline - EMEs

Dependent variable:			Δy_t			
	OLS			2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Δl_t	0.332*	0.311*	0.382***	0.245**	0.294***	0.302**
$\frac{\Delta C_t}{Y_t}$	0.177**	0.194***	0.209**	0.189*	0.171*	0.165**
$\frac{R_t}{Y_t}$	0.0808	-0.111***	-0.115***	-0.097*	-0.291	-0.334**
$\frac{R_{t-1}}{Y_t}$		0.071*	0.093**		0.477*	0.403***
$\frac{R_{t-2}}{Y_t}$		0.306***	0.255***		0.112***	0.093
$\frac{R_{t-3}}{Y_t}$			0.030***			0.110*
Capital return	17.7%**	19.4%***	20.9%**	18.9%*	17.1%*	16.5%**
R&D return (sum)	8.1%	26.7%***	26.3%***	-9.7%*	29.8%**	27.1%***
Sargan-Hansen p-value	-	-	-	0.43	0.64	0.68
Cragg-Donald F statistic	-	-	-	9.0	34.1	36.2
Observations	182,605	157,786	142,839	182,605	157,786	142,821

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample contains firms in 21 AEs between 1980 and 2019. Every regression includes country-year fixed effects and clusters the standard errors at firm level. The *R&D return (sum)* term is the sum of contemporaneous and lagged $\frac{R_{t-j}}{Y_t}$ ratios' coefficients, while its significance comes after a joint hypothesis test (H_0: sum = 0). On 2SLS specifications, a 1st stage is regressed on the variables $\frac{\Delta C_t}{Y_t}$, $\frac{R_{t-1}}{Y_t}$ and $\frac{R_t}{Y_t}$ using four instruments: a country-industry average of both contemporaneous and lagged R&D investment ($\overline{R}_{j,m,t}$, $\overline{R}_{j,m,t-1}$), and capital growth ($\overline{\Delta C}_{j,m,t}$), and the 2-periods lagged sales ($Y_{i,t-2}$). These specifications display the p-value of the Sargan-Hansen test and the Cragg-Donald F statistic of the 1st stage regression.

Table 6: R&D Returns - Baseline - AEs

The heterogeneity between firms and countries in EMEs is even more relevant when analyzing return rates (Hall et al., 2010). To assess whether the 37.6% return found is robust across firms and countries, I perform the estimation for different splits. Similarly to the investment rates (Section 3), I split firms by decades, firm's tech-level, firm's size and R&D intensity (measured as the R&D over sales ratio). For these later two metrics, the split's threshold uses the median firm, after averaging across years. These firms splits results are summarized in Table 7. On the other hand, Table 8 shows the results of countries splits by characteristic that may be affecting the returns of private R&D investment. The first split categorizes countries based on their income level (using WDI data). The second split divides countries depending whether there is a strong preferential tax treatment for R&D investment (5% or more), using the OECD's tax incentives dataset. The last split considers the financial account openness, using the median country (of the Chinn and Ito (2006) index) as the threshold to consider a country more financially open or closed.

Notably, Table 7 shows that R&D investment return has grown steadily over the last decades, from showing no significance in 1980-1999 to a high return of 41.4% in 2010-2019. At the same time, physical capital return has declined in the same period, from 21.2% in 1980-1999 to 15.2% in 2010-2019. On the other hand, high-tech firms stand out with an exceptional return of 53.3%, while low-tech companies also exhibit a considerable return of 32.3%. Surprisingly, larger firms show a lower return compared to smaller ones, 30.4% and 39.2% respectively, challenging again that economies of scale occur in R&D investment. Finally, looking at the R&D intensity split, firms with higher investment also benefit with higher returns: 41.2%. Two potential explanations arise: either firms invest more in R&D due to expected higher returns, or alternatively, R&D investment becomes more profitable at larger scales.

Now turning to country splits, Table 8 reveals distinctive trends. First, firms in higher income countries exhibit larger returns than those in lower income countries, replicating the results seen when comparing EMEs and AEs in Tables 5 and 6. Second, the impact of tax incentives on returns seems again negligible, as firms in countries with higher tax incentives do not necessarily show higher returns on R&D.[13] Lastly, regarding the country financial openness, firms in countries with more cross-country financial restrictions experience a higher return than those in countries that are more financially open.

[13] Appendix A.6 digs deeper on the income and tax incentive splits, creating four categories of countries that combines both metrics. Among the lower income countries, there seems to be a positive effect on the return by countries with high tax incentives, although there are not many observations in the low income/low tax incentives category to properly assess it.

	Decades			Tech-Level			Firm Size		R&D intensity	
	(a.1)	(a.2)	(a.3)	(b.1)	(b.2)	(b.3)	(c.1)	(c.2)	(d.1)	(d.2)
	1980-1999	*2000-2009*	*2010-2019*	*Low-tech*	*Med-tech*	*High-tech*	*Small*	*Large*	*Low*	*High*
Δl_t	0.362***	0.392***	0.417***	0.387***	0.383***	0.414***	0.574***	0.399***	0.421***	0.552**
$\frac{\Delta C_t}{Y_t}$	0.212**	0.198**	0.152***	0.192***	0.163**	0.174*	0.157***	0.183***	0.148***	0.179***
$\frac{R_t}{Y_t}$	-0.541	-0.215***	-0.052*	-0.402***	-0.078**	0.278**	0.425*	-0.625***	0.184	0.052*
$\frac{R_{t-1}}{Y_t}$	0.245***	0.128***	0.299***	0.028	0.211**	-0.173***	-0.562**	0.285	-0.210	0.415
$\frac{R_{t-2}}{Y_t}$	0.274	0.157	-0.124**	0.456	-0.485**	0.274***	0.548**	0.379**	-0.047	-0.254
$\frac{R_{t-3}}{Y_t}$	0.157*	0.201***	0.291**	0.241**	0.625	0.154*	-0.019	0.265	0.305***	0.199
Capital return	21.2%**	19.8%**	15.2%***	19.2%***	16.3%**	17.4%*	15.7%***	18.3%***	14.8%***	17.9%***
R&D return (sum)	13.5%	27.1%***	41.4%***	32.3%**	27.3%*	53.3%***	39.2%***	30.4%*	23.2%**	41.2%***
Sargan-Hansen p-value	0.48	0.18	0.19	0.57	0.22	0.56	0.45	0.39	0.08	0.42
Cragg-Donald F statistic	15.1	22.2	29.1	30.4	15.2	16.2	22.8	19.2	30.2	28.3
Observations	1,532	9,475	23,401	14,510	10,215	9,429	10,183	24,113	9,070	25,191

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample contains firms in 38 EMEs. Every regression includes country-year fixed effects and clusters the standard errors at firm level. Four splits are performed: by decades, by tech-level, by firm size (median firm's assets) and by R&D intensity (median firm's R&D/sales ratio). The *R&D return (sum)* term is the sum of contemporaneous and lagged $\frac{R_{t-j}}{Y_t}$ ratios' coefficients, while its significance comes after a joint hypothesis test (H_0: sum = 0). A 1st stage is regressed on the variables $\frac{\Delta C_t}{Y_t}$, $\frac{R_{t-1}}{Y_t}$ and $\frac{R_t}{Y_t}$ using four instruments: a country-industry average of both contemporaneous and lagged R&D investment ($\overline{R}_{j,m,t}$, $\overline{R}_{j,m,t-1}$), and capital growth ($\overline{\Delta C}_{j,m,t}$), and the 2-periods lagged sales ($Y_{i,t-2}$). Every specification displays the p-value of the Sargan-Hansen test and the Cragg-Donald F statistic of the 1st stage regression.

Table 7: R&D returns estimation: Firm Splits

	Income level		Tax incentives		Financial openness	
	(a.1)	(a.2)	(b.1)	(b.2)	(c.1)	(c.2)
	Lower	*Higher*	*None/Low*	*High*	*Low*	*High*
Δl_t	0.421***	0.387***	0.384***	0.424***	0.392***	0.441***
$\frac{\Delta C_t}{Y_t}$	0.133**	0.152**	0.134***	0.119**	0.224***	0.167**
$\frac{R_t}{Y_t}$	-0.159**	-0.174 **	-0.106**	0.028	-0.262***	-0.121**
$\frac{R_{t-1}}{Y_t}$	-0.209	-0.419 *	-0.427***	-0.184	0.153**	-0.116***
$\frac{R_{t-2}}{Y_t}$	0.257***	0.127*	0.551***	-0.242**	0.396	0.441*
$\frac{R_{t-3}}{Y_t}$	0.324	0.858***	0.353***	0.778**	0.155	0.128***
Capital return	13.3%**	15.2%**	13.4%***	11.9%**	22.4%***	16.7%**
R&D return (sum)	21.3%*	39.2%***	37.1%***	38.0%**	44.2%***	33.2%***
Sargan-Hansen p-value	0.29	0.34	0.31	0.15	0.54	0.48
Cragg-Donald F statistic	13.5	20.4	14.5	32.1	21.8	15.4
Observations	12,012	22,306	11,788	15,135	25,763	8,645

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample contains firms in 38 EMEs. Every regression includes country-year fixed effects and clusters the standard errors at firm level. Three splits are performed at the country level: by income level (WDI), by tax incentives (OECD's database, under 5% tax incentive being *None/Low*) and by financial openness (median country Chinn and Ito (2006) index). The *R&D return (sum)* term is the sum of contemporaneous and lagged $\frac{R_{t-j}}{Y_t}$ ratios' coefficients, while its significance comes after a joint hypothesis test (H_0: sum = 0). A 1st stage is regressed on the variables $\frac{\Delta C_t}{Y_t}$, $\frac{R_{t-1}}{Y_t}$ and $\frac{R_t}{Y_t}$ using four instruments: a country-industry average of both contemporaneous and lagged R&D investment ($\overline{R}_{j,m,t}$, $\overline{R}_{j,m,t-1}$), and capital growth ($\overline{\Delta C}_{j,m,t}$), and the 2-periods lagged sales ($Y_{i,t-2}$). Every specification displays the p-value of the Sargan-Hansen test and the Cragg-Donald F statistic of the 1st stage regression.

Table 8: R&D returns estimation: Country Splits

5 Conclusion

This study captured interesting findings about the trends on R&D investment levels and return rates by firms in emerging-market economies over the latest decades, using firm-level data in a cross-country analysis, which is not common on the literature. In a scenario of global productivity slowdown, which is stronger in EMEs, one can say that neither R&D investment nor private returns for that investment are the ones to blame. Both R&D investment and return rates have been growing steadily across different kind of firms in EMEs.

This R&D investment upward trend has taken place both in EMEs and AEs, reaching 3.6% and 8.0% respectively over the latest years analyzed. It is worth noting that the investment ratio is consistently higher in AEs than in EMEs, despite of the persistent growth in R&D by firms in EMEs. This upward trend is clearer in wealthier and more financially open countries, while firms in lower income countries have not shown any significant improvement. Also, the impact of tax incentives on R&D investment appears limited, since the difference between countries with high and low incentives is negligible. This investment increase has taken place despite the presence of borrowing constraints, which have also shown to be relevant when financing R&D projects, specially in EMEs.

At the same time, R&D investment return in EMEs is positive, significant and robustly higher than physical capital return, reaching an average of 37.6%. While the contemporaneous R&D investment has a negative impact in the output, the lagged terms are positive thus making the investment profitable at the mid-run. The return has grown steadily over the last decades (even surpassing AEs firms' returns), while physical capital return has slightly declined in the same period. High-tech and smaller companies are the ones showing higher returns. When looking at countries splits, firms in wealthier countries and more financially closed are experiencing higher returns compared to their counterpart. Lastly, one can observe that firms in countries with high tax incentives programs not necessarily show a higher return.

These findings can partially explain the problem of productivity slowdown in EMEs in two ways. The first one is to notice that although investment by firms has grown in EMEs, it is still far away from their counterparts in AEs. One of the reasons why this catch-up is not complete yet, would be the presence of borrowing constraints that has been proved to be affecting companies in

EMEs more than the ones in AEs. The second explanation depends on the hypothesis that the channel between R&D investment and productivity gains is not straightforward in EMEs. Having large firms robustly increasing their R&D investment and showing high returns from it would not be enough for pushing the whole economy's productivity. This would reinforce the relevance of spillovers in knowledge capital. Spillover benefits are highly correlated with institutionality, competitive markets and skilled workforce, which are indeed characteristics that differences AEs and EMEs.

An important limitation of these results is the external validity to the firms that are not public listed companies. However, these findings are important given the relevance of these firms for the rest of the country and the limitation of datasets. Future research should try to estimate spillovers effects between firms and/or the rest of the economy, to tackle the hypothesis that this is the main obstacle between private R&D and productivity gains. To contrast these findings, it would also be beneficial to deepen the analysis, in EMEs, using firm-level measures that may affect both investment and returns, such as workers' human capital or cost of financing R&D and capital, but also other measures of R&D output, like patents creation. Finally, the question about why do companies in EMEs do not invest more in R&D given the high returns is still open. Borrowing constraints were proven to be relevant, so future research could dig deeper on the effectiveness of other policy measures, such as government loan guarantee programs or different R&D subsidies policies.

References

Adler, G., Duval, R. A., Furceri, D., Çelik, S. K., Koloskova, K., and Ribeiro, M. P. (2017). Gone with the Headwinds: Global Productivity. *IMF Staff Discussion Note*, SDN/17/04.

Aghion, P., Berman, N., Eymard, L., Askenazy, P., and Cette, G. (2010). Credit Constraints and the Cyclicality of R&D Investment: Evidence from France. *Journal of the European Economic Association*, Vol. 10, No. 5:1001–1024.

Andrews, D., Criscuolo, C., and Gal, P. (2016). The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy. *OECD Productivity Working Papers*, No. (5).

Baker, M., Stein, J. C., and Wurgler, J. (2003). When does the market matter? Stock prices and the investment of equity-dependent firms. *The Quarterly Journal of Economics*, Vol. 118, No. 3:969–1005.

Benavente, J. M. and Calvo, C. (2019). Private Return to R&D Activities in Chile. *IDB Discussion Paper*, IDB-DP-706.

Bond, S., Harhoff, D., and Van Reenen, J. (2003). Corporate R&D and productivity in Germany and the United Kingdom. *LSE Research Online Documents on Economics*, No. 770.

Bond, S., Harhoff, D., and Van Reenen, J. (2010). Investment, R&D and Financial Constraints in Britain and Germany. *NBER Chapters, in: Contributions in Memory of Zvi Griliches*, pages 433–460.

Charles, J. and Williams, J. (1997). Measuring The Social Return To R&D. *The Quarterly Journal of Economics*, 113 (4):1119–1135.

Chinn, M. and Ito, H. (2006). What Matters for Financial Development? Capital Controls, Institutions, and Interactions. *Journal of Development Economics*, Volume 81, Issue 1:163–192.

De Gregorio, J. (2018). Productivity in Emerging-Market Economies: Slowdown or Stagnation? *PIIE Working Paper*, 18-12.

Decker, R. A., Haltiwanger, J., Jarmin, R. S., and Miranda, J. (2017). Declining Dynamism, Allocative Efficiency, and the Productivity Slowdown. *American Economic Review*, 107 (5):322–326.

Fazzari, S. M., Hubbard, R. G., and Petersen, B. C. (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, Vol. 1988, No. 1:141–206.

Feenstra, R. C., Inklaar, R., and Timmer, M. P. (2015). The Next Generation of the Penn World Table. *American Economic Review*, Volume 105, Issue 10:3150–3182.

Foray, D., Hall, B. H., and Mairesse, J. (2007). Pitfalls in estimating the returns to corporate R&D using accounting data. *CEMI Working Papers. College of Management of Technology.*

Gordon, R. J. (2012). Is U.S. Economic Growth Over? Faltering Innovation Confronts the Six Headwinds. *NBER Working Paper*, 18315.

Gordon, R. J. (2016). *The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War*. Princeton, NJ. Princeton University Press.

Goñi, E. and Maloney, W. F. (2017). Why Don't Poor Countries Do R&D? Varying rates of factor returns across the development process. *European Economic Review*, 94:126–147.

Griffith, R., Harrison, R., and Van Reenen, J. (2006). How Special Is the Special Relationship? Using the Impact of U.S. R&D Spillovers on U.K. Firms as a Test of Technology Sourcing. *American Economic Review*, 96 (5):1859–1875.

Griffith, R., Redding, S., and Van Reenen, J. (2004). Mapping the two faces of R&D: Productivity growth in a panel of OECD manufacturing industries. *Review of Economics and Statistics*, 86 (4):883–895.

Hall, B. H. (2010). Measuring the Returns to RD: The Depreciation Problem. *NBER Chapters, in: Contributions in Memory of Zvi Griliches*, pages 341–381.

Hall, B. H. and Lerner, J. (2009). The Financing of R&D and Innovation. *National Bureau of Economic Research*, Working Papers 15325.

Hall, B. H. and Mairesse, J. (1995). Exploring the relationship between R&D and productivity in French manufacturing firms. *Journal of Econometrics*, Vol. 65, No. 1:263–293.

Hall, B. H. and Mairesse, J. (2009). Measuring corporate R&D returns. *Presentation to the Knowledge for Growth Expert Group, Directorate General for Research, European Commission, Brussels*, January.

Hall, B. H., Mairesse, J., and Mohnen, P. (2010). Measuring the Returns to R&D. In Hall, B. H. and Rosenberg, N., editors, *Handbook of the Economics of Innovation*, chapter 24, pages 1033–1082. Elsevier.

Kwon, H. and Inui, T. (2003). R&D and Productivity Growth in Japanese Manufacturing Firms. *Economic and Social Research Institute, Cabinet Office*, Discussion Paper No. 44.

Lederman, D. and Saenz, L. (2005). Innovation and Development around the World, 1960-2000. *World Bank Policy Research Working Paper*, 3774:67–110.

Lichtenberg, F. and Siegel, D. (1991). The impact of R&D investment on productivity. New evidence using linked R&D-LRD data. *Economic Inquiry XXIX.*

Luintel, K. B. and Khan, M. (2017). Ideas production and international knowledge spillovers: Digging deeper into emerging countries. *Research Policy*, Vol. 46, No. 10.

Mulkay, B., Hall, B. H., and Mairesse, J. (2001). Firm Level Investment and R&D in France and the United States: A Comparison. In Bundesbank, D., editor, *Investing Today for the World of Tomorrow*, pages 229–273. Springer Berlin Heidelberg.

OECD (2013). Supporting Investment in Knowledge Capital, Growth and Innovation. *OECD Publishing.*

OECD (2015). Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities. *OECD Publishing.*

OECD (2023). The impact of R&D tax incentives: Results from the OECD microBeRD+ project. *Directorate for Science, Technology and Innovation*, DSTI/CIIE/STP(2022)3.

Ortega-Argilés, R., Piva, M., and Vivarelli, M. (2014). The transatlantic productivity gap: Is R&D the main culprit? *The Canadian Journal of Economics*, Vol. 47, No. 4:1342–1371.

Refinitiv (2020). Refinitiv Worldscope Fundamentals Database. Data Definitions Guide . Issue 16.

Rogers, M. (2010). R&D and productivity: Using UK firm-level data to inform policy. *Empirica*, 37:329–359.

Van Ark, B., O'Mahony, M., and Timmer, M. P. (2008). The Productivity Gap between Europe and the United States: Trends and Causes. *Journal of Economic Perspectives*, Vol. 22, No. 1:25–44.

Wakelin, K. (2001). Productivity growth and R&D expenditure in UK manufacturing firms. *Research Policy*, Vol. 30, No. 7:1079–1090.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data.* Cambridge, MA. MIT Press.

A Appendix

A.1 Firms and observations by country

Country	Firms	Observations	Country	Firms	Observations
Argentina	53	310	Lithuania	5	19
Bulgaria	57	81	Latvia	16	62
Brazil	193	1,109	Morocco	11	48
Chile	117	574	Mexico	94	433
China	4,325	28,733	Malaysia	827	2,965
Cote d'Ivoire	1	1	Nigeria	7	23
Colombia	40	190	Pakistan	81	585
Costa Rica	2	8	Peru	67	310
Czech Republic	29	115	Philippines	125	740
Ecuador	1	5	Poland	112	365
Egypt	64	238	Russia	393	1,219
Estonia	9	47	Singapore	288	1,700
Hong Kong	723	5,337	Slovak Republic	10	31
Hungary	15	87	Slovenia	12	55
Indonesia	133	739	Thailand	241	1,132
India	1,738	13,552	Turkey	279	2,814
Israel	417	3,912	Uruguay	1	5
Jordan	43	197	Venezuela	19	133
South Korea	2,463	23,942	South Africa	235	1,739

Note: Firms and observations include only those with R&D data.

Table A.1: Distribution of the sample by countries

A.2 Industry classification

Tech-level	Sector	Industry	Firms	Observations
Low-tech	Non-manufacturing	-	4,962	25,400
	Miscellaneous	20 Food & kindred products	662	4,587
		21 Tobacco	23	240
		22 Textile mill products	322	2,219
		23 Apparel & other textile products	167	1,130
		24 Lumber & wood products	88	388
		25 Furniture & fixtures	75	514
		26 Paper & allied products	206	1,486
		27 Printing & publishing	88	446
		31 Leather & allied products	45	362
		32 Stone, clay & glass	330	2,593
		39 Miscellaneous NEC	88	577
Subtotal			**7,056**	**39,942**
Medium-tech	Chemicals & chemicals-based	28 Chemicals (excl pharmaceuticals)	929	10,218
		29 Oil	106	1,006
		30 Rubber & plastics	252	1,749
	Metals & machinery	33 Primary metals	581	4,096
		34 Fabricated metals	319	2,295
		35 Machinery	768	6,119
		37 Autos & other transport	450	4,435
Subtotal			**3,405**	**29,980**
High-tech	Pharmaceuticals & medical instruments	283 Pharmaceuticals & biotechnology	700	6,393
		384 Medical & dental instruments	172	1,311
	Electrical equipment	36 Electrical equipment	828	7,095
		37 Aircraft	62	391
	Computers, communication eq. & scientific instruments	357 Office machinery	120	1,006
		367 Communication equipment	637	5,412
		38 Scientific instruments	266	2,025
Subtotal			**2,785**	**23,633**
Total			**13,246**	**93,555**

Note: Firms and observations include only those with R&D data.

Table A.2: Distribution of the sample by industry

A.3 Restricted sample

This section uses the sample of firms that report R&D data at least 5 years consecutively. This yields a sample of 8,093 firms. I replicate Table 3 from Equation (1) and Table 5 from Equation (7).

Dependent variable:	R_t/Y_t			$Capex_t/Y_t$		
	(1)	(2)	(3)	(4)	(5)	(6)
Q_{t-1}	0.0157**	0.0112**	0.0187**	0.168***	0.164***	0.169***
	(0.00461)	(0.00562)	(0.0160)	(0.00627)	(0.00674)	(0.00608)
$CF_t/Sales_t$	0.163***		0.159***	0.0428***		0.0614***
	(0.0601)		(0.0617)	(0.00603)		(0.00632)
$\Delta Debt_t/Assets_t$		0.0553***	0.0921***		0.114***	0.122***
		(0.0196)	(0.0216)		(0.00613)	(0.00641)
Country-year F.E.	✓	✓	✓	✓	✓	✓
Observations	64,307	64,257	63,957	63,694	63,872	63,694

Note: Standard errors in parentheses, clustered at firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Only firms, in EMEs, with at least five years of R&D data consecutively are included in the sample of the regressions. Every specification includes a constant, country-year fixed effects and two control variables: firm's $log(assets_t)$ and ROA_t.

Table A.3: R&D and Capital Investment Source Funding - Restricted Sample

Dependent variable:	Δy_t		
		2SLS	
	(1)	(2)	(3)
Δl_t	0.312	0.418***	0.417***
$\frac{\Delta C_t}{Y_t}$	0.425	0.174**	0.173***
$\frac{R_t}{Y_t}$	-0.552	-0.387***	-0.385***
$\frac{R_{t-1}}{Y_t}$		0.0898	0.0805
$\frac{R_{t-2}}{Y_t}$		0.667***	0.691***
$\frac{R_{t-3}}{Y_t}$			-0.0183
Capital return	42.5%	17.4%**	17.3%***
R&D return (sum)	-55.2%	37.0%***	36.8%***
Sargan-Hansen p-value	0.22	0.35	0.34
Cragg-Donald F statistic	1.13	29.2	23.5
Observations	48,290	39,465	33,877

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample contains firms in 38 EMEs between 1980 and 2019, with at least 5 years of R&D data consecutively. Every regression includes country-year fixed effects and clusters the standard errors at firm level. The *R&D return (sum)* term is the sum of contemporaneous and lagged $\frac{R_{t-j}}{Y_t}$ ratios' coefficients, while its significance comes after a joint hypothesis test (H_0: sum = 0). On 2SLS specifications, a 1st stage is regressed on the variables $\frac{\Delta C_t}{Y_t}$, $\frac{R_{t-1}}{Y_t}$ and $\frac{R_t}{Y_t}$ using four instruments: a country-industry average of both contemporaneous and lagged R&D investment ($\overline{R}_{j,m,t}$, $\overline{R}_{j,m,t-1}$), and capital growth ($\overline{\Delta C}_{j,m,t}$), and the 2-periods lagged sales ($Y_{i,t-2}$). These specifications display the p-value of the Sargan-Hansen test and the Cragg-Donald F statistic of the 1st stage regression.

Table A.4: R&D Returns - Baseline - Restricted Sample

A.4 Summary statistics of full sample

Variable	Mean	SD	P25	Median	P75	Obs.	Firms
R&D expenditure (million USD)	907	2,645	1.7	24.7	237.6	93,555	13,246
Capital expenditure (million USD)	39.5	172.08	0.97	6.0	30.1	288,124	27,184
R&D expenditure / Sales	0.030	0.120	0.001	0.008	0.033	92,222	13,102
Capital expenditure / Sales	0.114	0.230	0.016	0.044	0.111	284,200	26,779
Cash Flow / Assets	0.110	0.090	0.044	0.084	0.144	256,213	25,757
Sales Growth	0.211	0.509	-0.011	0.112	0.283	268,521	26,304
Labor Growth	0.075	0.255	-0.037	0.020	0.120	146,831	19,717

Note: The table shows summary statistics for the full sample of firms in EMEs. Sales growth and labor growth is the % increase from one year to the next.

Table A.5: Summary Statistics of full sample

A.5 R&D lags in baseline estimation

The next table extends Table 5 to include more lags, varying T in expression (7).

Dependent variable:	Δy_t											
	OLS						2SLS					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Δl_t	0.319***	0.369***	0.390***	0.386***	0.393***	0.395***	0.277	0.638	0.402***	0.442***	0.487***	0.418***
$\frac{\Delta C_t}{Y_t}$	0.152***	0.143***	0.164***	0.167***	0.163***	0.159***	0.542	0.151*	0.142**	0.160**	0.172**	0.181***
$\frac{R_t}{Y_t}$	-0.0624***	-0.303***	-0.301***	-0.271***	-0.298***	-0.200***	-0.897	-0.445**	-0.403**	-0.378***	-0.115*	-0.0895
$\frac{R_{t-1}}{Y_t}$		0.578***	0.0231	0.0825***	0.0131	0.219		0.772*	0.0922**	0.0718	0.130*	0.187
$\frac{R_{t-2}}{Y_t}$			0.579***	0.284***	0.486***	0.232**			0.699***	0.703**	0.494***	0.481***
$\frac{R_{t-3}}{Y_t}$				0.186***	0.146***	0.197***				-0.0212*	-0.138***	-0.209***
$\frac{R_{t-4}}{Y_t}$					-0.0264	-0.168*					0.011	-0.013*
$\frac{R_{t-5}}{Y_t}$						0.034						0.052
Capital return	15.2%***	14.3%*	16.4%***	16.7%***	16.3%**	15.9%**	54.2%	15.1&*	14.2%**	16.0%**	17.2%**	18.1%***
R&D return (sum)	-6.2%***	27.5%*	30.1%***	28.2%***	32.1%***	31.4%*	-89.7%	32.7%*	38.8%**	37.6%***	38.2%**	40.9%
Sargan-Hansen p-value	-	-	-	-	-	-	0.28	0.39	0.34	0.29	0.20	0.25
Cragg-Donald F statistic	-	-	-	-	-	-	1.24	15.1	20.2	21.4	19.6	19.2
Observations	53,309	48,178	41,043	34,410	28,196	22,440	53,309	48,180	41,043	34,408	28,194	22,438

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample contains firms in 38 EMEs between 1980 and 2019. Every regression includes country-year fixed effects and clusters the standard errors at firm level. The *R&D return (sum)* term is the sum of contemporaneous and lagged $\frac{R_{t-j}}{Y_t}$ ratios' coefficients, while its significance comes after a joint hypothesis test (H_0: sum = 0). On 2SLS specifications, a 1st stage is regressed on the variables $\frac{\Delta C_t}{Y_t}$, $\frac{R_{t-1}}{Y_t}$ and $\frac{R_t}{Y_t}$ using four instruments: a country-industry average of both contemporaneous and lagged R&D investment ($\overline{R}_{j,m,t}$, $\overline{R}_{j,m,t-1}$), and capital growth ($\overline{\Delta C}_{j,m,t}$), and the 2-periods lagged sales ($Y_{i,t-2}$). These specifications display the p-value of the Sargan-Hansen test and the Cragg-Donald F statistic of the 1st stage regression.

Table A.6: R&D Returns - Baseline - Changing Lags

A.6 Income level and tax incentives splits

	Lower Income		Higher Income	
	(a.1)	(a.2)	(b.1)	(b.2)
	None/Low Tax Incentives	*High Tax Incentives*	*None/Low Tax Incentives*	*High Tax Incentives*
Δl_t	0.370***	0.395***	0.416***	0.412***
$\frac{\Delta C_t}{Y_t}$	0.230**	0.149***	0.116***	0.121***
$\frac{R_t}{Y_t}$	-0.650*	0.0834***	-0.0230**	0.0669***
$\frac{R_{t-1}}{Y_t}$	0.389	-0.544**	-0.396	-0.619**
$\frac{R_{t-2}}{Y_t}$	0.268**	0.536***	-0.496	-0.700**
$\frac{R_{t-3}}{Y_t}$	0.140	0.293***	1.269**	1.624
Capital return	23.0%**	14.9%***	11.6%***	12.1%***
R&D return (sum)	14.8%	36.9%***	35.4%**	37.1%**
Sargan-Hansen p-value	0.09	0.31	0.21	0.18
Cragg-Donald F statistic	15.4	19.9	16.2	28.2
Observations	1,864	10,148	9,924	4,987

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The sample contains firms in 38 EMEs. Every regression includes country-year fixed effects and clusters the standard errors at firm level. Firms are split in four groups, being the combination of Lower and Higher income, with None/Low and High tax incentives. The *R&D return (sum)* term is the sum of contemporaneous and lagged $\frac{R_{t-j}}{Y_t}$ ratios' coefficients, while its significance comes after a joint hypothesis test (H_0: sum = 0). A 1st stage is regressed on the variables $\frac{\Delta C_t}{Y_t}$, $\frac{R_{t-1}}{Y_t}$ and $\frac{R_t}{Y_t}$ using four instruments: a country-industry average of both contemporaneous and lagged R&D investment ($\overline{R}_{j,m,t}$, $\overline{R}_{j,m,t-1}$), and capital growth ($\overline{\Delta C}_{j,m,t}$), and the 2-periods lagged sales ($Y_{i,t-2}$). Every specification displays the p-value of the Sargan-Hansen test and the Cragg-Donald F statistic of the 1st stage regression.

Table A.7: R&D Returns - Split by Income and Tax Incentives