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Why Are Some Firms More Financially Constrained Than Others? Evidence from Portuguese Firms

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Abstract

This dissertation intents to analyse what are the factors that explain the differences in firms' financial constraints, since some firms are more financially constrained than others. Most of the existing studies on financial constraints analyse firms by separating them into groups, according to classification schemes, and then using cash flow sensitivities as a proxy for firms' financial constraints.

The present study aims to complement these approaches and contribute to the scarce of empirical evidence for Portuguese firms. For that purpose, we use a sample of 492 firms from Portugal over a 10-year period, from 2009 to 2019. We classify firms according to certain characteristics that are believed to show the presence of constraints, such as, size, age and dividend payment. We analyse firms' financial constraints by estimating both investment cash flow sensitivities and cash flow sensitivities of cash, in order to see if the results are maintained across different measures.

Our results show that Portuguese firms are, overall, financially constrained. Consistent with the literature, we find that constraints are more severe on smaller firms and on firms that do not pay dividends. By contrast, we do not find evidence that firm age has any impact on the level of financial constraints.

Key-words: Financial constraints; Investment; Cash; Cash flow; Portugal

JEL-Codes: E22, G31, G32, G39

Resumo

Este estudo pretender analisar quais são os fatores que explicam as diferenças nas restrições financeiras das empresas, dado que enquanto que umas empresas são financeiramente restritas, outras não apresentam restrições a este nível. A maior parte dos estudos existentes focam-se na análise das empresas através da separação destas em grupos, de acordo com certos fatores, e em seguida recorrem ao uso das sensibilidades de fluxo de caixa como *proxy* para medir as restrições financeiras das empresas.

O presente estudo pretende complementar estas medidas e contribuir para a falta de evidencia empírica para as empresas Portuguesas. Assim, usamos uma amostra de 492 empresas durante um período de 10 anos, de 2009 até 2019. Classificamos as empresas de acordo com certos fatores que demonstram a presença de restrições como, idade, tamanho e o pagamento de dividendos. Analisamos as restrições financeiras das empresas através da estimação da sensibilidade do investimento ao fluxo de caixa e da sensibilidade da caixa ao fluxo de caixa.

Os nossos resultados mostram que, em geral, as empresas portuguesas têm restrições financeiras. Os resultados revelam que estas restrições são mais severas para certos fatores, tais como, empresas que são mais pequenas e não pagam dividendos, o que é consistente com a literatura. Por outro lado, não encontramos resultados claros de que a idade tenha impacto ao nível das restrições financeiras.

Palavras-chave: Restrições financeiras; Investimento; Fluxos de caixa; Caixa; Portugal

Classificação JEL: E22, G31, G32, G39

Index

List of Tables

1. Introduction

The objective of this report is to analyse what are the factors that explain the differences in firms' financial constraints, since some firms are more financially constrained than others. Firms' financial constraints can be defined by analysing how much firms' investment/cash stocks varies in regard to the firms' earnings. Thus, the aim of this report is to study the factors that explain that while some firms are able to invest regardless of their earnings - financially unconstrained firms - others are only able to invest when they are capable of - financially constrained firms.

Firms are financially constrained if they are unable to raise the necessary amount to finance their own optimal path of growth. The topic of firms' financial constraints has been discussed at length in the literature, and even though relatively easy to define, financial constraints are difficult to measure since they are not empirically observable.

The traditional viewpoint by Fazzari et al. (1988) that introduced the investment cash flow sensitivity as a way to measure financial constraints in the US, holds that firms that face stricter financing constraints have to count more on internal resources to make investments. Their findings suggested that low-dividend firms (constrained), measured by dividend payments, exhibit higher investment cash flow sensitivities than high-dividend ones (unconstrained), providing evidence that investment cash flow sensitivity can be a practical measure of financial constraints. Although several studies focused on the use of this method to identify and quantify firms' financial constraints, some critiques also arose from this measure, and Almeida et al. (2004) implemented an alternative approach to measure financial constraints. Rather than focusing on the sensitivity of investment to cash flow, they focus on the cash flow sensitivity of cash. By means of many criteria for categorising US firms as financially constrained or unconstrained, Almeida et al. (2004) report that the cash flow sensitivity of cash is positive for financially constrained firms, but statistically insignificant for financially unconstrained firms, providing support that firms with more frictions in raising external financing save a larger part of their cash flow as cash than those firms with less constraints.

Several studies state that companies with more difficulties in obtaining external capital hold more cash. Faulkender and Wang (2006) and Pinkowitz et al. (2006) provide evidence consistent with the idea that constrained firms value more cash holdings than unconstrained

firms. Denis and Sibilkov (2009) find evidence that US firms with higher frictions in obtaining outside financing save a larger part of their cash flow as cash than firms with lower frictions.

Considering that the vast majority of studies on this topic are focused in the US, the objective of this report is to fill in the gap in the literature concerning the scarce of empirical analysis on financial constraints in Europe, particularly in Portugal, where there are still a limited number of studies. So, the main research question we propose to answer is what are the factors explaining the differences in firm's financial constraints?

We evaluate the prediction of our theory by analysing a sample of Portuguese firms over a 10-year-period, from 2009 to 2019. We test the impact of firms' cash flow sensitivities for different groups of firms, the ones that are more financially constrained and the financially unconstrained, using two models: investment cash flow sensitivity and cash-cash flow sensitivity.

To achieve this, we follow two steps. First, we execute an *a priori* classification of firms into financially constrained and unconstrained groups, based on certain characteristics and financial information available in our dataset. This classification has been widely used in the literature with the objective of identifying and measuring the level of financial distress handled by firms, and the groups of firms that suffer the most with financial constraints, by differentiating them according to certain attributes. According to the literature the determinants the authors use to distinguish firms, are, dividend pay-out ratio, firm size, age, bond ratings and commercial paper ratings.

Second, we estimate two empirical models from separate approaches, so as to evaluate the level of such constraints within groups of firms. For such, the measures of financial constraints that can be applied are the investment cash flow sensitivity (hereafter ICFS) and the cash-cash flow sensitivity (hereafter CCFS), that can be used as a proxy to measure firms' financial constraints. In the report we apply both measures to analyse the separation of firms into financially constrained and financially unconstrained. We combine both approaches to find if the results alter or if the results are maintained across different measures. The use of different measures will allow us to derive conclusions on the consistency, advantages and disadvantages of such methodologies, as well.

Regarding the first method, financially constrained firms cannot get access external finance so they must depend on their internal funds when an investment opportunity arises, whereas, financially unconstrained firms can easily rely on external funds to finance their

investments. Therefore, while constrained firms will display a positive propensity to use cash-flows (internal finance) to finance investments, which translates into a positive and significant investment cash flow sensitivity, no systematic relationship should be found for unconstrained ones. Similarly, the degree to which a specific group of firms is financially constrained should be reflected on the cash flow sensitivity of cash. Therefore, the higher the cash flow sensitivity of cash, the more constrained is a group of firms. As a result, it is expected a positive and significant relationship between cash stocks and cash-flow for constrained firms, while no association should be found for unconstrained ones (Silva and Carreira, 2012).

The rest of the study proceeds as follows: in section 2 we review the literature, in section 3 we provide a comprehensive description of the methodology and the data employed. In section 4 we present the main results and their interpretations, and in section 5 we present the conclusions, limitations of our investigation and some suggestions for future research.

2. Literature Review

2.1. Firms' Investment Decisions

Financial constraints can be defined as the firms' inability to raise the necessary amount to finance their own optimal path of growth. In order to provide some theoretical background, this section intends to introduce the topic of financial constraints, by analysing the following studies that initiate the topic.

The areas in corporate finance that have a higher importance are the effects of financial constraints on firm behaviour, and the way in which firms conduct financial management. As propositioned by Keynes (1936) one of the main benefits of a liquid balance sheet is that firms are able to take on valuable projects when they appear. Nevertheless, this is limited to the amount to which firms have access to external capital markets. For instance, if a firm has unrestricted access to external capital, the firm is, consequently, financially unconstrained and it does not become necessary to safeguard against imminent investment needs. In this scenario, corporate liquidity is irrelevant. By contrast, when we have a firm facing financing frictions, liquidity management might turn out to be a relevant and important matter for corporate policy.

Moreover, Modigliani and Miller (1958) claim that in the absence of market frictions, financing and investment decisions of firms can be considered independent. In other words, investment and growth are not dependent on the availability of internal capital. However, when capital market imperfections are presented, firms cannot follow all value-increasing investment opportunities any longer. For instance, in the models of Greenwald et al. (1984) and Myers and Majluf (1984), capital market frictions increase the cost of external capital in relation to internally generated resources. Subsequently, firms that have attractive growth opportunities invest a smaller amount than the first-best optimum, which leads to a lower future growth and diminished operating performance and firm value. A method that can be employed to alleviate these undesirable effects is for firms with high costs of external finance (financially constrained firms) to depend more on internal funds, such as, cash flow and cash holdings.

2.2. Measuring Firms' Financial Constraints

Even though relatively easy to define, financial constraints are somewhat difficult to measure since they are empirically not observable, and researchers have struggled to develop reliable methodologies that allow identifying such constraints.

In this context, several previous studies propose alternatives, some not consensual, for measuring financial constraints. The empirical assessments can fundamentally be traced back to the important work of Fazzari et al. (1988) that introduced the investment cash flow sensitivity (ICFS) as a way to measure financial constraints.

2.2.1. Investment Cash Flow Sensitivity

Fazzari et al. (1988) propose that when firms encounter financing constraints, investment expenditure will alter with the availability of internal resources, instead of just with the availability of positive NPV projects. In this way, it is possible to assess the influence of financing frictions on corporate investment, by comparing the cash flow sensitivity of investment within a group of companies, separated according to a proxy for financial constraints.

Fazzari et al. (1988) regressed investment cash flow sensitivity, estimated Q (control for investment opportunities) on a sample consisting of 422 US firms, over the period of 1970 to 1984. The approach used involved classifying firms, *a priori*, as constrained or unconstrained on the basis of their dividend policy. By means of assuming that constrained firms, with the purpose of financing their investment, "retain all of the low-cost internal funds they can generate" and therefore pay lower dividends, Fazzari et al. (1988) advanced with the estimation of ICFS for each class of firms, and find that low-dividend firms present higher ICFS than high-dividend ones, providing evidence that ICFS can be a valuable measure of financial constraints. Their findings suggested that firms with the highest retention ratios, measured by dividend payments, exhibit higher ICFS than firms with the lowest retention ones.

Several studies focused on the use of ICFS to classify and measure firms' financial constraints, specifically, Ascioglu et al. (2008), Hovakimian (2009), and Lin et al. (2011) for the US; Guariglia (2008) for the UK; Chapman et al. (1996) for Australia; Audretsch and Elston (2002) for Germany; Kadapakkam et al. (1998) and Bond et al. (2003) for different countries.

Although Fazzari et al. (1988) provide evidence supporting their hypothesis, the interpretation of their findings has been defied on both theoretical and empirical bases by some authors, mainly, Kaplan and Zingales (1997) and Cleary (1999). These authors question the validity of the work of Fazzari et al. (1988), and in their studies, they find empirical evidence for the opposite, that is, the least constrained firms display higher investment cash flow sensitivity. Additionally, Alti (2003) reports that since cash flows contain important information in regard to a firm's investment opportunities, the cross-sectional patterns described by Fazzari et al. (1988) can be in line with a model without financing frictions, which creates uncertainty on the significance of the cash flow sensitivities of investment.

Allayannis and Mozumdar (2004) provide an explanation for this puzzle by exposing that the Kaplan and Zingales (1997) and Cleary (1999) results are "largely due to firms in distress as proxied by negative cash flow observations". Kaplan and Zingales's (1997) results are affected, as well, by a few influential observations in a small sample, and once such observations are eliminated from their sample, results are much closer to those in initial papers by Fazzari et al. (1988). Allayannis and Mozumdar (2004) also show that it is expected that firms with higher information asymmetry to have higher investment cash flow sensitivity.

Another critique of this measure is the use of Tobin's Q to control for investment opportunities in the model. Since marginal Q is not observable, researchers use average Q as an approximation (Hayashi, 1982). Nevertheless, the introduction of Q entails potential mismeasurements as a result of the violation of some assumptions, namely, imperfect competition and the association between firms' investment and financial decisions in these specific models. Furthermore, cash flow might possibly include information regarding investment opportunities, specifically for firms that face a higher uncertainty on the subject of their investment projects. In this case, cash flow might reveal additional information on the project's quality. Therefore, we should expect that a portion of the ICFS is attributable to investment opportunities that were not captured by Q. Consequently, using Q as a proxy is not enough to control for investment opportunities and thus interpretations in regard to cash flow sensitivities will be biased. Since the use of Tobin's Q has been questioned when formulating a model for the ICFS, some researchers have used instead for the empirical model an investment accelerator specification. (Bond et al., 2003). Using this investment accelerator specification has the advantage of not needing the calculation of Tobin Q.

2.2.2. Cash Flow Sensitivity of Cash

More recently, Almeida et al. (2004) implemented an alternative approach to measure financial constraints. Rather than focusing on the sensitivity of investment to cash flow, they focus on the cash flow sensitivity of cash. The idea behind the CCFS is that financially constrained firms can be identified by looking at firms' cash policy. If a firm is financially constrained it should have a systematic propensity to save cash with the intention of taking advantage of valuable future investment opportunities and hedge against future shocks, whereas unconstrained firms should not exhibit this propensity.

The use of CCFS to analyse financial constraints prevents a few of the problems related with the use of ICFS. Particularly, since cash is a financial variable and not a real one, it is challenging to discuss that the explanatory power of cash flows over cash policies could be attributed to its capability to predict future business conditions.

Almeida et al. (2004) empirically estimated their hypothesis, by using a sample of publicly traded US manufacturing firms over the 1971 to 2000 period. They retrieved data, available at Compustat database, on total assets, sales, market capitalization, capital expenditures, holding of cash and marketable securities. However, they excluded firm-years for which cash holdings surpassed the value of total assets, those for which market capitalization was lower than $10 million (in 1971 dollars), and firm-years presenting asset or sales growth beyond 100%, achieving a final sample of 29 954 firm-years.

By means of numerous criteria for categorising firms into financially constrained and unconstrained they found robust support for their theory that cash flow sensitivity of cash is positive for financially constrained firms, however statistically insignificant for financially unconstrained firms. Thus, the results provide confirmation that firms with more frictions in raising external financing save a larger part of their cash flow as cash than firms with less constraints. As a result, firms that are financially constrained are able to use their cash holdings to fund the needed expenditures. Moreover, it is also found that in the presence of negative macroeconomic shocks, financially constrained firms should increase their propensity to hold cash, whereas unconstrained firms should not.

Numerous studies report that firms with greater difficulties in obtaining external capital, accumulate a higher amount of cash and Faulkender and Wang (2006) and Pinkowitz et al. (2006) find evidence that corroborates the idea that cash holdings are more valuable for constrained firms than for unconstrained ones. Moreover, Denis and Sibilkov (2009) provide

evidence that companies with larger frictions in raising outside financing keep a higher portion of their cash flow as cash than do those companies with less frictions. The authors show that in the US the firms that are identified as more likely to deal with financial constraints have lower cash flow, higher cash holdings, are smaller, and have more intangible assets than the firms classified as unconstrained. Also focusing on the US market, Denis and Sibilkov (2009) use a sample of 74 347 public companies with financial data available on Compustat, over the period of 1985 to 2006 in order to understand why cash holdings are more valuable for financially constrained firms than for unconstrained firms, and why some financially constrained firms seem to hold only a small amount of cash. Regarding the sample, they require firms to have a minimum of $25 million in total book assets (in 1994 dollars). Additionally, with the purpose of eliminating possible effects of regulation, firms in the financial (SIC 6000–6999) and utility (SIC 4910–4939) industries are excluded. Lastly, firm-years with nonpositive values for total book assets, cash holdings, or negative values for capital expenditures are also excluded, arriving at a sample of 74 347 firm-year observations. Regarding the mean and the median standard deviation of the level of cash holdings and of the change in cash holdings, they are superior for financially constrained firms in all of the criteria. These results follow the prediction of Myers and Majluf (1984) in which firms that face greater costs of external financing should gather internally generated funds and use them later on to finance investments.

Han and Qiu (2007) follow the work of Almeida et al. (2004) but address an important issue that they do not cover in their work: a firm's precautionary cash holding in response to cash flow uncertainty. They estimated a dynamic panel cash holding model for financially constrained and unconstrained firms, where the dependent variable is cash, for a sample of publicly traded US firms using the Compustat quarterly data from 1997 to 2002, for a total of 33 617 observations. Han and Qiu (2007) study a two-period investment model which demonstrates that "the cash holdings of financially constrained firms are sensitive to cash flow volatility because financial constraints create an intertemporal trade-off between current and future investments". In the case of future cash flow risk not being fully diversifiable, this intertemporal trade-off provides constrained firms with incentives of precautionary savings: firms increase their cash holdings as a reaction to increases in cash flow volatility. Once again, no systematic association between cash holdings and cash flow volatility should be found for unconstrained firms. A characteristic of financially unconstrained firms is that they have enough financing capacity to attain the first-best investments (point where the marginal

return on investments is equal to the marginal cost of borrowing) in both periods in spite of the completion of the future cash flow. Therefore, optimal future investment is independent of optimal current investment. Consequently, there is no systematic relationship between cash holdings, investment levels and future cash flow volatility. Thus, a financially unconstrained firm does not have a precautionary motive for cash holdings.

On the other hand, a financially constrained firm is not able to take any extra future investments without decreasing current investments, since it has already used all of the external financing resources. As a result, the firm is only able to invest an additional amount in the future, by accumulating a higher amount of cash and by lowering current investments. For instance, an increase in future cash flow volatility makes the financially constrained firm more cautious, and also leads to an increase in cash holdings so they can invest more in the future, by means of reducing current investment. For a financially constrained firm, this precautionary motive of cash holding generates a positive association between cash holdings and cash flow volatility, and a negative association between current investments and cash flow volatility.

Additionally, a different strand in the literature studies the cross-sectional determinants of cash holdings. Opler et al. (1999) report that "cash holdings are negatively related to the level and the availability of a bond rating". The authors find that companies with a bond rating below investment grade and companies with no bond rating available accumulate more cash than companies that have an investment grade bond rating. In the same way, Kim et al. (1998) and Harford (1999) find that cash holdings are positively related with industry cash flow volatility. These authors report that the firms that face larger costs of external finance are the ones with lower or no bond ratings and those that operate in industries with higher cash flow volatility, which corroborates the idea that financially constrained firms accumulate more cash than financially unconstrained firms.

Since Almeida et al. (2004) focus on firm's cash policies, it is interesting to understand the theory behind the benefits and costs of holding cash, which has been a topic addressed in the literature, in the policy models that attempt to give an explanation for how firms decide on their cash policy. Taking this into account, the three theoretical models that try to explain cash management decisions are the following: the trade-off theory, the pecking order theory and the free cash flow theory. Starting with the trade-off theory, it suggests that the level of cash held by firms originates from a balance between costs and benefits associated with equity and debt financing, with the optimal level of cash emerging when the marginal benefit

of cash equals its marginal cost (Kim et al., 1998; Opler et al., 1999). The pecking order theory, developed by Myers and Majluf (1984) suggests that under asymmetric information, firms prefer internal financing to external financing, and debt to equity. There is an order of preference in the use of financing sources because of adverse selection costs. Thus, the theory states that retained cash/earnings will be the main source of financing and firms will hold as much of it as possible, so they are able to decrease the probability of having to raise external financing to fund positive NVP investment opportunities. Contrary to the trade-off theory, the pecking order theory implicates that there is no optimal level of cash. Finally, the free cash flow theory of Jensen (1986) proposes that managers use excess cash for their own benefit, at the cost of the shareholders' welfare, either by using it in compensation or ego increasing investments, for example acquisitions, or by retaining it with the purpose of increasing their independence from external markets.

2.3. Determinants of Financial Constraints

Several authors classify firms, *a priori*, according to empirical proxies for likelihood that firms face financial constraints using several alternative approaches, proposed by the literature, to separate firms into financially constrained and unconstrained groups.

The first index suggested by the literature is the dividend pay-out ratio. In the work of Fazzari et al. (1988) the authors report that unconstrained firms are more likely to have higher pay-out ratios, while constrained firms are likely to have lower pay-out ratios, since low-dividend firms (constrained) display higher ICFS than high-dividend ones (unconstrained). Han and Qiu (2007) follow this criterion and assign firms to the financially constrained group if they have not paid out dividends during the sample period and assign to the financially unconstrained group if they paid out dividends in some years. Moreover, Almeida et al. (2004) and Denis and Sibilkov (2009) follow a similar approach where for each year, firms in the bottom three deciles of the annual cash pay-out ratio distribution are allocated to the financially constrained group, while firms in the top three deciles of the annual cash pay-out ratio distribution are allocated to the financially unconstrained group.

The second index is firm size. Following the assumption that smaller firms are younger and less well known, they will be more vulnerable to capital market imperfections. Thus, Denis and Sibilkov (2009) rank, each year, firms based on their book value of total assets, and assign to the financially constrained (unconstrained) group those in the bottom (top)

three deciles of the size distribution. A similar approach is used in Erickson and Whited (2000) and Almeida et al. (2004). On a different note, Silva and Carreira (2010) measure firm size as number of employees instead of total assets. Thus, they create an indicator variable set at specific ranges to distinguish firms' size and consequently firms' financial constraints.

Regarding the firm size, according to the literature, smaller firms have limited access to debt, since they are financially more constrained than large firms, and are less likely to get external finance from institutions, especially in the case of newer, fast-growing countries with a higher risk-return profile (Berger and Udell, 1998; Hovakimian, 2009). Moreover, smaller firms play a main role in national economies around the world, generating employment and value added and contributing to innovation and economic growth. Consequently, it is relevant to provide the right conditions for smaller firms to develop and achieve prosperity in both developing and developed countries. Taking this into account, access to finance is a key factor for smaller firms to live up to their potential to innovate, grow and create jobs, considering that, since they are not large firms, they suffer from lack of equity, which works as constraint on their survival and growth.

The third index is age. According to Hovakimian (2009) age may also affect firm investment levels directly since, as previously said, smaller and younger firms are less well known, and more vulnerable to capital market imperfections. If a firm has just been established, there is not a lot of information available to investors, given that they tend to build relationships over time. Therefore, it is expected that younger firms face more severe financial constraints. Guariglia (2008) and Silva and Carreira (2010) measure a firms' age by creating a variable set at specific ranges to distinguish firms' age and consequently firms' financial constraints, namely, they divide firms into the young, middle-aged and old, in which younger firms are the ones who suffer the most from financial constraints.

The fourth and final index is bond ratings. Almeida et al. (2004), Han and Qiu (2007) and Denis and Sibilkov (2009) retrieve data on firms' bond ratings and classify those firms that not once had their public debt rated during the sample period as financially constrained. By contrast, they classify firms whose bonds have been rated during the sample period as financially unconstrained. Related methods for characterizing financial constraints are employed by Whited (1992), Kashyap et al. (1994), and Gilchrist and Himmelberg (1995). Similar to bond ratings there is also commercial paper ratings where data on firms' commercial paper is retrieved and if firms have never had their commercial papers rated during the sample period they are in the financially constrained group, and if firms have had

their commercial papers rated in the sample period, they are assigned to the financially unconstrained group. This approach follows from the work developed by Calomiris et al. (1995).

The additional method used by Almeida et al. (2004) is the KZ index from the work of Kaplan and Zingales (1997), where firms in the bottom (top) three deciles of the KZ index ranking are allocated to the financially unconstrained (constrained) group. According to Almeida et al. (2004) there is a positive relationship among the sample splits created by the first four measures of financial constraints. For instance, most small (large) firms lack (have) bond ratings, and most small (large) firms have low (high) dividend pay-outs, which is consistent with the results of Han and Qiu (2007). The clear exception among the sample splits is the financial constraint categorization presented by the KZ index. Hence, the authors who followed the work of Almeida et al. (2004) did not use the KZ index of Kaplan and Zingales (1997) since this measure does a weak job in regard to the characterization of the cross-sectional variation of cash policies for financially constrained firms against unconstrained firms (Denis and Sibilkov, 2009).

The literature on model specifications to measure financial constraints lies mainly in the approach where firms are classified, *a priori*, according to empirical proxies for likelihood that they face financial constraints, using different approaches to separate firms into financially constrained and unconstrained groups, based on each criterion. Therefore, after the sample is divided into subsamples for each classification scheme, then, the cash flow sensitivities can be estimated, for each group of firms.

The cash flow sensitivities can then be analysed, following the argument that constrained firms will exhibit a positive propensity to use cash-flows to finance investments, which translates into a positive and significant investment cash flow sensitivity; and constrained firms will exhibit a positive and significant relationship between cash stocks and cash-flow since the higher the cash flow sensitivity of cash, the more constrained a group of firms is. By contrast, no systematic relationship should be found for unconstrained ones (Silva and Carreira, 2012).

3. Methodology and Data Description

This section contains the research methodology used for analysing the research question, specifically, the models applied, the classification schemes and the data and sample used.

3.1. Empirical Models

Regarding the methodology, and in order to study the research questions we estimate two empirical models from different approaches, with the objective of evaluating the level of such constraints across groups of firms. For such, the measures of financial constraints that we apply are the ICFS and the CCFS that are used as a proxy to measure firms' financial constraints. In the report we use both measures to analyse the separation of firms into financially constrained and financially unconstrained. We combine both approaches to find if the results alter or if the results are maintained across different measures.

3.1.1. Model 1 – Investment-Cash Flow Sensitivity

To measure the change in the ICFS, we borrow insights from the literature (Moyen, 2004; Ascioglu et al., 2008) to build equation (3.1) and we derive an empirical equation for the estimation of ICFS based on an accelerator specification, that has the advantage of not necessitating the computation of Tobin's Q, following the work of Bond et al. (2003), Guariglia (2008) and Silva and Carreira (2010):

$$\frac{I_{i,t}}{K_{i,t-1}} = \rho \frac{I_{i,t-1}}{K_{i,t-2}} + \beta_1 \Delta y_{i,t} + \beta_2 \Delta y_{i,t-1} + \beta_3 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_4 \frac{CF_{i,t-1}}{K_{i,t-2}} + d_t + \alpha_i + \varepsilon_{i,t} \quad (3.1)$$

In equation 1, $I_{i,t}$ is investment for firm *i* in period *t*, $K_{i,t-1}$ is capital stock at the beginning of the period *t*, $\Delta y_{i,t}$ is sales growth and, $CF_{i,t}$ is the cash-flow, d_t are time dummies, α_i controls for unobserved firm heterogeneity and $\varepsilon_{i,t}$ is the error term.

The variable investment ($I_{i,t}$) is given by investment in plant, property and equipment, given by capital expenditures. We scale capital expenditures by capital stock ($K_{i,t-1}$) given by net plant, property and equipment at the beginning of the period. Thus, our scaled investment variable is ($I_{i,t}/K_{i,t-1}$).

We include the variable sales growth as a way to control for investment opportunities faced by firms. Sales is given by total sales and services and is computed as the 1-year change in sales over lagged sales.

The variable cash flow is defined as net income before extraordinary items plus depreciation and amortization. We scale firm's cash flow by capital stock at the beginning of the period. Thus, our cash flow variable is denoted as $(CF_{i,t}/K_{i,t-1})$.

Considering that while financially constrained firms cannot get external finance so they must depend on their internally generated resources when an investment opportunity arises, by contrast, financially unconstrained firms can easily rely on external funds to finance their investments. Consequently, constrained firms will exhibit a positive propensity to use cash-flows (internal finance) to finance investments, which translates into a positive and significant investment cash flow sensitivity, whereas no systematic relationship should be found for unconstrained ones (Silva and Carreira, 2012). Therefore, we expect the coefficients on cash flow to capital stock ratio to be positive and statistically significant if a firm is financially constrained and to be non-significant if a firm is financially unconstrained.

For the estimation of this model, we use the first-difference Generalized Methods of Moments (GMM) estimator developed by Arellano and Bond (1991), that allows us to eliminate firm specific effects, considers heteroskedasticity and autocorrelation, whilst allowing for the presence of endogenous variables, by using the model variables lagged two periods as instruments.

3.1.2. Model 2 – Cash-Cash Flow Sensitivity

To measure the change in the cash flow sensitivity of cash, we borrow insights from the literature (Almeida et al., 2004; Silva and Carreira, 2010) to build equation (3.2):

$$\Delta CS_{i,t} = \beta_0 + \beta_1 CF_{i,t} + \beta_2 \Delta y_{i,t} + \beta_3 Size_{i,t} + \beta_4 I_{i,t} + \beta_5 \Delta NWC_{i,t} + \beta_6 \Delta STDebt_{i,t} + \varepsilon_{i,t} \quad (3.2)$$

Where $\Delta CS_{i,t}$, the dependent variable, is the firm *i*'s 1-year change is cash stocks (measured by the amount of bank deposits and cash) years normalized by total assets at time *t*, $CF_{i,t}$ is cash flow, measured as net income before extraordinary items plus depreciation and amortization normalized by total assets, $\Delta y_{i,t}$ is sales growth used as a proxy for

investment opportunities. $Size_{i,t}$ is a control for firm size it represents the natural logarithm of assets, $I_{i,t}$ is the investment divided by total assets, $\Delta NWC_{i,t}$ is the change of noncash net working capital divided by total assets, $\Delta STDebt_{i,t}$ is the change of short-term debt divided by total assets and $\varepsilon_{i,t}$ is the error term.

The variables are divided by total assets to address the problem of heteroscedasticity because of difference in firms' size.

The level to which a specific group of firms is financially constrained should be reflected on their cash flow sensitivity of cash. Therefore, the higher the cash flow sensitivity of cash, the more constrained is a group of firms. As a result, it is expected a positive and significant relationship between cash stocks and cash flow for constrained firms, which translates into a positive and statistically significant β_1, whereas no such relationship should be found for unconstrained firms. Moreover, it is expected that financially constrained firms exhibit a positive correlation between cash stocks and new/better investment opportunities. Furthermore, firms with higher growth opportunities might have larger cash reserves for the purpose of capturing future growth opportunities. Therefore, we predict coefficient β_2 to be positive and statistically significant for constrained firms but statistically non-significant for the unconstrained ones.

We also control for the change in net working capital since working capital can be a substitute for cash, and for the change in short-term debt because, similarly to net working capital changes in short-term debt can be a substitute for cash or for the reason that firms might use short-term debt to build cash reserves.

We estimate the second model using firm fixed-effects, to take into account unobserved firm-level heterogeneity, as well as panel-robust standard errors.

3.2. Classification Schemes

In order the regress the models, we first classify firms in our sample, *a priori*, as financially constrained or unconstrained, based on certain features and financial information available. This way of classification has been widely used in the literature with the objective of identifying and measuring the level of financial distress faced by firms and identifying the groups of firms that experience the most with financial constraints, by differentiating them according to certain attributes. For this reason, we create subsamples by the following firm's

features that are believed to be proxies for financial constraints, particularly, size, age and dividend payment.

Starting with firm size, it is expected that smaller firms face stricter financial constraints, given that such firms do not have the influence larger firms have. Since in our second model we already have the variable $Size$, in order to avoid the presence of the same variable in the estimated equation and in the classification scheme, we follow Silva and Carreira (2010) and we measure firm size as number of employees as an alternative to total assets, since in our understanding, it is a much more exogenous variable. According to the European Commission, the definition of a small and medium-sized enterprises (SMEs) states the staff headcount to be lower than 250 employees for medium-sized firms, and lower than 50 for small firms (European Commission, 2015). Therefore, we create an indicator variable set at specific ranges to distinguish firms' size and consequently firms' financial constraints. First, considering that the information reported by firms under 20 employees is not reliable, the first range or size class is set between 20-49 employees. The first size class represents the smaller firms, those who are expected to face more severe financial constraints. The second partition is set between 50 and 249, and it represents the medium-sized firms. The last size class is for firms with a number of employees greater than 250, and they represent the larger firms.

In regard to age, it is expected that younger firms face harsher financial constraints than older firms. We compute age as the time elapsed since the establishment date of the firm. Accordingly, we consider young firms, those firms whose age falls in the lowest quartiles of the distribution of the ages. In the same way, we define as middle-aged firm-years, firms whose age is in the second and third quartiles of the distribution. Similarly, old firm firms are those with age in the highest quartile of the distribution.

Lastly, we have dividend payment. According to the literature, firms that pay lower dividends and have lower pay-out ratios are more likely to be constrained, since low-dividend firms exhibit higher cash flow sensitivity than high-dividend ones. Therefore, we compute a dummy variable that equals to 1 if a firm has paid dividends during the sample period (and is consequently unconstrained), and 0 if otherwise (constrained).

3.3. Data and Sample

For this study, we use a sample of Portuguese firms and collect panel data over a 10-year period, specifically from 2009 to 2019. Since a balanced panel data was used, firms need to respect some criteria to be included in the sample, such as, only companies that present values for all variables for every year of the period under analysis are considered, therefore observations that report either missing or with unreasonable values are dropped. Firms in the financial (SIC 6000–6999) and utility (SIC 4910–4939) sectors are eliminated. We eliminate firms with less than 20 employees as a result of the lack of quality of information given by such firms. Finally, we eliminate firm-years with nonpositive values for total book assets, cash holdings, and capital expenditures. Data from firms was retrieved from SABI database. All variables are winsorized at their 1st and 99th percentile, following the literature to mitigate the influence of extreme values.

As a result, our final sample comprises a total of 492 companies and 5 412 firm-years observations. Our dataset comprises a broad range of industries and the large sample period, from 2009 until 2019, is adequate to allow for macroeconomic cyclical variations.

The summary statistics for the variables in both models are shown in the following tables 1 and 2.

Table 1 presents the summary statistics for the variables of our first model, for the whole sample and by classification scheme subsamples. We can observe that mean investment decreases with firm's age, which suggests that older firms have a tendency to invest less than younger firms. Moreover, smaller firms display lower sales growth than larger firms while younger firm's sales growth are higher than older firms.

Table 2 presents the summary statistics for the variables of our second model, for the whole sample and by classification scheme subsamples. We can conclude that smaller and younger firms have higher cash stocks than larger and older firms. In addition, younger firms, on average, have larger cash flows.

These summary statistics are similar to those reported by authors that follow the same methodology.

Table 1 - Summary Statistics of Model (1)

This table presents the summary statistics of the variables in our first model of a sample of 5 412 firm-years from 492 firms from Portugal, over the period 2009 to 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Both total sample and subsample's means values of the variables used to estimate equation (3.1) are reported, standard deviations are given in parenthesis.

	Variables	$\frac{I_{i,t}}{K_{i,t-1}}$	$\frac{I_{i,t-1}}{K_{i,t-2}}$	$\Delta y_{i,t}$	$\Delta y_{i,t-1}$	$\frac{CF_{i,t}}{K_{i,t-1}}$	$\frac{CF_{i,t-1}}{K_{i,t-2}}$
Size	Small	1.1777	1.1652	0.0133	0.0218	0.4268	0.7512
		(0.5878)	(0.5325)	(0.3275)	(0.3294)	(0.9168)	(1.8554)
	Medium	1.2097	1.2012	0.0471	0.0508	0.5061	0.6360
		(0.5248)	(0.4917)	(0.3427)	(0.3418)	(0.8848)	(1.6420)
	Large	1.3371	1.3156	0.0287	0.0308	0.7439	1.2312
		(0.7864)	(0.7185)	(0.3445)	(0.3458)	(1.4169)	(2.8844)
Age	Young	1.2771	1.2709	0.0419	0.0501	0.6041	1.0757
		(0.6586)	(0.6125)	(0.3723)	(0.3777)	(1.1338)	(2.2563)
	Middle-aged	1.1804	1.1669	0.0309	0.0362	0.4751	0.7165
		(0.5518)	(0.5003)	(0.3365)	(0.3336)	(0.9072)	(1.8987)
	Old	1.1569	1.1438	0.0127	0.0174	0.3545	0.3718
		(0.5042)	(0.4612)	(0.2870)	(0.2873)	(0.7306)	(0.9854)
Dividend payment	No	1.1943	1.1815	0.0271	0.0336	0.4082	0.6754
		(0.5739)	(0.5220)	(0.3485)	(0.3493)	(0.8524)	(1.7376)
	Yes	1.2220	1.2146	0.0349	0.0393	0.6748	0.8742
		(0.5849)	(0.5499)	(0.2998)	(0.2993)	(1.1122)	(2.1225)
Total		1.2020	1.1906	0.0292	0.0352	0.4819	0.7304
		(0.5770)	(0.5300)	(0.3357)	(0.3362)	(0.9455)	(1.8539)

Table 2 - Summary Statistics of Model (2)

This table presents the summary statistics of the variables in our second model of a sample of 5 412 firm-years from 492 Portuguese firms, over the period 2009 to 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Both total sample and subsample's means values of the variables used to estimate equation (3.2) are reported, standard deviations are given in parenthesis.

	Variables	$\Delta CS_{i,t}$	$CF_{i,t}$	$\Delta y_{i,t}$	$Size_{i,t}$	$I_{i,t}$	$\Delta NWC_{i,t}$	$\Delta STDebt_{i,t}$
Size	Small	0.0072	0.0642	0.0133	14.7473	0.3751	0.2745	0.4239
		(0.0689)	(0.0686)	(0.3275)	(0.9834)	(0.2925)	(0.2257)	(0.2131)
	Medium	0.0089	0.0902	0.0471	15.6201	0.4001	0.2628	0.4116
		(0.0659)	(0.0744)	(0.3427)	(1.0746)	(0.3039)	(0.2127)	(0.1968)
	Large	0.0023	0.0911	0.0287	17.3994	0.3566	0.2037	0.3725
		(0.0544)	(0.0879)	(0.3445)	(1.2750)	(0.3048)	(0.1874)	(0.1860)
Age	Young	0.0092	0.0906	0.0419	15.0837	0.4015	0.1921	0.4598
		(0.0719)	(0.0809)	(0.3723)	(1.2147)	(0.2849)	(0.2352)	(0.2007)
	Middle-aged	0.0082	0.0775	0.0309	15.1577	0.3650	0.2898	0.4137
		(0.0695)	(0.0734)	(0.3365)	(1.1637)	(0.2930)	(0.2006)	(0.2036)
	Old	0.0048	0.0626	0.0127	15.8327	0.4040	0.2988	0.3706
		(0.0540)	(0.0622)	(0.2870)	(1.3013)	(0.3191)	(0.2122)	(0.1970)
Dividend payment	No	0.0065	0.0672	0.0271	15.0726	0.3912	0.2769	0.4264
		(0.0650)	(0.0686)	(0.3485)	(1.1932)	(0.3022)	(0.2178)	(0.2054)
	Yes	0.0104	0.1040	0.0349	15.8994	0.3689	0.2333	0.3859
		(0.0712)	(0.0799)	(0.2998)	(1.2008)	(0.2887)	(0.2167)	(0.2001)
Total		0.0076	0.0076	0.0774	0.0292	15.3011	0.3850	0.2648
		0.0668	0.0668	0.0737	0.3357	1.2511	0.2987	0.2184

4. Results and Discussion

In this section we will present the results of the estimations for the two models (ICFS and CCFS), first for the whole sample and then specific to each of the criterion.

4.1. Overall Sample

The following tables 3 and 4 report the results for the estimation of the models for the whole sample. Starting with ICFS, considering the results on the first model (table 3) it shows that, in general, Portuguese firms have a high sensitivity of investment to cash flow (0.356), positive and significant at 1% level. This estimate suggests that for each euro of additional cash flow, Portuguese firms will increase their investment, on average, in 36 cents.

Table 3 – Investment-Cash Flow Sensitivity Estimation

This table presents the estimation output of the first model (equation 3.1) for the whole sample using Arellano-Bond estimation and Generalized Methods of Moments (GMM). The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

VARIABLES	Coefficient
$\frac{I_{i,t-1}}{K_{i,t-2}}$	1.455***
	(0.449)
$\Delta y_{i,t}$	0.0796***
	(0.0240)
$\Delta y_{i,t-1}$	0.107***
	(0.0228)
$\frac{CF_{i,t}}{K_{i,t-1}}$	0.356***
	(0.0145)
$\frac{CF_{i,t-1}}{K_{i,t-2}}$	0.0904***
	(0.0084)
Constant	1.629***
	(0.0296)
Observations	3,936

On the same note, the results of the estimation of the second model (table 4) report a positive and significant at 1% level cash-cash flow sensitivity (0.183), which confirms that, overall, Portuguese firms face financial constraints. This estimate suggests that for each euro of additional cash flow, Portuguese firms will save around 18 cents.

Table 4 - Cash-Cash Flow Sensitivity Estimation

This table presents the estimation output of the second model (equation 3.2) for the whole sample using firm fixed-effects and robust standard errors. The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Robust standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

VARIABLES	Coefficient
$CF_{i,t}$	0.183***
	(0.0233)
$\Delta y_{i,t}$	0.0058*
	(0.0030)
$Size_{i,t}$	0.0054
	(0.0039)
$I_{i,t}$	0.0021
	(0.0046)
$\Delta NWC_{i,t}$	-0.0987***
	(0.0116)
$\Delta STDebt_{i,t}$	-0.0182*
	(0.0098)
Constant	-0.0571
	(0.0609)
Observations	5,412

Both methodologies report the same results. Moreover, the results of our estimation are consistent with Silva and Carreira (2010) that report that Portuguese firms, on average, increase their investment in 32 cents for each euro of extra cash flow, and save 18 cents out of each euro of cash flow, when estimating for the overall sample.

4.2. Classification Schemes

Regarding size, both estimates used to measure financial constraints are presented in tables 5 and 6. Concerning ICFS (table 5), overall, smaller and medium-sized firms present

statistically significant coefficients at 1% level, while larger firms only display statistically significant coefficients at 10% level.

The results show that small and medium-sized firms are those most affected by financial constraints, since they invest 33 cents and 43 cents out of every euro of extra cash flow, respectively (positive and significant at the 1% level). On the other hand, the estimates of ICFS on large firms indicate that large firms only invest around 8 cents out of every euro of extra cash flow (significant at 10%). This shows that ICFS are higher for smaller companies (constrained) than for larger companies (unconstrained).

Table 5 - Investment-Cash Flow Sensitivity estimation by firm size class

This table presents the estimation output of the first model (equation 3.1) for size subsamples using Arellano-Bond estimation and Generalized Methods of Moments (GMM). The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

	SIZE		
VARIABLES	Small	Medium	Large
$\frac{I_{i,t-1}}{K_{i,t-2}}$	1.740***	-0.557	-0.645
	(0.583)	(0.614)	(1.043)
$\Delta y_{i,t}$	0.140***	0.0438	0.0591
	(0.0358)	(0.0331)	(0.105)
$\Delta y_{i,t-1}$	0.0974***	0.115***	0.0647
	(0.0347)	(0.0304)	(0.103)
$\frac{CF_{i,t}}{K_{i,t-1}}$	0.333***	0.434***	0.0835*
	(0.0211)	(0.0216)	(0.0473)
$\frac{CF_{i,t-1}}{K_{i,t-2}}$	0.104***	0.0596***	0.0443*
	(0.0119)	(0.0126)	(0.0249)
Constant	1.688***	1.534***	1.838***
	(0.0434)	(0.0397)	(0.128)
Observations	1,944	1,744	248

On the subject of CCFS (table 6), the results show that small and medium-sized firms are those most affected, and that save 21 cents and 17 cents out of every euro of extra cash

flow, respectively (positive and significant at the 1% level). However, for large firms the estimates of CCFS are not statistically significant, which indicates that such firms do not experience financial distress, since there is no systematic relation between cash flow and cash stock, for unconstrained firms. This might happen because it is easier for those firms to obtain financing from bank loans or from the equity market. These results suggest that cash stocks are more valuable for constrained firms than for unconstrained firms.

Table 6 - Cash-Cash Flow Sensitivity estimation by firm size class

This table presents the estimation output of the second model (equation 3.2) for size subsamples using firm fixed-effects and robust standard errors. The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Robust standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

	SIZE		
VARIABLES	Small	Medium	Large
$CF_{i,t}$	0.212***	0.172***	-0.0376
	(0.0370)	(0.0294)	(0.0886)
$\Delta y_{i,t}$	0.0024	0.0098**	0.0039
	(0.0046)	(0.0041)	(0.0097)
$Size_{i,t}$	0.0096	0.0044	0.0029
	(0.0064)	(0.0054)	(0.0080)
$I_{i,t}$	-0.0101	0.0149**	-0.0132
	(0.0063)	(0.0071)	(0.0109)
$\Delta NWC_{i,t}$	-0.103***	-0.0969***	-0.0920
	(0.0170)	(0.0155)	(0.0608)
$\Delta STDebt_{i,t}$	-0.0150	-0.0283**	0.0224
	(0.0155)	(0.0130)	(0.0382)
Constant	-0.110	-0.0451	-0.0304
	(0.0967)	(0.0859)	(0.160)
Observations	2,673	2,398	341

When controlling for firm size, we find that the results are maintained across both measures and that smaller firms (constrained) have higher ICFS and CCFS than larger firms (unconstrained), which provides evidence that smaller firms are financially constrained. These results are consistent with the literature (Almeida et al., 2004; Guariglia, 2008; Silva and Carreira, 2010) and the predictions of our model.

Concerning age (tables 7 and 8) we do not find a clear relation between age and financial constraints. The estimates for ICFS (table 7) show that firms are sensitive to cash flow regardless of their age class, with larger firms investing around 50 cents out of each euro of extra cash flow, and small firms investing only 33 cents (both statistically significant at 1% level). This result is not what we would expect, given that we would expect higher sensitivities for younger not older firms.

Table 7 - Investment-Cash Flow Sensitivity estimation by age class

This table presents the estimation output of the first model (equation 3.1) for age subsamples using Arellano-Bond estimation and GMM. The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

	AGE		
VARIABLES	Young	Middle-Aged	Old
$\frac{I_{i,t-1}}{K_{i,t-2}}$	-0.190	1.448***	-2.792***
	(0.638)	(0.548)	(0.749)
$\Delta y_{i,t}$	0.0520	0.123***	-0.0273
	(0.0451)	(0.0339)	(0.0547)
$\Delta y_{i,t-1}$	0.135***	0.119***	0.0055
	(0.0427)	(0.0321)	(0.0517)
$\frac{CF_{i,t}}{K_{i,t-1}}$	0.328***	0.369***	0.497***
	(0.0258)	(0.0198)	(0.0368)
$\frac{CF_{i,t-1}}{K_{i,t-2}}$	0.111***	0.0699***	-0.00783
	(0.0140)	(0.0121)	(0.0246)
Constant	1.814***	1.517***	1.620***
	(0.0623)	(0.0393)	(0.0559)
Observations	1,104	1,864	968

On the other hand, estimates for CCFS (table 8) still report positive and statistically significant coefficients at 1% level, for every age class, but the impact is higher for younger firms. The CCFS are higher for younger firms than for older firms. These estimates suggest

that for each euro of additional cash flow, small firms will save around 20 cents while larger firms will save 16 cents.

Regarding age, the results are mixed across both models. In the first model the results obtained are not consistent with the literature since firms that have higher ICFS are older firms instead of younger firms (0.497 against 0.328). However, in the second model, CCFS are higher for younger firms than for older firms (0.196 against 0.160).

Silva and Carreira (2010) also find mixed results in their estimations by age classes. The authors recommend that in regard to age the results should be handled with attention, with the intention of determining if they originated from complications related with the estimations or classification schemes.

Table 8 - Cash-Cash Flow Sensitivity estimation by age class

This table presents the estimation output of the second model (equation 3.2) for age subsamples using firm fixed-effects and robust standard errors. The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Robust standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

	AGE		
VARIABLES	Young	Middle-Aged	Old
$CF_{i,t}$	0.196***	0.180***	0.160***
	(0.0482)	(0.0306)	(0.0363)
$\Delta y_{i,t}$	0.0088	0.0069	-0.0020
	(0.0060)	(0.0042)	(0.0042)
$Size_{i,t}$	0.0021	0.0093	0.0034
	(0.0067)	(0.0061)	(0.0062)
$I_{i,t}$	-0.0101	0.0005	0.0133**
	(0.0133)	(0.0072)	(0.0054)
$\Delta NWC_{i,t}$	-0.0639***	-0.113***	-0.121***
	(0.0184)	(0.0180)	(0.0249)
$\Delta STDebt_{i,t}$	-0.0180	-0.0183	-0.0122
	(0.0171)	(0.0146)	(0.0220)
Constant	-0.0154	-0.107	-0.0237
	(0.107)	(0.0934)	(0.0996)
Observations	1,518	2,563	1,331

In regard to dividend payment, this classification is the main used in the literature, since the primordial work of Fazzari et al. (1988), to separate financially constrained from financially unconstrained firms. Both estimations, present in the following tables 9 and 10, suggest that this classification can be used to categorize firms into financially constrained and unconstrained.

For the first model (table 9), firms that do not pay dividends invest around 40 cents for every euro of extra cash flow, against 22 cents for those who pay dividends. Therefore, ICFS sensitivities are higher for the firms that do not pay dividends (constrained), both statistically significant at 1% level.

Table 9 - Investment-Cash Flow Sensitivity estimation by dividend payment

This table presents the estimation output of the first model (equation 3.1) for dividend payment subsamples using Arellano-Bond estimation and GMM. The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

	DIVIDEND PAYMENT	
VARIABLES	No	Yes
$\frac{I_{i,t-1}}{K_{i,t-2}}$	1.405***	0.789
	(0.497)	(0.688)
$\Delta y_{i,t}$	0.0890***	0.0218
	(0.0276)	(0.0477)
$\Delta y_{i,t-1}$	0.120***	-0.00876
	(0.0260)	(0.0468)
$\frac{CF_{i,t}}{K_{i,t-1}}$	0.404***	0.218***
	(0.0174)	(0.0248)
$\frac{CF_{i,t-1}}{K_{i,t-2}}$	0.0911***	0.0610***
	(0.0098)	(0.0155)
Constant	1.608***	1.713***
	(0.0343)	(0.0530)
Observations	2,848	1,088

For the second model (table 10), CCFS are higher for the firms that pay no dividends (0.216 against 0.109), both positive and statistically significant at 1% level. These estimations suggest that for each euro of additional cash flow, firms that pay no dividends will save around 22 cents, while firms that pay dividends will save around 11 cents. Therefore, CCFS sensitivities are higher for the firms that do not pay dividends (constrained).

Both measures reported results consistent with the literature, in which firms that pay no dividends (constrained) have higher sensitivities to cash flow than firms that pay dividends (unconstrained), therefore dividend payment is another factor that explains the differences in firms' financial constraints.

Table 10 - Cash-Cash Flow Sensitivity estimation by dividend payment

This table presents the estimation output of the second model (equation 3.2) for dividend payment subsamples using firm fixed-effects and robust standard errors. The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Robust standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

	DIVIDEND PAYMENT	
VARIABLES	No	Yes
$CF_{i,t}$	0.216***	0.109***
	(0.0290)	(0.0370)
$\Delta y_{i,t}$	0.0069**	0.0021
	(0.0031)	(0.0083)
$Size_{i,t}$	0.0049	0.0087
	(0.0042)	(0.0091)
$I_{i,t}$	0.0028	0.0011
	(0.0055)	(0.0084)
$\Delta NWC_{i,t}$	-0.0872***	-0.127***
	(0.0126)	(0.0269)
$\Delta STDebt_{i,t}$	-0.0142	-0.0285
	(0.0114)	(0.0193)
Constant	-0.0523	-0.0985
	(0.0654)	(0.147)
Observations	3,850	1,562

Taking into account all of the results, firms in Portugal appear to be financially constrained. This might be caused by a relative underdevelopment of capital markets in Portugal when compared to the USA or the UK, that have more developed markets (Silva and Carreira, 2010).

Nevertheless, we find some patterns in our results that smaller firms and firms that do not pay dividends tend to be more financial constrained as they have higher ICFS and CCFS which is consistent with the literature, since firms with more frictions in raising external financing have to rely more on internal funds and save a larger fraction of their cash flow as cash to fund the needed expenditures, than those firms with less constraints. As to age, we do not find a clear pattern across both methodologies, therefore the results are inconclusive.

5. Conclusion

In this study, we have analysed the factors that explain the differences in firms' financial constraints, considering that some firms are more financially constrained than others. Firms are financially constrained if they are unable to raise the necessary amount to finance their own optimal path of growth.

We analysed firms' financial constraints by estimating two models based on cash flow sensitivities, namely, investment cash flow sensitivity and cash-cash flow sensitivity, upon a large sample of 492 Portuguese firms of a broad range of industries over a 10-year period. We split our sample according to firm's attributes that are widely used in the literature to analyse financial constraints (size, age and dividend policy), with the intention of testing the validity of such classification schemes and also comparing measurement methodologies.

We found evidence that Portuguese firms are, overall, financially constrained. After creating subsamples for each classification scheme, our results show that financial constraints are more severe to those firms that are smaller and do not pay dividends, which is consistent with the literature and within both models estimated. However, unlike both factors above, we do not find robust evidence that age is a good criterion to explain differences in firm's financial constraints, since we obtained mixed results across methodologies.

As a whole, firms appear to be extremely financially constrained in Portugal, which might be caused by the relative underdevelopment of financial markets. It is expected that firms operating in countries with less developed financial markets, alongside with ineffective legal and regulatory systems, will face more constraints, as there will be a larger number of frictions in the market.

This work adds to the discussion of financial constraints both by presenting new results on the Portuguese economy, and by testing and comparing alternative methodologies used to measure constraints and categorise firms by their financial distress. This study also helps to fill in the gap in the literature concerning the scarce of empirical analysis on financial constraints in Europe, particularly in Portugal, where there are still a limited number of studies.

Lastly, we have several suggestions for future research, namely the development of more consistent measures of financial constraints, since they are very difficult to measure because they are not observable, and the most used methods are the application of investment and cash-cash flow sensitivities which are based on proxies. Moreover, future research could

analyse financial constraints in different sectors of economic activity. Additionally, appropriate policies to alleviate financial constraints could be explored, since this study shows the difficulties of firms in resorting to external finance, specifically firms with smaller size. Smaller firms are vastly important in economy, since they contribute to innovation and economic growth and generate employment. Therefore, policies should be adopted to alleviate firm's financial constraints and to provide the right conditions for smaller firms to develop and achieve prosperity.

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Appendices

Appendix 1 – Correlation Matrices

Table 11 - Correlation Matrix for Model (1) variables

This table presents the correlation matrix of the first model (equation 3.1). The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

Variables	$\frac{I_{i,t}}{K_{i,t-1}}$	$\frac{I_{i,t-1}}{K_{i,t-2}}$	$\Delta y_{i,t}$	$\Delta y_{i,t-1}$	$\frac{CF_{i,t}}{K_{i,t-1}}$	$\frac{CF_{i,t-1}}{K_{i,t-2}}$
$\frac{I_{i,t}}{K_{i,t-1}}$	1					
$\frac{I_{i,t-1}}{K_{i,t-2}}$	0.247***	1				
$\Delta y_{i,t}$	0.127***	0.0505***	1			
$\Delta y_{i,t-1}$	0.0829***	0.143***	-0.0530***	1		
$\frac{CF_{i,t}}{K_{i,t-1}}$	0.495***	0.237***	0.0952***	0.0412**	1	
$\frac{CF_{i,t-1}}{K_{i,t-2}}$	0.302***	0.319***	0.0418**	0.0375**	0.470***	1

Table 12 - Correlation Matrix for Model (2) variables

This table presents the correlation matrix of the second model (equation 3.2). The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

Variables	$\Delta CS_{i,t}$	$CF_{i,t}$	$\Delta y_{i,t}$	$Size_{i,t}$	$I_{i,t}$	$\Delta NWC_{i,t}$	$\Delta STDebt_{i,t}$
$\Delta CS_{i,t}$	1						
$CF_{i,t}$	0.165***	1					
$\Delta y_{i,t}$	0.0581***	0.111***	1				
$Size_{i,t}$	-0.0254	-0.0138	0.0214	1			
$I_{i,t}$	-0.0186	0.140***	-0.0567***	-0.0608***	1		
$\Delta NWC_{i,t}$	-0.0733***	-0.106***	-0.0196	-0.0911***	-0.248***	1	
$\Delta STDebt_{i,t}$	-0.0618***	-0.182***	0.0407**	-0.180***	-0.125***	-0.172***	1

Appendix 2 – Estimation Results

Table 13 - Estimations results for Model (1) total sample and subsamples

This table presents the estimation output of the first model (equation 3.1) for the whole sample using Arellano-Bond estimation and Generalized Methods of Moments (GMM) and for firm size class, age class and dividend payment subsamples. The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

	TOTAL	SIZE			AGE			DIVIDEND PAYMENT	
VARIABLES		Small	Medium	Large	Young	Middle-Aged	Old	No	Yes
$\frac{I_{i,t-1}}{K_{i,t-2}}$	1.455***	1.740***	-0.557	-0.645	-0.190	1.448***	-2.792***	1.405***	0.789
	(0.449)	(0.583)	(0.614)	(1.043)	(0.638)	(0.548)	(0.749)	(0.497)	(0.688)
$\Delta y_{i,t}$	0.0796***	0.140***	0.0438	0.0591	0.0520	0.123***	-0.0273	0.0890***	0.0218
	(0.0240)	(0.0358)	(0.0331)	(0.105)	(0.0451)	(0.0339)	(0.0547)	(0.0276)	(0.0477)
$\Delta y_{i,t-1}$	0.107***	0.0974***	0.115***	0.0647	0.135***	0.119***	0.00550	0.120***	-0.0088
	(0.0228)	(0.0347)	(0.0304)	(0.103)	(0.0427)	(0.0321)	(0.0517)	(0.0260)	(0.0468)
$\frac{CF_{i,t}}{K_{i,t-1}}$	0.356***	0.333***	0.434***	0.0835*	0.328***	0.369***	0.497***	0.404***	0.218***
	(0.0145)	(0.0211)	(0.0216)	(0.0473)	(0.0258)	(0.0198)	(0.0368)	(0.0174)	(0.0248)
$\frac{CF_{i,t-1}}{K_{i,t-2}}$	0.0904***	0.104***	0.0596***	0.0443*	0.111***	0.0699***	-0.0078	0.0911***	0.0610***
	(0.0084)	(0.0119)	(0.0126)	(0.0249)	(0.0140)	(0.0121)	(0.0246)	(0.0098)	(0.0155)
Constant	1.629***	1.688***	1.534***	1.838***	1.814***	1.517***	1.620***	1.608***	1.713***
	(0.0296)	(0.0434)	(0.0397)	(0.128)	(0.0623)	(0.0393)	(0.0559)	(0.0343)	(0.0530)
Observations	3,936	1,944	1,744	248	1,104	1,864	968	2,848	1,088
Number of firms	492	243	218	31	138	233	121	356	136

Table 14 - Estimations results for Model (2) total sample and subsamples

This table presents the estimation output of the second model (equation 3.2) for the whole sample using firm fixed-effects and robust standard errors and for firm size class, age class and dividend payment subsamples. The sample consists of 5 412 firm-years from 492 Portuguese firms, over the period 2009 through 2019. All variables were retrieved from the SABI database and are winsorized at the 1st and 99th percentiles. Robust standard errors are reported in parenthesis. Statistical significance is denoted by *** at 0.01, ** at 0.05 and * at 0.10.

	TOTAL	SIZE			AGE			DIVIDEND PAYMENT	
VARIABLES		Small	Medium	Large	Young	Middle-Aged	Old	No	Yes
$CF_{i,t}$	0.183***	0.212***	0.172***	-0.0376	0.196***	0.180***	0.160***	0.216***	0.109***
	(0.0233)	(0.0370)	(0.0294)	(0.0886)	(0.0482)	(0.0306)	(0.0363)	(0.0290)	(0.0370)
$\Delta y_{i,t}$	0.0058*	0.0024	0.0098**	0.0039	0.0088	0.0069	-0.0020	0.0069**	0.0021
	(0.0030)	(0.0046)	(0.0041)	(0.0097)	(0.0060)	(0.0042)	(0.0042)	(0.0031)	(0.0083)
$Size_{i,t}$	0.0054	0.0096	0.0044	0.0029	0.0021	0.0093	0.0034	0.0049	0.0087
	(0.0039)	(0.0064)	(0.0054)	(0.0080)	(0.0067)	(0.0061)	(0.0062)	(0.0042)	(0.0091)
$I_{i,t}$	0.0021	-0.0101	0.0149**	-0.0132	-0.0101	0.0005	0.0133**	0.0028	0.0011
	(0.0046)	(0.0063)	(0.0071)	(0.0109)	(0.0133)	(0.0072)	(0.0054)	(0.0055)	(0.0084)
$\Delta NWC_{i,t}$	-0.0987***	-0.103***	-0.0969***	-0.0920	-0.0639***	-0.113***	-0.121***	-0.0872***	-0.127***
	(0.0116)	(0.0170)	(0.0155)	(0.0608)	(0.0184)	(0.0180)	(0.0249)	(0.0126)	(0.0269)
$\Delta STDebt_{i,t}$	-0.0182*	-0.0150	-0.0283**	0.0224	-0.0180	-0.0183	-0.0122	-0.0142	-0.0285
	(0.0098)	(0.0155)	(0.0130)	(0.0382)	(0.0171)	(0.0146)	(0.0220)	(0.0114)	(0.0193)
Constant	-0.0571	-0.110	-0.0451	-0.0304	-0.0154	-0.107	-0.0237	-0.0523	-0.0985
	(0.0609)	(0.0967)	(0.0859)	(0.160)	(0.107)	(0.0934)	(0.0996)	(0.0654)	(0.147)
Observations	5,412	2,673	2,398	341	1,518	2,563	1,331	3,916	1,496
R-squared	0.046	0.053	0.049	0.027	0.040	0.051	0.061	0.053	0.038
Number of firms	492	243	218	31	138	233	121	356	136