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TO INVEST OR NOT TO INVEST? THE FACTORS THAT SOLVE THE QUESTION

IN DEPTH ANALYSIS OF THE MANUFACTURING INDUSTRY SECTOR

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Abstract

We examine macroeconomic and microeconomic factors that influence investment decisions taken by Portuguese SMEs. We find from a macroeconomic perspective, the EPU index, interest rate and inflation to be statistically significant and to drive down the investment rate, whereas the GDP growth rate has a positive impact. From a microeconomic perspective, we find lagged investment, EBITDA margin, lagged retention ratio, long-term debt, tangible collateralizable assets and firm size to be statistically significant factors positively influencing investment, whereas lagged effective tax rate and financing costs have a negative effect. In addition, motivated by the statistical relevance of collateralizable assets in explaining investments, we explore how bank financing can evolve within the context of a digital economy. Finally, an analysis of the manufacturing industry sector was performed. The findings show that different factors affect firms' investment in this specific sector.

Keywords:

Investment decisions, SMEs, Bank financing, Macroeconomic factors, Microeconomic factors, Intangibles, Portugal

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1. Introduction

Firm investment is crucial to stimulate the economic development and sustainable growth of a country (Wehinger 2011). Throughout the years, much literature refers to the numerous factors impacting firms' investment decisions (Farooq et al. 2021; Pacheco 2017; Farinha and Prego 2013). Given the significance of firm investment on economic activity, understanding the determinant factors behind firms' investment decisions is essential, which raises important questions. What are the effects of macroeconomic and microeconomic factors on firms' investment decisions? What drives firms to postpone their investment projects? Do the expected factors affect investment decisions as intuitively anticipated?

The research was done in collaboration with Banco BPI and aims to find an answer to the questions posed above. According to Wehinger (2011), financial institutions play a role in ensuring investment channels are in place for firms, while Gómez (2019) elaborated on how credit constraints deter firms' investments. In that regard, these findings set the motivation for BPI to extend its understanding of the factors influencing firms' investment decisions. Our analysis is focused on small and medium-sized enterprises (SMEs), excluding micro firms from our analyses. In addition, since microenterprises often exhibit investment patterns that are highly uncorrelated to internal factors and the macroeconomic scenario, their exclusion shields the models from probable outliers. In 2019, the aggregate investment of SMEs was around €16,218 million, demonstrating an upward trend in the last ten years, except for 2020 due to the pandemic crisis, reinforcing the importance of the analysis of factors affecting firms' investments.

Using data from *Banco de Portugal* database, a two-fold analysis is conducted, separating macroeconomic from microeconomic variables, on the relevant factors affecting the investment

decisions of non-financial private firms spread across all industries. Although the regression analysis is done separately, the choice of the variables is not random since most of the macroeconomic variables considered greatly influence the microeconomic indicators of the firms under consideration. The analysis consists of a dynamic panel data methodology, employing a GMM-System estimator, which was introduced by Arellano and Bover (1995) and improved by Blundell and Bond (1998). Our data consists of an unbalanced set of 55,739 SMEs for the period from 2006 to 2020. In 2019, the sample accounts for sales of approximately €47bn, and €83bn of total assets. Moreover, firms' aggregate investment in the sample amounts to €2.7bn, representing an investment rate of 10.5%.

The dependent variable presented in our model is defined as investment in both tangible and intangible assets (Farinha and Prego 2013). Although not currently relevant for BPI (since BPI does not finance intangible intensive firms with little to nontangible collateralizable assets), intangible assets were included in our model given the increasing importance that they have been assuming in the investments undertaken by firms (Thum-Thysen et al. 2017). The set of macro and microeconomic explanatory factors chosen follow the relevance attributed to them by the literature further developed below. Our findings present that the Economic Policy Uncertainty Index (EPU), GDP growth rate, Inflation Rate, firm's profitability, internal funds (measured by the retention rate), external funds (stock of debt), financing cost, effective tax rate, the level of tangible assets to serve as collateral and firm size are significant factors in explaining investment decisions undertaken by firms.

Critically reflecting on the results obtained, key conclusions take us to a different section of this research. More specifically, we find strong dependability of investment decisions on tangible collateralizable assets. Evidence collected from cross-country banking sectors, suggests that banks' liquidity creation has been having a crucial role in boosting investment in tangible assets, while not contributing much to the growth of industries heavily reliant on intangible assets

(Beck et al. 2020). Nevertheless, the contribution of intangibles to output growth has been increasing considerably, being one to three times superior to the contribution of tangibles within the EU-15 (Thum-Thysen et al. 2017).

Furthermore, in Portugal, the lack of knowledge among the banking on how to evaluate the risk inherent to intangible assets and projects creates credit constraints for innovative firms (EIB Investment Survey 2021). The rise in the pace with which the world is moving towards a more knowledge-based economy is bound to force a change in the traditional banking system (Demmou and Franco 2021). In this regard, important questions are raised. How are banks and economies adapting to the increasing relevance of intangible-intensive firms? Can BPI position itself as a relevant player in financially supporting these firms?

Thus, the next section of this research is focused on analysing the challenges posed to traditional banks by the economic transformation in place. In that regard, we analyse the intangibles financing market in other economies. Given the literature findings of a rise in the importance of such market, we compose a set of recommendations for BPI to position itself as a relevant player in the digital economy to come, based on practices to achieve deep knowledge regarding intangible assets. The set of recommendations should help BPI to better evaluate the credit risk of intangible intensive firms, ultimately allowing the bank to benefit from competitive advantage within the Portuguese banking sector to the financing of innovative firms, contributing to a swift transition of the Portuguese economy to a knowledge-based one.

Finally, an additional individual analysis was performed on firms belonging to the manufacturing industry sector. This specific sector was chosen to be analysed given the marketing and historical relevance it has for BPI and because it aggregate a relevant share of firms with which BPI establishes lending relations. We indeed find that different factors affect firms' investment in this sector.

2. Literature Review

2.1. The Portuguese Context

According to the National Statistics Office, Portuguese SMEs are crucial to the development of the country's economy. In 2020, the Portuguese micro, small and medium sized enterprises accounted for 99.7% of all firms and 71.8% of the country's workforce. Moreover, non-financial SMEs were responsible for approximately 59.6% of the total turnover and 69% of the total aggregate investment. In 2020, Portuguese enterprises consisted of 89.6% of micro firms, 8.7% small firms and 1.4% medium-sized firms. Portuguese non-financial and private firms accounted for only 0.3% of large-sized firms (Banco de Portugal 2020).

Portuguese firms are also found to be more leveraged than their European peers (IMF 2019). This implies that Portuguese SMEs' risk profiles may differ from those usually perceived in other studies about the relationship between investment and firm situations. Even though this difference has decreased over time, the high levels of corporate debt in these enterprises is still transversal across industries.

The Commission Recommendation 2003/361/EC defined micro, small and medium-sized enterprises in the following way:

- "The category of micro, small and medium-sized enterprises (SMEs) is made up of firms which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million."
- "Within the SME category, a small enterprise is defined as a firm which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million."

- "Within the SME category, a microenterprise is defined as a firm which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million."

2.2. The Dependent Variable: Investment Rate

Studying the factors influencing corporate investment is crucial given the importance of firms' investments for a country's economic development, as previously denoted in Wehinger (2011). Moreover, several authors have studied certain factors impacting corporate investments for Portuguese SMEs in specific. Farinha and Prego (2013) explored how Portuguese firms' financial status influenced their level of investment and Pacheco (2017) studied how firm specific factors, regarding their capital structure and profitability measures, impact their investment decisions. However, no papers are found to analyse the impact of both a macroeconomic and a microeconomic perspective on the factors affecting firms' investments in the Portuguese context. Moreover, we also analyse more (micro) factors than those of the mentioned authors.

2.3. Macroeconomic Variables

Given the influence of investments on the macroeconomic scenario of a country we are also interested in understanding if macroeconomic indicators produce changes to investment decisions taken at firm level. Below we present available literature in that regard.

2.3.1. Economic Policy Uncertainty

Uncertainty is a crucial element influencing corporate investments, as firms prefer to operate more cautiously during periods of high uncertainty, consequently delaying investment choices

(Al-Thaqeb and Algharabali 2019). The Economic Policy Uncertainty Index (EPU) is a commonly used statistic to highlight the environment's uncertainty. The index is calculated using media coverage of policy-related economic uncertainty, tax code changes, and monetary policy changes.

Hassett and Metcalf (1999) and Fernandez-Villaverde et al. (2011) both in Kang et al. (2014) found that the impact of uncertainty is mediated by fiscal policy. They demonstrated that the stability of budget adjustments and tax credit work as a subsidy to boost firms' investment, whereas fiscal volatility produces a negative impact on economic activity.

Kang et al. (2014) discovered that firms' investments is affected by the interaction between firm specific uncertainty (or micro uncertainty) and economic policy uncertainty (or macro uncertainty). Precisely, this study demonstrated that EPU negatively impacts investment decisions of firms, and that the influence of economic policy uncertainty on firms' investments is stronger for firms with greater firm specific uncertainty. The uncertainty caused by the EPU shock in interaction with the uncertainty at the company level (volatility in stock prices) has a substantial impact on the investment choices made by the firm.

Baker et al. (2013) in Kang et al. (2014) described the components contributing for economic policy uncertainty (tax legislation expiry, news-based policy uncertainty, federal spending, and CPI). The author examined the influence of economic policy uncertainty on corporate investment for 2700 US companies from 1985 to 2010. Policy shocks based on the news have a major detrimental effect on the long-term investment decisions of businesses. In both the short-run and long-run, a shock to the federal government's expenditure policy has also a detrimental impact on corporate investment. Inflation and tax policy shocks are found not to have a major impact on investment at the company level. In addition, empirical data indicate

that the effect is quantitatively magnified throughout the years 2007–2010, indicating that this variable has a greater impact on investment decisions during times of crisis (Kang et al. 2014).

In addition, Julio and Yook (2012) discovered that political uncertainty influences the investment expenditures of businesses. According to the study, a rise in uncertainty can only reduce current investment if there is a possibility of a negative outcome. In the context of national elections, this implies that enterprises may postpone investment in expectation of potentially unfavourable changes to the country's general macroeconomic (taxes or monetary policies) and regulatory environment. Comparing election years to non-election years, firms' investment tends to fall by an average of 4.8% due to concerns regarding growth potential and economic circumstances. In certain instances, though, the results of an election might be interpreted as good news regardless of who ultimately wins.

Given the previously outlaid literature, it can be hypothesised that,

Hypothesis 1: Uncertainty is significant and negatively related to investment activity.

2.3.2. GDP growth rate

Unlike other macroeconomic metrics, a high GDP growth rate affects the whole economic cycle. For instance, when GDP increases, per capita income rises as well, resulting in an increase in consumer's demand. This shock impacts firms' operations as they have to meet this increase in demand for goods. Therefore, as firms' operations are internally related to each other, firms start to expand all their operations through capital expenditures, such as the purchase of additional machinery, buildings, and other assets (Farooq et al. 2021).

Accordingly, despite the GDP's impact on the entire economy, it also has an impact on the fundamentals of firms' investment decisions. According to Becker (2006), when the economy

is booming, firms increase their investment in more profitable projects to guarantee a return. Therefore, a threshold decline in the GDP growth rate has a detrimental effect on corporate investment decisions (Valadkhani 2009 in Farooq et al. 2021).

Additionally, a higher GDP growth rate boosts the whole economic cycle, which lowers corporate costs and improve the ease of doing business. This ease of doing business draws business owners' attention and leads to increased investment (Tokuoka 2013 in Farooq et al. 2021).

On the basis of these findings, it can be hypothesised that,

Hypothesis 2: GDP growth rate is significant and has a positive effect on company investment.

2.3.3. Interest rate

Literature on the impact the interest rate has on investment decisions is not fully clear. On the one hand, a survey made by Graham and Harvey (2001) revealed that investment choices are frequently made using rules of thumb, such as the payback period, instead of traditional economic models (mainly in small firms or by older, long-tenure CEOs). Moreover, members of J.P Morgan's corporate finance advisory group clarify why it is still improbable that the cost of capital for most firms suffers a material increase even if interest rates increase as they are forecasted to. This is due to the high and sticky hurdle rates (Morgan 2014). Both pieces of information imply that investment decisions may be less susceptible to variations in interest rates than assumed by traditional investment theory.

On the other hand, traditional investment theory believes changes in interest rates to have a significant impact on corporate investment, more specifically, a negative impact. According to

such theory, monetary policy can alter the desirable capital stock and investment, as the required capital stock is partly determined by the interest rate. The expected effects are that lower interest rates decrease the capital expenditures of a firm and induce a lower financing cost, which stimulates companies to invest more and boosts the amount of successful investment projects; in contrast, when interest rates are higher, investors are eventually discouraged from investing in fixed assets (Farooq et al. 2021).

On the basis of these findings, it can be hypothesised that,

Hypothesis 3: Interest rate is significant and negatively related to investment level.

2.3.4. Inflation rate

Inflation is a key macroeconomic variable that affects numerous business activities in any country and threatens economic growth (Ayyoub, Chaudhry and Farooq 2011 in Farooq et al. 2021).

An increasing inflation rate indicates money is losing its value, which, ceteris paribus, decreases consumers' purchasing power and increases the cost of investing. Given this, periods of high inflation rates are associated with uncertainty and are considered unfavourable times for companies to invest (Farooq et al. 2021). Consequently, in high inflationary periods, there is a reduction in the investment activity of companies.

Prezas (1991) elaborated on how, for constant tax-paying firms, optimal investment is lower when inflation rate is higher, as the latter has an impact on the probability of accounting loss, interest tax shields and the real value of depreciation.

In addition, Hochman and Palmon (1983) demonstrated that the influence of inflation on investment is independent of a firms' capital structure.

Given the consensus on the impact inflation has on firms' investment decisions, it can be hypothesised that,

Hypothesis 4: Inflation rate is significant and has an inverse relationship with corporate investment.

2.3.5. Fiscal policy

Another important macroeconomic factor influencing firms' investment decisions is related to the fiscal policy pursued by the government. Possible measures of fiscal policy are direct transfers from the state to firms, in the form of subsidies for instance, and the decisions the government makes on the corporate tax rate. It is anticipated that changes in fiscal policy have significant effects on the capital structure of firms, which will ultimately affect firms' investment decisions. Tax policy changes, for instance, alter both the cash flows of investment opportunities and the corresponding discount rate, thus affecting investment decisions as well (Haley 1971). However, given the little variability throughout the years to the aggregate corporate tax rate charged on Portuguese firms, a macroeconomic variable of the corporate tax rate would not be a relevant explanatory variable. Thus, a variable of effective tax rate for each firm will be retrieved later on, as a microeconomic variable since this will present higher variability.

One important factor promoting firms' investments, especially within the Portuguese context, is related to the availability of European funds to finance the investment projects of both the state and the firms. European funds delivered to Portuguese firms under the scope of European Regional Development Fund (ERDF) have been crucial to stimulate firms' investments. As an example, the *Portugal 2020* fund, that falls within ERDF, amounted to 30.9B€; 20.3B€ of which have already been invested as of the second term of 2022. 41% of *Portugal 2020* is

intended directly to improve the competitiveness of Portuguese firms, through the support of investments in both tangible and intangible assets, according to *Banco Português de Fomento* policy guidelines.

Thus, understanding how firms in Portugal have responded to past stimulus packages is particularly relevant given the additional funding that Portugal has received from the EU - *Portugal 2030*, which amounts to 23B€. *Portugal 2030* establishes, as a priority, the digitalization of the Portuguese economy, therefore much of the funding is expected to be allocated to projects able to foster the transition from an industrial to a knowledge-based economy.

Liu et al. (2018), based on evidence from the investments undertaken by Chinese firms, pointed out that stimulus packages implemented by the government allow both State Owned Enterprises (SOEs) and non-SOEs to obtain better access to bank loans and motivate them to incur in more investment, which is important to achieve economic recovery. The evidence is, however, weaker for SOEs when compared to non-SOEs and weaker also in regions where corruption is more widespread.

Within the European framework, Aiello et al. (2020) found grants and funds to be relevant drivers for investment in innovation by SMEs. This importance is especially notorious when comparing the investment pattern of EU and non-EU SMEs. The authors also found that the tougher access to credit by SMEs to finance their innovative investments induces them to search for alternative sources of funding, such as funds and grants. Public support is, therefore, shown to be important to the easing of constraints on access to credit for firms seeking to finance their innovative investments. Given this, it is hypothesized that,

Hypothesis 5: Stimulus packages is significant and positively related to investment activity.

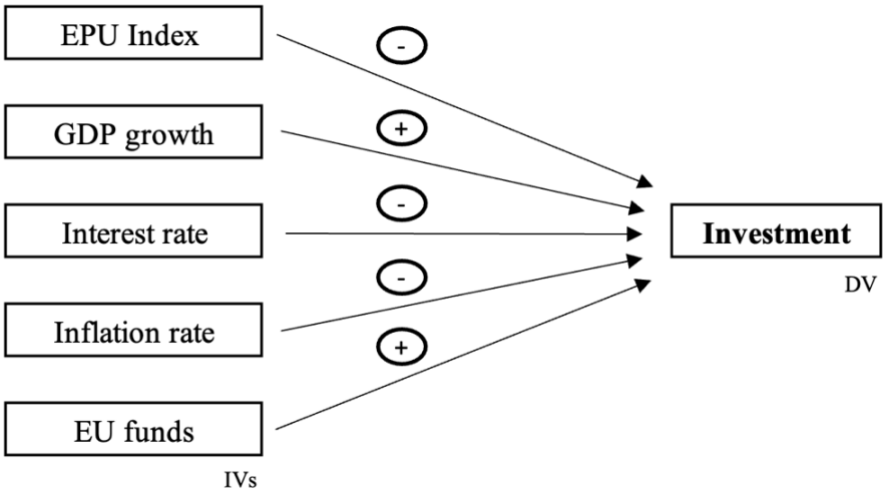


Figure 1: Summary of the expected relation between the Macroeconomic Variables and Investment

2.4. Microeconomic Variables

While the macroeconomic variables evaluate how firms are affected by the state of the economy irrespective of their capital structure, we find relevant to explore how firm-specific characteristics influence their investment decisions. We are also highly motivated by much discussion and conflicting results in the literature. Therefore, we decide to include and evaluate the effect of the chosen set of variables that are presented next.

2.4.1. Previous investment

Eberly et al. (2012) found evidence that points towards the statistical relevance of a lagged effect of investment in the investment decisions undertaken by firms in subsequent periods. Christiano et al. (2005) confirmed that the specification of investment adjustment costs predicts the manifestation of a lag-investment impact. In fact, the results of this study revealed lagged investment to be one of the most relevant predictors of a firms' current investment.

Such fact is also further sustained by Bloom et al. (2009) in Eberly et al. (2012). The author analysed a set of 4000 firms dispersed between the US, Europe, and Asia. The study is done by analysing the decision-making procedure that sustains the investment budget of plant managers. Often firm managers set it, by default, equal to last year's budget. If the plant manager disagrees with the budget and asks for increases to the amount invested, it increases the likelihood that the budget will not be approved by the firm's management. This is further evidence that demonstrates that past investment decisions impact current ones.

On the basis of these findings, it can be hypothesised that,

Hypothesis 6: Previous Investment is significant and positively related with investment level.

2.4.2. Profitability

Companies with higher levels of profitability, according to Pacheco (2017), tend to invest more in the following year, confirming that profitability and investment move in the same direction. Nonetheless, Pacheco (2017) also found that the profitability variable may be either representing the importance of internal funds on investment, in case agency problems and financial constraints take place, or may be operating as an alternative for investment opportunities.

In particular, using micro-econometric procedures and detailed data from a sample of private and non-financial enterprises presented in the Bank of Spain Database from 1985 to 2001, Hernando and Martínez-Carrascal (2008) investigated how firms' tangible investment respond to a range of indicators (profitability being one) that are typically taken into consideration to describe the financial position of firms. The results for the sensitivity of investment to the profitability variable revealed to be statistically significant and positive.

These theories support the "investment-cash flow hypothesis." Investment-cash flow sensitivity (ICF) has been analysed extensively in corporate finance literature. According to several studies, companies that are already more susceptible to severe financing constraints have a larger investment-cash flow sensitivity. Consequently, firms' financial conditions, mainly cash flow levels, are critical drivers of corporate investment (Brown 2009). According to Pacheco (2017), information asymmetries between managers and its creditors may explain why investment decisions rely on firm's internal financial conditions.

On the basis of these findings, it can be hypothesised that,

Hypothesis 7: Profitability is significant and positively related with the level of investment.

2.4.3. Internal funds

As mentioned previously, profits are one of the most important aspects of a business. Without profits, a company cannot think of internal sources of finance. Having this in mind, a possible metric to measure internal funds is the retention ratio, as it takes into consideration the share of net income retained to fund business' operations.

Retention ratio

Some researchers have studied, for many years, the influence that internal funds have on firms' investment decisions. In the first place, it is crucial to determine how firms can fund their projects and initiatives. Internal financing, debt financing, and equity issuance are the most common methods for companies to finance new investments. In addition, leasing is also a way that firms can acquire machinery and other production equipment. According to the "pecking order theory", companies rely first on internal funds, then on debt, and finally on equity issuance. This theory states that information asymmetries make internal funding less expensive than external funding, which is why companies should prioritize internal financing (Myers and Majluf 1984).

The question is whether or not internal funds are capable of independently explaining firms' investment decisions. There have been many studies (e.g. Oliner and Rudebusch 1992; Whited 1992) confirming that internal funds are able to explain investment spending for firms that are expected to face financing restrictions when accessing external financing.

Moreover, according to Vogt (1994), companies with low long-term dividend policies, and hence a high long-term retention ratio, are considerably more dependent on internal funds than firms with higher pay-out policies. This finding is coherent with the "pecking order theory",

which states that internal funds have a significant positive influence on business' investment expenditures.

Given the consensus on the influence that firm internal funds have on corporate investment decisions, it can be hypothesised that,

Hypothesis 8: Retention Ratio is significant and positively related with the level of investment.

2.4.4. Effective tax rate

As previously mentioned, the effective tax rate is influenced by the tax policy pursued by the government. However, the effective tax rate, i.e. the taxes paid as a proportion of a firms' earnings, varies from company to company. This variation is mainly due to decisions made by the firms' managers regarding the allocation of the earnings or given some tax avoidance incentives in place (Sánchez-Ballesta et al. 2021). The fact that the effective tax rate varies across different firms, entails that this variable will be rather considered a microeconomic (firm-specific) one.

According to the Tax Foundation Database, the corporate tax rate has been declining over the years. The worldwide corporate tax rate averaged roughly 48% in 1980, while in 2020 it averaged approximately 36%. At the moment, the average rate in Portugal is 31.5%, ascending from an all-time minimum corporate tax rate of 26.5% registered in 2010.

According to Haley (1971), changes in corporate tax rates impact firms' investment decisions by changing the cash flows of investment opportunities and the rate used to discount these cash flows. Both the influence of these taxes on cash flows and the potential implications of firms' taxes on the discount rate have been widely analysed in literature.

Although a decrease in the effective tax rate decreases the interest tax shield value for firms that incur in debt to finance their investments, most literature found suggests that lower corporate tax rates might stimulate investments through the relaxation of liquidity constraints (Masso 2002) or by reducing banks' agency costs and bankruptcy rates (Strulik 2008), which positively impact companies' investment decisions.

Vartia (2008) also found that increasing the corporation tax rate has a detrimental effect on firm-level investment. Specifically, corporate income taxes discourage investment by increasing the cost of capital. Another part of this study is related to the potential linkages between taxes and productivity, which confirmed the theory that taxes impact productivity by multiple channels and that, due to distinguishing industry aspects, certain industries are intrinsically more impacted by tax rates than others.

Given the literature found, it can be hypothesised that,

Hypothesis 9: Effective income tax rate is significant and negatively related to investment.

2.4.5. External funds

Regarding how the level of debt impacts firms' investment, literature is anything but in consensus. Nevertheless, numerous studies do agree that financing decisions undertaken by firms are in alignment with the "pecking-order theory". This indicates that firms rely primarily on internal funds, but when these are insufficient, firms prefer to use debt to fund (the rest of) their investment needs (Fama and French 2002; Pacheco 2017). It is, therefore, expected that debt can aid in explaining the investment patterns of SMEs.

Farinha and Prego (2013), using data of Portuguese firms, demonstrated that, the financial position of a firm is a significant factor as an explanatory variable of firms' investment

decisions. They found variables related to a firm's financial constraints, including leverage, to display a negative impact on investment. Moreover, other authors such as Cleary (1999) also found a negative relationship between debt and investment.

There is, however, a method that can create more interesting results regarding the impact that the level of debt has on firm investment– analysing both effects of short- and long-term debt, which Pacheco (2017) did. Initially, Pacheco (2017) hypothesised investment and debt to be positively related. However, in his results, total debt despite presenting a negative coefficient, was always insignificant. Then, he segmented debt according with its maturity (short- and long-term). He found that firms' level of short-term debt presents a negative and statistically significant coefficient with investment, on which he elaborated implying that if firms have payments due soon, this may motivate them to forgo investment projects. For long-term debt, in contrast, he found a positive coefficient, to which he explained that firms with higher investment rates seem to not be financially limited, as they are able to incur in more debt in order to finance larger investments. Moreover, these firms obtain accumulated assets, through the issued debt, which further eases the little limitations they have, as they can now provide a higher level of collaterals on the loans they ask for.

In addition, according to Vermeulen (2002) in Pacheco (2017), debt is more relevant in explaining investment during recessions and for small firms, indicating that larger firms may have other financing alternatives. In contrast, Farinha and Prego (2013) stated that larger firms are more capable of lowering informational asymmetries between the firm and creditors, and are financially constrained, given their financial situation seems to not be a determining factor in deterring investment for these firms. This implies that when a small firm and a larger firm are both financially constrained, the larger can more easily get access to credit than the small firm.

Given the literature found, it can be hypothesised that,

Hypothesis 10: Stock of short-term debt is significant and negatively related with the level of investment.

Hypothesis 11: Stock of long-term debt is significant and positively related with the level of investment.

2.4.6. Assets to serve as collateral

Firm-specific factors seem to be important to the perception of idiosyncratic risk that financial institutions attribute to certain firms when granting credit. One specific metric that much literature finds important for the risk analysis performed by banks when lending money is the firms' availability of tangible assets to serve as collateral.

The increasing availability of tangible assets on a company's balance sheet is expected to result in better conditions when obtaining credit, i.e., reduced interest rates paid on loans. Some studies have discovered evidence that confirms this relation. Titman (2013) stated the relevance of collateralizable tangible assets in debt financing, arguing that tangible assets are essential for firms to boost capital expenditure, particularly to innovation, in order to promote the expansion of the capabilities of existing technologies. Mayer (1990) in Gan (2007) agreed that the presence of tangible assets on a firm's balance sheet is fundamental since bank loans, the major source of external financing, are mostly backed by tangible collateral. This suggests that a higher availability of collateral facilitates debt financing and, consequently, fosters firms' investment activity. Gan (2007) also analysed whether a decline in collateral value impacts the investing activity of firms. The results demonstrated that decreases in the collateral value diminish firms' borrowing capacity, which in turn results in decreased investment rates (Gan 2007).

However, Gan (2007) argued that, despite the common consensus in the literature regarding the collateral channel impact, there are few studies recognizing and measuring its full economic effect.

Given the literature found, it can be hypothesised that,

Hypothesis 12: Tangible assets to serve as collateral is significant and positively related with investment.

2.4.7. Financing cost

Binsbergen et al. (2010) found the firm-specific cost of debt to be mainly influenced by company characteristics such as the collateral value, the firm size, the level of intangibles and the firm's cash flows. The paper also found that there is a higher cost associated with being over levered than that associated with being under levered.

According to conventional investment theory, there should be a monotonic ordering of firms' investment levels based on how severe their financing constraints are. Such a theoretical assertion appears completely reasonable given that, in general, the more severely financially constrained a corporation is (either due to restrictions on credit availability or higher financing costs), the fewer the occasions in which the firm will still consider the investments to be worthwhile pursuing (Kasahara 2008). According to the author's model, the financially constrained firm invests later than the unconstrained firm, given its cost constraints. Nevertheless, the severely constrained firm, subject to both cost and no-financing limitations, might invest sooner than the unconstrained one. This outcome results from the severely constrained firm's pre-emptive incentive: even though it may encounter relatively high financing costs at the time, it might participate more actively in its investment decisions to

prevent additional financing risks in the future (Kasahara 2008). Thus, this would imply that despite higher financing costs, some firms may still choose to invest more.

Hirth and Uhrig-Homburg (2010) studied how the investment timing from firms is influenced by liquidity constraints and capital market frictions. Firms delay investments when such frictions and constraints, including the cost of debt, are expected to increase in the present. Whereas, when future financing costs are expected to rise, firms anticipate and accelerate their current investments.

Farinha and Prego (2013), through evidence collected from Portuguese SMEs for the period comprehended between 2006 and 2011, demonstrated that a firm's financial situation is significant as an explanatory factor of investment decisions, as they found a statistically significant negative coefficient for the cost of debt, implying that the likelihood of future investments to be profitable to pursue decreases as the cost of capital increases. These findings corroborate the idea that the financial strain organisations experience does influences their investment decisions.

Hoffmann and Kleimeier (2021) studied the cost of capital for innovative firms. The authors concluded that because innovative firms carry greater risks for lenders, derived from possible innovative failure, uncertain and volatile investment cash flows, and few assets to use as collateral, innovative firms end up facing greater financing constraints which are reflected in an increased financing cost, in comparison to non-innovative firms.

Given the literature discussed, it can be hypothesised that,

Hypothesis 13: Cost of debt is significant and negatively related with investment.

2.4.8. Firm size in volume

Literature on the impact firm size has on investment decisions is in disagreement. On the one hand, Beck et al. (2005) found firm size to be negatively correlated with financial constraints, which in turn curtails investment and firm growth. The authors consider financial constraints to be related with difficulties in dealing with bank bureaucracy, the need to have special connections with banks to access credit and collateral requirements demanded. In other words, the higher the firm is in volume, the less financial constraints it should be subject to. And, as fewer financial constraints are seen by Beck et al. (2005) to increase investment (due to the negative relation between the two), this implies that bigger firm size in volume increases investment.

Similarly, Pacheco (2017) stated that smaller, often younger firms tend to be presented with a higher financing cost as these firms usually don't have much of an operating history and have fewer collaterals to serve as guarantee to loans, which leads them to be considered riskier. Thus, since the author also found a negative relation between financing cost and investment, smaller firms are expected to be subject to higher financing costs and in turn, incur in less investment. This suggests a positive relation between a firm's size and its rate of investment.

In spite of this, larger, therefore more mature and established firms, may present lower investment rates, possibly as a result of technological diminishing returns to scale and/or increasing returns to scale regarding external financing costs, which in turn, imply a negative effect of firm size on investment (Gebauer et al. 2017 in Pacheco 2017). Indeed, the results from the study by Pacheco (2017) demonstrated that a firm's size has a negative impact on a firms' investment rate.

Additionally, Pacheco (2017) asserted that smaller firms invest more, probably due to their desire to grow and achieve a minimum level of efficiency in order to survive. SMEs may also reduce investment levels once they reach beyond a certain size in order to stabilize their growth. Again, this implies a negative relation between firm size and investment.

Given this literature, it can be hypothesised that,

Hypothesis 14: Firm size is significant and negatively related with investment activity.

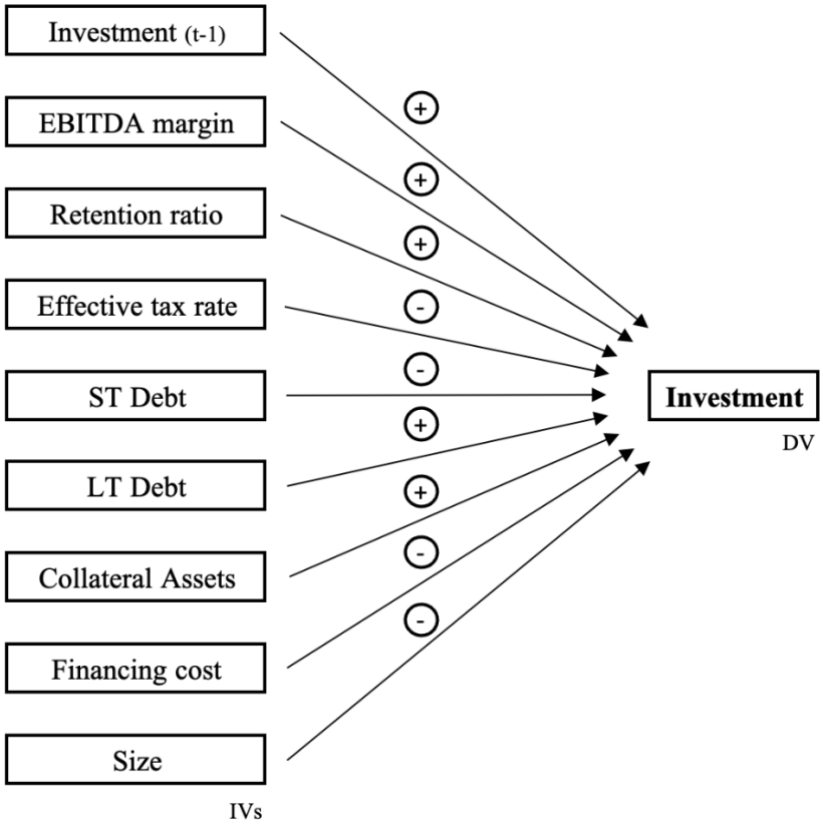


Figure 2: Summary of the expected relation between the Microeconomic Variables and Investment

3. Methodology

3.1. Dataset

The dataset chosen, both for the analysis of the macro and microeconomic factors will consist of a 14-year dataset which begins in 2006 and ends in 2020.

The analysis is focused on a set of Portuguese non-financial SMEs that exhibit annual sales revenues of at least 2 million euros. Micro firms are not included in the dataset, firstly given that, according to Banco BPI, the type of loans these firms usually request are not intended to be used as productive investment, and secondly since micro firms often exhibit incomplete and potential abnormal data.

We have collected micro variables from Central Balance Sheet - Harmonized Panel (CBHP) dataset from the *Banco de Portugal*. The macro variables used were retrieved directly from BPstat, the Tax Foundation website and from *Banco Português de Fomento* website. Data concerning CPI, real interest rate and GDP growth rate were gathered from BPstat website, historical information on the effective corporate tax rate was retrieved from Tax Foundation website and the information on the funds attributed to firms was taken from *Banco Português de Fomento* website.

We have deleted from the dataset all the observations which registered negative liabilities, assets and gross operating income, since such observations correspond to probable incomplete or incoherent data on the IES forms. In order to guarantee the exclusion of outliers which would damage the interpretation and significance of the considered dependent variables, we have eliminated from our dataset the set of observations belonging to the 1st and 99th percentile.

These conditions result in a sample consisting of 176,759 observations, across 55,739 firms. In 2019, the sample accounts for sales of approximately €47bn, and €83bn of total assets. Moreover, firms' aggregate investment in the sample amounts to €2.7bn, representing an investment rate of 10.5%.

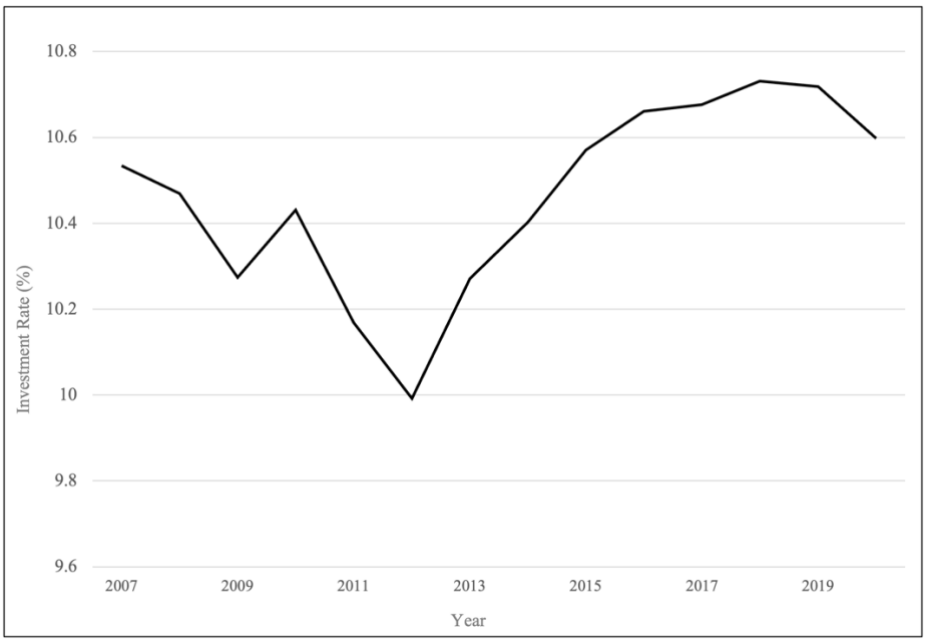
3.2. Dependent variable: Investment rate

Productive investment incurred in by firms is considered in our model as the dependent variable. Although it can be commonly acknowledged that investment in CAPEX concerns a great part of productive investments, according to OECD, the stock of intangible assets of Portuguese firms has grown at a faster pace than the stock of tangible assets for the period between 1995 and 2014. This reason further motivates the inclusion of the investment in intangibles in the dependent variable for our regression model. Our dependent variable is defined as the logarithm of the annual change in tangible and intangible fixed assets (plus depreciation and amortization).

However, we find necessary to acknowledge and to point towards a possible limitation of the investment in CAPEX metric. Currently, it is common for firms to engage in leasing contracts in order to expand the stock of fixed capital available to them. According to the European Investment Fund, leasing was used to finance 16.7% of European SME's investments in fixed assets during 2010. However, it is important to note that such operational leasing contracts are not included in the tangible and intangible fixed assets account in the balance sheet (they only impact the profit and loss statement). Therefore, it is probable that the real investment of the considered set of companies in capital might be underestimated.

In 2019, the aggregate investment of SMEs was around €16,218 million. Graph 1 presents the evolution of the mean investment rate across all firms in our dataset. From the lowest point in

2012, due to the Portuguese financial crisis, the investment rate demonstrates an upward trend, with the exception of 2020 due to the pandemic crisis.



Graph 1: Evolution of Investment Rate

3.3. Independent variables and descriptive statistics

In the next section, we assess the relationship between our independent variables and several micro and macroeconomic indicators, performing a bivariate analysis, which allows for a brief overview of the relationship between the investment rate and the explanatory variables.

3.3.1. Macroeconomic variables and empirical analysis

Economic Policy Uncertainty

One often used indicator to illustrate the uncertainty environment is the Economic Policy Uncertainty Index. Such index is built taking into account the newspaper coverage of policy-related economic events responsible for affecting uncertainty, changes to tax code law and changes to monetary policy. As observable in Graphs 1 and 2 in the Appendix, periods of higher

uncertainty coincide with periods in which investment decelerates. This is the case between the years of 2009-2012. It is assumed that firms decide to postpone investment in face of greater uncertainty around tax code and monetary policy changes. Similarly, during periods of lower uncertainty, the investment rate accelerates, as observed in the period between 2012-2014, for example.

GDP Growth

The GDP growth rate is calculated as the annual change in the GDP. As seen in Graphs 1 and 3 in the Appendix, the variation in the investment rate has been somewhat correlated with the level of economic activity. Slowdowns in the investment rate coincide with years of economic recession (2010-2012), while increases to the pace of investment coincide with years of economic expansion (2014-2018, for example).

Interest Rate

We are considering the real interest rate, which takes into account inflation adjustments. It is useful to note that the interest rate considered corresponds to that charged by banks for loans under 1M€. As can be observed in Graphs 1 and 4, increases in interest rates coincide with periods where the investment rate grows at a slower pace (for example, 2010-2012). Similarly, from 2012 to 2020, a downward trend of the interest rate coincides with an upward trend on the investment rate.

Inflation Rate

The inflation rate is measured by changes in the consumer price index. By crossing the data in Graphs 1 and 5 in the Appendix, one can observe that periods when inflation decreases coincide with periods when investment rate increases (for example, 2007-2009). Similarly, in the period

from 2009 to 2012, a shift from a deflationary scenario to an inflationary one occurs and during the same time period the investment rate decelerates.

Moreover, following the same reasoning as with the interest rate, the graphs suggest there might be a lagged effect of the inflation rate on investment rate as well, thus, this effect is also included in our model.

European Union Funds

The European Funds considered for our model are the ones under the ERDF initiative, that have been attributed to small and medium sized Portuguese, for the time span considered.

In Graph 6 in the Appendix, the evolution pattern seems to follow an upward trend up until the year of 2012. From that moment onwards, the funds suffer a sharp decrease, with the trend following a descending path until 2016, when it starts recovering.

It is, however, interesting to notice an unexpected occurrence in the evolutions of these variables. From 2012 onwards, the EU funds have a downward trend, whereas the investment rate follows an upward trend. This suggests these indicators evolve inversely between each other.

3.3.2. Microeconomic variables

The Graphs 8, 12, 14, 16, and 18 in the Appendix display the evolution of the investment rate with respect to different levels of the variables of interest (considering the percentiles of order 10, 50 and 90).

Profitability

The EBITDA margin was the chosen variable for the profitability, given that it is the profitability measure most often used by firms when making investment decisions since it incorporates all the costs that are relevant for firms.

Analysing Graphs 1 and 7 in the Appendix, the EBITDA margin and the dependent variable seem to move in the same direction. Graph 8 investigates the impact of different levels of firms' EBITDA margins on investment rate. One can observe that firms with higher levels of EBITDA margin are the ones investing the most, followed by the ones with a medium level and finally those with lower level. This fact further points to a positive relationship between firms' EBITDA margin and their investment patterns.

Moreover, when paying close attention to Graphs 1 and 7 in the Appendix, one can see the average EBITDA margin greatly increases from 2008 to 2009, whereas a rise in the investment rate is only observed in 2009 and 2010. This may suggest a lagged effect of profitability on the investment rate as well.

Internal Funds

Comparing Graphs 1 and 9 in the Appendix, one can also observe these somewhat follow the same trends, except for slight deviations from this pattern, during the time period between 2010 and 2016. It can also be noted that the evolution of the retention ratio seems to precede that of the investment rate, suggesting a lagged effect of changes to the retention policy of firms on their level of investment.

Effective Tax Rate

In Graphs 1 and 10 in the Appendix, the behaviour displayed by the effective tax rate and the investment rate appear to somewhat move in inverse directions. While the tax rate exhibits a downward trend for the time frame comprehended between 2012 and 2020, the investment rate displays a persistent growth starting in 2012 and stretching until 2018.

Moreover, following the same reasoning as with the previous variables, the graphs suggest there might be a lagged effect of the effective tax rate on investment rate as well, thus, this effect is also accounted for.

External Funds

The debt level of the firm is segmented in short- and long-term debt. In Graphs 1 and 11 in the Appendix, one can observe that the share of short-term debt has been following a downwards trend whereas the share of long-term debt has been following an upwards trend. That is, firms appear to be engaging in a progressive change to their debt structure, substituting short- for long-term debt. Also, from Graph 12 in the Appendix, it can be denoted that firms that depend more heavily on long-term debt invest more than those that depend more on short-term debt.

Assets to serve as Collateral

Comparing Graphs 1 and 13 in the Appendix, one can infer that periods when the share of firm's collateralizable assets coincide with periods when firms increase their pace of investment.

When extending the analysis to Graph 14, the expected impact collateralizable assets have on investment rate seems to be reinforced, since firms with greater levels of collaterals are those that exhibit greater investment rates. Indeed, firms with higher levels of collaterals present higher investment rates, followed by firms with a medium level of collaterals and finally, firms with low levels of collaterals. This outcome suggests that the value of assets to serve as collateral might be important to explain an easier access to credit by firms.

Financing Cost

The financing cost was computed as the interest paid over the firm's total liabilities. The evolution of firms' financing cost can be observed in Graph 15 in the Appendix, presenting a downward trend since 2007, with the exception of the financial crisis period (2010 - 2012).

From Graph 16 in the Appendix, almost throughout the entire dataset, it is noteworthy that firms with low financing costs are those that exhibit the lowest investment rates, while the firms with medium financing costs are those that exhibit the greatest investment rates. This fact suggests that the inverse relationship between financing costs and investment rate does not occur. This seemingly unexpected finding might be explained by the fact that in a bivariate study, some factors that affect investment rates are not taken into account. For example, small businesses are thought to be riskier and hence have higher financing costs. Although they might face higher financing costs due to the firm's riskiness, they nonetheless have a high growth potential, which may account for the small enterprises' greater investment demand.

Firm Size

Firm size was analysed both as a volume metric (logarithm of sales) and as a categorical variable (small and medium-sized firms). From Graph 17 in the Appendix, one can realize the occurrence of a downward trend for the period between 2007 and 2011 and an upward trend taking place from 2011 to 2019. This seems to be following somewhat the same trends as the dependent variable, suggesting that as the firm size increases, the firm invests more.

The analysis of Graph 18 in the Appendix presents medium firms display investment rates to be, on average, 2 percent greater than those displayed by small firms. This reinforces the analysis obtained from the firm size in volume, supporting the idea that as the firm size in volume is bigger, the investment rates are higher.

Table 1: Summary of Descriptive Statistics

Explanatory Variables	Pre-Crisis (2006 - 2011)	Crisis year (2012)	Pos-Crisis (2013 - 2019)	Covid Crisis (2020)
EPU Index	124.87	210.08	206.68	265.25
GDP Growth Rate	0.295	-4.050	1.943	-8.300
Interest Rate	6.579	7.080	3.884	2.220
Inflation Rate	2.017	2.760	0.660	-0.130
EU Funds	1,544.52	2,304.80	1,297.22	1,862.30
EBITDA Margin	0.065	0.011	0.083	0.032
Retention Ratio	0.064	0.060	0.079	0.069
Effective Tax Rate	0.369	0.505	0.352	0.235
Short-Term Debt	0.582	0.575	0.490	0.458
Long-Term Debt	0.145	0.174	0.182	0.239
Collateralizable Assets	0.282	0.286	0.282	0.287
Financing Cost	0.020	0.017	0.011	0.007
Firm Size in volume	14.032	13.99	14.130	14.050

Table 1 presents a summary of the above descriptive statistics analysis by different sample periods, and we find it more relevant to segment to pre- and post-financial crisis as well as the recent covid crisis. One can observe that in crisis years, factors such as EPU, interest rate and EU funds seem to increase, whereas GDP growth rate and EBITDA margin present lower levels for crisis years, as intuitively expected. Table 2 in Appendix presents a more detailed summary of each variables' descriptive statistics.

3.4. Econometric methodology

On an initial note, we would like to clarify that when selecting the explanatory factors, two risks were considered, both for the collective and for the individual analysis. On the one hand, we tried to avoid the risk of overfitting the model, through the insertion of too many variables. On the other hand, the variables choice was done in such a way that no extremely relevant factors were left outside of the model, in an attempt to shield the regression analysis performed later from omitted variable bias.

We intend to develop two distinct models to separately assess how macroeconomic and microeconomic factors influence corporate investments decisions. The aim of the econometric analysis is to determine the significance, test the sign and correlation between the factors already mentioned and the investment rate.

As we point to develop our analysis within groups, we decided that the appropriate model to use consists of a panel data methodology – this accounts for time series and a cross-sectional aspect. It is a subset of longitudinal data where observations occur for the same subjects each time, in our case, the behaviour of entities is observed across time. Considering our data structure - many panels and few measurement instances -, it is most suitable to use Dynamic Panel Data instead of Static.

The Dynamic Panel Data approach has several advantages over the Static variant. First, the possibility to account for the heterogeneity of the individuals and use of multiple instrumental variables to account for the endogeneity of the model's variables, often referred as "lagged variables". Notwithstanding, the use of General Method of Moments (GMM) is plagued by two major concerns: the proliferation of instruments and the serial autocorrelation of errors. These two concerns will be greater if the panel is comprised of a sample with a large time span and a small number of firms, which is the exact opposite of our situation.

The selected estimation methodology requires the application of the GMM-System estimator, which was introduced by Arellano and Bover (1995) and improved by Blundell and Bond (1998). The actual command in stata *xtabond2* was developed by Roodman (2005). We decided on this command instead of *xtabond* as it is preferable for our data structure. In addition, this model is appropriate when there are fixed individual effects, in this case, firm specific effects.

Running this command in stata, we are able to add options with it. We chose to add the following: *twostep*, which specifies a two-step estimator should be calculated, forcing the heteroscedastic weight matrix into the estimation; *robust*, which in a two-step estimation avoids downwardly skewing standard errors; *small*, demands small-sample rectifications to the covariance matrix; *nodiffsargan*, which prevents re-estimating the model for each difference-in-Sargan/Hansen test; *orthogonal*, requests the forward orthogonal deviations which is important in unbalanced panels (as is our case) so as to not magnify the gaps in the data.

For all estimations with *xtabond2*, the Hansen test and the Arellano and Bond test are presented. The Hansen test assesses the overidentification of instruments, meaning too many variables are being included in the model. As dynamic panel data requires no correlation in the errors term, the Arellano and Bond test investigates the first and second order conditions of the serial autocorrelation of errors (labelled AR 1 and AR 2).

The following macroeconomic and microeconomic regressions are performed in order to test the various hypothesis.

Macroeconomic Regression:

$$\textbf{Investment}_{i,t} = \beta_1 * \textbf{EPU}_{i,t} + \beta_2 * \textbf{GDP}_{i,t\,;\,i,t-1} + \beta_3 * \textbf{Interest Rate}_{i,t} + \beta_4 * \textbf{Inflation}_{i,t\,;\,i,t-1} + \beta_5 * \textbf{EU Funds}_{i,t} + (S_i + \varepsilon_{i,t}) \quad (1)$$

Microeconomic Regression:

$$\textbf{Investment}_{i,t} = \beta_{1,2} * \textbf{Investment}_{i,t-1\,;\,i,t-2} + \beta_{3,4} * \textbf{EBITDA}_{i,t\,;\,i,t-1} + \beta_{5,6} * \textbf{Retention}_{i,t\,;\,i,t-1} + \beta_{7,8} * \textbf{Tax Rate}_{i,t\,;\,i,t-1} + \beta_9 * \textbf{ST Debt}_{i,t} + \beta_{10} * \textbf{LT Debt}_{i,t} + \beta_{11} * \textbf{Collaterals}_{i,t} + \beta_{12} * \textbf{Financing Cost}_{i,t} + \beta_{13} * \textbf{Size}_{i,t} + (\theta_t + S_i + \varepsilon_{i,t}) \quad (2)$$

where: Investment $_{i,t}$ – firms' i investment rate at year t;

β – Estimation coefficients of the explanatory variables;

$X_{i,t}$ – Vector of explanatory variables of interest for the i-th firm at year t (EPU Index, GDP growth rate, Interest Rate, Inflation Rate, EU Funds, EBITDA Margin, Retention Ratio, Effective Tax Rate, Short-term Debt, Long-term Debt, Assets to serve as collateral, Financing Cost and Firm Size);

$X_{i,t-1}$ – Vector of lagged explanatory variables of interest for the i-th firm in year t-1;

θ_t – Time effects controlling for macroeconomic impacts (using year dummies);

S_i – Firm specific effects controlling for heterogeneity across firms;

$\varepsilon_{i,t}$ – Error term, accounting for unexplained impacts on $Y_{i,t}$.

4. Results and Discussion

Table 3: Correlation Matrix

	Investment Rate	EPU Index	GDP Growth	Interest Rate	Inflation	EU Funds	EBITDA Margin	Retention Ratio	Effective Tax Rate	ST Debt	LT Debt	Collateral Assets	Financing Cost	Firm Size
Investment Rate	1.000													
EPU Index	0.029	1.000												
GDP Growth	0.047	-0.199	1.000											
Interest Rate	-0.071	-0.727	-0.040	1.000										
Inflation	-0.027	-0.191	0.201	0.562	1.000									
EU Funds	-0.072	-0.024	-0.677	0.423	0.208	1.000								
EBITDA Margin	0.215	0.006	0.090	-0.054	-0.030	-0.099	1.000							
Retention Ratio	0.038	0.012	0.015	-0.024	-0.010	-0.023	0.004	1.000						
Eff Tax Rate	-0.012	-0.023	0.006	0.055	0.041	0.031	0.028	-0.019	1.000					
ST Debt	-0.154	-0.164	0.003	0.183	0.092	0.048	-0.392	0.030	-0.007	1.000				
LT Debt	0.090	0.101	-0.057	-0.089	-0.044	0.031	-0.069	-0.001	-0.022	-0.294	1.000			
Collateral Assets	0.293	0.024	-0.006	-0.023	-0.004	-0.002	0.128	-0.003	-0.052	-0.188	0.356	1.000		
Financing Cost	0.035	-0.278	0.005	0.308	0.164	0.047	0.030	-0.019	0.047	0.017	0.185	0.133	1.000	
Firm Size	0.484	0.034	0.031	-0.045	-0.016	-0.033	0.139	0.041	0.013	-0.063	-0.121	-0.094	0.020	1.000

The analysis of the correlation matrix as the one depicted in Table 3 is useful in order to ascertain possible collinearity taking place between the set of parameters chosen. The level of correlation to be attained in order to conclude the existence of collinearity between the factors is widely debated within the literature. For instance, Gujarati and Porter (2009) state that the correlation level beyond which collinearity may be inferred corresponds to 50%.

For that reason, particular attention should be addressed to the correlation values between inflation and interest rates, the GDP Growth and EU Funds, and the interest rate with the EPU index. However, it is important to note that such collinearity suspicions rely over a data set that is composed of merely 14 observations, that is, one observation per variable for each of the considered years under analysis. A reduced dataset implies little variability between the factors and that might be contributing for the apparent problem of multicollinearity between some of the macroeconomic factors.

Although the dataset is reduced, which implies natural limitations towards a valid interpretation of the correlation coefficients, it is still useful to check how the macroeconomic variables are related to each other. Some results, such as the strongly negative correlation between EU Funds and the GDP Growth, come as unexpected.

Moving to the analysis of the regression results, in order to analyse if the chosen model is the most appropriate, we studied the computed adjusted R-square. The result reveals the goodness of fit of the model to be 64%, which indicates that 64% of the change in firms' investment rate is explained by the independent variables under analysis. This result indicates our model is worthwhile studying.

In addition, we performed the Hansen and the Arellano-Bond tests, already explained in the previous section, to understand if the GMM-System estimator was the most appropriate estimation method for our data structure.

As the Dynamic Panel Data estimators are instrumental variables methods, it is particularly recommended to do the Hansen test, where the null hypothesis confirms the validity of all overidentification restrictions. According to Roodman (2009), the p-value presented in the result for this test should be in the range of $0.05 \leq$ p-value < 0.8, being the optimal to find a probability $0.1 \leq$ p-value < 0.25. The probability obtained in our model is equal to 0.212, meaning that the variables used in our model are valid, and consequently confirms the presence of no overidentification. In that regard, there is no indication to reject the null hypothesis.

Another important diagnostic when using a Dynamic Panel Data methodology is the Arellano-Bond Autocorrelation Test (AR), where the null hypothesis states that autocorrelation does not exist. By definition, the differenced equation exhibits residuals that are serial correlated. Nevertheless, the justification of the serial independence in the errors imply that the differenced equation residuals must not have a significant AR(2) behaviour. The second lags of endogenous variables are unlikely to be appropriate instruments for their existing values if this statistic is revealed to be significant. As the Arellano-Bond test for AR(2) in our model presents a probability equal to 0.112, we do not reject the null hypothesis, indicating that the error terms are not serially correlated.

That being so, both statistical tests confirmed that the conditions and restrictions of the estimations were found, avoiding overidentification and granting a better fit of the model.

4.1. Macroeconomic model results

The regression results of our macroeconomic study are presented in Table 4. Besides the macroeconomic variables included in our model, we also decide to analyse the impact of crisis years on investment rate and its relationship with our macroeconomic variables themselves.

Table 4: Macroeconomic Regression

Dynamic Panel-Data estimation, two-step system GMM

Variables	Coefficients	*t*-value	Probability
EPU Index	- 0.007	-2.98	0.003***
GDP Growth *t*	0.025	4.43	0.000***
GDP Growth *t-1*	0.041	2.51	0.000***
Interest Rate *t*	-0.060	-5.24	0.000***
Inflation *t*	-0.012	-1.91	0.051*
Inflation *t-1*	-0.025	-4-44	0.000***
EU Funds	-0.0001	0.52	0.602
c	10.886	66.37	0.000***

Note: **** p-value<0.01, ** p-value<0.05, * p-value<0.1*

1. EPU index

The Economic Policy Uncertainty Index presents a statistically significant and negative coefficient, demonstrating that economic uncertainty is negatively related to firms' investment, which is in line with our hypothesis 1. On average, a one unit increase in the EPU index has a negative 0.7 percent effect on the investment rate. In fact, our findings are consistent with studies from many authors **(**Al-Thaqeb and Algharabali 2019; Kang et al.2014; Julio and Yook 2012). Their reasoning is that firms prefer to operate more cautiously during periods of high uncertainty, consequently postponing investment choices.

In addition, according to Baker et al. (2013) in Kang et al. (2014), this effect is quantitatively magnified throughout the years 2007–2010, indicating that this variable has a greater impact on investment decisions during times of crisis. To confirm this, we included a factor interaction between EPU index and a dummy for crisis years, to which we obtained a negative coefficient. In that regard, our findings are in line with the theory proposed by the mentioned author, thus it is possible to infer that in years of crisis, the uncertainty is higher.

This result validates our hypothesis 1, thus it should not be rejected, indicating that EPU index has a significant and negative impact on corporate investment decisions.

2. GDP growth rate

For the GDP growth rate, we decide to introduce a lag to this variable in order to analyse both the effects the GDP growth rate in year t and in t-1 have on investment in year t.

The GDP growth has the expected positive and significant statistics in both year t and year t-1, indicating that a high GDP growth rate creates new corporate investment options, as it encourages and stimulates the sectors of the economy. Our results show that on average, a one percent increase in the GDP growth rate for year t and t-1 has a positive 3 and 4 percent, respectively, effect on investment rate.

This result was already expected, as many studies address the relationship between GDP growth and corporate investment activity (Farooq et al. 2021; Becker 2006). The reasoning behind these studies is that firms' activities are internally related to each other, then, when GDP rises, per capita income rises as well, resulting in an increase in consumer's demand. To satisfy the increase in consumer demand, firms expand their operations through capital expenditures.

Furthermore, our findings also show a negative correlation between crisis years and GDP growth, confirming that during crisis year, GDP suffers a contraction.

This result validates our hypothesis 2, thus it should not be rejected, implying that GDP growth rate of year t and year t-1 has a significant and positive impact on year t firms' investment.

3. Interest rate

Our results for the interest rate present a statistically significant negative coefficient, indicating that as interest rates increase or decrease, investment rates decrease or increase, respectively. Our results show that on average, a one percent increase in the interest rate has a negative 6 percent effect on the investment rate. These results align with our hypothesis 3 as well as with the conclusions of Farooq et al. (2021). The rationale behind their conclusions is that, ceteris paribus, higher interest rates mean a higher cost of investment, which in turn causes lower income investors to back away from investing and overall demand for investing is lower. Similarly, lower interest rates mean a lower cost of investment, which will stimulate investment and increase overall investment.

Nevertheless, the results for this variable should be considered with an important note in mind, as there is a probability of biasedness - the especially high correlations between interest rate and uncertainty and inflation may be affecting the results of this variable as they are all being included in the same model and present correlations above 0.5.

Having this in mind, we fail to reject hypothesis 3, as we have significant results for the interest rate affecting investment rates negatively.

4. Inflation Rate

For Inflation, we also decide to analyse both the effects the inflation rate in year t and in t-1 have on investment in year t.

The results show that, although not as relevant as other variables, both coefficients are statistically significant and influence investment negatively. For year t and year t-1, on average, a one percent increase in the inflation rate has a negative 1 and 2.5 percent effect on the investment rate, respectively. Our findings confirm the studies by Ayyoub, Chaudhry and Farooq (2011) in Farooq et al. 2021. Their reasoning is that higher inflation rates decrease purchasing power of consumers, which in turn will limit business opportunities and decrease investment, as it is the same as experiencing an unusual increase in the cost of investment (Farooq et al. 2021).

Moreover, our results show a positive correlation between crisis years and inflation, indicating that during crisis years, inflation suffers an increase. However, it is also important to note there is a possibility of biased results as inflation presents a strong correlation with interest rate.

Given the statistically significant negative relations found, we fail to reject our hypothesis 4 and state that inflation rate is a significant predictor of investment rate, affecting it negatively.

5. EU funds

Regarding the stimulus packages from European funds for companies to invest, our results show that this relationship is not significant – we found a negative coefficient, but it is, however, statistically insignificant -, as well as it is not a relevant coefficient in magnitude. This non-significance result might be delivered by the fact that most of the firms present in our dataset were not included or supported financially with European funds, as only 44 thousand firms were supported under the ERDF programme and, within those 44 thousand firms, there are some micro firms, which were excluded from our data set. Although this variable has shown a non-significant statistical effect in our model, this does not mean this variable is economically insignificant, as EU funds are frequently used by a number of firms who would not be able to get bank funding for investment projects otherwise.

In addition, our results may also be biased due to a very high correlation between EU funds and GDP growth (-0.67), which are both being included in the same model which may cause bias issues. The results also show a positive correlation between crisis years and EU funds, indicating that during crisis years, more EU funds are distributed to ease the negative impact of the crisis.

This leads us to reject hypothesis 5, as we do not find a positive statistically significant relationship between EU funds and investment rates.

4.2. Microeconomic model results

The regression results of our microeconomic model are presented in Table 5. The significance level of all microeconomic explanatory variables are winsorized at 1%.

Table 5: Microeconomic Regression

Dynamic Panel-Data estimation, two-step system GMM

Variables	Coefficients	t-value	Probability
Investment Rate t-1	0.161	18.26	0.000***
Investment Rate t-2	0.044	5.46	0.000***
EBITDA Margin t	1.04	9.88	0.000***
EBITDA Margin t-1	0.817	6.06	0.000***
Retention Ratio t	-0.046	-1.61	0.106
Retention Ratio t-1	0.119	3.73	0.000***
Eff Tax Rate t	-0.009	-1.29	0.197
Eff Tax Rate t-1	-0.0137	-2.16	0.031**
ST Debt	0.063	1.38	0.166
LT Debt	0.752	11.54	0.000***
Collateral Assets	2.101	33.54	0.000***
Financing Cost	-5.827	-9.41	0.000***
Firm Size	0.681	43.67	0.000***
c	-2.42	-17.53	0.000***

Note: **** p-value<0.01, ** p-value<0.05, * p-value<0.1*

1. Previous investment

As already mentioned, the dependent variable chosen in our model is the investment rate. Based on literature, we decide to study the effect of firms' previous investment in the current investment, including two lags of the investment rate as independent variables in our model. The results present a high t-value confirming the inference of a GMM model.

These significant and positive statistics indicate that the previous investment is one valid predictor of current investment. For year t-1 and year t-2, on average, a one percent increase in previous investment has a positive 0.16 and 0.04 percent effect on the investment rate, respectively. This outcome is in line with our hypothesis 6 and with the results from Eberly et al. (2012) and Christiano et al. (2005). Their reasoning is that the specification of investment adjustment costs predicts the manifestation of a lag-investment impact.

This leads us to not reject our hypothesis 6, indicating that firms' previous investments of year t-1 and t-2 have a significant and positive impact on investment.

However, it is important to note that when previous investment is retrieved of our model, the other variables coefficients maintain the same results and significance, confirming the robustness of our statistic results.

2. EBITDA Margin

For this variable, we also decide to introduce a lag in order to study how EBITDA Margin in year t and year t-1 affect investment rate of year t.

EBITDA Margin, both in year t and year t-1, present the expected significant and positive coefficients, implying that firms with higher EBITDA margins tend to invest more in year t. Our findings show that, on average, a one percent increase in the profitability rate in year t and

t-1 has a positive 104 and 82, respectively, percent change on investment rate. This result is in line with our hypothesis 7 as well as with some authors (Pacheco 2017; Hernando and Martínez-Carrascal 2008; Brown 2009). These authors support the "investment-cash flow hypothesis", defending that firms that are already more susceptible to severe financing constraints have a larger investment-cash flow sensitivity.

In addition, in order to study if small firms rely more on their cash-flows than medium firms, we also performed another regression adding a factor with the interaction between EBITDA margin and a dummy for medium firms. We obtained the expected results, confirming that medium firms rely less on their cash-flows in comparison to small firms, suggesting that larger firms use more frequently external funds to finance their investments.

Having said that, hypothesis 7 should not be rejected, as we find that profitability in year t and t-1 has a positive and statistically significant effect of approximately 104% and 82%, respectively, on investment rate.

3. Retention ratio

With respect to the retention ratio variable, we also decided to introduce a lag to this variable and the results were quite interesting.

Analysing the retention ratio for year t-1, we obtain a positive statistically significant coefficient, indicating that retention ratio and investment rate move in the same direction. For year t-1, on average, a one percent increase in the retention ratio has a positive 12 percent effect on the investment rate. These findings are in line with some literature (Vogt 1994; Oliner and Rudebusch 1992; Whited 1992), including with the “pecking order theory” proposed by Myers and Majluf (1984).

However, when analysing the retention ratio for year t, we obtain a negative coefficient that is only significant at roughly a 90% confidence level. This may be due to the fact that the retention ratio at the end of year t is not a depiction of the retention ratio of the firm at the time they invested in that same year. One possible explanation for a negative sign in the coefficient of this variable is the fact that firms may choose to invest their internal funds in financial instruments, which are not included in our investment rate variable. As the interest rate paid for bank loans is sometimes lower than the opportunity cost of firms not investing their internal funds in financial instruments, firms may decide to finance their tangible investments with bank loans.

We also perform another regression adding a factor with the interaction between lagged retention ratio and a dummy for medium firms. Our findings present that besides the positive effect that the retention ratio and being a medium firm in comparison to a small one have on investment, the marginal effect of the retained earnings of a medium firm (in comparison to a small one) on investment rate is negative. This indicates that medium firms rely less on internal funds in comparison to small firms.

With this being said, we fail to reject hypothesis 8, as our results for year t-1 present that retention ratio has a positive impact on investment rate.

4. Effective tax rate

Regarding Effective Tax Rate, we also decide to introduce a lag to this variable, in order to study the impact of this variable in year t and year t-1 on investment rate of year t.

The results for effective tax rate in year t-1 are in line with what we were expecting. This variable presents a significant and negative coefficient, indicating that companies with a higher effective tax rate in the year t-1 tend to invest less in the following year. This finding is in line

with some authors (Sánchez-Ballesta et al., 2021; Masso, 2002; Strulik, 2008; Vartia, 2008). For year t-1, on average, a one percent increase in the effective tax rate has a negative 1.4 percent effect on investment rate. The rationale behind is that lower corporate tax rates might stimulate investments through the relaxation of liquidity constraints and trough the decreasing of banks' agency costs and bankruptcy rates. In addition, the influence of these taxes on cash flows and the potential implications of firms' taxes on the discount rate is also suggested to impact firms' investment.

However, when looking at results of the effective tax rate for year t, it displays a negative coefficient but is not statistically significant. Possibly, these results may be due to the fact that during the year, firms do not yet know the actual effective tax rate they will be subject to at the end of the year, so its effect on that year's investment is not certain.

Thus, we fail to reject hypothesis 9 for year t-1, as our results for that period present that effective tax rate negatively impact the investment rate of year t. However, is important to note that our results for this variable in year t presents non-significant results, thus our hypothesis only applies when studying the relation between effective tax rate in year t-1 and investment rate in year t.

5. Short term debt

Our results for the short-term debt impact on investment rate are not what we expected. We hypothesised short-term debt would be negatively related with investment rates, as we expect companies to forgo investment projects if they have high short-term payments due to be paid. However, we obtained a statistically insignificant coefficient. This is possibly due to errors in data gathering, as we can see in Table 1 that short-term debt and investment rate have a weak negative correlation, so they can have some influence on each other that is not being accurately

represented in our model. Also, a possible reason may be that short-term debt is usually used to finance a firm's day-to-day operations and not t the type of investments we are considering.

Thus, we reject hypothesis 10, as we do not find a statistically significant negative relation between short-term debt and investment rate.

6. Long term debt

For the long-term debt, in contrary to the short-term one, the results are the expected ones. We find a positive statistically significant coefficient, indicating that firms are able to incur in more investment by borrowing funds externally to fund their investment projects. Our results show that on average, a one percent increase in the long-term debt has a positive 75 percent change on the investment rate. Furthermore, the high magnitude of the t-value for this variable (11.5), implies we have high evidence against the null hypothesis.

This effect is in accordance with the results from Pacheco (2017), as he realized firms may be able to invest more due to the accumulated assets obtained through debt. Thus, higher long-term debt appears to foster investment. Pacheco (2017) indicated that creating incentives for businesses to switch from short-term debt to long-term debt might produce a likely beneficial element for investment.

In Table 1, it is also of noting that long-term debt and collateralizable assets have a medium-positive correlation, indicating that firms with higher collateralizable assets are able to secure external funds more easily, which in turn will allow them to invest in more assets that can later turn into collaterals.

In addition, we perform another regression adding a factor with the interaction between LT debt and a dummy for medium firms. Our results show that the influence long-term debt has on investment rate should be greater for medium firms in comparison to small ones. Moreover, we

also want to analyse the impact that leverage has in explaining investment during downturns. In order to do this, we performed two different regressions, one with a factor interaction between long-term debt and GDP growth, to which we obtain a negative coefficient indicating that in booming (recessing) times the effect of long-term debt on investment is lower (higher); the second regression included a factor interaction between long-term debt and crisis years dummy, to which we obtain a positive coefficient, confirming the results obtained before, as this indicates that during crisis years, long-term debt has a higher impact on investment.

Thus, we fail to reject hypothesis 11, as we find a statistically significant positive impact of long-term debt on investment rate.

7. Assets to serve as collateral

The assets to serve as collateral presents a significant and positive coefficient, indicating that the increasing availability of tangible assets on a company's balance sheet is expected to result in better conditions when obtaining credit. Our results present that, on average, a one percent increase in the share of tangible collateralizable assets has a positive 210 percent change on the investment rate. Our findings align with our hypothesis 12 as well as with the conclusions of Titman (2013) and Gan (2007). Titman (2013) argued that the motivation behind this relation is that collateralizable tangible assets back firms' debt financing, resulting in a boost of capital on firms to invest and expand their capabilities. The study of Gan (2007) agrees with this, confirming that a greater availability of collateralizable assets in a firm's balance sheet is essential for a firm to contract debt, as this source of funding most often requires a tangible guarantee.

In addition, in order to analyse the influence of collateralizable assets on investment by firm size, we perform another regression adding a factor with the interaction between collateralizable assets and a dummy for medium firms. Our findings indicate that collateralizable assets have a

higher impact on investment for medium firms. This may be due to the higher amount of collateralizable assets that these firms own, implying better conditions when accessing to credit, which affects positively the investment activity when the latter is financed through loans.

Moreover, we also want to analyse the interaction between collateralizable assets and long-term debt. In this regard, we perform another regression with such interaction, and we obtain a negative coefficient. This indicates that the more collateralizable assets, the lower the impact of long-term debt on investment. Similarly, we also find a negative coefficient for the interaction between this variable and financing cost, again indicating that more assets to serve as collateral imply a lower impact of the financing cost on investment.

That being so, hypothesis 12 is not rejected, as we find that collateralizable assets has a statistically significant and positive impact on investment.

8. Financing cost

Regarding the financing cost for firms, we find a statistically significant negative coefficient, as expected, indicating that as the cost of financing is higher or lower, firms invest less or more, respectively. Our results show that, on average, a one percent increase in the financing cost has a negative 583 percent change on the investment rate - which is the most relevant impact on investment rates that we have found through our analysis. Furthermore, the high magnitude of the t-value for this variable (-9.4), also implies we have high evidence against the null hypothesis.

This aligns with the results from Farinha and Prego (2013), suggesting that future expenditures are less likely to be worthwhile when financing costs increase.

To investigate the impact of the financing cost on the decision to invest for medium firms in comparison to small ones, we perform another regression adding a factor with the interaction

between financing cost and a dummy for medium firms. We obtain a negative coefficient for this interaction factor, indicating that the financing cost has a lower impact on investment for medium firms in comparison to small ones. One possible reason for this is that medium firms tend to have a lower financing cost, so this factor will not weight as much on the decision to invest for these medium firms in comparison to small ones.

From Table 1, it is also observable the correlation between financing cost and the interest rate, which is medium-positive strong. To build on this, we performed another regression with an interaction term between the firm's financing cost and the interest rate. We obtained a positive coefficient, meaning that the higher the interest rate, the higher the impact of the financing cost on the investment rate. This may be since obtaining loans and paying off loans will be significantly more expensive when interest rates are higher, as well as the cost of debt will be lower when interest rates are lower.

Thus, we fail to reject hypothesis 13, as we find a negative statistically significant coefficient for the impact of the financing cost on investment rates.

9. Firm size

Our results regarding the effect of firm size in volume on investment decisions undertaken by firms are surprising as we were in line with the reasoning by Pacheco (2017), that smaller firms would invest more as they are trying to grow. However, we obtain a highly statistically significant and positive coefficient. Our results show that, on average, a one percent point increase in the firm size in volume has a positive 0.68 percent change on the investment rate.

Our findings align with those of Beck et al. (2005). They found a negative relation between firm size in volume with financial constraints, as well as a negative relation of financial constraints with investment, thus yielding a positive relation of firm size with investment.

Thus, we reject our hypothesis 14, as we find a statistically significant positive coefficient for the firm size in volume, which indicates it is positively related with investment rates, going against our hypothesis.

Table 6: Summary of expected and obtained results between explanatory variables and investment

Explanatory Variables	Expected Relation	Observed Relation	Hypothesis failed to be rejected?
H1 EPU Index	-	-	YES
H2 GDP Growth Rate	+	+	YES
H3 Interest Rate	-	-	YES
H4 Inflation Rate	-	-	YES
H5 EU Funds	+	NS	NO
H6 Previous Investment	+	+	YES
H7 EBITDA Margin	+	+	YES
H8 Retention Ratio			YES
t	+	NS	NO
t - 1	+	+	YES
H9 Effective Tax Rate			YES
t	-	NS	NO
t - 1	-	-	YES
H10 Short Term Debt	+	NS	NO
H11 Long Term Debt	+	+	YES
H12 Assets to serve as Collateral	+	+	YES
H13 Financing Cost	-	-	YES
H14 Firm Size	-	+	NO

Note: "+" Positive Relation; "-" Negative Relation; NS - Non Significant

In Table 6, one can observe that three of our initial hypotheses are globally rejected. Two of them, the EU funds and the short-term debt, both appear to be not statistically significant in explaining firm's investment, indicating that these factors do not relevantly impact firm's investment. The other hypothesis that is globally rejected concerns firm's size in volume, as the relationship found between this variable and firm's investment is opposite to the initially hypothesised one. However, this does not mean that firm size is not relevant in explaining firm's investment, it only means it affects investment positively instead of negatively, as expected.

Furthermore, two other hypotheses are partially rejected. Both the retention ratio and the effective tax rate for year t appear to be not statistically significant in explaining investment for year t. However, we do not globally reject these hypotheses as the variables in t-1 are found to be relevant in explaining firm's investment.

5. Financing Investment in a Digital Economy

As previously suggested by much of the cited literature, tangible assets to serve as collateral play a key role in explaining a firm's investment behaviour. The results delivered by our regression analysis support such fact and the statistical relevance of the coefficient makes it one of the most impacting variables on the investment rates displayed by firms. Such fact was the igniting point to the topic that we approach on the last part of this document.

The economic transformation happening in most of the developed economies is making them more reliant on innovative investments and technological developments in order to achieve growth (OECD 2011). This transformation produces unavoidable changes to the composition of the balance sheets of firms, where the growing importance of intangibles can pose challenges to the availability of collaterals when seeking credit (Demmou et al. 2019). This fact seems to be consistent with the results obtained by Bańkowska et al. (2020), where European innovative firms were found to be the category of firms experiencing the greatest credit constraints when seeking financing.

In that regard, we recognized and found crucial to lay the foundations to the discussion about the role of commercial banking on a digital economy, especially by analysing its relationship with intangible assets. We acknowledge that such subject is far from having immediate consequences for BPI, especially given the characteristics of the Portuguese economy. Nonetheless, the recognition and valuation of strategic intangibles is something that, as later discussed, takes time and effort.

We acknowledge the limitations derived from the comparisons established below, especially given certain economic contexts that are distant from the Portuguese one. However, it is also

undeniable that the economic transition shifting most of the OECD countries towards knowledge-based economies is also happening in Portugal, as later explored.

By gathering and analysing information on how banks and countries have been adapting to this economic transition, the ultimate goal is to deliver a set of recommendations that will help BPI to better adapt and thrive in the context of a digital economy.

5.1. Characterization of intangible investments

Over the last two decades, investment in intangibles has grown by 130% in the US and 87% in the EU-28 (Thum-Thysen et al. 2017). Data collected by the ECB and the Eurostat demonstrates that the European average intangible investment amounts to 15% of total investments, as of 2017. The leading country in intangible investments is France, corresponding to 23% of total investments, followed by Germany at 15%, and Italy and Spain at 10%. Furthermore, a 2016 industry analysis from the European Union Intellectual Property Office found that Intellectual Property Rights (IPRs) intensive industries are responsible for 42% of EU's economic output and are also responsible for 93% of EU's exports.

However, the exponential growth in intangibles has not been followed by improvements to firm's valuation methods, such as improved accounting standards, in order to incorporate the value of intangibles and to mitigate the uncertainty generated among credit institutions (Thum-Thysen et al. 2017).

The greater uncertainty derived from intangible specific characteristics prevents private institutions to extend their credit to firms that greatly rely on intangible assets or to firms that intend to invest directly in intangible projects. For that reason, the financing of intangibles is still much more dependent on private equity instruments and retained earnings rather than on

debt instruments (Cecchetti and Schoenholtz 2017). This scenario is confirmed by recent data provided by the ECB (Bańkowska et al. 2020). Nearly 70% of the European SMEs said to rely mainly on bank loans to fund investments in fixed assets, while only approximately 15% of the European SMEs were able to finance investments in innovative projects through bank loans. The EIB, through its Survey on Investment and Investment Finance (EIBIS), found European banks to only finance 38% of the investments performed by EU firms on R&D.

The European Investment Bank (EIB) subdivides investments in intangibles into four subcategories: I) Research and Development (R&D) which includes acquisition of intellectual property; II) software, data, website activities and IT networks; III) training of employees and IV) improvements to business process and organisation.

The previously acknowledged types of intangible assets vary immensely in regard to their characteristics. The difficult collateralisation of intangible assets result from the non-tradability and the lack of visibility affecting most intangibles, which entails a reduction of the scope for asset-backed financing strategies. Thum-Thysen et al. (2017) also develops on the lower ex-ante verifiability of intangibles (inability of assessing their value before they have started generating cash flows) as an additional barrier. However, intellectual property seems to group the intangibles that can more easily overcome such limitations (Andrews and de Serres 2012). Indeed, Schneider (2019) found IPRs, such as patents and trademarks, to be extremely relevant for SMEs. The cited literature further developed that the correct identification and valuation of such valuable intangible assets enable the latter to be used as collateral for loans and motivates outside investment by clearly communicating the value of the firm.

Segol et al. (2021) found that the barriers to investment in intangibles assets in Europe are mainly due to a bank-based economic area. The authors found that lending rates, maturity and collateral requirements have negative effects on investments in multiple intangible assets. The

cited literature concludes that the European lending framework gives support to the credit guarantee schemes for the firms that are not able to provide enough collateral value. The state, as a guarantor, fights a market failure and helps alleviate financial constraints and promote investments in intangibles through many economies of the Union.

5.2. The Portuguese context

COTEC, an association seeking to better understand and support innovative Portuguese firms, acknowledges that also in Portugal the transition to a more knowledge-based economy is gradually happening. Portuguese innovative firms are found to exhibit greater financial robustness than their non-innovative peers (COTEC 2021). The report further found that innovative firms have been able to generate, on average, seven new IPRs per year and the investment intensity in knowledge amounts to 4%. Innovative Portuguese firms displayed an average 15% CAGR of revenues during from 2019-2021, while the overall set of Portuguese SMEs displayed a growth rate of 4.2% in 2019 and -9.8% in 2020 (INE 2020).

In Portugal, the aggregate investment in intangibles in 2018, as a share of GDP, amounted to 6.8% while that in tangibles amounted to 13%. Portugal ranks below the European average for investments in intangibles, which equals 8.3% of GDP, and above the European average of investments in tangibles, which amounts to 12.1% of GDP (Villarroya 2021). The same study also found that 34.4% of total investments in Portugal were channelled to intangibles, while the remaining 65.6% were channelled to tangibles. The European average sits at 40.6% and 59.4%, respectively.

Portuguese SMEs are also found to be mostly concentrated in low productivity sectors, which is supported by the score of Portuguese SMEs in the Digital Intensity Index composed by the

EU. The index points that 40% of the Portuguese SMEs have extremely low values of digital intensity.

Innovation in Portugal

As a consequence of the shift in EU and national policies to promote the digital transition, Portugal's Investment in R&D has grown by almost 3 times, from little over €1bn in 2015, to roughly €3bn, in 2019. More than half of such investment in R&D was led by private enterprises (DGEEC 2020).

An important consequence of the innovative path followed by the Portuguese economy is related to the emergence of start-ups. Start-ups can be defined as young projects that thrive to launch an innovative product, business model or market segment. Although Portuguese start-ups only account for little over than 1% of Portugal's GDP, they have been steadily growing both in number and in size. Currently, there are more than 2,000 start-ups actively operating in the country which allow Portugal to currently register a number of start-ups per capita that sits 13% above the European average (Startup Portugal 2021). Such facts helped the Portuguese to become the 17th most innovative EU country, according to EU's Innovation Scoreboard.

In 2021, the number of Portuguese unicorns grew to 7. As of 2021, the Portuguese unicorns achieved a market valuation of €34.2bn. Such value, in 2021, corresponded to 44% of the total market value for the 20 biggest publicly traded Portuguese firms.

5.2.1. How are innovative Portuguese SMEs financed?

Debt financing

Commercial debt might be provided in three different ways: Unsecured lending, secured lending and guaranteed lending. It might look at first glance that a correct valuation of

intangible assets can only contribute to foster the use of such assets as collateral in secured lending. However, if financial institutions are able to value intangibles more accurately and from there derive better prospects about a firm's strength and growth potential, then it can also help to foster unsecured lending. From all the means of financing made available to firms, debt is the one where intangibles and intellectual property have the greatest potential do add value (Brassell and Boschmans 2019).

Debt remains the primary source of external financing for Portuguese SMEs. Such heavy reliance on debt financing is also supported by government guaranteed schemes through bank loans. Outstanding business loans to SMEs in 2020 in Portugal amounted €58.9bn, of which €13.6bn were guaranteed by the government. Government guarantees have grown from 5.4% of total loans in 2009 to 10.5% in 2018 and they have been especially important given that banks have tightened significantly the lending conditions imposed on SMEs, requiring better quality and higher collaterals. SMEs needing collaterals to access bank lending rose from 76.3% in 2009 to 89.9% in 2020 (OECD 2022).

Eça et al. (2022) found that the paradigm surrounding financing procedures of Portuguese SMEs has been changing throughout time. The greater digitalization of the economy has also altered the landscape surrounding financial intermediation. While not long ago the financing of SMEs was almost totally ensured by banks, nowadays it seems that Fintech's have been gaining relevance on such financing operations. The cited literature analyses the borrowing of funds of Portuguese SMEs by a Portuguese FinTech and concludes that FinTech lending allows for firms to expand their debt capacity, entailing a substitution of bank debt for FinTech debt. The differences in risk appetite portrayed by banks and FinTech's explain differences to the requirements set when extending credit. FinTech's are willing to lend to riskier firms at the

expense of greater interest charged. The risk in such lending can arise from the unsecured extension of credit which is often performed by FinTech's.

The European Investment Bank (EIB) asserted that Portugal needs to provide a solution to the credit constraints imposed on firms looking to finance their digital projects. It found that the lack of investment in R&D, lack of qualified workers and the difficult access to investment condemns Portuguese SMEs to sit below the European average in what regards the level of digital transformation. EIB further explained that such constraints are often due to a relevant intangible component that entangles the risk assessment from credit institutions and due to the lack of sufficient physical or tangible collaterals that SMEs have to offer. Such facts can also explain the persistent greater financing constraints faced by Portuguese firms, when compared to the European average (EIB Investment Survey 2021).

Equity financing

Equity financing is a broadly used means of financing by intangible rich SMEs in their early stage of development. This is due to the fact that it does not impose maturity constraints on the repayment of capital and does not demand collaterals. Equity finance might be performed by angel investors, specialist funds, venture capital firms or even private equity houses. Equity financiers usually take interest on deals that occur when there is a rapidly expanding product or service business, or when there are technologies, software's and brands with clear demand.

In 2020, venture capital financing to Portuguese SMEs amounted to €42m (OECD 2022). Equity financing does not follow a clear pattern and it has always been irrelevant, in value, when compared to debt lending. From 2017 to 2021, equity financing either in the form of venture capital or angel-investors, amounted to €270m (OECD 2022).

The dynamics established by venture capital activities in Portugal are also partly due to the support given by the EIB. In 2008, the Portugal Venture Capital Initiative (PVCi) was established with the aim of promoting co-operation between several public and private entities in order to stimulate venture capital and private equity activities in Portugal. From 2008 until 2018, PVCi invested more than €320m in the Portuguese economy.

Portuguese government commitment with digitalisation

The Portuguese government has already signalled the total alignment with the EU in promoting the transition of the Portuguese economy towards a more digital economy. At the European level, Next Generation EU includes a 10-year €800bn investment plan to ensure a smooth transition to a more digital, greener and social European Economy. *Portugal 2030* is the economic plan that began in 2021 and will last until 2027. It will distribute €23bn in order to attain the objectives set under the Next Generation EU plan previously mentioned. €5.3bn of those are targeted at ensuring the digital transformation of the Portuguese entrepreneurial landscape.

Indústria 4.0 is the name of the national strategy set in place by the ministry of economy to promote the transformation of the Portuguese economy. This strategy sits upon three different scopes of action: to provide the Portuguese firms with the necessary tools to embrace the fourth industrial transformation, by promoting Portuguese suppliers of technology and by turning Portugal into a Tech-Hub in order to stimulate outside investment and know-how sharing between firms and entrepreneurs.

5.3. How are banks adapting to the context of a digital economy?

5.3.1. Venture capital activities performed by banks

Hellmann et al. (2008) analysed data from banks operating in the US and found evidence that banks also use venture capital in order to build lending relationships. A prior relationship between a bank and a firm through venture capital markets increases the likelihood of the bank granting loan, and with more favourable conditions to that company in subsequent periods, which plays in favour of both parties involved.

Several European banks have been adapting and transforming their operations in order to provide an answer to the change in demand of consumers over financial products and the escalating relevance of Venture Capital firms and FinTech's. Banks' venture capital activities are funded with private investors' money, which allows for a transfer of the risk of such investments.

Barclays Ventures, a branch of Barclays, was created in 2018. Its scope of action is to adapt the available instruments offered by the bank, both financial and non-financial, to tackle the challenges posed by the technological progress of the market. As of today, Barclays Venture financed 142 firms through its venture capital activities.

Another example is that of Mouro Capital. Mouro Capital is the corporate venture capital division belonging to Santander Group. The firm is focused on supporting firms that will shape the future of financial services. Currently it has $400m of assets under management, with investments made in start-ups spread across Europe, North America and Latin America.

In Portugal, there is within the banking sector, one relevant player in the venture capital activities. CaixaBI, the branch of *Caixa Geral de Depósitos* that deals with risk capital. With

over 20 years of experience, Caixa BI currently manages a total capital of €475m from start-ups spread across several industries.

Finally, the recent acquirer of BPI, CaixaBank also has a branch whose activity is targeted at venture capital operations. Caixa Capital Risc invests in innovative companies in their early stages of development, either through convertible loans or equity. The company currently holds investments in more than 100 companies, mainly in Spain, spread across sectors such as life sciences, information technologies and industrial technologies.

5.3.2. Intangible backed financing

Bank lending against intangible assets, although widely recognized as a possible tool to promote smooth financing and spur investment amongst SMEs, has known little to no developments in recent years, except for south-east Asia. China, for instance, is the most active state-backed intellectual property (IP) financing market in the world, although not being the most relevant example for the point we want to address, as in this case, all of the risk is being supported by the government (due to the 100% guarantee scheme provided).

A 2021 WIPO report studies the developments on Singapore's IP-backed financing. Singapore started their journey in 2014 with several financial institutions establishing partnerships with IP property offices of the country. Under this scheme, the government shared the risk (often in 80%) of IP-backed loans with financial institutions. Up until 2018, roughly $9m had been distributed to firms on such terms. The reduced size of the programme was mainly due to high upfront valuation costs of intangibles supported by firms that deterred a great number of applicants to bank loans.

The country exhibiting the most experience and mature practices on intangible backed financing is the United States. The main motivation for the use of IP assets as collateral was the 2008

crisis. Banks, which held a lot of collaterals in the form of real state, found their selves in an under-collateralised position following the downfall in the housing prices. As a solution to overcome the lack of tangible collaterals, banks started collateralizing IP assets.

In the United States, as opposed to other countries, the national intellectual property office (US Patent and Trademark Office) is focused solely on the rights and regulatory component of innovation, therefore all of the initiatives that connect intellectual property and intangible-backed financing are performed by the private sector. In recent times, the use of relevant patents as collateral for loans granted by banks has been increasingly popular. JP Morgan Chase leads the ranking for the most patents taken as collateral (over 48,000), followed by the Bank of America (47,000), the Citigroup (35,000), Wells Fargo (33,000), Wilmington Trust (32,000) and the Deutsche Bank (27,000).

Another consideration to make on intangible securities, specifically in the case for the US, relates to the loan agreement in case of default. It became common that specialized valuation firms evaluated portfolios of intangibles from several firms and attributed a "certified purchase asset price", while ensuring the portfolios were marketable and well-protected. In case of default, banks would have enforceable rights over the portfolios that were given as collateral.

5.3.3. Challenges on intangible backed financing: valuation

One of the greatest challenges for financial institutions upon the possibility of including intangibles as collaterals refers to its valuation. There are multiple ways to evaluate intangible assets, however such valuations are complex. The complexity derives from the insufficient number of transparent markets where intangibles are traded and because intangibles are extremely heterogeneous in regard to their characteristics. Also, the volatility in intangible prices, since they depend on various factors, poses additional challenges to their valuation.

Brassell and Maguire (2017) studied the valuation methods of intangibles and concluded the income approach and within that, the royalty method, to be the most commonly used valuation method. The income approach refers to the income contribution that the intangible delivers to the income of a company, based on market conditions and historical performance. Within the income approach, the royalty method corresponds to an estimate of how much a third party would pay to license the technology. The income approach and other valuation approaches have already been standardized and the standards most often considered are the International Valuation Standards Council (IVSC) and the International Standard, ISO 10668.

Nonetheless, the great amount of valuation methods, which can lead to distant valuations over the same asset, imply the need to earn the confidence of the market. Brassell and Boschmans (2019) found that can be achieved by having the evaluations performed by state backed organizations, multinational accounting practices or other private sector evaluation specialists.

5.3.4. Challenges on intangible backed financing: illiquid secondary markets

Certain characteristics of intangibles pose challenges to the mission of monetizing them, causing concerns near financial institutions regarding their liquidation, if ever taken as collateral. There is, however, secondary market activities taking place worldwide. Although most of the trade occurs informally, there are formal channels, such as auctions, where intangibles are traded (Brassell and Boschmans 2019).

Intangible assets can be sold or licensed to a third party. There is a great value derived from charging license fees and royalties to third parties for the use of certain intellectual property rights. In 2018, US cross border trade of IP rights entailed earnings, in the form of licensing fees and royalties, of $129bn (Congressional Research Service 2020) and the value of the US market for licensing IPRs was worth $61bn in 2019 (IBISWorld). This places the United States as an extremely active market in the trade of intangible assets. Recently, there has also been a

trend in the United States, motivated by a very much developed legal framework of protection of IPRs, for corporations to acquire portfolios of patent rights in order to successfully enforce them in case of infringement and from there derive profits (Brassell and Boschmans 2019).

5.4. How should BPI adapt to the market transformation?

Having characterized the situation and the developments that have happened in other countries regarding the financing of SMEs, in an increasingly digital world economy, where Portugal is no exception, we aim at delivering possible measures to be implemented in order to best assist BPI in adapting and thriving within a digital economy.

5.4.1. The case for intangible backed loans

Progresses in regard to intangible backed loans are still a distant reality. Firstly, in an initial stage, the incentives must be set in place by the government, by creating guarantee schemes for loans backed on intangibles and this way dissipating the risk falling upon financial institutions (Brassell and Boschmans 2019). As found earlier, this was crucial to the success inherent to the Chinese case. Secondly, intangible backed financing is also a distant reality given the general lack of knowledge regarding this asset class and its valuation from most of the financial institutions. Furthermore, intangible backed financing would face additional constraints in a market such as the Portuguese one, given the absence of liquid secondary markets for intangibles to be traded, as opposed to what takes place in the US However, planned initiatives such as the Capital Market Union of the EU could help in improving the liquidity on secondary markets for such assets.

Although recognizing that this is still a distant reality, it is crucial that BPI sets the foundations in order to acquire knowledge on intangible assets. Some of the literature depicted below and collected from countries ranking in far better positions than Portugal when it comes to

innovation scoreboards, point towards the relevance and the benefits derived from a deep knowledge over intangibles.

5.4.2. Recommendations

1. Building knowledge on intangibles through traditional credit lending

Brassell and King (2013), after having studied the role of intellectual property in easing business finance in the UK, have recommended that banks should start paying more attention to the intangibles found on firms' balance sheets. That is the case since the authors found intangibles to provide the basis for greater profits and enterprise value of the firms detaining them. The authors also found that those who have used IP in financing suggest loss levels to be low. Such reality derives, firstly, from the fact that the specific IP being funded is usually an important business asset that underpins cash flow. Secondly, because it is usual that the senior management has financial stake in the IP, therefore it can bring the benefits that banks traditionally link to personal guarantees.

France Business Financing Observatory (OFE 2017) has signalled that the digital transformation of SMEs will likely represent a challenge since it will difficult firms' access to external financing. The Observatory's research found that, although the largest banks in France have capabilities and developed structure to support innovative companies, often front-line relationship managers lack in depth understanding of the business for its appropriate diagnosis and referral.

Fidrmuc et al. (2018) focused on the relationship established between German SMEs and the banking sector between 2005 and 2012. The results obtained by the cited literature show that firms that present high share of intangible assets do not experience constraints in accessing to credit when comparing to firms with low share of intangibles. However, firms with greater

share of intangible assets are more likely to engage in persistent and exclusive bank relations. The authors point that this might arise in an attempt to overcome information asymmetries when applying for a bank loan.

In line with some of the previous characterizations and recommendations of financing dynamics in European countries, we recommend BPI to start analysing the intangible assets present on companies' balance sheet when extending credit. This will improve BPI's understanding on intangible assets over time while ensuring that financing is being extended to firms that perform better than their non-innovative peers (COTEC 2021). Also, BPI should thrive to develop and maintain long-lasting relations with its most innovative clients. The long-term analysis of innovative firms' performance will not only reduce the information asymmetries regarding the role of some key intangible assets, as it will allow BPI to better grasp the categories of intangibles that contribute the most to foster such growth.

2. Building knowledge on intangibles through venture capital

The positive growth prospects on the innovative pattern displayed by the Portuguese economy and the lack of dependence on public regulation to initiate this activity, lead us to advice BPI to start its own and specialized branch on venture capital. Following the initiatives undertaken by several European banks in recent years, BPI should take advantage of a relatively small and underdeveloped venture capital market in Portugal. In 2019, venture capital was the main source of financing for Portuguese start-ups (68.3% of total financing), but the majority of that capital (66.8%) came from international investors (BGI, EIT Digital).

BPI could make use of its vast knowledge on the Portuguese private sector and capitalize on CaixaBank's increased financial power and accumulated expertise, derived from its own venture capital activities in Spain, to rapidly establish itself as a key player in the Portuguese venture capital market.

By joining the venture capital market, BPI would also gain knowledge on the activities performed by a set of innovative firms as well as understand the dynamics associated to the use of key intangibles. Furthermore, as referred in Hellmann et al. (2008), this could be a way to develop long-term lending relationships with innovative firms.

We acknowledge that this recommendation might be conflicting with the strategy followed and designed for BPI by CaixaBank. CaixaBank has manifested its desire to extinguish the private equity activities led by BPI. The goal of CaixaBank is to focus the activity of BPI solely on commercial banking activities. However, we also acknowledge that the dynamics around the digital transformation of the Portuguese economy should entail an adaptation from BPI's activities in order to follow such transformations. The great expertise and know-how of BPI over the Portuguese economy, and specifically Portuguese firms, allied with the knowledge obtained by CaixaBank through their venture capital activities in Spain, should help promote a swift and successful implementation of BPI in the Portuguese venture capital market. Also, it is important to notice that venture capital activities are not constrained to the Portuguese market, as seen in the examples previously described.

Ultimately, we expect the development of deep knowledge regarding intangible assets derived by both of our recommendations to be a fundamental step for BPI to achieve competitive advantage when the time comes to use intangible assets as collateral.

6. Conclusions

We study the impact of several factors on the investment decisions taken by firms over tangible and intangible assets, from both a macroeconomic and microeconomic perspective. The dataset chosen for the analysis corresponds to Portuguese SMEs, except for micro firms.

Regarding the macroeconomic factors, we find EPU, inflation, and interest rate to be statistically significant factors that negatively affect firms' investment rates. On the other hand, we find the GDP growth rate to be statistically significant and to positively impact firms' investments. EU funds are found not to be statistically significant in explaining firms' investments, however, we do not reject the possibility of its economic relevance.

The microeconomic analysis demonstrated financing cost and lagged effective tax rate to be statistically significant and to deter firm investment. Previous investment, EBITDA margin, lagged retention ratio, the stock of long-term debt, and collateralizable assets are found to be statistically significant and to positively influence firm investment. The retention ratio and effective tax rate in year t are found not to be statistically significant.

We find the set of statistically significant variables with the most relevant coefficients to be the tangible assets to serve as collateral, the financing costs, and the level of long-term debt. These factors should be the ones most closely examined by BPI when assessing a company in order for the bank to better adjust the financial products it offers to the companies. The results on debt should entail BPI to provide loans with long maturity dates in order to spur firm investment, as short-term debt does not appear to have an impact on investment but long-term does.

The statistical significance and the relevance of the coefficient associated with collateralizable assets set the starting point for the research on the role of banks in a digital economy. Supported

by relevant literature on this topic, it is observable that banks and economies have been adapting in various regions of the world to the growing importance of intangible assets. Finally, we recommend BPI put some measures in place to develop in-depth knowledge of intangibles to better evaluate the risk inherent to innovative firms.

7. Limitations and Future research

There are some limitations associated with the study here presented. Firstly, some potential factors influencing firms' investment decisions, such as the firms' credit rating among financial institutions, management's level of education, the sector where they are inserted, and some country-specific political, financial, and economic factors were not considered. Another limitation concerning the analysis performed regards the dataset used. Although micro firms indeed often present incoherent and counterintuitive data that result from their firm-specific context, we also acknowledge that their exclusion from the dataset prevents the interpretation of the results found for a vast majority of active Portuguese firms. Finally, our results are conditioned on the metrics used both for the dependent and the independent variables, which may in some cases affect the results.

Future research is suggested on examining the possibility for non-linear relationships between the variables in question; and on the recommendations delivered regarding the role of BPI in a digital economy, since this is a constantly changing and evolving reality.

8. Manufacturing Industry Sector Analysis

Despite the economic transition toward growing importance of services in the Portuguese economy, the manufacturing industry continues to be a crucial sector in the country. Manufacturing industry includes companies whose activities are characterized, in general terms, by the transformation, by any process, of raw materials from various economic activities into new products. This sector is still responsible for around 12% of Portuguese GDP, however, it suffered a substantial decrease since 1996, from 17% to 12% in 2020 (The World Bank 2022). Besides the great relevance of this sector to the Portuguese economy, it is also of great importance to BPI, as they are historically recognized to be a bank supporting industry investment.

The main purpose of this section of the research is to present an assessment of the factors that affect investment decisions undertaken by non-financial companies in the manufacturing industry sector from 2006 to 2020. These companies are included in Section C - Manufacturing, of the Portuguese Economic Activity Classification.

In this study, the Manufacturing Industry sector is divided into four segments of economic activity, according to the classification of technological intensity adopted by Eurostat and the National Statistics Office (INE). This classification is based on the allocation of companies to different technological intensities, dividing the manufacturing industries into the segments of High tech; Medium-high tech; Medium-low technology; and Low technology.

What are the effects of specific industrial factors on manufacturing firms' investment decisions? Do the energy crisis significantly reduce investment in this sector? Do the transition to a more innovative world impact the investment of manufacturing firms? In this section of the research, the goal is to find an answer to these questions, assessing the factors that affect specifically

manufacturing firms' investment. The analysis consists of a dynamic panel data methodology, using data from the Banco de Portugal regarding all non-financial private Portuguese firms operating in this sector. The data consists of an unbalanced set of 19,041 firms for the period under analysis.

This section also includes an overview and characterization of the manufacturing industry sector, a literature analysis of the factors to be studied, and a brief methodology followed by the results and discussion.

8.1. Sector characterization

In 2020, companies in the manufacturing industry sector accounted for around 5% of all non-financial companies in Portugal, in which around 82% of them are microenterprises, 14% are small firms, 3.4% are medium firms and 0.6% are large firms. This sector employ 17.1% of the personnel in service, made 22.4% of the Gross Value Added (GVA) and 23.3% of the Turnover of all Portuguese non-financial companies (INE, 2020).

Table 7: Manufacturing Industry in 2020

	Industrial Sector	Extractive Industry	Manufacturing Industry
% of GDP	19.4	7.4	12
GVA (in millions €)	21,570	435	21,135
in % of the industrial sector		2.1	97.9
in % of total non-financial firms	22.9	0.5	22.4
Turnover (in millions €)	87,544	1,106	86,438
in % of the industrial sector		1.2	98.8
in % of total non-financial firms	23.6	0.3	23.3

Source: INE, Banco de Portugal, and The World Bank

The divisions with highest turnover weighting in the manufacturing industry in 2020 were: Manufacture of food products (15.4%), Manufacture of motor vehicles (10.7%), Manufacture of metal products (8.1%), Manufacture of coke and petroleum products (5.4%) and Manufacture of chemicals (5.4%). Considering these five divisions together, they accounted for 45.0% of the turnover generated in the Manufacturing sector (INE, 2020).

Table 8: The five manufacturing divisions with the largest share in turnover in 2020

	Nº of firms	Turnover
Manufacture of food products	13.1%	15.4%
Manufacture of motor vehicles	1.1%	10.7%
Manufacture of metal products	17.4%	8.1%
Manufacture of coke and petroleum products	0.0%	5.4%
Manufacture of chemicals	1.3%	5.4%
Other divisions	67.1%	55.0%

Source: INE, Integrated Corporate Accounting Systems

Regarding the degree of technological intensity of manufacturing industry firms, Table 9 demonstrate that Portugal has a strong predominance of low and medium-low technology firms, which represent more than 90% of all manufacturing industry companies and generating 75% of their sales. Even though firms operating in the segments of high and medium-high technological intensity only account for 10% of the manufacturing sector, they are responsible from 25% of the turnover and 1/5 of the investment of the sector. These numbers demonstrate the importance of these industries in boosting economic growth, and, for that reason, the introduction of the new technological developments in firms' operations should be incentivized.

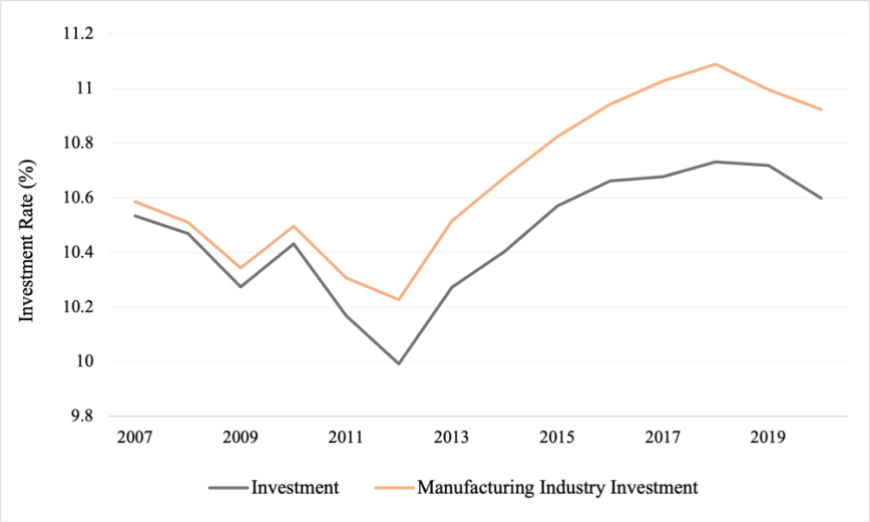
Table 9: Manufacturing industry: structure by technological intensity in 2020

	Nº of firms	Sales	Investment
High tech	1.2%	5.1%	3.4%
Medium-high tech	8.9%	22.5%	17.5%
Medium-low tech	33.2%	30.0%	31.4%
Low tech	56.8%	42.3%	47.7%

Source: Eurostat, Banco de Portugal

Lastly, graph 20 present the evolution of the manufacturing industry investment and of the total investment based on data retrieved from the CBHP *Banco de Portugal* dataset. There are two important points to note. Firstly, the evolution of manufacturing industry investment seems to follow the same pattern of the investment of all non-financial SMEs across all sectors, which may indicate that manufacturing industry investment may be affected by similar factors to the ones considered for total investment. One can observe that both follows an upward trend from 2012 to 2020, and in 2012 is observed a major down point mainly due to the financial crisis

that affected Portugal in that period. Secondly, it is also possible to observe that, ceteris paribus, firms in the manufacturing industry sector present a higher investment rate than firms in other sectors. Specifically, manufacturing industry sector presents, on average, a positive impact of 339 percent on the investment rate when compared to firms in other sectors of activity.



Graph 19: Evolution of Mean Manufacturing Industry Investment and Mean of Total Investment

8.2. Factors that affect Manufacturing Industry firms' investment

The microeconomic factors influencing investment decisions of manufacturing industry firms are not expected to significantly differ much from the general set of SMEs initially considered in this research. Nevertheless, firms operating in this sector may have different exposure to those factors. Therefore, they are tested to observe if the impact on investment alter, but the analysis is mainly focused on the analysis of the macroeconomic factors, which may end up impacting the investment of this sector in a more interesting way.

In this regard, there are specific macroeconomic factors for the manufacturing industry sector that are important to analyse. Among them are the GDP growth rate, the Industrial Confidence Index, the cost of industrial raw materials, the exports of industrial goods, and finally, technological advancements.

GDP Growth

GDP growth rate gives to the companies an indication of the relative performance of the economy over time, which ends up impacting firms' investment decisions. With this being so, when this indicator is high, meaning the economy is booming, per capita income rises as well, resulting in an increase in consumer's demand. This shock impacts firm's operations as they have to meet this increase in demand for goods. Therefore, firms start to expand their operations increasing their investment in fixed assets. On the other hand, if the economy is passing through a recession, it will have a detrimental effect on firms' investment decisions (Farooq et al. 2021).

According to a study made by Make UK, in 2022, after the 2008's financial crisis, manufacturing investment decreased by 2% annually during five years, compared with an average yearly rate of 4% in the five years before the financial crisis. This study is in line with Farooq et al. (2021) confirming that, in crisis years, the GDP growth rate tends to be lower, negatively affecting the investment activity, specially of the manufacturing industry, as this sector is more sensitive to changes in this variable by verified on data from *INE*.

Given the previously outlaid literature, it can be hypothesised that

Hypothesis A: GDP growth rate is significant and positively related to manufacturing industry investment activity.

Industry Confidence Index

Uncertainty is a variable that should be discussed as it disrupt the manufacturing industry's supply chain. Manufacturers, when presented with unexpected events (such as financial, pandemic, or energy crisis), have more difficulty along the supply chain to keep up with the market needs. For example, during the recent pandemic crisis, buying behavior changed and

many manufacturers were not able to adapt their supply chain. Currently, as a results of the war in Ukraine, many products that where produced there are now in shorter supply, leading to a disruption in the whole manufacturing sector.

Drakos and Konstantinou (2013) examined if the addition of industry uncertainty in their analysis is a significant and relevant factor to study. The Industrials Price Index, a progressive indicator that incorporates the influence of many bases of industry uncertainty, was used to measure industry uncertainty in the study. Using this metric, the study discovered that rising industry uncertainty considerably decreases the likelihood of investment activity, demonstrating the significant and negative relation between industry uncertainty and investment activity.

Huizinga (1993) analysed the US manufacturing industry sector and confirmed that a rise in the uncertainty of real output prices and real wages reduces investment rate of this sector. As the contemporary industrial system is fundamentally based on energy, and amongst the energy prices, oil price uncertainty is the one that impact most the investment of firms, this negative influence of uncertainty on investment is found to be more pronounced in the manufacturing industry sector, as uncertainty about future energy prices significantly influences these enterprises to delay irreversible investment choices. In fact, the first author suggesting that the volatility of oil prices would have an effect on strategic investment decisions of manufacturing firms was Bernanke (1983). In this study, oil was seen as the cost of industrial production, therefore oil price uncertainty translates into higher costs of production. Based on this, a higher uncertainty of energy prices lead to a greater option value of delay firms' investments.

According to a Qualitative Manufacturing Industry Survey (ICIT) made by *Instituto Nacional de Estatísitica* (INE), the Manufacturing Industry confidence indicator increased significantly in 2021, reaching the maximum since March 2018. In 2021, the evolution of the indicator was

due to the positive contribution of all components, opinions on the evolution of global demand, production expectations and assessments regarding stocks of finished goods. This survey determined that the industry confidence indicator positively motivates manufacturing firms to invest.

Given the previously outlaid literature, it can be hypothesised that

Hypothesis B: Industry Confidence Index is significant and positively related to manufacturing industry investment activity.

Cost of Industrial Raw Materials

The cost of raw materials play a significant role in firms' investment. The increase in the cost of raw materials cause a drop in investment as it rises the cost of production. In that regard, the increase in the cost of raw materials discourage investment activity by firms, which has a relevant adverse effect on the economic growth of the economy (Long et al. 2021).

Within the industrial sector, manufacturing is distinguished for its huge energy consumption intensity. According to conventional knowledge, energy price shocks are predicted to influence changes in firms' investment spending. These shocks affect manufacturing firms' investment level in two ways. Firstly, energy price variations cause a decline in buyer's consumption (Edelstein and Kilian 2009; Hamilton 2009; Kilian 2009; all cited in Drakos and Konstantinou 2013), diminishing the demand for manufacturing products and, subsequently, as firms do not have to produce in such high quantities, firms' fixed investment also reduce. Secondly, it is anticipated that such energy price shocks lead to higher marginal cost of production, which in turn affects firms' investment spending by lowering the rate of return on investment (Edelstein and Kilian 2007 in Drakos and Konstantinou 2013).

The growing of energy goods prices (such as electricity, coal, and crude oil) is a major concern for the modern industrial system, as the increase in the subsidy bill causes the fiscal deficit to rise. A greater fiscal deficit will lead to the instability of the economy, as it will rise inflation and create a current account deficit, impacting the economy's overall development (Mohanty 1997 in Sadath and Acharya 2015).

Ratti et al. (2011) have used a dynamic panel methodology to examine the impact that changes in energy prices have on the investment of manufacturing firms. This analysis consider 15 European countries and utilizes data on factors such as energy prices, investment, capital stock, sales, cash stock, and cash flow, from 1991 to 2006. The specific country regression found that an increase in the cost of industrial energy goods has a statistically significant and negative influence on firms' investment in fourteen out of fifteen of the analysed countries. This impact is found to be higher on the manufacturing companies. On average, a 1% increase in energy costs results in a 1.9% decrease on investment. Moreover, the larger a company is, the less pronounced the negative impact of higher energy costs on investment (Sadath and Acharya 2015).

Therefore, when studying variations on investment of manufacturing firms, the volatile impact of changes in raw material prices should be considered. Given the previously outlaid literature, it can be hypothesised that

Hypothesis C: Cost of Industrial Raw Materials is significant and negatively related to manufacturing industry investment level.

Exports of Industrial Goods

Some researchers suggest that there is a reverse relation between tangible investment and exports. Rho and Rodrigue (2016) investigated this relation between firm investment and

exports. Firstly, they found that the higher export activity may involve investments in tangible assets designed to expand the capacity of firm's production and its capability to absorb the great marginal costs associated with accessing the exports market. On the other hand, the reverse causality is also observed as exports boost a company's expected profitability, consequently encouraging investment, especially among companies that rely heavily on internal funds. In that regard, exports have a positive effect on a firm investment activity.

According to a study made by BPI, in 2019, the production on Portuguese manufacturing industries is focused on the external market, demonstrating that industry is essential for Portugal to increase its export activity. Reinforcing the importance of the export activity of the manufacturing sector is the fact that the percent of companies with an export profile is considerably higher in this sector than in the other sectors of the Portuguese non-financial companies (NFCs): 16.2% (about 6,500 companies) against 6% of all NFCs. No less important are the data concerning the importance of these companies in the manufacturing industries as a whole: 71.9% of turnover, 68.5% of GVA and 53.2% of employment.

With this being said and based on *Banco de Portugal* data, it is found that export activity has been one of the main responsible for the recovery of the manufacturing industry sector, as it increases its turnover and, subsequently increases investment activity of the manufacturing sector as a whole.

Given the previously outlaid literature, it can be hypothesised that

Hypothesis D: Exports of industrial goods is significant and positively related to manufacturing industry investment activity.

Technological Advancements

According to much research on the impact of technological change in economic growth, many authors confirm that technological change is a major factor explaining specifically the growth of industrial productivity. Wakelin (2001) explored this relationship among UK manufacturing enterprises. In this study, the author uses R&D expenditures as the metric to measure the technological advancement of UK. As expected, a positive relationship between R&D expenditures and firm productivity was found, indicating that R&D spending creates investment opportunities. Moreover, this paper also confirms that innovative firms, which have a higher technological intensity, presents a higher relevance when considering the impact of R&D expenditures on firms' investment.

R&D expenditures and tangible investments are related in distinctive ways. First, innovative operations may demand the creation of further plant and equipment which requires firms' tangible investment (Carboni 2017). On the other hand, and according to Lin (2012), technological advancements improve the efficiency of the tangible assets acquired by firms, which lowers the cost of production and increase the expected return on firms' fixed assets investment. Carboni (2017) also found that high-tech companies are expected to tolerate high capital costs, and therefore to have higher levels of investment, as these firms expect higher returns on their tangible investments.

Given the previously outlaid literature, it can be hypothesised that

Hypothesis E: R&D expenditures are significant and positively related to manufacturing industry investment activity.

8.3. Methodology

The dataset chosen consists of a 14-year period (2006-2020), focused on a set of Portuguese non-financial private small and medium firms. Micro enterprises are not included in the dataset,

given the possibility of incomplete and incoherent data. The analysis in this research uses information retrieved from *Banco de Portugal* annual Central Balance Sheet database and *Banco de Portugal* statistics (BPstat). The sample for this sector consists of 72,265 observations across 19,041 unique firms.

For the same reasons discussed for the analysis across all sectors, a Dynamic Panel Data model is used to analyse the impact of the already mentioned explanatory factors on investment rate of the manufacturing industry sector. Thus, the following regressions are estimated:

Microeconomic Regression:

$$\begin{aligned}\textbf{Industrial Inv}_{i,t} = \beta_{1,2} * \textbf{Investment}_{i,t-1\,;\,i,t-2} + \beta_{3,4} * \textbf{EBITDA}_{i,t\,;\,i,t-1} + \beta_{5,6} * \textbf{Retention}_{i,t\,;\,i,t-1} \\ + \beta_{7,8} * \textbf{Tax Rate}_{i,t\,;\,i,t-1} + \beta_{9} * \textbf{ST Debt}_{i,t} + \beta_{10} * \textbf{LT Debt}_{i,t} + \beta_{11} * \textbf{Collaterals}_{i,t} \\ + \beta_{12} * \textbf{Financing Cost}_{i,t} + \beta_{13} * \textbf{Size}_{i,t} + (\theta_t + S_i + \varepsilon_{i,t})\end{aligned} \quad (4)$$

Macroeconomic Regression:

$$\begin{aligned}\textbf{Industrial Investment}_{i,t} = \beta_1\ \textbf{GDP Growth}_{t-1} + \beta_2\ \textbf{Ind Confidence Index}_{i,t} + \beta_{3,4}\ \textbf{Cost of} \\ \textbf{Raw Materials}_{i,t;\,i,t-1} + \beta_5\ \textbf{Exports of Industrial Goods}_{i,t} + \beta_6\ \textbf{Technological} \\ \textbf{Advancements}_{i,t} + (S_i + \varepsilon_{i,t})\end{aligned} \quad (5)$$

where: **Industrial Inv** $_{i,t}$ – industrial firms' i investment rate at year t; **β** – estimation coefficients; $\mathbf{X_{i,t}}$ – Vector of explanatory variables of interest for the i-th firm at year t; $\mathbf{S_i}$ – Firm specific effects controlling for heterogeneity across firms; $\boldsymbol{\varepsilon_{i,t}}$ – Error term, accounting for unexplained impacts on $Y_{i,t.}$; $\boldsymbol{\theta_t}$ – Time effects controlling for macroeconomic impacts (using year dummies);

8.4. Results and discussion

The regression results are presented in Table 10. Besides this analysis, the discussion also present the effect of the mentioned variables on investment rate according to firms' different technological intensities.

Table 10: Micro and Macroeconomic Regression Model for the Manufacturing Industry Sector

Dynamic Panel-Data estimation, two-step system GMM

Variables	Coefficients	t-value	Probability
Investment Rate t-1	0.172	12.52	0.000***
Investment Rate t-2	0.047	3.83	0.000***
EBITDA Margin t	2.2	11.58	0.000***
EBITDA Margin t-1	0.968	4.17	0.000***
		-1.82	
Retention Ratio t	-0.077	2.33	0.069
Retention Ratio t-1	0.111	3.73	0.020**
Eff Tax Rate t	-0.034	-3.2	0.001***
Eff Tax Rate t-1	-0.0132	-1.43	0.154
ST Debt	0.361	5.62	0.000***
LT Debt	0.947	10.34	0.000***
Collateralizable Assets	2.268	23.95	0.000***
Financing Cost	-7.225	-8.16	0.000***
Firm Size	0.797	33.19	0.000***
c	-4.373	-24.87	0.000***

Note: **** p-value<0.01, ** p-value<0.05, * p-value<0.1*

Dynamic Panel-Data estimation, two-step system GMM

Variables	Coefficients	*t*-value	Probability
GDP Growth Rate *t-1*	0.019	2.66	0.008***
Industrial Confidence Indicator	0.022	3.83	0.000***
Cost of Industrial Raw Materials *t*	-0.042	-4.33	0.000***
Cost of Industrial Raw Materials *t*	-0.015	-1.30	0.192
Exports of Industrial goods	0.001	6.21	0.000***
Technogical Advancements	0.622	2.34	0.019**
c	9.267	20.54	0.000***

Note: **** p-value<0.01, ** p-value<0.05, * p-value<0.1*

Firstly, succinctly analysing the results of the microeconomic regression, one can observe that the statistics results of the factors that impact manufacturing industry investment do not differ from those obtained for the same variables affecting investment across all sectors. The factors present the same sign in the coefficient, however, the only thing to note is that in this specific sector, the variables present a higher magnitude of impact. Besides this, the interpretation of the results is the same as for the analysis across all sectors.

Regarding the macroeconomic factors analysis, the GDP growth rate in year t-1 presents a significant and positive coefficient (0.019). The results present that, on average, a one percent

increase in the GDP growth rate in year t-1 has an approximately 2 percent positive effect on investment rate. This is in align with hypothesis A as well as with the conclusions of Farooq et al. (2021). The rationale behind their conclusions is that GDP growth rate gives firms an indication of the relative performance of the economy over time, which ends up impacting firms' investment decisions. When the economy is booming, per capita income rises, resulting in an increase in consumer's demand. To meet this higher demand, firms start to expand their operations, increasing their investment in fixed assets. Thus, hypothesis A is not rejected, indicating that GDP growth in year t-1 has a significant and positive impact on investment.

Similarly, industrial confidence index presents a significant and positive impact on manufacturing firms' investment rate, as found in related work (Drakos and Konstantinou 2013; Huizinga 1993; Bernanke 1983). On average, a one unit increase in this indicator has a positive 2.2 percent effect on investment rate. The reasoning behind this relation is that if the confidence in industry is low, it generates a sentiment of uncertainty in the industry business, which has a negative impact on the economic activity and, consequently on firms' investment activity. Also, energy prices, especially oil prices, are particularly unstable and, as the industrial system is strongly based on energy, this culminate in a lower sentiment of confidence in the sector. In addition, as mentioned in the literature, this negative impact of industrial uncertainty on investment is substantially increased in years of crisis. In this regard, an interaction factor between the industrial confidence indicator and a dummy for crisis years was added to the model, to which the expected results that in years of crisis, this indicator is lower. With this being said, our hypothesis B is failed to be rejected, confirming that industrial confidence index has a significant and positive impact on firms' investment.

Contrarily to other macroeconomic determinants, the cost of industrial raw materials rate presents a significant but negative coefficient, implying that when the cost of these goods

increases, the investment level of the industrial firms decreases. This variable was studied for year t and year t-1 but only presented significant values for year t. On average, a one percent increase in the cost of industrial raw materials in year t has an approximately 4.2 percent negative effect on investment rate. The results for year t are in line with some authors (Long et al. 2021; Sadath and Acharya 2015; Drakos and Konstantinou 2013; Ratti et al. 2011). The rationale behind this negative impact of this variable on investment is mainly due to the fact that an increase in raw material prices lead to higher production costs, which may inhibit investment (Long et al. 2021). Therefore, hypothesis C is not rejected, confirming that the cost of industrial raw materials for year t has a negative impact on the investment activity of manufacturing firms. Moreover, as the manufacturing sector is known for its high intensity of energy consumption, the shocks on energy prices are particularly discussed in literature (Drakos and Konstantinou 2013). Moreover, literature also found that the negative effect of higher energy prices on investment is significantly stronger on high-tech firms. To confirm this, a factor with the interaction between the cost of energy prices and a dummy for medium-high- and high-tech firms were added in a new regression. The results verified what was expected. The marginal effect of energy price shocks of a medium-high- and high-tech firm (in comparison to a firm with a lower technological intensity) on investment rate is negative by 78 percent. This indicates that when considering lower technological firms, the effect of the cost of energy on investment is lower, indicating that these firms rely less on the cost of these goods.

As moving forward, the exports of industrial goods presents a positive and significant relationship with investment rate. This is in line with some authors (e.g. Rho and Rodrigue 2016), which argue that exports increase a firm's expected profitability, consequently promoting investment. The high magnitude of the t-value for this variable (6.21), means we have high evidence against the null hypothesis. However, the coefficient does not show a high impact on investment as, on average, a one unit increase in the exports of industrial goods has

only a positive effect of 0.01 percent on investment rate. Although the results are in line with the conclusions of some authors, it is not possible to state that the export activity of industrial goods is one of biggest drivers of firms' investment activity, as the coefficient does not prove to be very relevant. In spite of that, the results are in line with our hypothesis D, leading us to not reject it.

Lastly, technological advancements has the expected positive and significant statistics, indicating that more advancements in technology stimulates manufacturing firms to innovate and embrace new investment options. In fact, on average, a one percent increase in R&D expenditures has a positive effect of 62 percent on the investment rate, being the variable exhibiting the greatest impact on investment. This is in line with literature and with hypothesis 5. The study of Carboni (2017) noted that innovative activities may demand the creation of further plant and equipment which implies firms' physical investment. On the other hand, Lin (2012) noted that technological advancements increase the efficiency of tangible capital and lower manufacture costs, thus expected returns are increased. With this being said, the hypothesis E is not rejected, as it was found a statistically significant positive impact of technological advancements on investment rates.

Moreover, according to Wakelin (2001) and Lin (2012), the rate of return to R&D expenditures is higher for high-tech firms than for low-tech firms, as these firms are more likely to suffer high capital costs. In order to understand if this literature is in line with our results, a factor with the interaction between the R&D variable and a dummy for high-tech firm was added in a new regression. The results are in line with the literature of the mentioned authors, indicating that the marginal effect of R&D expenditures on investment for firms with a high technological intensity is much greater than for firms with a low technological intensity. On average, a one percent increase in R&D expenditures has an additional 489 percent effect on investment rate

when considering medium-high and high-tech firms in comparison to other lower technological intensity firms.

8.5. Conclusions

In this section of the research, the effect of specific industry factors on investment decisions taken by manufacturing industry firms is studied. Regarding microeconomic factors, taking into account the same factors considered in the analysis across all sectors, one can conclude that the statistics for the manufacturing industry firms do not differ from those obtained for the same variables affecting investment across all sectors. The factors present the same sign in the coefficient, however, the only thing to note is that in this specific sector, the variables present a higher magnitude of impact.

The impact of the specific industrial factors on manufacturing firms' investment is more interesting to study. Among the analysed factors, the ones that present the most relevant results are the cost of industrial raw materials and technological advancements. Regarding the cost of industrial raw materials, its negative and relevant impact on manufacturing firm's investment confirm that, specifically energy price shocks, do significantly reduce manufacturing firms' investment. In this regard, banks should monitor closely this factor to immediately respond to it when the shock hits the market. The findings also indicate that the transition of the economy to a more innovative world positively impact the investment of manufacturing firms, indicating that BPI could start considering entering in this innovative market by financing more high technological intensive firms.

That said, these factors should have special focus from BPI when grant credit to a company in order for the bank to better adjust the financial products it offers to them.

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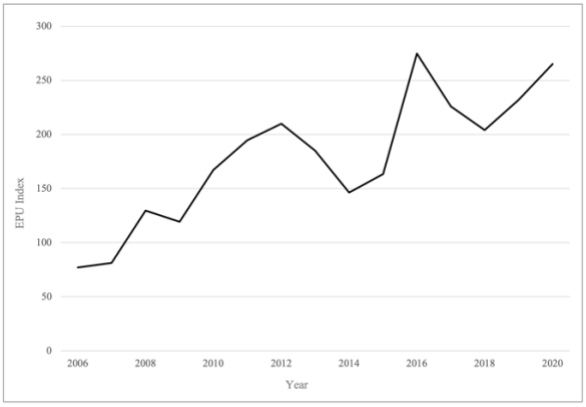
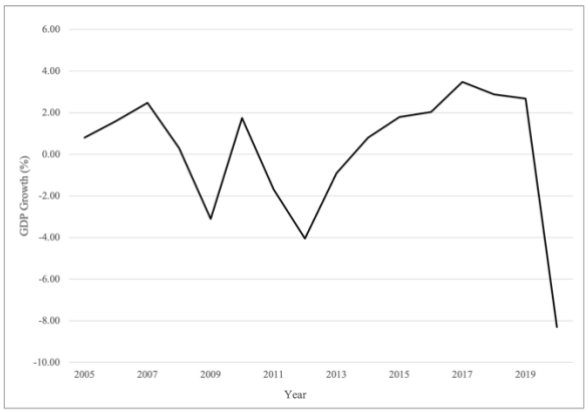
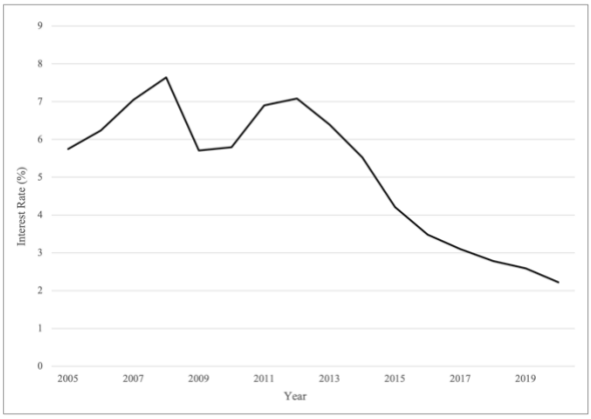
10. Appendix



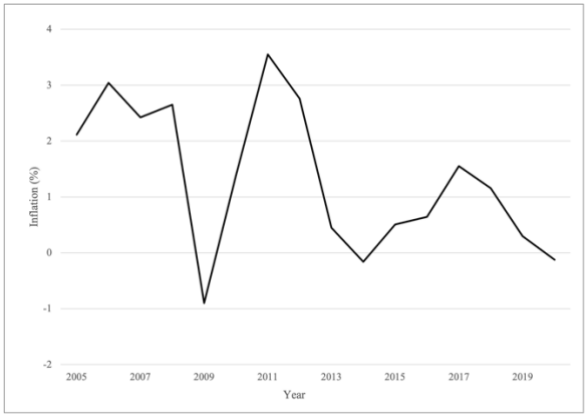
Graph 2: Evolution of EPU Index



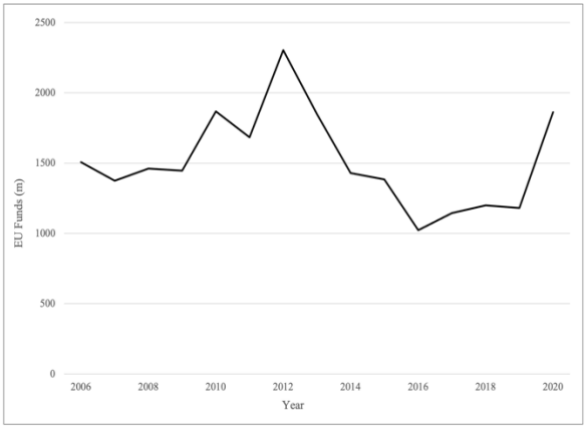
Graph 3: Evolution of GDP growth



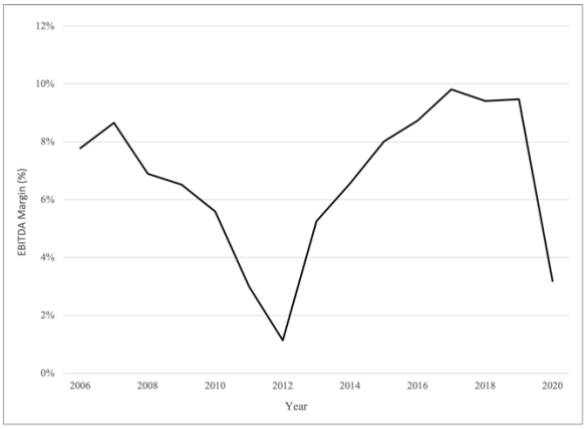
Graph 4: Evolution of Interest Rate



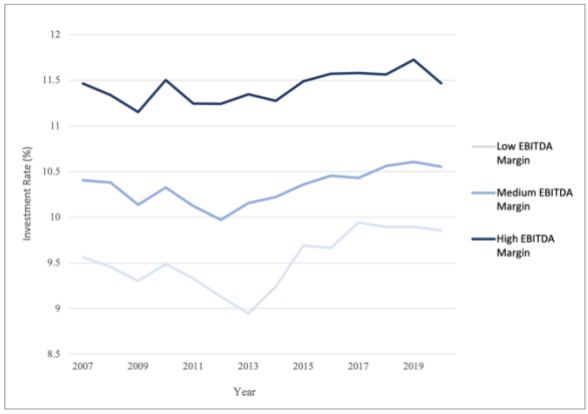
Graph 5: Evolution of Inflation Rate



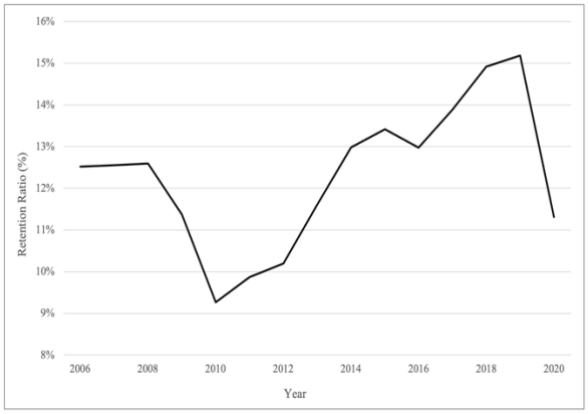
Graph 6: Evolution of EU Funds



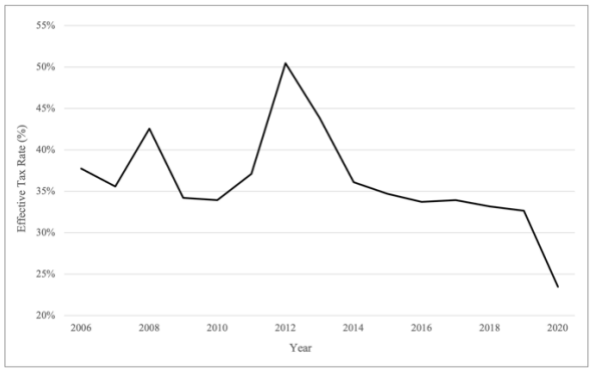
Graph 7: Evolution of EBITDA Margin



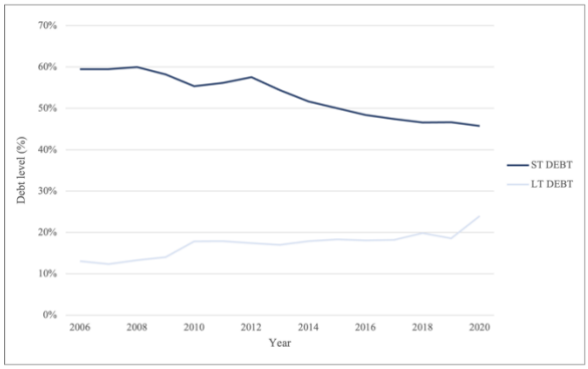
Graph 8: Evolution of Investment Rate according to different levels of EBITDA margins



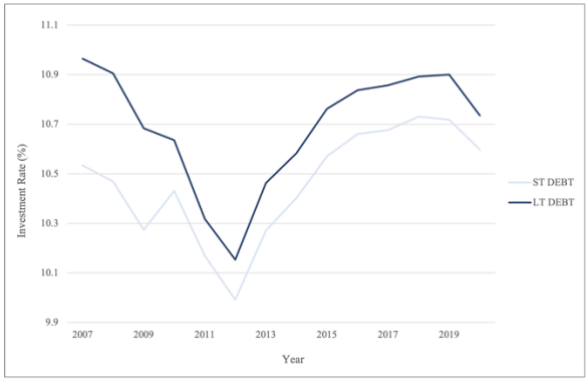
Graph 9: Evolution of the Retention Ratio



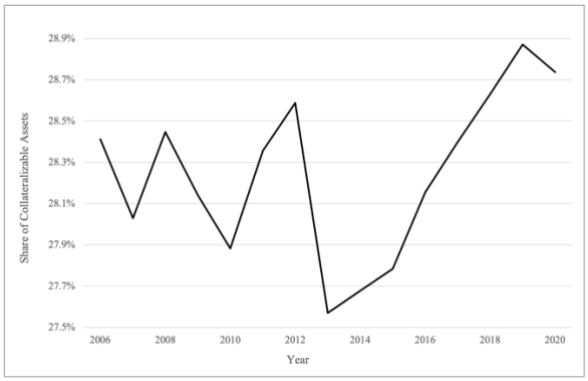
Graph 10: Effective Tax Rate



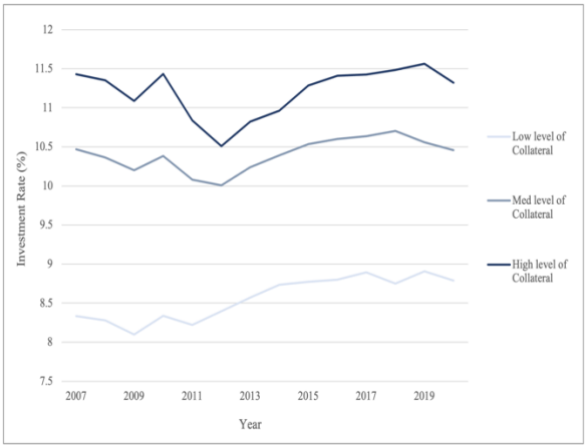
Graph 11: Evolution of Debt level



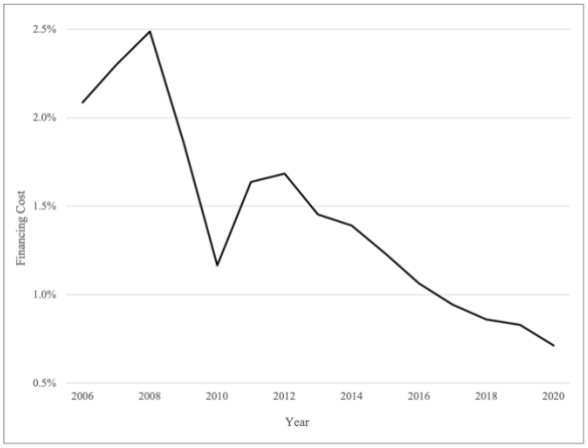
Graph 12: Evolution of Investment Rate according to different debt maturity



Graph 13: Evolution of Collateralizable Assets

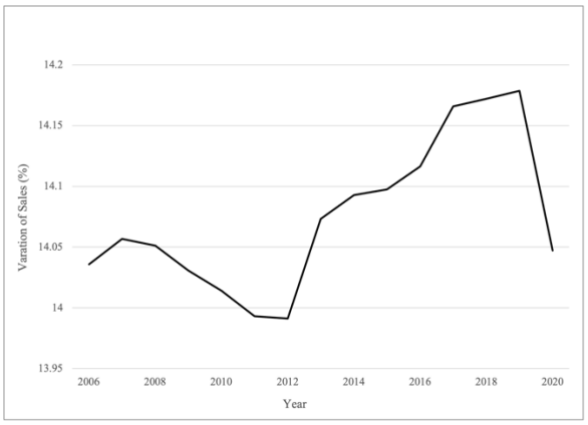


Graph 14: Evolution of the Investment Rate according to different levels of collateral

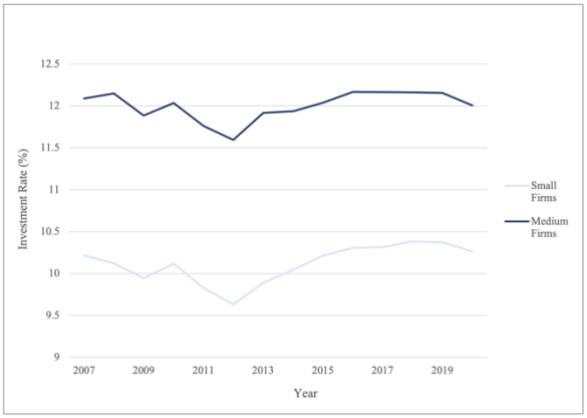


Graph 15: Evolution of Financing cost

Graph 16: Evolution of Investment Rate according to different *financing* cost levels



Grapgh 17: Evolution of the variation of sales



Graph 18: Evolution of Investment Rate by firm size

Table 2: Summary Statistics

Explanatory Variables	Observations	Mean	Standard Deviation	Mininum	Maximum
EPU Index	258,116	173.73	60.33	77	274.75
GDP Growth Rate	258,116	0.15	3.15	-8.3	3.48
Interest Rate	258,116	5.14	1.83	2.22	7.64
Inflation Rate	258,116	1.32	1.31	-0.9	3.55
EU Funds	258,116	1503.28	318.09	1022.3	2304.8
EBITDA Margin	257,418	0.07	0.21	-1.38	0.85
Retention Ratio	258,116	0.07	0.37	-1	1
Effective Tax Rate	258,116	0.36	0.93	-2.22	15.79
Short Term Debt	258,010	0.53	0.36	0.02	3.1
Long Term Debt	258,010	0.17	0.22	0	1.44
Assets to serve as Collateral	258,010	0.28	0.24	0	0.96
Financing Cost	257,865	0.02	0.02	0	0.11
Firm Size	257,418	14.07	1.39	2.3	20.96

Table 11: Four degrees of technological intensity - correspondence with CAE-Rev.3

High-tech	**Division 21** - Manufacture of basic pharmaceutical products and pharmaceutical preparations; **Division 26** - Manufacture of computer, electronic and optical products and communications equipment; **Group 303** - Manufacture of aircraft, spacecraft and related machinery.
Medium-high tech	**Division 20** - Manufacture of chemicals and chemical products, except pharmaceutical products; **Division 27** - Manufacture of electrical equipment; **Division 28** - Manufacture of machinery and equipment; **Division 29** - Manufacture of motor vehicles and motorcycles; **Division 303** - Manufacture of air and spacecraft and related machinery. **Division 29** - Manufacture of motor vehicles, trailers, semi-trailers and parts thereof; **Group 254** - Manufacture of weapons and ammunition; **Group 302** - Manufacture of railway locomotives and rolling stock; **Group 304** - Manufacture of military fighting vehicles; **Group 309** - Manufacture of transportation equipment; **Group 325** - Manufacture of medical and surgical instruments and supplies.
Medium-low tech	**Division 19** - Manufacture of coke, refined petroleum products and fuel pellets; **Division 22** - Manufacture of rubber and plastic products; **Division 23** - Manufacture of other non-metallic mineral products; **Division 24** - Manufacture of basic metals; **Division 25** - Manufacture of fabricated metal products, except machinery and equipment, excluding **Group 254** - Manufacture of weapons and ammunition; **Division 33** - Repair, maintenance and installation of machinery and equipment; **Group 182** - Re- production of recorded media; **Group 301** - Shipbuilding.
Low tech	**Division 10** - Manufacture of food products; **Division 11** - Manufacture of beverages; **Division 12** - Manufacture of tobacco products; **Division 13** - Manufacture of textiles; **Division 14** - Manufacture of wearing apparel; **Division 15** - Manufacture of leather and related products; **Division 16** - Manufacture of wood and of products of wood and cork, except furniture; Manufacture of articles of straw and plaiting materials; **Division 17** - Manufacture of paper and paper products; **Division 31** - Manufacture of furniture; **Division 32** - Other manufacturing excluding 325 - Manufacture of medical and surgical instruments and supplies; **Group 181** - Printing and services related to printing.