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Do Size, Age and Dividend Policy Provide Useful Measures of Financing Constraints? New Evidence from a Panel of Portuguese Firms

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Do size, age and dividend policy provide useful measures of financing constraints? New evidence from a panel of Portuguese firms

Carlos Carreira[*] and Filipe Silva[§]

Abstract

This paper investigates if firms' size and age, and dividend payment can work as good proxies of financial constraints faced by firms. The motivation is that, these proxies have been used by several authors to sort and distinguish firms according to a level of financial distress. To conduct our empirical tests, we make use of two different approaches in order to obtain robust results—first, we estimate the sensitivity of investment to cash-flow, then we employ the sensitivity of cash stocks to cash-flow. Our results, while supporting previous literature on the inverse relationship between size, dividend policy and financial constraints, they cast some doubts on previously devised relationships between age and the level of constraints. Additionally, our results suggest that, contrary to what is commonly accepted, the relationship between size and financial constraints seems to be in general U-shaped.

Keywords: Financial constraints; Firm size; Firm age; Dividend policy; firm-level studies.

JEL Classification: L8; D92; G32; L00; L2.

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1. Introduction

Despite economic theory provides some insights on the causes and effects of financial constraints, empirical literature has struggled to find consistent measures of these constraints (see Silva and Carreira, 2012). Firms have both internal and external forms of financing their operational and investment activities. Even if we abstain from thinking in terms of opportunity costs, obtaining funds externally requires a premium to be paid, which is associated with the risk that external investors have to bear when they decide to lend. Thus, the existence of information asymmetries (Stiglitz and Weiss, 1981; Myers and Majluf, 1984) sets a wedge between the costs of internal and external sources of finance, creating a financial hierarchy and aggravating the constraints faced by firms.

Financial constraints are empirically not observable. In fact, there is no item on the balance sheet that tells us if a firm is financially constrained. The use of proxies is the simplest and most practical way to measure constraints. By definition, if a given variable is highly correlated with financial constraints, it may prove to be a good proxy. The large majority of the empirical literature on financial constraints either uses an *a priori* firm classification or constructs an index that, in their turn, relies on a different variety of proxies, such as: cash-flow, cash stocks, size, age, export, R&D intensity, leverage, dividend payout ratio, group membership, and ownership. Notorious examples are the KZ (Kaplan-Zingales) index of Lamont et al. (2001) and the WW index of Whited and Wu (2006) that are built using dividend payments inter alia, and the SA (Size-Age) index of Hadlock and Pierce (2010) that is based solely on size and age variables.[1] However, even though there might be different variables that correlate with financial constraints, a good proxy for financial constraints is rather hard to find (Cleary et al., 2007).

The main purpose of this paper is to test if size, age, and dividend payment, which have been used by several authors to sort and distinguish firms according to a level of financial distress, are good proxies of financial constraints. To conduct our empirical tests, we estimate the sensitivity of investment to cash-flow (hereafter ICFS), the traditional measure of financial constraints. As a robustness test, we also estimate the sensitivity of cash stocks to cash-flow (hereafter CCFS), a relatively new approach proposed by Almeida et al. (2004).

To accomplish the empirical test, we use a large unbalanced panel of Portuguese firms covering the period 1996-2004. Our results, while supporting previous literature on the inverse relationship between size, dividend policy and financial constraints, they cast some doubts on previously devised relationships between age and the level of constraints. Inferences using this sample, representative of Portuguese firms, may be made with respect to, at least, the EU economy (cf. Cabral, 2007). However, some specific characteristics of the Portuguese economy must be taken into account. In particular, if indeed firms in economies with less developed financial markets suffer from more severe financial constraints (Carreira and Silva, 2010), then, with respect to, for example the UK economy, firms in Portugal are expected to present higher levels of financial constraints.

[1] The KZ index is based on cash-flow, long-term debt, dividends, liquid assets and Tobin's Q (normalised by total assets) and the WW index is computed using cash-flow, long-term debt, dividends, logarithm of total assets (also normalised by total assets).

This paper adds to the discussion on firms' financial constraints by testing and comparing different accepted proxies used to measure the financial distress faced by firms. Moreover, it expands earlier puzzling results to the Portuguese context.

The remainder of paper is organized as follows. Section 2 will make a brief incursion on the expected relationship between financial constraints and firms' size and age, and dividend policy, while Section 3 summarises the literature on financial constraints and describes the empirical methodology followed. In Section 4 we present the dataset and variables used. Section 5 presents and discusses the main results, while Section 6 pulls the pieces together and concludes.

2. Size, age, dividend payment and financial constraints

Size, age, and dividend payment seem to work as good proxies for financial constraints and, as a consequence, they can be able to provide consistent insights on the degree of firms' financial distress. In fact, the problems with asymmetric information in capital markets are more severe for small and young firms. On the one hand, it is reasonable to expect that smaller firms face more severe financial constraints since such firms do not have the reach or visibility that larger firms have, so investors have difficulties in screening the quality of projects. As a result, smaller firms tend to be more credit rationed (e.g. Petersen and Rajan, 1995). As an example, if a firm is large enough to be quoted, information with respect to this firm will be widely available. On the other, if a firm has just been created, not much information is available to potential investors. Over time, firms tend to build relationships with creditors, banks and investors in general, allowing them to obtain external funds in an easier manner as lenders gain some insight in both firms' characteristics and quality. As a result, one should also expect that younger firms face more severe financial constraints (see Carreira and Silva, 2010, for a survey of empirical literature).

Dividend policy was the main classification scheme, primarily used to distinguish financially constrained from unconstrained firms. The rationale is that firms might pay low dividends because they require investments that exceed their internal cash flow and, as a consequence, they retain all internal funds they can generate (Fazzari et al., 1988).

3. Measuring financial constraints

When it comes to financial constraints, the difficulty associated with its definition raises serious problems with respect to empirical tests. In fact, since these constraints are not directly observable, it is not easy to come up with a clear-cut definition. For the purpose of this paper, we define financial constraints as the inability of a firm to raise the necessary amounts (due to financial market frictions that lead to external finance shortage) to finance their investment and growth. Perhaps due to the problems in objectifying what is understood as financial constraints, researchers have struggled and still devote their time in trying to measure financial constraints in an appropriate manner (see Silva and Carreira, 2012). Therefore, we employ two methodologies to test the robustness of our findings.

3.1. Investment-cash flow sensitivity

The empirical assessment of financial constraints can essentially be traced back to the seminal work of Fazzari et al. (1988) that introduced ICFS as a measure of constraints. The rationale behind is that, financially constrained firms cannot obtain external finance or they do obtain them at significantly high costs. Therefore, these firms must rely on their internally generated funds once an investment opportunity arises. Meanwhile, financially unconstrained firms can easily resort to external funds to finance their investments. Accordingly, while constrained firms will exhibit a positive propensity to use cash-flows to finance investment (positive and significant ICFS), no systematic relationship should be found for unconstrained ones.

Fazzari et al. (1988) started by classifying each firm *a priori* as constrained and unconstrained, based on their dividend policy and then estimated ICFS for each class of firms. They regress investment on cash-flow, estimated Q (investment opportunities) and year and firm dummies, upon a sample consisting of 422 USA firms (1970-84). Their findings, that low-dividend firms (constrained) exhibit higher ICFS than high-dividend ones (unconstrained), provided evidence that ICFS could be a useful measure of financial constraints.

Since the influential work of Fazzari et al. (1988), numerous studies focused on the use of ICFS to identify and measure firms' financial constraints—the contributions of Hadlock (1998) for the US; Chapman et al. (1996) for Australia; Guariglia (2008) for the UK; Audretsch and Elston (2002) for Germany; Kadapakkam et al. (1998) and Bond et al. (2003) for different countries are just examples (see Silva and Carreira, 2012, for theoretical and empirical critiques of this methodology). Following Bond and Meghir (1994) and in line with Harhoff (1998), we will also resort to an investment accelerator model in order to estimate the sensitivity of investment to cash-flow (hereafter ICFS Model):

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

where I_{it} is the investment for firm i in period t, $K_{i(t-1)}$ is the beginning of period t capital, Δy_{it} is the output growth, CF_{it} is the cash-flow; d_t are year dummies, α_i controls for unobserved firm heterogeneity and ε_{it} the error term.

This particular accelerator specification has the advantageous feature of not requiring the computation of Tobin's Q—we use sales growth (Δy_{it}) instead of Q as a proxy for investment opportunities. We refrain from using Tobin's Q for two different reasons. Firstly, we are not able to calculate it due to the lack of financial market information in our dataset—we are only able to calculate it for the small subsample of firms that are publicly traded, thus losing significant information, in particular, observations of smaller and younger firms. The second reason is more of a theoretical one. On the one hand, marginal Q is unobservable, so researchers use average Q as a proxy (see Hayashi, 1982, for the derivation of average Q). On the other, the introduction of Q directly into the estimation of investment models for the purpose of analysing financial constraints may cause the sensitivities to cash-flows to be overestimated, as they might contain information about investment opportunities that were not captured by Q—Alti, 2003, in a model where financial frictions are absent, shows that, even after Q correction, firms exhibit ICFS. Sales growth is often used in empirical work on countries with less developed financial markets where information on firm's market value is scarcer (e.g. Budina et al., 2000; Konings et al., 2003). In some cases lagged sales may even outperform Q (see Fazzari et al., 1988, pp. 173-74).

3.2. Cash-cash flow sensitivity

Recently, in a different perspective of demand for liquidity, Almeida et al. (2004) suggest that financially constrained firms may alternatively be identified by looking at their cash policy. If a firm is constrained, it has to pass-up present investment opportunities and hoard cash, in order to be able to take advantage of profitable future investment opportunities and hedge against future shocks. The same is not true when it comes to unconstrained firms, since they are able to resort to external finance whenever investment opportunities arise (by definition of financial constraints). Therefore, one should expect a positive and significant association between cash stocks and cash-flow for constrained firms, while no such relationship should be found for unconstrained ones. The degree to which a certain group of firms is financially constrained should be reflected on the cash to cash-flow sensitivity estimate, as in ICFS—the higher the CCFS, the more constrained is such group of firms. Han and Qiu (2006), for US publicly traded firms from 1997 to 2002, and Baum et al. (2011), for a large international sample of firms from 1989 to 2006, corroborate this finding—to our knowledge, only a few works have used this approach so far. However other recent works do not support this view. For example, Pál and Ferrando (2010) found that, for Euro-area firms between 1994 and 2003, all firms presented positive and significant CCFS. Meanwhile, Lin (2007), for publicly traded Taiwanese firms between 1990 and 2004, also finds that, contrary to Almeida et al. (2004), both constrained and unconstrained firms present significant CCFS but, as expected, such sensitivity is higher for constrained firms. Finally, analysing firm-level data for 35 countries between 1994-2004, Khurana et al. (2005) find that there is a negative association between financial development and CCFS providing further evidence that this methodology is a useful measure of firm's financial constraints.

The financial nature of the cash stock variable should, in principle, work as a shield against miss-measurements in Q (sales growth in our case) and investment opportunities hidden in cash-flow because it is not expected that firms will increase their cash stocks if cash-flow signals a new\better investment opportunity, unless they are financially constrained. However, Acharya et al (2007) show that financially constrained firms will tend to use cash to increase cash stocks if their hedging needs are high. Yet, if their hedging needs are low, they will instead use cash to reduce debt. Therefore one might find firms whose propensity to save cash out of cash flow is low, even if they are financially constrained. Consequently, controlling for investment opportunities is necessary in an empirical equation to estimate the sensitivity of cash to cash-flows.

Additionally, Almeida et al. (2004) assumes that cash is the only way to transfer resources across time. In fact, in a subsequent paper, Almeida et al. (2011) point out that since holding cash is not the only form of inter-temporal allocation of capital—in the original work they assumed that all fixed investment is illiquid—, CCFS may actually be negative for constrained firms since firms may invest in relatively liquid assets, other than cash (Riddick and Whited, 2009). As a result, we will try to control for this effect in our model through investment in non-cash net working capital and financial investments.

Therefore, keeping these caveats in mind, we implement a slight modification to the Almeida et al. (2004) baseline empirical equation. In the spirit of Lin (2007), we substitute the variation of short term-debt by the sum of net debt and equity issuances

(ISS_{it}), and interest rate variation (ΔINT_{it}). The former modification is due to the fact that debt and equity issuances, while being a signal of easier access to external funds, might have a significant impact upon cash stocks (by accounting procedures). With respect to the latter, firms may decide to reduce their borrowings or pay back debt, according to expected interest expenses. However, instead of benchmark interest rates variations, we use variations of interest paid, which allows for firm variation, thus can also be seen as a form of credit rating. In both specifications, all variables are scaled by total assets. Furthermore, we also control for financial investments ($FinI_{it}$), that not only are a demand for cash but may also work as an alternative way to transfer resources across time. The augmented empirical equation is as follows (hereafter CCFS Model):

$$\Delta CS_{it} = \beta_1 CF_{it} + \beta_2 \Delta y_{it} + \beta_3 S_{it} + \beta_4 I_{it} + \beta_5 \Delta NWC_{it} + \beta_6 ISS_{it} + \beta_7 \Delta INT_{it} + \beta_8 FinI_{it} + d_t + \mu_{it}, \qquad (2)$$

where ΔCS_{it} is the variation in cash stocks for firm i in period t, S_{it} is the log of total assets, ΔNWC_{it} is the variation of noncash net working capital, and μ_{it} the error term.

4. Data and variables

To conduct our empirical analysis, we use an unbalanced panel of Portuguese firms (CAE–Rev. 2.1 15 to 37 and 50 to 93, manufacturing and services, respectively) covering the period 1996–2004. The raw data is drawn from the combination of two statistical data sources, both run by the Portuguese Statistical Office (INE): *Inquérito às Empresas Harmonizado* (IEH), an annual business survey with information on balance sheets; and Ficheiro de Unidades Estatísticas (FUE) that contains generic characteristics—class size, age, and main sector of activity—of all Portuguese firms.

The longitudinal dimension of the panel, required for our analysis, was constructed using firm's unique identification code.

The IEH survey comprises all firms operating in Portugal with more than 100 employees, plus a representative random sample of firms with less than 100 employees—the sample is representative (at 3-digit level), both in terms of employment size and sales. For the purpose of this paper, the following filters were applied: firstly, due to lack of good data, firms with less than 20 employees were eliminated from the estimation sample;[2] secondly, given the number of observations, those firms operating in manufacture of coke, refined petroleum products and nuclear fuel industry (CAE 23) were excluded; finally, we also exclude financial industry (CAE 65, 66, and 67)—inclusion of this sector would naturally bias the estimation favouring unconstrained firms. As a result, we have, for the period 1996-2004, an unbalanced panel of 22,651 firms and a total of 86,455 (year-firm) observations.

Table 1 summarises the measurement methods of the main variables used in the empirical analyses.

[2] We note that firms with less than 20 employees represent about 71% of Portuguese manufacturing firms, but only 16% of total employment (average over the period; source: OECD database).

Table 1. Variables measurement methods

Variables	Description
Size (*S*)	Log inflation-adjusted assets.
Investment (*I*)	Gross investment.
Capital (K)	Total assets
Cash- flow (*CF*)	Net income before taxes plus depreciation.
Cash stock (*CS*)	Total cash holdings.
Investment opportunities (Δy)	Output (given by total sales and services) growth. Since we do not have financial markets information that would allow us to compute Tobin's Q, we use output growth to proxy for investment opportunities.
Debt and equity issuances (*ISS*)	Sum of debt and equity issuances. For the year 2001 equity issuances are reported as missing. The reason lies in legal changes that took place with the introduction of the Euro (most firms adjusted their equity not necessarily meaning issuing equity).
Non-cash net working capital (*NWK*)	Difference between non-cash current assets and current liabilities.
Variation of interest paid (ΔINT)	Variation of interest paid by firms, which may also reflect a firm-specific rating, scaled by total assets.
Financial investments (*FinI*)	Firms' financial investments, scaled by total assets.

Notes: All variables of interest were winsorized at 1% level in order to avoid problems with outliers in the estimation procedures. Deflators used include the Industrial Production Price Index and Labour Cost Index, both drawn from INE, and the GDP deflator, drawn from the Portuguese Central Bank. Nevertheless, no deflators were used when a variable was constructed as a ratio of two nominal values (normalized). In such cases we assume that the price growth rates are homogeneous.

5. Empirical results

5.1. Summary statistics

Table 2 provides descriptive statistics for the overall sample, as well as for size classes, age classes and dividend payment subsamples—Table 2a reports statistics of variables used in the ICFS Model, while statistics for CCFS Model are in Table 2b. We split the sample into four size classes: firms with 20–50, 51–100, 101–250, and 251 or more employees (small, medium-small, medium-large, and large firms, respectively). The thresholds result from an adjustment of the European Commission firm size classification to the specificity of our dataset.[3] Namely, the threshold 100 employees (in line with OECD standards) allows to distinguish within the 51-250 heterogeneous class the medium-small firms from medium-large ones. Additionally, it also deals with possible representativeness problems due to the fact that in our dataset firms with less than 100 employees are drawn randomly, while it covers the universe of firms with more than 100 employees. With respect to firm age, we create three age classes: younger than 10, 11-40, and over 40 years old (young, mature, and old firms, respectively). The first threshold allows to accommodate the dynamics of entry and exit observed at early years (see Caves, 1998; Carreira and Teixeira, 2011a), thus distinguishing young from mature firms (about this threshold, see also Carreira and Teixeira, 2011b). A possible relative inertia of older firms (Hannan, 2005) or even a change in firm objectives (Coad, 2010), led us to define an upper class of old firms. (However, different specifications were tested in order to provide robust results, available from authors on request.)[4]

An interesting pattern that can be observed in Table 2a is that mean investment decreases with firm age. In other words, older firms tend to invest less than younger firms. A symptom of financial constraints might emerge from the comparison of firm's dividend policy, since firms that pay dividends have, on average, lower cash-flows than firms that do not pay dividends and so, the former are possibly retaining fewer funds

[3] European Commission sets upper thresholds at 10, 50 and 250 employees for micro, small and medium enterprises, respectively.

[4] We should note that there is a problem with size and age sample partition since either we compute the firm mean values and disregard that such firm may move across classes along the time, or we assign the current value which may implicate that the same firm is accounted for the estimation of different classes. We opt for the former.

Table 2. Descriptive statistics

	Overall	Size classes				Age classes			Dividend policy	
Variables		Small	Medium-small	Medium-large	Large	Young	Mature	Old	Nonpayers	Payers
a) ICFS Model variables										
I_{it} / $K_{i(t-1)}$	0.075	0.073	0.074	0.074	0.073	0.094	0.074	0.071	0.081	0.073
	(0.108)	(0.114)	(0.107)	(0.100)	(0.095)	(0.136)	(0.104)	(0.107)	(0.106)	(0.118)
$I_{i(t-1)}$ / $K_{i(t-2)}$	0.087	0.083	0.087	0.088	0.090)	0.105	0.086	0.080	0.099	0.082
	(0.119)	(0.124)	(0.118)	(0.111)	(0.112)	(0.141)	(0.115)	(0.115)	(0.121)	(0.124)
Δy_i	0.041	0.024	0.036	0.037	0.078	0.086	0.036	0.028	0.051	0.041
	(0.280)	(0.297)	(0.260)	(0.258)	(0.259)	(0.374)	(0.274)	(0.231)	(0.258)	(0.309)
$\Delta y_{i(t-1)}$	0.063	0.044	0.062	0.062	0.108)	0.127	0.058	0.044	0.098	0.053
	(0.285)	(0.302)	(0.275)	(0.262)	(0.279)	(0.367)	(0.280)	(0.234)	(0.249)	(0.321)
CF_{it} / $K_{i(t-1)}$	0.095	0.091	0.095	0.095	0.102	0.109	0.095	0.084	0.109	0.072
	(0.094)	(0.096)	(0.089)	(0.090)	(0.095)	(0.116)	(0.089)	(0.093)	(0.078)	(0.122)
$CF_{i(t-1)}$ / $K_{i(t-2)}$	0.102	0.100	0.103	0.103	0.108	0.114	0.103	0.090	0.121	0.072
	(0.093)	(0.094)	(0.089)	(0.090)	(0.097)	(0.112)	(0.090)	(0.091)	(0.076)	(0.121)
Observations	18,359	5,206	4,382	4,831	2,402	1,611	12,830	3,212	7,483	4,562
No. of firms	6,242	2,308	1,726	1,597	751	854	4,481	1,158	3,423	2,399

Table 2 (continued)

Variables	Overall	Size classes				Age classes			Dividend policy	
		Small	Medium-small	Medium-large	Large	Young	Mature	Old	Nonpayers	Payers
b) CCFS Model variables										
ΔCS_{it}	0.003	0.003	0.002	0.002	0.004	0.005	0.002	0.003	0.002	0.003
	(0.062)	(0.068)	(0.059)	(0.057)	(0.062)	(0.074)	(0.061)	(0.056)	(0.062)	(0.062)
CF_{it}	0.085	0.084	0.086	0.084	0.088	0.094	0.085	0.077	0.098	0.070
	(0.089)	(0.089)	(0.088)	(0.088)	(0.091)	(0.106)	(0.084)	(0.089)	(0.071)	(0.104)
Δy_{it}	0.037	0.026	0.036	0.035	0.069	0.071	0.033	0.024	0.054	0.017
	(0.288)	(0.304)	(0.277)	(0.279)	(0.283)	(0.370)	(0.279)	(0.236)	(0.270)	(0.306)
S_{it}	15.539	14.634	15.397	15.933	17.286	15.535	15.493	15.725	15.581	15.489
	(1.448)	(1.119)	(1.036)	(1.151)	(1.578)	(1.789)	(1.338)	(1.532)	(1.377)	(1.526)
I_{it}	0.063	0.0617	0.064	0.064	0.062	0.072	0.062	0.060	0.067	0.058
	(0.081)	(0.085)	(0.082)	(0.079)	(0.075)	(0.094)	(0.078)	(0.081)	(0.082)	(0.080)
ΔNWC_{it}	-0.048	-0.042	-0.047	-0.053	-0.055	-0.054	-0.046	-0.051	-0.043	-0.053
	(0.166)	(0.178)	(0.164)	(0.159)	(0.155)	(0.195)	(0.162)	(0.154)	(0.148)	(0.185)
ISS_{it}	0.035	0.033	0.036	0.032	0.043	0.030	0.037	0.032	0.041	0.027
	(0.209)	(0.214)	(0.206)	(0.209)	(0.203)	(0.246)	(0.205)	(0.193)	(0.192)	(0.228)
ΔINT_{it}	-0.001	-0.001	-0.001	-0.001	-0.000	-0.001	-0.001	-0.001	-0.000	-0.001
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.009)	(0.007)	(0.007)	(0.007)	(0.008)
$FinI_{it}$	0.039	0.026	0.034	0.044	0.071	0.028	0.039	0.050	0.042	0.036
	(0.088)	(0.076)	(0.082)	(0.089)	(0.116)	(0.081)	(0.087)	(0.100)	(0.090)	(0.086)
Observations	17,283	5,688	4,549	4,817	2,229	2,480	11,837	2,966	9,351	7,932
No. of firms	4,771	1,591	1,289	1,292	599	689	3,259	823	2,670	1,864

Notes: Mean values and standard deviations, given in parentheses. Small, medium-small, medium-large and large firms are those with 20–50, 51–100, 101–250 and 251 or more employees, respectively. Young, mature and old firms are those younger than 10, 11-40 and over 40 years old, respectively.

than the latter. Furthermore, smaller firms exhibit lower output growth while younger firms' output growth is larger than older ones. In addition to the patterns previously discerned, younger firms, on average, have larger cash-flows, while both smaller and younger firms have lower financial investments, as expected (Table 2b).

Tables 3 presents the correlations and its significance levels across the variables used in the ICFS and CCFS models—since most of variables do not follow a normal distribution, we compute Spearman's rank correlation coefficients. It is possible to observe that correlations are significant for most variables used in both models. Exceptions are the small and non-significant correlations between cash stock variation and both size (total assets) and variation of interest paid for CCFS Model. Still for the same model, negative correlations between cash stock variation and both investment and non-cash net working capital are as expected as they are demands and not sources of cash. Finally, the correlation between cash-flow and debt and equity issuances is negative possibly indicating that either when there is a shortage in internal funds, firms resort to issuances or, on the contrary, when firms have large cash flows they use them to reduce debt.

5.2. Overall sample estimation

Table 4a reports the estimation results of ICFS Model. For its estimation, we resort to the Arellano-Bond first differences estimator that allows us to eliminate firm specific effects, takes into account heteroskedasticity and autocorrelation, while allowing for the presence of endogenous variables.[5] As a result, suitable instruments have to be devised. We use the twice and further lagged values of the right handside variables in the

[5] We also use Windmeijer's (2005) finite-sample correction for the two-step covariance matrix.

equation (until a maximum of 4 lags), two-digit industry indicators, variation of interest paid, age, size, a dummy for firms that invest in R&D, exports and imports—see Arellano and Bond (1991) for a detailed discussion of the estimator and Roodman (2009) for STATA implementation.[6]

Table 3. Spearman's rank correlation matrices

a) ICFS Model variables

	$I_{it} / K_{i(t-1)}$	$I_{i(t-1)} / K_{i(t-2)}$	Δy_{it}	$\Delta y_{i(t-1)}$	$CF_{it} / K_{i(t-1)}$	$CF_{i(t-1)} / K_{i(t-2)}$
$I_{it} / K_{i(t-1)}$	1.000					
$I_{i(t-1)} / K_{i(t-2)}$	0.476*	1.000				
Δy_{it}	0.156*	0.114*	1.000			
$\Delta y_{i(t-1)}$	0.137*	0.143*	0.154*	1.000		
$CF_{it} / K_{i(t-1)}$	0.323*	0.307*	0.242*	0.194*	1.000	
$CF_{i(t-1)} / K_{i(t-2)}$	0.335*	0.316*	0.068*	0.217*	0.763*	1.000

b) CCFS Model variables

	ΔCS_{it}	CF_{it}	Δy_{it}	S_{it}	I_{it}	ΔNWC_{it}	ISS_{it}	ΔINT_{it}
ΔCS_{it}	1.000							
CF_{it}	0.083*	1.000						
Δy_{it}	0.118*	0.239*	1.000					
S_{it}	-0.002	-0.055*	0.039*	1.000				
I_{it}	-0.028*	0.320*	0.159*	-0.019	1.000			
ΔNWC_{it}	-0.253*	0.005	0.025*	0.052*	-0.283*	1.000		
ISS_{it}	0.111*	-0.144*	0.174*	0.044*	0.204*	0.036*	1.000	
ΔINT_{it}	-0.009	-0.075*	0.125*	0.016*	0.087*	-0.014	0.213*	1.000
$FinI_{it}$	0.022*	-0.074*	-0.036*	0.405*	-0.041*	-0.003	0.007	-0.002

Notes: Spearman's rank correlation coefficients with Sidak-adjusted significance level. * denotes statistical significance at the .01 level.

[6] Some instruments may vary or be dropped, depending on the classification scheme used.

Table 4. ICFS and CCFS Models estimations

Variables	Overall	Size classes: Small	Size classes: Medium-small	Size classes: Medium-large	Size classes: Large	Age classes: Young	Age classes: Mature	Age classes: Old	Dividend policy: Nonpayers	Dividend policy: Payers
a) ICFS Model										
$I_{i(t-1)} / K_{i(t-2)}$	0.139***	0.124***	0.133***	0.090***	0.076***	0.129*	0.122***	0.045	0.165***	0.148***
	(0.015)	(0.032)	(0.029)	(0.026)	(0.034)	(0.077)	(0.021)	(0.040)	(0.029)	(0.028)
Δy_i	0.063**	-0.012	-0.010	0.038	0.025	0.086**	0.038	0.064	0.062	-0.035
	(0.027)	(0.021)	(0.024)	(0.025)	(0.032)	(0.044)	(0.028)	(0.047)	(0.057)	(0.073)
$\Delta y_{i(t-1)}$	-0.001	0.003	-0.007	0.0038	0.010	0.002	-0.003	-0.005	-0.005	0.016
	(0.004)	(0.007)	(0.007)	(0.007)	(0.010)	(0.018)	(0.005)	(0.011)	(0.009)	(1.434)
$CF_{it} / K_{i(t-1)}$	0.320**	0.317*	0.043	-0.128	0.103	0.158	0.205	0.421**	0.971***	0.153
	(0.134)	(0.191)	(0.144)	(0.171)	(0.177)	(0.211)	(0.178)	(0.185)	(0.478)	(0.207)
$CF_{i(t-1)} / K_{i(t-2)}$	0.081	-0.010	0.035	0.196**	0.010	-0.089	0.009	0.168	-0.171	0.000
	(0.054)	(0.073)	(0.067)	(0.088)	(0.113)	(0.159)	(0.067)	(0.105)	(0.106)	(0.001)
Observations	18,359	5,206	4,382	4,831	2,402	1,612	13,373	3,374	7,483	4,562
No. of firms	6,242	2,308	1,726	1,597	751	854	4,652	1,220	3,423	2,399
AR(2) p-value	0.998	0.114	0.426	0.664	0.737	0.770	0.726	0.448	0.752	0.089
Hansen chi2 p-value	0.395	0.028	0.934	0.013	0.908	0.050	0.067	0.268	0.725	0.351
Wald Chi2	309.7	26.67	132.9	71.55	99.62	46.02	375.8	34.53	161.5	47.74

Table 4 (continued)

Variables	Overall	Size classes				Age classes			Dividend policy	
		Small	Medium-small	Medium-large	Large	Young	Mature	Old	Nonpayers	Payers
b) CCFS Model										
CF_{it}	0.184***	0.283***	0.167***	0.121***	0.122**	0.198***	0.194***	0.121***	0.225***	0.128***
	(0.017)	(0.035)	(0.035)	(0.027)	(0.036)	(0.048)	(0.020)	(0.041)	(0.028)	(0.025)
Δy_{it}	0.015***	0.013**	0.015***	0.019***	0.002	0.018**	0.011***	0.028***	0.012***	0.015***
	(0.003)	(0.005)	(0.006)	(0.005)	(0.007)	(0.008)	(0.003)	(0.008)	(0.004)	(0.006)
S_{it}	0.015***	0.017**	0.016**	0.012**	0.011	0.013	0.0165***	0.007	0.012**	0.005
	(0.004)	(0.009)	(0.008)	(0.006)	(0.008)	(0.011)	(0.005)	(0.009)	(0.005)	(0.007)
I_{it}	-0.219***	-0.259***	-0.205***	-0.183***	-0.214***	-0.213***	-0.236***	-0.149***	-0.300***	-0.167***
	(0.012)	(0.023)	(0.023)	(0.019)	(0.032)	(0.031)	(0.014)	(0.025)	(0.018)	(0.021)
ΔNWC_{it}	-0.149***	-0.171***	-0.125***	-0.134***	-0.162***	-0.139***	-0.159***	-0.109***	-0.195***	-0.098***
	(0.006)	(0.011)	(0.012)	(0.011)	(0.017)	(0.015)	(0.008)	(0.015)	(0.010)	(0.010)
ISS_{it}	0.079***	0.107***	0.069***	0.061***	0.069***	0.062***	0.085***	0.071***	0.114***	0.053***
	(0.004)	(0.008)	(0.009)	(0.007)	(0.010)	(0.011)	(0.005)	(0.009)	(0.007)	(0.007)
ΔINT_{it}	-0.210***	-0.373**	0.146	-0.210	-0.412	-0.3953	-0.210*	-0.047	-0.138	-0.146
	(0.094)	(0.161)	(0.182)	(0.167)	(0.285)	(0.271)	(0.111)	(0.215)	(0.142)	(0.166)
$FinI_{it}$	-0.129	-0.269	-0.107	-0.105	-0.110***	-0.074	-0.143***	-0.104***	-0.128***	-0.129***
	(0.018)	(0.050)	-(0.047)	(0.026)	(0.028)	(0.046)	(0.021)	(0.039)	(0.025)	(0.037)
Observations	15,277	4,586	4,051	4,531	2,109	2,047	10,609	2,621	7,180	4,774
No. of firms	4,771	1,591	1,289	1,292	599	689	3,259	823	2,670	1,864
Hansen chi2 p-value	0.435	0.158	0.246	0.404	0.138	0.663	0.372	0.266	0.145	0.872
R-squared	0.176	0.253	0.154	0.158	0.185	0.175	0.203	0.141	0.251	0.129

Notes: Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively. Further test statistics available from the authors on request. Year dummies are included in all regressions. Small, medium-small, medium-large and large firms are those with 20–50, 51–100, 101–250 and 251 or more employees, respectively. Young, mature and old firms are those younger than 10, 11-40 and over 40 years old, respectively.

As can be seen in first column of Table 4a, the regression of ICFS Model reports a high sensitivity of investment to cash flow (0.320), significant at the 5% level. This means that Portuguese firms, on average, increase their investment in 32 cents for each euro of extra cash flow, illustrative of the financial distress faced by such firms—one would expect that firms operating in Portugal would face severe financial constraints due to the relative underdevelopment of Portuguese financial markets. We test for the overall significance of the regression obtaining a highly significant Wald test statistic (309.7). For the purpose of comparison, just as mere examples since such estimates result from different sample types—e.g. quoted or non-quoted firms, firms with more than 100 or 250 employees, *inter alia*—and different economic realities, Harhoff (1998) for Germany obtains a 0.314 estimate on ICFS, while Bond et al. (2003) find ICFS of -0.055, -0.033, 0.180 and 0.520 for Belgium, France, Germany and UK, respectively.

Estimation results of CCFS Model are presented in Table 4b. The financial and investment covariates are endogenous, so there is a need to estimate this model using instrumental variables (GMM) again along with fixed effects to take account of unobserved firm-level heterogeneity and panel-robust standard errors. The set of instruments includes twice lagged cash flow, twice lagged sales growth, lagged investment, lagged variation of noncash net working capital, two-digit industry indicators (for overall samples), size (measured as number of employees), lagged bond issuance, lagged variation in interest payments, and lagged financial investments.

As expected, the regression of CCFS Model reports positive and significant sensitivities of cash to cash-flow confirming that, in general, Portuguese firms face financial constraints. Coefficients reported on cash flow are significantly different from zero at the 1% level for the overall sample (Table 4b, column 1). The reported R-squared (0.184) is within the usual in these models. The estimated CCFS is 0.184, meaning that Portuguese firms, on average, save 18 cents out of each euro of extra cash flow, which is symptomatic of the presence of financial constraints. As an example of benchmark CCFS values, for a sample of COMPUSTAT manufacturing firms and based on size as a-priori classification, Almeida et al. (2004) find CCFS estimates of 0.384 for constrained firms and 0.036 for unconstrained ones. With respect to firm age, Lin (2007), for Taiwan, finds that coefficients vary from 0.197 to 0.409 for constrained firms and from -0.104 to -0.026 for unconstrained ones, depending on the regression technique.

5.3. Firms' size and financial constraints

Both models used to measure financial constraints provide evidence that there is an inverse relationship between firm size and financial constraints. With respect to ICFS analysis, as can be seen in columns 2-5 of Table 4a, those seem to affect only the small-firms that invest 32 cents out of an extra euro of cash flow (significant at the 10% level). On the other hand, the estimates on ICFS for medium- and large-firms are not statistically different from zero, indicating that such firms do not suffer from financial distress. As to CCFS analysis (see columns 2-5 of Table 4b), besides reporting a descending trend, coefficients on cash-flow for all size classes are significant at the 1% level. This indicates that we might be in presence of a negative relationship between size and financial constraints. Given that there is a potential bias caused by the correlation between size classes (by employees) and the covariate S (log total assets), we tested an alternative regression excluding this variable, but the interpretation of results remains unchanged.

In order to test the robustness of our findings, we re-estimated both models, but this time including an interaction term of cash-flow and size variable. Even though we cannot interpret the magnitude of the estimates, their sign provides useful information. As we can see in Tables 5 (column 1), while it is not totally clear that financial constraints are lower for larger firms using ICFS—the interaction term is negative, but not statistically different from zero—, the result is quite straightforward using CCFS—larger firms have significantly lower financial constraints.

Finally, to test the nonlinearity hypothesis, Table 6 reports the estimation results of interactions of cash-flow with size class dummies (only CCFS Model; other regressions available from the authors on request). In that case, we do not find the expected inverse relationship between size and constraints, since the estimated interaction coefficients decrease until medium-large class and then increases for large firms. This suggests that a non-monotonic (U-shaped) relationship between firm size and financial constraints might be present.

We further investigate this relationship by testing the inclusion of size and its quadratic term with cash-flow (Table 7). The size estimates seem to confirm the presence of an U-shaped relationship to financial constraints. Hence, these results cast some doubts on previously devised monotonic relationships between firm size and financial constraints.

Table 5. *ICFS and CCFS Models estimations with size and age interactions*

Variables	Size	Age	Size * Age
a) ICFS Model			
$I_{i(t-1)} / K_{i(t-2)}$	0.1278*** (0.019)	0.1073*** (0.021)	0.1343*** (0.017)
Δy_i	0.0813** (0.037)	0.0710** (0.030)	0.0565* (0.032)
$\Delta y_{i(t-1)}$	-0.0074 (0.008)	-0.0080 (0.006)	-0.0045 (0.006)
$CF_{it} / K_{i(t-1)}$	1.3840 (1.147)	-0.5133 (0.811)	0.9846 (2.057)
$CF_{i(t-1)} / K_{i(t-2)}$	0.0342 (0.066)	0.0301 (0.076)	0.0522 (0.080)
Size	-0.2287 (0.244)		0.0171 (0.044)
Age		-0.3184* (0.174)	-0.1763 (0.166)
$[CF_{it} / K_{i(t-1)}]$ * *Size (or Age or both)*	-0.0974 (0.108)	0.2772 (0.274)	-0.0815 (0.270)
Observations	18,359	17,982	17,982
No. of firms	6,242	6,031	6,031
AR(2) p-value	0.657	0.549	0.928
Hansen chi2 p-value	0.527	0.560	0.403
Wald Chi2	289.9	457.2	304.0
b) CCFS Model			
CF_{it}	0.3708*** (0.079)	0.2373*** (0.085)	0.4280*** (0.110)
Size	-0.0186*** (0.004)		-0.0179*** (0.004)
Age		-0.0187 (0.013)	-0.0076 (0.012)
CF_{it}* *Size (or Age or both)*	-0.0407** (0.016)	-0.0159 (0.027)	-0.0313** (0.014)
Δy_{it}	0.0149*** (0.003)	0.0141*** (0.003)	0.0142*** (0.003)
S_{it}	0.0204*** (0.004)	0.0158*** (0.004)	0.0209*** (0.004)
I_{it}	-0.2206*** (0.012)	-0.2168*** (0.012)	-0.2178*** (0.012)
ΔNWC_{it}	-0.1500*** (0.006)	-0.1499*** (0.006)	-0.1508*** (0.006)
ISS_{it}	0.0779*** (0.004)	0.0782*** (0.004)	0.0770*** (0.004)
ΔINT_{it}	-0.2080** (0.094)	-0.1824* (0.095)	-0.1762* (0.096)
$FinI_{it}$	-0.1419*** (0.018)	-0.1222*** (0.017)	-0.1337*** (0.017)
Observations	15,277	15,008	15,008
Number of firms	4,771	4,661	4,661
Hansen chi2 p-value	0.377	0.378	0.449
R-squared	0.188	0.185	0.188

Notes: Robust standard errors are in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively. Size and Age are in logarithms. Year dummies are included in all regressions.

Table 6. *CCFS Model with size and age classes interactions*

Variables		Size	Age
$CF_{it} * \overline{SIZE_i}$:	Small firms	0.230*** (0.030)	
	Medium-small firms	0.163*** (0.028)	
	Medium-large firms	0.114*** (0.023)	
	Large firms	0.132*** (0.030)	
$CF_{it} * \overline{AGE_i}$:	Young firms		0.179*** (0.038)
	Mature firms		0.169*** (0.019)
	Old firms		0.125*** (0.034)
Δy_{it}		0.015*** (0.003)	0.015*** (0.003)
I_{it}		-0.201*** (0.012)	-0.201*** (0.012)
ΔNWC_{it}		-0.123*** (0.006)	-0.122*** (0.006)
ISS_{it}		0.086*** (0.006)	0.086*** (0.006)
ΔINT_{it}		-0.091 (0.103)	-0.097 (0.104)
$FinI_{it}$		-0.118*** (0.018)	-0.116*** (0.018)
Observations		13,874	13,874
Number of firms		4,322	4,322
Hansen chi2 p-value		0.473	0.364
R-squared		0.158	0.156

Notes: Small, medium-small, medium-large and large firms (20–50, 51–100, 101–250 and 251 or more employees, respectively) and young, mature and old firms (10, 11-40 and over 40 years old, respectively) are classes dummies. Year dummies are included in all regressions. Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively. Further test statistics available from the authors on request.

Table 7. *CCFS Model with both size and age interactions*

Variables	Coefficients
CF_{it}	0.157*** (0.047)
$Size_{it}$	-0.000** (0.000)
CF_{it} * $Size_{it}$	-0.000* (0.000)
CF_{it} * $Size_{it}^2$	0.000*** (0.000)
Age_{it}	0.000 (0.002)
CF_{it} * Age_{it}	0.003 (0.002)
CF_{it} * Age_{it}^2	-0.000 (0.000)
Δy_{it}	0.015*** (0.003)
I_{it}	-0.196*** (0.012)
ΔNWC_{it}	-0.122*** (0.006)
ISS_{it}	0.084*** (0.006)
ΔINT_{it}	-0.061 (0.105)
$FinI_{it}$	-0.116*** (0.018)
Observations	13,724
Number of firms	4,255
Hansen chi2 p-value	0.882
R-squared	0.157

Notes: Year dummies are also included. Robust standard errors in parentheses. ***, **, and * denote statistical significance at the .01, .05, and .10 levels, respectively. Further test statistics are available from the authors on request.

5.4. Firms' age and financial constraints

With respect to age, we do not find a clear pattern that links age to financial constraints. Whilst the estimates on ICFS by age class renders us a puzzle, since we would not expect higher sensitivities for older firms, as we can see in Table 4a (columns 6-8). Additionally, old-firms' investment seems not to react neither to investment opportunities, nor to previous investment, which adds to the argument that possibly these firms are either "inert" or have different objectives. On the other hand, the results of CCFS Model suggest an inverse relationship between age and constraints (Table 4b, columns 6-8). While for the old-firms, cash-flow appears to have a smaller effect on cash stocks (estimated coefficient is 0.121), the opposite is true for young- and mature-firms, that save 20 and 19 cents out of every euro of extra cash-flow, respectively.

Introducing interaction terms reveals that neither interaction coefficient seems to be statistically significant at conventional levels (Table 5a and b, column 2). Nevertheless, we should point that while using ICFS Model the coefficient is positive, in contrast with the negative sign of the corresponding CCFS interaction term. Conversely, this finding is reversed when we consider the interaction of cash-flow with age class dummies (Table 6). In fact, we find that the estimated interaction coefficients are lower and statistically significant for older firms—that is, an inverse relationship between firm age and financial constraints. However, when we test the interaction of age and its quadratic term with cash-flow, we observe that the two interaction terms are not statistically different from zero (Table 7).

Finally, we also test whether firms that are both small and young (large and old) face higher (lower) financial constraints using another interaction term of cash flow with both Size and Age (column 3). While for the ICFS Model, there is no straightforward conclusion due to an insignificant interaction coefficient, the CCFS estimates clearly denote higher constraints for smaller and younger firms.

5.5. Dividend payment and financial constraints

Dividend policy was the main classification scheme, primarily used to distinguish financially constrained from unconstrained firms. Both estimations confirm that dividend policy may be used to sort firms into financially constrained and unconstrained (Tables 4a and b). First, for ICFS Model, the pattern is clear since nonpayers appear to invest 97 cents out of every 1 euro of extra cash-flow, while the same estimate for firms that pay dividends is not statistically significant. Second, CCFS are higher for firms that pay no dividends (0.225 against 0.128), both statistically significant and different at the 1% level. However, the differences in ICFS are remarkably large, possibly indicating that financial constraints measured through the former might be overestimated. It may be possible to argue that using ICFS might drive researchers to report firms as financially constrained more often, or at a larger degree than it should be expected.

6. Concluding remarks

In this study we test if firm's size and age, and dividend payment can work as good proxies of financial constraints faced by firms. The motivation is that, these proxies have been used by several authors to sort and distinguish firms according to a level of financial distress. To accomplish the empirical test, we split our sample of Portuguese firms according to the three proxies and then we estimate the investment-cash flow sensitivities and the cash-cash flow sensitivities by such group of firms.

Our results, while supporting previous literature on the inverse relationship between size, dividend policy and financial constraints, they cast some doubts on previously devised relationships between age and the level of constraints. Furthermore, some patters rose from the data indicating a potential U-shaped relationship between size and financial constraints faced by firms.

These results have important implications. Firstly, when it comes to empirical research that relies on (either one or both) size and age as proxies of financial constraints, our findings put into perspective widely accepted results on financial constraints and firm's size and age. Secondly, the design of policy actions should be discriminative and specially devised for smaller firms.

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