Competition, Cash Holdings, and Financing Decisions*

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Abstract

We use a dynamic model of cash management in which firms face competitive pressure to show that competition increases corporate cash holdings as well as the frequency and size of equity issues. In our model, these effects are driven by small, financially constrained firms, in contrast with the theories based on strategic interactions in which large leaders or incumbents value more cash. We test these predictions on Compustat firms for the period 1980-2007 and show that product market competition has first order effects on the cash holdings and financing decisions of constrained firms, in ways consistent with our theory.

Keywords: product market competition; cash holdings; financing decisions.

JEL Classification Numbers: G32, G35.

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1 Introduction

In perfect capital markets, firms can instantly raise funds at no cost and there is no role for internal capital. In the presence of capital market frictions, such as costs of raising funds or capital supply uncertainty, survival or investment may depend on a firm's cash holdings. That is, when other sources of funds are costly, limited, or unavailable, firms can use their cash holdings to fund capital expenditures or cover unexpected operating losses to avoid inefficient closure. Consistent with this view, several studies report that firms facing greater difficulties in obtaining external capital accumulate more cash and/or save a greater fraction of their cash flow as cash (see e.g. Opler, Pinkowitz, Stulz, and Williamson, OPSW 1999, or Almeida, Campello, and Weisbach, 2004).

Despite the substantial development of the literature on corporate cash holdings, little attention has been paid so far to the effects of product market competition on the decision to retain earnings or on the decision to issue securities for the purpose of cash savings. Yet, since a monopolist is less likely to face financial difficulties than a firm facing cutthroat competition, economic intuition suggests that product market competition should be a prime determinant of these decisions. The purpose of this paper is therefore twofold. First, we seek to understand when and how product market competition affects corporate cash holdings. Second, we are interested in determining its effects on the decision to issue equity for cash savings. To this end, we build a model in which firms face competitive pressure and optimize their cash holdings as well as the size and frequency of their equity issues. We then examine whether the predictions of the model are supported by the data on firms' cash management and financing decisions.

To develop our predictions on the relation between competition and cash holdings and financing decisions, we start by formulating a model in which a firm operates a set of assets that generate stochastic cash flows. In the model, the firm faces financing constraints, in that raising outside funds to cover potential losses and avoid inefficient closure is costly. The profitability of assets in place depends on the intensity of product market competition and, hence, so does the risk that the firm will have to raise costly external finance. Using this model, we show that the value of cash holdings increases with the intensity of product market competition, so that firms should hold larger cash balances and make larger equity issues when operating in more competitive industries. We also demonstrate that product market competition has no bearings on cash holdings or the size of equity issues in the absence of financing constraints. Lastly, we show that even though product market competition increases target cash holdings and the size of equity issues – which suggests that it should have a negative effect on the frequency of equity issues – it also increases the frequency at which firms raise outside equity by eroding firm profitability.

To test these predictions, we form a large sample of Compustat firms for the period 1980-2007. Our sample consists of 78,080 firm-year observations, in which industries are defined using their 4-digit SIC code. For this sample, we estimate a series of cross-sectional regressions relating cash holdings and the funds received from stock issues to different measures of product market competition. In a first step of our analysis, we estimate our empirical model on the full sample. In a second step, we re-estimate our empirical specification on two subsamples comprising either financially constrained firms or unconstrained firms. This allows us to assess the effects of financing constraints on the relation between competition and cash holdings and financing decisions. To address potential endogeneity concerns, we also estimate a series of IV regressions in which we use import penetration as a measure of competition and instrument industry measures of import penetration with import tariff rates and foreign exchange rates. Lastly, to test our hypothesis on the relation between competition and the frequency of equity issues, we estimate a mixed proportional hazard model relating product market competition to a firm's equity issuance hazard.

Our estimations reveal that cash holdings and equity issues are related to product market competition in ways consistent with our theory. Notably, cash holdings are positively associated with the intensity of product market competition as measured by the price-to-cost margin of the firm (EPCM), the text based Herfindahl-Hirschman Index (HHI TNIC), or the product market fluidity measure developed by Hoberg, Phillips, and Prabhala (2012). The magnitude of the effect is substantial and larger than that of firm characteristics, such as cash flow volatility, that have long been recognized as prime determinants of cash management decisions. In addition, these results hold after controlling for a host of variables. Also consistent with the model's predictions, we find that the association between competition and cash holdings is stronger for firms facing greater financing constraints and that unconstrained firms' cash holdings are not systematically related to product market competition. Lastly, the IV approach confirms our result that more competition results in higher cash holdings.

Turning to equity issues, our estimations reveal that a stronger competition results in larger equity inflows. Here again, this result holds after controlling for a host of variables, is stronger among firms facing tighter financing constraints, and is confirmed by the IV approach. Because firms raise more funds when product market competition is stronger, we could expect them to access capital markets less often. Yet, consistent with our model's prediction, we find that by eroding profitability competition increases the frequency of equity issues. Notably, a one standard deviation decrease in the EPCM measure results in an increase of the equity issuance hazard rate by 5.7%. If we measure competition by HHI TNIC or fluidity, a one standard deviation increase in competition results in an increase of the equity issuance hazard rate by 3.7% or 14.5%.

Our paper relates to the literature examining the relation between strategic interactions and firms' cash holdings and financing decisions. Most of the literature has either tried to examine the effects of financial policies on predatory behavior (see e.g. Bolton and Scharfstein, 1990, Chevalier, 1995, Kovenock and Phillips, 1997, or Campello, 2003) or on potential entry by competitors (see Benoit, 1984, or Ma, Mello, and Wu, 2013). The paper that is most closely related to ours in this literature is Frésard (2010) (see also the recent papers by Frésard and Valta, 2013, and Lyandres and Palazzo, 2013). In his empirical study, Frésard shows that larger relative-to-rivals cash reserves lead to systematic future market share gains at the expense of industry rivals and that cash rich firms may induce losses for financially weak firms and drive them out of the market, thereby reducing competition. Thus, his empirical study suggests that cash policy comprises a substantial product market dimension and that there may be a negative relation between the dispersion of cash holdings within an industry and the intensity of product market competition.

Our paper complements the literature based on strategic interactions by showing that there exists also an opposite, feedback effect of product market competition on the level of cash holdings within an industry. Notably, our theoretical analysis demonstrates that by reducing profitability, competition leads firms to hold more cash and to increase the frequency and the size of their equity issues. Our empirical analysis shows that these predictions are borne in the data and that the magnitude of the effects is substantial. Importantly, theories in which cash holdings are motivated by purely strategic considerations predict that large firms have greater incentives to hold cash and value more cash. Indeed in these models, the value of cash typically arises due to a predatory motive or an entry preemption motive and the firm engaging in predation or preemption is generally the large or unconstrained incumbent. By contrast, our theory predicts that smaller and more constrained firms facing competitive pressure value more cash. We find that this prediction – that is unique to our model – is supported by the data.

Our paper also contributes to the line of research that uses dynamic models to examine the relation between product market competition and financing decisions. Several papers examine the effects of competition on debt financing in oligopolies (see for example Lambrecht, 2001, Morellec and Zhdanov, 2008, or Chu, 2012) or in perfectly competitive industries (see Miao, 2005). However, to the best of our knowledge, there is no paper in this literature that examines the relation between competition and firms' financing *and* cash holdings decisions.

Lastly, our paper relates to the growing literature that uses dynamic models to examine the determinants of corporate cash holdings (see for example Bolton, Chen, and Wang, 2011, Décamps, Mariotti, Rochet, and Villeneuve, 2011, Boileau and Moyen, 2012, Hugonnier, Malamud, and Morellec, 2014, Eisfeldt and Muir, 2014, or Falato, Kadhyrzanova, and Sim, 2013). The paper that is most closely related to ours in this literature is Della Seta (2013). Della Seta examines the relation between cash holdings and competition, assuming that firms cannot raise outside funds. By contrast, firms in our model can raise outside funds, thereby allowing an analysis of the relation between competition and financing decisions. In addition, Della Seta is a purely theoretical study whereas our main focus is on the empirical relation between product market competition and corporate decisions.

The paper is organized as follows. Section two describes the model and derives our testable hypotheses. Section three describes the data. Section four presents our empirical results. Section five concludes. All the proofs are gathered in the Appendix.

2 Model

2.1 Assumptions

Throughout the model, agents are risk-neutral and discount cash flows at a constant rate ρ. We consider a set of $i = 1, ..., n$ firms contemplating entry in an oligopolistic market. Firms are ex-ante identical, and can produce a single consumption good with their capital stock k_i. Each unit of installed capital can produce one unit of output at a cost $\Gamma(q_i) = \gamma q_i$, where $\gamma > 0$ is the constant marginal cost of production. The produced good is non-storable so that output equals demand. All the output is sold at a single price, determined by the demand for the good and the total industry output, denoted by $Q = \Sigma_i^n q_i$. The inverse demand function of the industry is given by $P(Q) = \alpha - Q$, where $\alpha > 0$ is a constant representing the maximum market clearing price (see Tirole, 1988 chapter 3, or Osborne, 2004 chapter 3). We assume that $\gamma < \alpha$, to rule out cases in which the marginal cost of production is always higher than the output price.

Each firm entering the industry chooses its output q_i to maximize shareholder value, given the output choice of its competitors. Firm i therefore installs the physical capital $k_i = q_i$ upon entry. (We examine the entry decision below.) Since all firms face the same costs and demand function, we focus on a symmetric equilibrium in which firms initially choose the same output level and commit to this level thereafter. Accordingly, we omit the subscript i below.[1] The operating cash flow of the firm at any time $t > 0$ increases with the market clearing price $P(Q)$, decreases with the marginal cost of production γ, and is given by

$$d\Pi_t = (P(Q) - \gamma)\, q dt + \sigma dW_t$$

where σ is a positive constant and $(W_t)_{t\geq 0}$ is a Brownian motion representing stochastic shocks to cash flows. As in DeMarzo and Sannikov (2006) or DeMarzo, Fishman, He, and Wang (2012), this specification implies that management controls the mean but not

[1] As firms do not adjust physical capital after entry, we focus on the open-loop Nash equilibrium of our repeated Cournot game. In our model, initial investment in capital acts as a commitment device. Indeed, because of the capacity constraint $k^\star$, firms cannot deviate and increase their output. It is not optimal either to deviate and decrease output below $q^\star$, as this would increase the equilibrium price to the benefit of the other firms in the industry. Therefore, any deviation from the maximum output $q^\star$ is suboptimal and the solution simplifies to the static Cournot game played at time zero, in which firms initially decide on the equilibrium level of capital and output (see Fershtman and Kamien, 1987).

the volatility of the cash flow process Π.

Because of the Brownian shock W, the firm is exposed to potential operating losses that can be covered either using cash reserves or by issuing new equity.[2] Specifically, we allow management to retain earnings inside the firm and denote by C_t the firm's cash holdings at any time $t > 0$. We assume that there is a cost of holding cash by considering that cash reserves earn a constant interest rate $r < \rho$ inside the firm. The difference between ρ and r is a carry cost of liquidity.

We also allow the firm to increase its cash holdings or cover operating losses by raising funds in the capital markets. We consider that when raising outside funds, the firm has to pay a proportional cost p and a fixed cost f (see e.g. Altinkilic and Hansen, 2000, or Kim, Palia, and Saunders, 2008, for evidence on issuance costs). Our specification implies that when raising the amount $(1+p)\xi + f$, the firm gets ξ. The net proceeds of an issuance are then stored in the cash reserve, whose dynamics evolve as

$$dC_t = rC_t dt + (P(Q) - \gamma)\, q dt + \sigma dW_t - dD_t + dG_t - d\Phi_t, \quad C_t \geq 0, \tag{1}$$

where dD_t represents the payouts to shareholders over the time interval $[t, t+dt]$, dG_t represents the financing raised and $d\Phi_t$ represents issuance costs. Equation (1) shows that cash reserves grow with earnings, with outside financing, and with the interest earned on cash holdings and decrease with payouts to shareholders and issuance costs.

The firm can choose to abandon its assets at any time by distributing all of its cash. Alternatively, it can be liquidated if its cash buffer reaches zero following a series of negative shocks. We consider that the liquidation value of assets is given by $\theta k^\star + C_\tau$, where $1 - \theta \in [0, 1]$ represents a liquidation cost and τ is the time of liquidation.

[2]The model can easily be extended to incorporate credit lines. Credit lines would allow the firm to carry negative cash balances and would change the point at which firms issue equity. However, they would have no qualitative effect on our predictions on the relation between product market competition and firms' cash holdings and financing decisions.

In the model, management acts in the best interest of shareholders and, conditional on entering the industry, chooses the firm's production (q), payout (D), financing (G), and liquidation (τ) policies to maximize the present value of future dividends to incumbent shareholders. That is, management solves:

$$\max_{(D,G,q,\tau)} \mathbb{E}_c \left[\int_0^\tau e^{-\rho t} \left(dD_t - dG_t \right) + e^{-\rho\tau} (\theta k^\star + C_\tau) \right].$$

The first term in this expression represents the present value of payments to incumbent shareholders until the liquidation time τ, net of the claim of new investors on future cash flows. The second term represents the firm's discounted liquidation value.

2.2 *Solving management's optimization problem*

We solve the model using backward induction, i.e. starting with the value of a generic firm in the industry, that we denote by $V(c)$. We then use this value to derive the condition under which entry is optimal.

To derive the value of an active firm, we start by assuming that issuance costs are sufficiently low to guarantee that the condition

$$\max_{\xi \geq 0} \left\{ V(\xi) - (1+p)\xi - f \right\} > \theta k^\star, \tag{2}$$

holds. Later in the analysis, we verify that this condition is always satisfied when firms find it optimal to enter the industry. Under this condition, raising outside financing is better than liquidating operations, because the continuation value net of the issuance costs (the left hand side) is higher than firm value in liquidation (the right hand side). In this case, the firm is infinitely lived and we have $\tau = \infty$. When this condition is not satisfied, firms never raise funds and are liquidated as soon as $c = 0$.

When condition (2) is satisfied, management only needs to select the production, payout, and financing policies that maximize the value of shareholders' claim. Since raising funds is costly and the only benefit of raising funds is to avoid liquidation, management postpones equity issuances until cash reserves are exhausted (i.e. until $c = 0$), as in Décamps, Mariotti, Rochet, and Villeneuve (2011). In addition, because the marginal cost of cash holdings is constant and their marginal benefit is decreasing, we conjecture that there exists some level $C^\star$ for the cash buffer where the marginal cost and benefit of cash holdings are equalized and it is optimal to start paying dividends. Below $C^\star$, the optimal policy is to build up cash reserves by retaining earnings and to raise outside funds when $c = 0$.

To solve for firm value, consider first the region $(0, C^\star)$ over which it is optimal to retain earnings. In this region, firm value satisfies:

$$\rho V(c) = \max_{q \geq 0} \left\{ V'(c) \left[rc + (P(Q) - \gamma) q \right] + \frac{\sigma^2}{2} V''(c) \right\}. \tag{3}$$

The left-hand side of this equation represents the required rate of return for investing in the firm. The right-hand side is the expected change in firm value in the region where the firm retains earnings. The first term captures the effects of cash savings on firm value while the second one captures the effects of cash flow volatility.

The choice of production size q is made ex ante by management to maximize firm value. The first order condition yields:

$$q^\star = \frac{\alpha - \gamma}{n+1},$$

that is the static symmetric Nash solution when firms compete à la Cournot. Thus, each firm installs $k^\star = q^\star$ units of capital at time zero and total output in equilibrium is $Q = K = \frac{n}{n+1}(\alpha - \gamma) < \alpha - \gamma$. This in turn guarantees a market clearing price given by

$$P(Q) = \frac{\alpha + n\gamma}{n+1} = \gamma + \frac{\alpha - \gamma}{n+1},$$

and implies that the firm's expected profit on any time interval $[t, t + dt]$ satisfies:

$$q^\star (P(Q) - \gamma)\, dt = k^\star \frac{\alpha - \gamma}{n+1} dt.$$

Plugging the expression for the expected profit of the firm in equation (3), we finally get that firm value solves in the retention region $(0, C^\star)$:

$$\rho\, V(c) = \left[rc + k^\star \frac{\alpha - \gamma}{n+1}\right] V'(c) + \frac{\sigma^2}{2} V''(c).$$

As long as the marginal value of cash is greater than one, it is optimal to retain earnings. As cash reserves increase, the likelihood of costly equity financing decreases. As a result, the marginal value of cash decreases until it reaches one and it is optimal to start paying dividends. We then have the following boundary condition:

$$\lim_{c \uparrow C^\star} V'(c) = 1, \tag{4}$$

where the value-maximizing dividend threshold $C^\star$ satisfies the high-contact condition

$$\lim_{c \uparrow C^\star} V''(c) = 0. \tag{5}$$

If the firm has too much cash (i.e if $c > C^\star$), it is optimal to distribute all cash holdings above C^* with a specially designated dividend or a share repurchase and we have:

$$V(c) = V(C^\star) + c - C^\star.$$

Lastly, under condition (2), the firm raises equity every time its cash buffer is depleted in order to avoid liquidation. Accordingly, the value-matching condition at zero is

$$V(0) = V(\xi^\star) - (1+p)\xi^\star - f, \tag{6}$$

implying that the value of the shareholders' claim when raising outside financing is equal to the continuation value less issuance costs. The value-maximizing amount of outside financing $\xi^\star$ is then determined by the first order condition:

$$V'(\xi^\star) = 1 + p, \tag{7}$$

which ensures that the marginal cost of outside funds is equal to the marginal benefits of cash holdings at the post-issuance level of cash reserves.

Solving management's optimization problem yields the following Proposition.

Proposition 1 *The value $V(c)$ of the financially constrained firm is given by*

$$V(c) = \begin{cases} \frac{F''(C^\star)G(c) - G''(C^\star)F(c)}{2\sqrt{r}\rho}\sigma^3 e^{(rC^\star + \pi^\star(n))^2/(r\sigma^2)} & \text{if } 0 \leq c < C^\star \\ c - C^\star + V(C^\star) & \text{if } c \geq C^\star \end{cases}$$

where $C^\star$ is the unique solution to equation (5), $\pi^\star(n) \equiv \left(\frac{\alpha-\gamma}{n+1}\right)^2$, the functions F and G are defined in the Appendix, and firm value at the dividend threshold $C^\star$ satisfies

$$V(C^\star) = \frac{1}{\rho}\left\{rC^\star + k^\star \frac{\alpha - \gamma}{n+1}\right\}.$$

In equilibrium, firm size is given by

$$k^\star = \frac{\alpha - \gamma}{n+1},$$

and the size of new issues $\xi^\star$ is the unique solution to equation (7).

Having derived the value of an active firm, we are now interested in determining when entry is optimal. Suppose that firms have no cash initially. The optimal size of the initial equity issue, given by $\xi^\star + k^\star$, is such that the marginal cost of outside funds is equal to their marginal benefit and the entry condition can be written as

$$V(\xi^\star) \geq (\xi^\star + k^\star)(1+p) + f. \tag{8}$$

Condition (8) implies that firms enter the industry as long as the fixed cost of raising funds is below $\bar{f}$ defined by $\bar{f} \equiv V(\xi^\star) - (\xi^\star + k^\star)(1+p)$. Lastly, note that condition (8) implies that condition (2) holds since $V(\xi^\star) - \xi^\star(1+p) - f \geq (1+p)k^\star \geq \theta k^\star$. That is, if a firm initially finds it profitable to enter the industry, it also finds it optimal to raise funds whenever its cash buffer drops to zero instead of liquidating operations.[3]

[3] In our model, firms are symmetric and either all firms enter or no firm enters the market. Introducing heterogeneity among firms through, e.g. asymmetric production costs as in Ledvina and Sircar (2012), would allow us to get a richer industry structure. However, this would not change our predictions on the relation between product market competition and cash holdings and financing decisions.

2.3 Empirical predictions

2.3.1 Optimal cash holdings

In the model, an active firm determines the optimal level of cash holdings by balancing their cost with their benefits, i.e. the possibility to cover operating losses without having to issue costly equity. As a result, a change in profitability – due to changes in n, α, and γ – in the volatility of the cash flow shock σ, or in the costs of outside funds, p and f, will lead to a change in the value-maximizing level of cash holdings $C^\star$. The following Proposition provides a formal characterization of the effects of firm characteristics, product market competition, and financing constraints on optimal cash holdings.

Proposition 2 *Target cash holdings $C^\star$ are increasing with cash flow volatility σ, the number of firms in the industry n, the marginal cost of production γ, and issuance costs p and f, and decreasing with firm size $k^\star$ and the maximum clearing price α.*

Figure 1 shows the marginal cost curve of being short of cash and the marginal cost curve of holding cash. The marginal cost curve of being short of cash is downward sloping and convex as the value of the firm is an increasing and concave function of the firm's cash reserves. The marginal cost of holding cash is constant, given by $\rho - r$. Proposition 2 shows that an increase in product competition, in financing constraints, in production costs, or in cash flow volatility shifts the marginal cost curve of being short of cash to the right and increases the optimal level of cash holdings.

One question that naturally arises in our setup relates to the joint effects of product market competition and financing constraints on target cash holdings. The following Proposition provides a formal characterization of these effects.

Proposition 3 *The effects of product market competition on target cash holdings increase with the severity of financing constraints in that $\frac{\partial^2 C^\star}{\partial n \partial f} > 0$.*

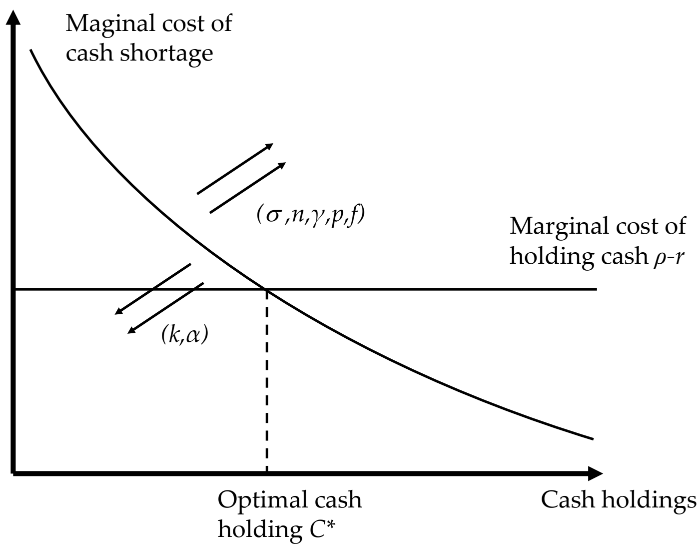

Figure 1: The optimal level of cash holdings is given by the intersection of the marginal cost curve of being short of cash and the marginal cost curve of holding cash.

The joint effects of product market competition and financing constraints on cash management decisions are illustrated by Figure 2, which plots target cash holdings $C^{\star}$ as a function of the intensity of product market competition, n, for low, medium, and high intensity of the financial constraint f (i.e. for $f = 0.01$, $f = 0.05$, and $f = 0.1$ on the left panel), and as a function of f, for low, medium, and high intensity of competition n (i.e. for $n = 1$, $n = 5$, and $n = 10$ on the right panel). Input parameter values are set as follows: the discount rate $\rho = 6\%$, the volatility of cash flows $\sigma = 14\%$, the cost of holding cash $\rho - r = 2\%$, the strength of the product market competition $n = 5$, the maximum clearing price $\alpha = 2$, and the marginal cost of production $\gamma = 0.1$.

Insert Figure 2 Here

Consistent with Proposition 3, Figure 2 reveals that the effects of competition on the value-maximizing level of cash holdings get reinforced by financing constraints. It also shows that the effects of competition on cash holdings are quantitatively very strong.

In summary, our model produces the following unique predictions on corporate cash holdings. First, as product market competition intensifies (as n increases), profitability decreases and firms optimally respond by increasing their cash holdings. This leads to the following testable hypothesis:

HYPOTHESIS 1: *Cash holdings increase with the strength of product market competition.*

Second, when there are no financing constraints, firms can issue securities at no cost and have no need for cash holdings. As financing constraints increase (i.e. as f increases), the wedge between the costs of inside and outside equity increases. Firms optimally respond by hoarding more cash. This leads to the following testable hypothesis:

HYPOTHESIS 2: *The effect of product market competition on optimal cash holdings increases with the intensity of financing constraints.*

At this stage it is important to note that theories in which cash holdings are motivated by purely strategic considerations predict that large firms have greater incentives to hold cash and value more cash. Indeed in these models, the value of cash typically arises due to a predatory motive or an entry preemption motive and the firm engaging in predation or preemption is generally the large or unconstrained leader or incumbent. Thus, a distinguishing feature of our theory is that it predicts that smaller and more constrained firms facing competitive pressure value more cash.

2.3.2 Financing decisions

When deciding on the size of equity issues, the firm balances the benefits of having greater cash reserves following the issue with the costs of issuing equity. The following Proposition provides a formal characterization of the effects of firm characteristics, product market competition, and financing constraints on the size of equity issues.

Proposition 4 *When issuing equity, the optimal issue size $\xi^\star$ is increasing in cash flow volatility σ, product market competition n, the marginal cost of production γ, and issuance costs f, and decreasing in firm size $k^\star$ and the maximum clearing price α.*

The intuition underlying the effects of volatility, competition, firm size, marginal costs of production, and the maximum clearing price on the optimal issue size is similar to that underlying their effects on optimal cash holdings. The effect of fixed issuance costs on the optimal issue size are related to the financing condition (2), which shows that the larger f, the larger the amount that needs to be raised by the firm. Figure 2 illustrates the joint effects of competition and financing constraints on equity issues and shows that the optimal issue size and target cash holdings respond in a similar fashion to changes in the firm's environment. We then have the following testable hypotheses:

HYPOTHESIS 3: *The optimal issue size increases with product market competition.*

HYPOTHESIS 4: *The effect of product market competition on the optimal issue size increases with the severity of financing constraints.*

Another question of interest is whether product market competition affects the frequency at which firms access financial markets and, therefore, the present value of issuance costs. Intuitively, the answer to this question is not clear since product market competition has potentially two opposite effects on the frequency of equity issues. On the one hand, competition increases target cash holdings and the size of equity issues, which suggests that it should have a negative effect on the frequency of equity issues. On the other hand, competition reduces profitability and hence makes it more likely that the firm will make losses and will need to raise outside capital, everything else equal. To address this question, we compute the probability of an equity issue over any given horizon $T > 0$ as a function of the intensity of product market competition, defined as

$$\mathbb{P}_0\left(t; T, c\right) \equiv \mathbb{P}\left[\tau_0(C^\star) \leq T \middle| C_t = c\right],$$

where $\tau_0(C^\star)$ is the first time that the cash reserves process with payouts at $C^\star$ reaches 0. The Appendix shows how to compute this probability.

Insert Figure 3 Here

Figure 3 plots the probability of an equity issue as a function of the current cash buffer ($C \in [0.01, C^\star]$) over an horizon of two (left panel) and five (right panel) years. The solid line plots this probability for a monopolist ($n = 1$) while the long-dashed and short-dashed lines plot these probabilities for industries with $n = 5$ and $n = 10$ firms, respectively. Input parameter values are set as in Figure 2. Figure 3 shows that the probability of an equity issue increases with competition (i.e. the profitability effect dominates). As expected, this probability also increases with the horizon and decreases with the financial strength of the firm, as measured by C.

This leads to the following testable hypothesis:

Hypothesis 5: *Product market competition increases the frequency of equity issues.*

In the remainder of the paper, we test hypotheses 1 through 5 on Compustat firms for the period 1980-2007.

3 Data and methodology

3.1 Sample

Our sample of firms is based on Compustat Industrial Annual files. Following Bates, Kahle and Stulz (BKS, 2009), we examine firms over the 1980-2007 period. We remove firms from regulated industries (SIC 4900-4999) and financial firms (SIC 6000-6999). In addition, following Clarke (1989), we remove firms with 4-digit SIC codes ending either by 0 or 9 that group firms with not well defined industry. Observations with missing

SIC code, total assets, cash and short term investments, sales, and operating income are deleted. We also drop observations with negative or zero total assets or sales, as well as observations with a negative EBITDA larger than total assets (see Bris, Koskinen, and Nilsson, 2009). The final sample consists of 78,080 firm-year observations, in which industries are defined by their 4-digit SIC code.

We collect the data on imports, exports, and tariffs compiled by Feenstra (1996) and Feenstra, Romalis, and Schott (2001). Data on imports, exports, and tariffs are available at the product level as defined by the Harmonized System (HS) established by the World Customs Organization (WCO). Feenstra (1996) and Schott (2010) provide concordance tables that map products to SIC codes. Using these tables, we define industry level variables at the four-digit SIC level. These data are available for manufacturing industries from 1980 to 1999. In addition, we collect data on domestic production from the Bureau of Economic Analysis, data on foreign exchange rates from Datastream, and data on Consumer Price Indices from the IMF. Finally, we collect data on firm industry exposure from Compustat Segments.

3.2 Methodology

To test Hypotheses (1) and (2) on the relation between cash holdings and competition, we estimate the following model:

$$Cash_{i,t} = \beta_1 Competition_{j,t-1} + \beta_2 FinConstraint_{i,t-1} + \beta_3 Y_{i,t-1} + \varphi_j + \nu_t + \epsilon_{i,t}. \quad (9)$$

The subscripts i, j, and t represent firm, industry, and year, respectively. Equation (9) relates cash holdings to the intensity of product market competition and the severity of financing constraints. $Competition_{j,t-1}$ is the competition measure for industry j, in year $t-1$, where firm i operates. $FinConstraint_{i,t-1}$ is the financing constraint measure for firm i at time $t-1$. Our main focus is on the coefficient estimates β_1 and β_2. The set of control variables $Y_{i,t-1}$ includes variables that are commonly believed to affect cash holdings (see BKS, 2009, and OPSW, 1999). φ_j accounts for time-invariant industry fixed effects. ν_t accounts for year fixed effects. The definition and construction of the dependent, explanatory, and control variables are summarized in Table 1.

Insert Table 1 Here

In equation (9), cash holdings are measured as cash and short term investments deflated by book assets, as in BKS. The cash ratio may be defined in various ways. OPSW use cash deflated by book assets minus cash. Haushalter, Klasa, and Maxwell (2008) use the log of the OPSW measure. The drawback of these measures is that they generate extreme outliers. Unreported robustness checks show that our conclusions are not affected by the definition of the dependent variable. Volatility is computed as the mean of standard deviations of operating income before depreciation (OIBDP) deflated by total assets (AT) over 10 years for firms in the same industry, as defined by the 4-digit SIC code. Firm size is defined as the log of net sales (SALE).

Turning to the tests of Hypotheses (3) and (4) on the relation between issue size and competition, we estimate the following model:

$$Issue_{i,t} = \beta_1 Competition_{j,t-1} + \beta_2 FinConstraint_{i,t-1} + \beta_3 Z_{i,t-1} + \varphi_j + \nu_t + \epsilon_{i,t}. \quad (10)$$

The subscripts i, j, and t represent firm, industry, and year, respectively. In this equation, the set of control variables $Z_{i,t-1}$ includes variables that are commonly believed to affect equity issuances (see e.g. Baker and Wurgler, 2002, and McLean, 2011). Equity issuances are defined as sales of common and preferred stock (SSTK) net of repurchase (PRSTKC), deflated by total assets (AT). Therefore, $Issue_{i,t}$ represents funds received from stock issuances at time t, as in McLean (2011). In unreported tests, we obtain similar results when employing the net equity issues proxy in Baker and Wurgler (2002), defined as the change in book equity minus the change in balance sheet retained earnings, divided by assets.

In a first step, we estimate equations (9) and (10) to assess the effect of competition and financing constraints on cash and equity issues. In a second step, we examine the effects of financing constraints by estimating the specification in equation (9) and (10) when splitting the full sample in two subsamples comprising either financially constrained firms or unconstrained firms.

Finally, we also test Hypothesis (5) on the relation between the frequency of equity issues and competition. To do so, we follow Leary and Roberts (2005) and estimate a mixed proportional hazard model, for which the hazard function at time t for firm i with covariates $x_i(t)$ is assumed to be

$$\lambda_i(t) = \omega_i \lambda_0(t) \exp(x_i(t)'\beta). \tag{11}$$

In this model, t is the time to equity issuance (or equivalently the length of the spell), $\lambda_0(t)$ is the baseline hazard function, that we model as a non-parametric step function of discrete spell lengths, and $\exp(x_i(t)'\beta)$ is the relative risk associated with the set of covariates $x_i(t)$. These covariates characterize observed differences between firms and β is an unknown parameter vector. Lastly, ω_i is a random variable representing unobserved heterogeneity. We assume that the unobserved heterogeneity has a gamma distribution with mean zero and variance s^2. We estimate the model via maximum likelihood.

The baseline hazard is interpreted as the hazard function when all covariates are zero. The covariates allow the hazard function to shift up or down depending on their values and the parameter vector β. The covariates that we consider include our proxies for the intensity of competition as well as control variables. ω_i accounts for omitted covariates so that the estimated hazard functions are not affected by unobserved heterogeneity.

Most firms in the Compustat dataset exhibit issuance activity every period. This is in part due to continued exercise of stock options by executives (see McKeon, 2013). For the duration analysis, we thus follow Leary and Roberts (2005) and focus on large equity issues or spikes. An equity issuance spike occurs if equity issuance, defined as sales of common and preferred stock (SSTK), deflated by total assets (AT), is greater than 3%. In robustness tests, we change the equity issuance spike threshold to 5% or 7%. As an additional robustness test, we define equity issuance spikes in terms of the deviation of the ratio of equity issuance to total assets from the firm level median of this ratio (following Whited, 2006). This alternative definition for equity issuance spikes does not have any material impact on our results.

3.3 Intensity of competition measures

We construct four measures to reflect the intensity of product market competition. First, we use the excess price-cost margin (EPCM) (see e.g. Lindenberg and Ross, 1981, Nickell, 1996, Aghion et al., 2005, or Gaspar and Massa, 2006). The price-cost margin (PCM) is defined as operating income (before depreciation) over sales. EPCM is defined as the difference between a firm's PCM and the average PCM of its industry. We control for industry PCM in order to account for inter-industry differences unrelated to market power. In this specification, we assume that marginal and average costs are equivalent (see Carlton and Perloff, 1989). The price-cost margin is used in most of the industrial organization (IO) literature and refers to the ability of the firm to price above marginal cost (see Lerner, 1934). A greater value of EPCM indicates a greater ability to extract profits and, hence, a lower intensity of competition.

Our second proxy for the intensity of competition is the Herfindahl-Hirschman Index (HHI). A higher HHI implies weaker competition. The HHI is a widely used proxy for competition that is well grounded in industrial organization theory (see Tirole, 1988). In our estimations, the HHI is based on the text-based network industry classification (TNIC) available in the Hoberg and Phillips data library. This dynamic industry classification is based on product descriptions from annual firm 10-K filings with the Securities and Exchange Commission (SEC). Hoberg and Phillips (2011) use this new classification and show that it is better at explaining the cross-section of firm characteristics (see also Hoberg and Phillips, 2010). This proxy is available for the years 1996 to 2007.

Our third proxy for the intensity of competition is the product market fluidity measure developed by Hoberg, Phillips, and Prabhala (2012) and available in the Hoberg and Phillips data library. Higher fluidity signals a more competitive environment. This proxy is also based on business descriptions from firm 10-Ks and captures the structure and evolution of the product space occupied by firms. In particular, it captures competitive threats faced by firms in their product markets and the changes in rival firms' products relative to the firm. This proxy is available for the years 1997 to 2007.

Lastly, we use foreign competition as measured by the degree of import penetration (see Bertrand, 2004) to examine the effects of competition on cash holdings. Import penetration (IP) is defined as total value of imports divided by imports plus domestic production. In order to account for possible endogeneity between corporate decisions and import penetration, we instrument import penetration with import tariffs and the exchange rate. The *ad valorem* tariff rate is defined as the total value of duties collected by the U.S. customs divided by the total free-on-board value of imports. The foreign exchange rate is the weighted average of the log real exchange rates of exporting countries. It is expressed in foreign currency per U.S. dollar. The weights are defined as the share of each foreign country exports over total imports. The real exchange rates are nominal rates that are adjusted for the U.S and the foreign country Consumer Price Indices. All measures are constructed at the four-digit SIC level. In addition, we compute firm level measures. To do so, we construct weights for each firm that correspond to the fraction of sales associated with each industry. The firm specific measures then correspond to the weighed average of industry measures where the weights represent the exposure of the firm to the industries it operates in.

3.4 Financing constraint measures

Financing constraints are unobservable at the firm level. As a result, empiricists have proposed an array of methods to measure these constraints. Since there is no agreement on which measure is the best proxy for financing constraints, we rely on four different measures that complement each other.

The literature on financing constraints argues that a firm's payout ratio may be used to measure financial constraints (see Fazzari, Hubbard and Petersen, 1988). Thus, for every year in our sample, we rank firms based on their payout ratio. Financially constrained (unconstrained) firms are identified as being in the bottom (top) three deciles of the annual payout ratio distribution. The payout ratio is defined as total distributions (dividends and stock repurchases) deflated by operating income. All firms having the same payout ratio are assigned to the same group.

The second measure we use for firms' financing constraints is firm size (see Gilchrist and Himmerlberg, 1995, and Erickson and Whited, 2000). Small firms are typically young, less known, and more vulnerable to capital market imperfections and, thus, are more likely to face financing difficulties. In addition, larger, more established firms are more likely to have a well functioning treasury department and well established relations with financial institutions rendering access to capital markets easier. For every year, we rank firms based on their size. Financially constrained (unconstrained) firms are identified as being in the bottom (top) three deciles of the annual size distribution. Similar results are obtained if we use firm age instead of firm size.

We use the market assessment of firms' credit risk as third measure of financing constraints (see Whited, 1992, and Gilchrist and Himmelberg, 1995). We categorize firms as financially constrained if the credit rating is either missing or non investment grade. Financially unconstrained firms are firms with an investment grade rating. Similar results are obtained if we use instead commercial paper rating.

We use the Whited and Wu financial constraints index as fourth measure (WW index). Firms with high WW index are small firms, that rely mainly on equity financing, exhibit low growth and have low cash flows. Formally, the index is defined as follows:

$$\text{WW} = -0.091\text{CF} - 0.062\text{DIVPOS} + 0.021\text{TLTD} - 0.044\text{LNTA} + 0.102\text{ISG} - 0.035\text{SG}$$

where CF is cash flows from operations, DIVPOS is a dummy variable equal to 1 if the firm pays dividends, TLTD is long term debt over assets, LNTA is the natural logarithm of total assets, ISG is the three-digit SIC industry sales growth rate and SG is the firm sales growth rate. We compute the WW index every year for each firm. Financially constrained (unconstrained) firms are then identified as being in the top (bottom) three deciles of the WW index annual distribution.

Insert Table 2 Here

Table 2 reports the number of firm-year observations classified as constrained or unconstrained for the four financial constraints criteria. For example, there are 50,865 constrained firm-year observations and 25,937 unconstrained according to the payout ratio criterion. Table 2 shows that the four criteria are positively but not perfectly correlated. Indeed, out of the 50,865 payout constrained firm-year observations, 22,703 are considered constrained and 7,208 unconstrained with respect to the size criterion. The remaining observations are considered as neither constrained nor unconstrained. Each of the four measures of financing constraints thus conveys incremental information, which contributes to the robustness of the analysis.

3.5 Descriptive statistics

Table 3 presents descriptive statistics of the sample. Our sample exhibits characteristics similar to those in prior studies (see e.g. BKS, 2009, McLean, 2011, Hoberg, Phillips, and Prabhala, 2013). Mean cash holdings are 0.17 with a standard deviation of 0.20, whereas equity issues have a mean of 0.04 and a standard deviation of 0.13.

Insert Table 3 Here

The mean excess price-cost margin (EPCM), our first proxy for the intensity of competition, is -0.17 with a standard deviation of 0.59. The mean EPCM is slightly lower than those reported by Aghion et al. (2005) or Gaspar and Massa (2006) because our sample period also includes more recent years. Turning to the Hoberg and Phillips measures of competition, HHI TNIC has an average of 0.18 with a standard deviation of 0.20, whereas product market fluidity is 7.30 with a standard deviation of 3.38. The results are consistent with Hoberg, Phillips, and Prabhala (2013).

Insert Figure 4 Here

Figure 4 (left panel) plots firms' cash holdings over the sample period. At the beginning of the sample period in 1980, the average cash ratio for the firms in our sample is 10%. At the end of the sample period in 2007, this ratio is more than 20%. The right panel of Figure 4 illustrates the time trend in EPCM. We observe a decrease in EPCM consistent with an increase of competition intensity (see also Gaspar and Massa, 2006). This time-trend in EPCM can be attributed to market deregulation – which reduces barriers to entry that enable market power (see Andrade, Mitchell, and Stafford, 2001) – and market globalization (see Ryan, 1997, and Bernard, Jensen, and Schott, 2005).

4 Empirical results

4.1 Cash holdings and competition

We start the analysis by examining the relation between competition and cash holdings. To do so, we estimate the specification in equation (9). Table 4 reports the estimation results and shows that, consistent with Hypothesis (1), cash holdings increase with the intensity of competition as proxied either by EPCM, HHI, or fluidity. Notably, a one standard deviation change in the intensity of competition leads to a change of cash holdings in the range of 2% to 3.7%.

Insert Table 4 Here

The table also shows that a one standard deviation change in the severity of financing constraints leads to a change of cash holdings up to 4.3%.[4] In addition, we find that cash holdings increase with cash flow volatility. More precisely, a one standard deviation change cash flow volatility leads to a change in cash holdings in the range of 1.8% to 2.4%, respectively. All coefficients are significant at the 1% level.

Across specifications, control variables have signs that are consistently in line with those in prior contributions (see BKS, 2009, and OPSW, 1999). Specifically, we obtain positive coefficients on market-to-book ratio, cash flow and R&D and negative coefficients on net working capital, capital expenditures, leverage and acquisitions.

Table 4 also reveals that the results are robust to the inclusion of year and industry fixed effects. Year fixed effects control for common time trends in cash holdings across all industries, while industry fixed effects control for time invariant differences in cash holdings across industries. In addition, we estimate equation (9) based on Fama-MacBeth approach. This alternative specification allows us to investigate cross-industry effects. The estimated coefficients are all significant at the 1% level and of similar magnitudes than under the baseline model.

Table 5 presents an additional set of robustness tests. In columns 1, 4, and 7, we estimate the baseline model where we use an alternative measure of cash holdings. We define cash holdings as the ratio of cash to net assets, where net assets equal total assets

[4]We do not include WW index as it is correlated with some of the control variables like firm size.

minus cash as in OPSW. This definition can generate extreme outliers. To control this problem, we use the logarithm of this measure. We observe that across competition measures, the estimated coefficient is negative and statistically significant, confirming our prior results.

Insert Table 5 Here

In columns 2, 5, and 8, we run an alternative specification in which we introduce additional control variables as in BKS (2009). Specifically, we control for proximity to an IPO, as cash holdings should be higher immediately after raising capital and decreasing as time goes by and the proceeds are spent. Moreover, we add a dummy equal to one for firm-year observations registering operating losses, taking into account the evidence in BKS (2009) that firms with negative net income keep more cash. The coefficients for all our proxies for the intensity of competition and financial constraints have signs and statistical significance in line with Table 4. In addition, the coefficients of the additional controls are consistent with those reported in BKS (2009).

Next, in columns 3, 6, and 9, we estimate the model using a between regression approach. This specification constitutes an alternative to examine cross-industry effects. Corroborating our prior results, the estimate on the competition measures are economically and statistically significant. Taken together, these first results provide strong evidence that product market competition affects cash holdings. In the following, we further characterize the nature of this "competition effect."

Hypothesis (2) states that the impact of competition on cash holdings increases with the severity of financing constraints. In order to formally test Hypothesis (2), we estimate model (9) by splitting the sample into two groups: constrained and unconstrained firms. To classify firm-year observations as constrainted or unconstrainted, we use the four criteria reported in Section 3.4. Table 6 reports our estimates.

Insert Table 6 Here

We observe that the set of constrained firms displays significant coefficients on all measures of *Competition*, while unconstrained firms show statistically or economically insignificant coefficients. The inclusion of instruments for (the absence of) financing constraints markedly increases (decreases) the effects of competition on cash holdings. In particular, one standard deviation change in EPCM leads to a change of cash holdings in the range of 7.6% to 9% for financially constrained firms (i.e. coefficients that are three to four times larger than in Table 4). In addition, the tests for the difference in coefficients between constrainted and unconstrainted firms confirm that the effect of competition on cash is exacerbated by the intensity of financing constraint, as the difference is always significant. We also find that the coefficients on the control variables are not affected by these sample splits.

Our analysis so far indicates that cash holdings increase with competition, as measured either by EPCM, HHI TNIC, or product market fluidity. There is however the concern of potential endogeneity. First, firms may affect their competitive environment by adapting their cash hording behavior. See for example Frésard (2010). Second, there could be an omitted variable problem. For example, risk averse managers may hold large cash balances to reduce their exposure to idiosyncratic risk. To address these concerns, we have to rely on a source of variation in competition that is independent of managerial choices. We do so by examining the effect of foreign competition on cash holdings.

Specifically, we follow Bertrand (2004) and investigate how import penetration affects cash holdings. In particular, to identify exogenous variation in foreign competition, we instrument industry measures of import penetration with import tariff rates and foreign exchange rates. The first instrument is motivated by the international trade literature. Bernard, Jensen, and Schott (2006) and Tybout (2003) document that firms are more exposed to foreign competition due to trade liberalization and to reductions in tariff rates. Reductions in tariff rates reduce the cost for foreign firms of entering the U.S.

market and increase import penetration. Tariff rates are not under the discretion of managers and thus constitute a valid instrument. The second instrument, the exchange rate, is positively correlated with industry level measures of import competition.[5] It is reasonable to believe that the exchange rate is mainly determined by macroeconomic factors but not affected by firm level characteristics.

To identify the causal effect of competition on cash holdings, we estimate equation (9) using import penetration as a measure of competition. In particular, we estimate a set of IV regressions that are constructed in two stages. In the first stage, import penetration is regressed on lagged values of the two instruments, import tariff rates and foreign exchange rates, and a set of control variables. In the second stage, we regress cash holdings on the fitted values of import penetration implied from the first stage and a set of control variables. All regressions control for year and industry fixed effects.

Insert Table 7 Here

Table 7 reports estimates of the effect of import penetration on cash holdings. In specifications (1) and (2), we measure import penetration, tariff rates, and foreign exchange rates at the industry and firm level, respectively. The estimated coefficients range from 0.201 to 0.498 and are significant at the 1% level. These effects are economically large. A one standard deviation change in import penetration leads to an increase in cash holdings in the range of 2.61% to 6.5%. The IV approach thus confirms the results reported in Section 4 that more competition results in higher cash holdings.

The results of the first stage also confirm our intuition that tariff rates and foreign exchange rates are respectively negatively and positively associated with import penetration. The large R^2 shows that the predictive power of the instruments is strong. We also report a series of tests to support the validity of the IV approach. First, we

[5] Cuñat and Guadalupe (2009) and Xu (2012) use a similar approach to examine the effect of competition on the structure of compensation and incentives of executives and leverage ratios, respectively.

test the null hypothesis that all instruments are jointly equal to zero. The F-statistic with a p-value < 0.01 rejects the null hypothesis and suggests that tariff rates and foreign exchange rates are strong instruments. Second, we implement a Hansen J-test of overidentifying restrictions. J-statistics with p-values in the range of 0.30 to 0.27 do not reject the null hypothesis that instruments are uncorrelated with the error term and can be excluded from the second stage regression.

4.2 Equity issues and competition

To test Hypothesis (3) on the relation between the funds received from stock issuances and competition, we start by estimating equation (10) on the full sample. Table 8 reports the estimation results.

Insert Table 8 Here

Consistent with the model, Table 8 shows that the size of equity issues increases with *Competition*, as measured either by EPCM, HHI TNIC, or product market fluidity. For instance, a one standard deviation increase in the intensity of competition as measured by EPCM (column 1 to 3) leads to an increase in the size of equity issues of 1.2%. All the competition coefficients are significant at the 1% level, confirming our Hypothesis (3) that competition is an important determinant of the funds received from stock issues.

In addition, we find that the coefficients of the control variables are in line with Baker and Wurgler (2002) and McLean (2011). Namely, market-to-book is positively related whereas firm size and cash flow is negatively related to the funds received from stock issues. For instance, a one standard deviation in firm size leads to a decrease in the size of equity issues in the range of 1.7% to 2.6%. The coefficients are highly significant across specifications. Since large firms have easier access to capital markets, this result supports our Hypothesis (4) about the relationship between the size of equity issues and the severity of financing constraints. Table 8 also reveals that these results are robust to the inclusion of year and industry fixed effects or to a Fama-MacBeth estimation.

Table 9 reports a set of additional robustness tests. First, we estimate an alternative specification where we define equity issuance as sale of common and preferred stock over total assets. This definition does not adjust for repurchases. Results in columns 1, 4, and 7 show that the estimates of *Competition* are all statistically significant at the 1% and exhibit the same magnitudes as under the base specification. Next, we estimate a specification where we add control variables that capture the precautionary motive for equity issues, as in McLean (2011). Notably, to capture valuable investment opportunities and financing needs, we follow the literature in using acquisitions and capital expenditures. The results reported in columns 2, 5, and 8 show that our prior findings are not affected by this alternative specification. The competition coefficients remain highly significant. Finally, the results are also robust to an estimation based on a between regression as shown in columns 3, 6, and 9.

Insert Table 9 Here

To further characterize the effects of financing constraints on the relation between the size of equity issues and the intensity of competition, we re-estimate model (10) by splitting the sample into two groups: constrained and unconstrained firms. Table 10 reports the estimates for the two groups of firms. The results show that constrained firms have highly significant coefficients for our three measures of competition, across the four different proxies of financial constraints. By contrast, the coefficients of *Competition* for financially unconstrained firms are significantly lower in absolute value, as confirmed by the results of the tests for difference in coefficients between the two groups of firms.

Insert Table 10 Here

The results in Table 10 confirm that the relation between competition and the size of equity issues is magnified by the severity of financing constraints. For instance, a one standard deviation change in EPCM leads to an increase in the size of equity issues of 3.8% to 5.2%, that is more than three times higher than in Table 8. While we do not report the coefficients of the control variables to save space, their size and significance are consistent with the results on the entire sample. Taken together, the results are strongly supportive of our Hypothesis (4) that the effect of competition on the size of equity issues is magnified by the severity of financial constraints.

As a last robustness test, we estimate equation (10) using import penetration as a measure of competition. As in Table 7, we instrument import penetration with import tariffs and the exchange rate to identify exogenous variation in foreign competition. Table 11 reports estimates of the effect of import penetration on equity issuance. The estimated coefficients range from 0.044 to 0.057 and are significant at the 5% level. The IV approach again indicates that more competition results in larger equity inflows. A p-value < 0.01 for the F-statistic and a p-value in the range of 0.47 to 0.51 for the Hansen J-test provide strong support for the validity of the instruments.

Insert Table 11 Here

In addition to its implications for the relation between competition and the size of equity issues, the model has also implications for the frequency at which firms access equity markets. We test Hypothesis (5) by examining the relation between product market competition and the frequency of equity issues. To do so, we estimate the mixed proportional hazard model described by equation (11). As discussed in section 3.2, we follow Leary and Roberts (2005) and focus on equity issuance spikes. In our sample, we observe firms without equity issuance spikes (censored firms) as well as firms with several equity issuance spikes. There are a total of $24,434$ issuance spikes representing a fraction of 30.23% of spikes in the data. The median time spell between equity issuance spikes is 3 years and the median number of spikes per firm is 3.

Insert Table 12 Here

Table 12 reports estimation results of the mixed proportional hazard model. The estimated coefficients show in which direction and by how much every covariate shifts the baseline hazard function. Consistent with Hypothesis (5), we observe in columns 1 to 3 that product market competition increases the frequency of equity issues. The coefficients on the proxies for the intensity of competition are statistically and economically significant. Notably, a one standard deviation decrease in the EPCM measure results in an increase of the equity issuance hazard rate by 5.7% (i.e. $(exp(-0.094 \times (-0.59)) - 1) \times 100)$). If we measure competition by HHI or fluidity, a one standard deviation increase in competition results in an increase of the equity issuance hazard rate by 3.7% or 14.5%, respectively. In addition, we find that the frequency of equity issues increases with the market-to-book ratio and decreases with firm size and cash flow. The estimated coefficients on tangibility and leverage are not robust. The results for these control variables are consistent with evidence reported by Leary and Roberts (2005). Also, the variance of the gamma distribution, s^2, is statistically significant across all specifications but one, showing the importance of accounting for unobserved heterogeneity.

To assess the robustness of our results, we change the threshold for equity issuance spikes from 3% to 5% or 7%. Columns 4 to 9 show that our results are robust to this change. We observe that a one standard deviation increase in competition leads to an increase of the equity issuance hazard in the range of 4.7% to 17.2% or 4.01% to 18.8% if the threshold is set to 5% or 7%, respectively. Overall, our results provide strong evidence that product market competition increases the frequency of equity issues.

5 Conclusion

This paper examines the effects of product market competition on firms' cash holdings and equity issuance decisions in the presence of financial constraints. To do so, we build a dynamic cash management model in which firms face competitive pressure and optimize the level of their cash holdings, the amount raised when issuing new equity, as well as the frequency of equity issues. Using the model, we show that product market competition reduces profitability and leads firms to increase their cash holdings and the frequency and size of their equity issues. In addition, while the theories based on strategic interactions predict that large and unconstrained firms have greater incentives to hold cash to preempt entry or engage in predation, we show that the effects of competition on financial decisions are driven by smaller or more constrained firms in our model.

We take the model to the data and find that firms operating in more competitive industries hold more cash, access equity markets more often, and raise more funds from outside investors, consistent with the predictions of the model. Also consistent with our theory, we find that the effects of product market competition on firms' cash holdings and financing decisions are stronger for small firms and when financial constraints are more severe. Importantly, the magnitude of the effects that we document is substantial. We find for example that competition has much more impact on cash holdings than many of the variables, such as cash flow volatility, that have long been recognized as prime determinants of cash management decisions.

Appendix

A. Proof of Proposition 1

We start by deriving the function $V(c)$ reported in Proposition 1. The optimal firm policy is characterized by a region $(0 < c < C^\star)$ where it is optimal to retain earnings and a region $(c \geq C^\star)$ where it is optimal to make dividend payments. In the region $(0 < c < C^\star)$, firm value satisfies

$$\rho\, V(c) = V'(c)\left[rc + \pi^\star(n)\right] + \frac{\sigma^2}{2} V''(c), \tag{12}$$

with $\pi^\star(n) \equiv \left(\frac{\alpha-\gamma}{n+1}\right)^2$.[6] The change of variable $V(c) = g\left(-\frac{[rc+\pi^\star(n)]^2}{r\sigma^2}\right)$ transforms equation (12) for $V(c)$ into the Kummer's equation for $g(.)$

$$zg'' + (b-z)\,g' - ag = 0, \tag{13}$$

where $a \equiv -\frac{\rho}{2r}$, $b \equiv 1/2$, and $z \equiv -(rc + \pi^\star(n))^2/r\sigma^2$. According to standard results (see Abramowitz and Stengun 1969, Chapter 13), the general solution to (13) can be found using the two linearly independent solutions

$$F(c) = M(a,b,z) = M\left(-\frac{\rho}{2r}, \frac{1}{2}, -\frac{(rc+\pi^\star(n))^2}{r\sigma^2}\right)$$

$$G(c) = z^{1-b} M(1+a-b, 2-b, z) = \frac{rc+\pi^\star(n)}{\sqrt{r}\sigma} M\left(\frac{1}{2}\left(1-\frac{\rho}{r}\right), \frac{3}{2}, -\frac{(rc+\pi^\star(n))^2}{r\sigma^2}\right)$$

where $M(.)$ is the confluent hypergeometric function (or Kummer's function of the first kind).[7] Therefore, the general solution takes the form

$$V(c) = \gamma_1 F\,(c) + \gamma_2 G\,(c) \tag{14}$$

where the two constants γ_1 and γ_2 are identified by imposing the smooth-pasting and super-contact conditions at the dividend thresholds. To do so, we exploit the following lemma.

Lemma 5 *The following relations between the two linearly independent solutions $F(c)$ and $G(c)$ of the ODE (12) hold:*

$$F'(c)G(c) - F(c)G'(c) = -\frac{\sqrt{r}}{\sigma} e^{-(rc+\pi^\star(n))^2/(r\sigma^2)}$$

$$F''(c)G(c) - G''(c)F(c) = \frac{2}{\sigma^3}\sqrt{r}\left[rc+\pi^\star(n)\right] e^{-(rc+\pi^\star(n))^2/(r\sigma^2)}$$

$$F''(c)G'(c) - F'(c)G''(c) = \frac{2}{\sigma^3}\sqrt{r}\rho e^{-(rc+\pi^\star(n))^2/(r\sigma^2)}$$

[6] The parameters α, γ, n enter in the free boundary problem only through $\pi^\star$. Therefore, throughout the proof we use $\pi^\star(n)$ instead of these deep parameters of the model.

[7] For simplicity, we have left the imaginary root out of the expression of $G(c)$, being like a constant and not altering the result.

Proof. The left hand side of the first relation is the wronskian. The right hand side follows from Abel's identity (see Hartman (1982, Section XI.2)). The second relation is the differentiation of the first one. The third relation follows from the fact that $F(c)$ and $G(c)$ solve equation (12) and satisfy the first relation. ■

Using conditions (4) and (5) and Lemma (5), it follows that the coefficients in (14) are respectively

$$\gamma_1 = \frac{-G''(C^\star)\sigma^3}{2\sqrt{r}\rho} e^{(rC^\star+\pi^\star(n))^2/(r\sigma^2)} \text{ and } \gamma_2 = \frac{F''(C^\star)\sigma^3}{2\sqrt{r}\rho} e^{(rC^\star+\pi^\star(n))^2/(r\sigma^2)}.$$

implying that, for any $0 \leq c \leq C^\star$, firm value is given by

$$V(c) = \frac{F''(C^\star)G(c) - G''(C^\star)F(c)}{2\sqrt{r}\rho} \sigma^3 e^{(rC^\star+\pi^\star(n))^2/(r\sigma^2)}.$$

This expression for $V(c)$ is a function of the dividend threshold $C^\star$. By Lemma A.3 in Décamps, Mariotti, Rochet, and Villeneuve (DMRV, 2011), $C^\star$ is the unique solution to (6), and in turn uniquely determines the optimal issuance amount $\xi^\star(C^\star)$. This follows by the concavity of the value function, that holds by arguments similar to Lemma A.1 in DMRV (2011). Exploiting these results, it follows that the unique solution to the free boundary problem (4)-(6) is

$$V(c) = V(c \wedge C^\star) + (c - C^\star)^+.$$

B. Proof of Propositions 2, 3, and 4.

We now establish the properties of the target cash level $C^\star$, as reported in Proposition 2. Note that in the absence of financing costs, i.e. when $p = f = 0$, the payout threshold is zero and the value function is the line $V^\star(c) = \frac{\pi^\star(n)}{\rho} + c$ with slope 1, as it is optimal to pay out all positive revenues and exploit the costless and infinitely elastic supply of equity. For a financially constrained firm, p and f are strictly positive and it is optimal to keep a cash reserve. In the following, we let V be a function of cash holdings and of the parameters of interest, i.e. $V(c, .)$, and we use the subscript to indicate partial derivatives. We start by proving the monotonicity with respect to the volatility of cash flows.

Lemma 6 *Target cash holdings $C^\star$ are monotone increasing in σ^2.*

Proof. To establish the result, we need to show that $C^\star_{\sigma^2}(\sigma^2) > 0$. To do so, we define the auxiliary function

$$g(X, \sigma^2) = V(X, \sigma^2) - \frac{rX + \pi^\star(n)}{\rho},$$

which is equal to zero when $X = C^\star(\sigma^2)$. Using this equality and the implicit function theorem, it follows that

$$C^\star_{\sigma^2}(\sigma^2) = -\frac{g_{\sigma^2}(C^\star, \sigma^2)}{g_{C^\star}(C^\star, \sigma^2)} = -\frac{\rho}{\rho - r} V_{\sigma^2}(C^\star, \sigma^2).$$

To prove the claim we can equivalently show that $V_{\sigma^2}(c,\sigma^2) < 0$ for any c on the domain, and therefore also at $C^\star(\sigma^2)$.[8] Recall that $V(c,\sigma^2)$ satisfies the ordinary differential equation (12). Differentiating with respect to σ^2, we get

$$\rho\, V_{\sigma^2}(c,\sigma^2) - V_{c\sigma^2}(c,\sigma^2)\,[rc + \pi^\star(n)] - \frac{\sigma^2}{2} V_{cc\sigma^2}(c,\sigma^2) = \frac{1}{2} V_{cc}(c,\sigma^2). \tag{15}$$

The liquidation time is $\tau = \infty$ under condition (2), and the cash reserves process has continuous path except at times $\tau_{0,i}$, denoting the i-th time that the reserves process hits zero. At any $\tau_{0,i}$, the reserves process jumps from 0 to $\xi^\star$ as a consequence of the equity issuance. Keeping this in mind, we fix an arbitrary $T \geq 0$ and, applying Itô's formula, it follows that

$$\begin{aligned} e^{-\rho T} V_{\sigma^2}(C_T,\sigma^2) =& V_{\sigma^2}(C_0,\sigma^2) - \int_0^T e^{-\rho s} \frac{1}{2} V_{cc}(C_s,\sigma^2) ds + \int_0^T e^{-\rho s} \sigma V_{c\sigma^2}(C_s,\sigma^2) dW_s \\ & - \int_0^T e^{-\rho s} V_{c\sigma^2}(C_s,\sigma^2) dD_s + \left[V_{\sigma^2}(\xi^\star,\sigma^2) - V_{\sigma^2}(0,\sigma^2)\right] \Sigma_{\tau_{0,i}\leq T}\, e^{-\rho \tau_{0,i}}. \end{aligned} \tag{16}$$

In this equation, the second term on the right hand side follows from (15). The third term is a square integrable martingale because $V_{c\sigma^2}(c,\sigma^2)$ is bounded on $0 < c \leq C^\star$. Turning to the fourth term, we recall that the optimal payout policy is such that D increases only when C hits $C^\star$, i.e. that the cash reserves process is reflected at $C^\star$. So, we need to determine the value of the term $V_{c\sigma^2}(c,\sigma^2)$ at $C^\star$. Taking the derivative of $V_c(c,\sigma^2)$ with respect to σ^2, it follows that $V_{c\sigma^2}(C^\star,\sigma^2) = 0$ because of the smooth-pasting and high-contact conditions at $C^\star$. Therefore, the fourth term on the right hand side is zero. Finally, by differentiating with respect σ^2 the value matching condition (6) at zero,

$$V_{\sigma^2}(0,\sigma^2) = V_c(\xi^\star,\sigma^2)\xi^\star_{\sigma^2}(\sigma^2) + V_{\sigma^2}(\xi^\star,\sigma^2) - (1+p)\xi^\star_{\sigma^2}(\sigma^2)$$

and recalling that $V_c(\xi^\star,\sigma^2) = 1+p$, it follows that $V_{\sigma^2}(0,\sigma^2) = V_{\sigma^2}(\xi^\star,\sigma^2)$. Thus, the last term on the right hand side of (16) turns out to be zero. It then follows that

$$V_{\sigma^2}(c,\sigma^2) = \mathbb{E}\left[\int_0^T e^{-\rho s} \frac{V_{cc}(C_s,\sigma^2)}{2} ds \,\middle|\, C_0 = c\right] + \mathbb{E}\left[e^{-\rho T} V_{\sigma^2}\left(C_T,\sigma^2\right) \middle|\, C_0 = c\right]$$

holds. In this equation the first term on the right hand side is non-positive, because of the concavity of V over the interval $0 \leq c < C^\star$ and $V_{cc}(C^\star,\sigma^2) = 0$. Turning to the second term, V has bounded derivatives so there exists a positive constant K such that $|e^{-\rho T} V_{\sigma^2}(C_T,\sigma^2)| \leq e^{-\rho T} K$, implying that $\lim_{T\uparrow\infty} E_c\left[e^{-\rho T} V_{\sigma^2}(C_T,\sigma^2)\right] = 0$. It then follows that $V_{\sigma^2}(c,\sigma^2)$ is negative, and the claim follows. ■

We can use similar arguments to establish the monotonicity with respect to $\pi^\star(n)$.

Lemma 7 *Target cash holdings $C^\star$ are monotone decreasing in $\pi^\star(n)$.*

[8] To ease the notation, in the following we just use $C^\star$ instead of $C^\star(\sigma^2)$.

Proof. As before, we define the auxiliary function

$$h(X,\pi^\star(n)) = V(X,\pi^\star(n)) - \frac{rX+\pi^\star(n)}{\rho},$$

which is equal to zero when $X = C^\star(\pi^\star(n))$. By the implicit function theorem, it follows that

$$C_{\pi^\star(n)}(\pi^\star(n)) = -\frac{h_{\pi^\star(n)}(C^\star,\pi^\star(n))}{h_{C^\star}(C^\star,\pi^\star(n))} = \frac{\rho}{\rho-r}\left(\frac{1}{\rho} - V_{\pi^\star(n)}(C^\star,\pi^\star(n))\right).$$

To establish the required monotonicity, we need to prove that $C_{\pi^\star(n)}(\pi^\star(n))$ is negative, or equivalently that the $V_{\pi^\star(n)}(c,\pi^\star(n)) > \frac{1}{\rho}$ for any c, and therefore also for $c = C^\star$. Differentiating (12) with respect to $\pi^\star(n)$, we get

$$\rho V_{\pi^\star(n)}(c,\pi^\star(n)) - V_{c\pi^\star(n)}(c,\pi^\star(n))\,[rc+\pi^\star(n)] - \frac{\sigma^2}{2}V_{cc\pi^\star(n)}(c,\pi^\star(n)) = V_c(c,\pi^\star(n)). \quad (17)$$

As in the proof of Lemma 6, it follows by Itô's formula that

$$\begin{aligned} e^{-\rho T}V_{\pi^\star(n)}(C_T,\pi^\star(n)) &= V_{\pi^\star(n)}(C_0,\pi^\star(n)) - \int_0^T e^{-\rho s}V_c(C_s,\pi^\star(n))ds \\ &\quad + \int_0^T e^{-\rho s}\sigma V_{c\pi^\star(n)}(C_s,\pi^\star(n))dW_s - \int_0^T e^{-\rho s}V_{c\pi^\star(n)}(C_s,\pi^\star(n))dD_s \\ &\quad + \left[V_{\pi^\star(n)}(\xi^\star,\pi^\star(n)) - V_{\pi^\star(n)}(0,\pi^\star(n))\right]\Sigma_{\tau_{0,i}\le T}e^{-\rho\tau_{0,i}} \end{aligned} \quad (18)$$

holds for any $T \ge 0$, where again we denote by $\tau_{0,i}$ the i-th hitting time at which the reserves process reaches zero before T. The second term on the right hand side is motivated by (17), while the third term is a square integrable martingale because $V_{c,\pi^\star(n)}(c\pi^\star(n))$ is bounded on $0 < c \le C^\star$. The fourth term is zero because of the optimal payout policy and the fact that $V_{c\pi^\star(n)}(C^\star,\pi^\star(n)) = 0$ (which follows from differentiating $V_c(c,\pi^\star(n))$ with respect to $\pi^\star(n)$ and using the fact that $V_c(C^\star,\pi^\star(n)) = 1$ and $V_{cc}(C^\star,\pi^\star(n)) = 0$). Finally, the last term on the right hand side turn out to be zero, by differentiating with respect $\pi^\star(n)$ the value matching condition (6), and recalling that $V_c(\xi^\star,\pi^\star(n)) = 1+p$. By taking expectations in (18), it then follows that

$$V_{\pi^\star(n)}(c,\pi^\star(n)) = \mathbb{E}\left[\int_0^T e^{-\rho s}V_c(C_s,\pi^\star(n))ds\middle|\, C_0 = c\right] + \mathbb{E}\left[e^{-\rho T}V_{\pi^\star(n)}(C_T)\middle|\, C_0 = c\right].$$

The first term on the right hand side is positive, as $V_c > 1$ over $0 \le c < C^\star$ and $V_c(C^\star,\pi^\star(n)) = 1$. Thus, the first term is not less than $\frac{1}{\rho}$, while $\lim_{T\uparrow\infty} E_c\left[e^{-\rho T}V_{\pi^\star(n)}(C_T,\pi^\star(n))\right] = 0$ by arguments similar to Lemma 6. Therefore, $V_{\pi^\star(n)}(c,\pi^\star(n)) > \frac{1}{\rho}$ as required, and the claim follows. ∎

The parameters α, γ, n only enter in the free boundary problem through $\pi^\star(n)$, defined by $\pi^\star(n) = (\frac{\alpha-\gamma}{n+1})^2$. Thus, the result below follows from Lemma 7.

Lemma 8 *Target cash holdings $C^\star$ increase with n and γ and decrease with α and k.*

Proof. We have

$$\begin{aligned}
\frac{\partial C^\star\left(\pi^\star(n,\alpha)\right)}{\partial \alpha} &= C^\star_{\pi^\star(n,\alpha)}\left(\pi^\star(n,\alpha)\right)\ \frac{2(\alpha-\gamma)}{(n+1)^2} < 0,\\
\frac{\partial C^\star\left(\pi^\star(n)\right)}{\partial n} &= C^\star_{\pi^\star(n)}\left(\pi^\star(n)\right)\ \frac{2(\alpha-\gamma)^2}{-(n+1)^3} > 0,\\
\frac{\partial C^\star\left(\pi^\star(n,\gamma)\right)}{\partial \gamma} &= C^\star_{\pi^\star(n,\gamma)}\left(\pi^\star(n,\gamma)\right)\ \frac{2(\gamma-\alpha)}{(n+1)^2} > 0,
\end{aligned}$$

where the inequalities are motivated by the result in Lemma 7 and the parametric restrictions $\alpha > \gamma$ and $n > 0$. Additionally, note that the Cournot equilibrium yields that $\pi^\star(n) = (k^\star)^2$, $k > 0$, so the required monotonicity with respect to k follows. ■

We finally prove the monotonicity with respect to p and f.

Lemma 9 *Target cash holdings $C^\star$ are monotone increasing in p and f.*

Proof. To prove the claim, we first establish that $V(c)$ is decreasing in p and f, following the intuition in DMRV (2011). Consider a given decrease of the issuance costs either in the proportional or the fixed component or both, i.e. $\bar{p} \leq p$ or $\bar{f} \leq f$ with at least one strict inequality. Suppose that under this scenario the firm keeps the same dividend policy and issues new equity when reserves are depleted to reach the target level $\xi^\star$, i.e. the dynamics of the cash reserves are still the same as for p and f. Under this policy, the amount spent for the issuance is lower than before as equity is less costly. Thus, the policy yields a strictly higher firm value, so that $V(c)$ is strictly decreasing in p and f.

We now need to link the monotonicity of $V(c)$ to the payout threshold $C^\star$. That is, given that $V(c)$ decreases with p and f, if we show that $V(c)$ decreases in $C^\star$ the claim will follow. To do so, we consider the solutions $\phi_0(c)$ and $\phi_1(c)$ to the ODE

$$\rho\,\phi_i(c) = \phi_i'(c)\left[rc + \pi^\star(n)\right] + \frac{\sigma^2}{2}\phi_i''(c),$$

subject to $\phi_0(0) = 1$, $\phi_1(0) = 0$, $\phi_0'(0) = 0$, $\phi_1'(0) = 1$. Using these solutions, we can represent the function V as

$$V(c, C^\star) = V(0, C^\star)\phi_0(c) + V'(0, C^\star)\phi_1(c).$$

Since we want to establish the monotonicity of V with respect to the payout threshold, we use the value-matching and smooth-pasting conditions at $C^\star$ to derive an expression for $V(0, C^\star)$ and $V'(0, C^\star)$. Simple calculations yield

$$\begin{aligned}
V(0, C^\star) &= \frac{V(C^\star)\phi_1'(C^\star) - V'(C^\star)\phi_1(C^\star)}{\phi_1'(C^\star)\phi_0(C^\star) - \phi_1(C^\star)\phi_0'(C^\star)} \qquad (19)\\
V'(0, C^\star) &= \frac{V'(C^\star)\phi_0(C^\star) - V(C^\star)\phi_0'(C^\star)}{\phi_1'(C^\star)\phi_0(C^\star) - \phi_1(C^\star)\phi_0'(C^\star)}
\end{aligned}$$

where the denominator is the wronskian $W(c)$ of the two linearly independent solution $\phi_0(c)$ and $\phi_1(c)$. Using Abel's identity, we have that $W(C^\star) = e^{-C^\star(rC^\star+2\pi^\star(n))/(\sigma^2)}$ which is strictly positive. By differentiating (19) with respect to $C^\star$ it follows that $V_{C^\star}(0, C^\star) = \frac{r-\rho}{\rho\, W(C^\star)}\, \phi_1'(C^\star)$, and since $r < \rho$ we just need to prove that $\phi_1'(C^\star) > 0$ to infer the claim. To do so, recall that $\phi_1(0) = 0$ and $\phi_1'(0) = 1$, and since

$$\rho\, \phi_1(c) = \phi_1'(c)\, [rc + \pi^\star(n)] + \frac{\sigma^2}{2} \phi_1''(c),$$

holds for any $c \geq 0$, we have $\phi_1''(0) = -\frac{2\pi^\star(n)}{\sigma^2} < 0$. This in turn implies that ϕ_1 is increasing and concave at zero. Note that $\phi_1(c)$ does not admit a positive local maximum C_M, because in this case $\rho\, \phi_1(C_M) = \frac{\sigma^2}{2} \phi_1''(C_M)$ and the left hand side would be positive while the right hand side negative. Therefore, a positive local maximum does not exist, and $\phi_1'(c)$ is positive for any positive c, i.e. $\phi_1'(C^\star) > 0$. It then follows that $V_{C^\star}(0, C^\star)$ is negative, implying that an increase in the dividend threshold lowers the firm value at zero. Exploiting similar arguments, we have that $V_{cC^\star}(0, C^\star) > 0$, implying that an increase in the dividend threshold increase the first derivative at zero.

Now, take two dividend thresholds $X_1 < X_2$ and define $k(c) = V(c, X_1) - V(c, X_2)$. The results derived above imply that $k(0) > 0$ and $k'(0) < 0$. In addition, we have

$$V(X_2, X_1) = \frac{rX_1 + \pi^\star(n)}{\rho} + X_2 - X_1 > \frac{rX_2 + \pi^\star(n)}{\rho} = V(X_2, X_2)$$

as $(\rho - r)\,(X_2 - X_1) > 0$, implying that $k(X_2) > 0$ and $k'(X_2) = 0$. For any $X_1 \leq c \leq X_2$, we have $k'(c) = 1 - V_c(c, X_2) < 0$ and $k''(c) = -V_{cc}(c, X_2) > 0$. As a result, $k(c)$ is decreasing and convex on this interval. In addition, $k(c)$ cannot have a positive local maximum nor a negative local minimum on $0 < c < X_1$, implying that $k(c)$ is nonnegative for any $0 < c \leq X_2$, so $V(c, X_1) > V(c, X_2)$ for any c. It follows that $V(c)$ is decreasing in the dividend boundary. ■

The joint effects of competition and financing constraints on target cash holdings are illustrated in the following lemma.

Lemma 10 *The cross derivative* $\frac{\partial^2 C^\star}{\partial n \partial f}$ *is positive.*

Proof. We start by proving that $V_c(c, f)$ is an increasing function of f for any c. Consider two values of the fixed cost $f_2 > f_1$, and the function

$$k(c) = V(c, f_2) - V(c, f_1).$$

By Lemma 9 we have $C_2^\star(f_2) > C_1^\star(f_1)$, and $k(c)$ is always negative. At C_1^*, $k'(C_1^*) = V'(C_1^*, f_2) - 1 > 0$ and $k''(C_1^*) = V''(C_1^*, f_2) < 0$, so the function is increasing and concave on $[C_1^\star, C_2^\star]$. In addition, $k(c)$ evolves as $\rho\, k(c) = k'(c)\, [rc + \pi^\star(n)] + \frac{\sigma^2}{2} k''(c)$ on $[0, C_1^\star]$, so there cannot exists a negative local minimum (nor a positive local maximum) for the function, otherwise $k < 0,\ k' = 0,\ k'' > 0$ ($k > 0,\ k' = 0,\ k'' < 0$) and the ODE would not be satisfied.

This means that $V_c(c, f_2) > V_c(c, f_1)$, for any c. By Lemma 7, $V_{\pi^\star(n)}(c, f_2) > V_{\pi^\star(n)}(c, f_1)$, and then $C^\star_{\pi^\star(n)}(c, f_2) < C^\star_{\pi^\star(n)}(c, f_1)$. So, $C^\star_n(n, f_2) > C^\star_n(n, f_1)$ by Lemma 8. The claim follows. ■

We finally characterize the properties of the issue size $\xi^\star$.

Lemma 11 *For any given $p > 0$, the issue size $\xi^\star$ is monotone increasing in n, σ^2, f, and γ, and decreasing in k and α.*

Proof. To prove the claim, let us define the function $V(c, X)$ of a firm that distributes dividends to maintain its cash holdings below the level X. We first show that, for $X_1 < X_2$, we have that $V'(c, X_1) \leq V'(c, X_2)$ for any c. We define the auxiliary function

$$k(c) = V(c, X_2) - V(c, X_1),$$

that is negative by Lemma 9. By previous results, $k(c)$ is also increasing and concave at X_1. As the function evolves as $[rc + \pi^\star(n)]k'(c) + 0.5\sigma^2 k''(c) - \rho k(c) = 0$ on $[0, X_1]$, it cannot have neither a positive local maximum nor a negative local minimum (otherwise $k'(c) = 0$, $k(c) < 0$ and $k''(c) > 0$). It then follows that $V'(c, X_1) \leq V'(c, X_2)$ for any c. Therefore, we have that

$$V'(\xi^\star(X_1), X_2) \geq V'(\xi^\star(X_1), X_1) = 1 + p$$

so that $\xi^\star(X_1) < \xi^\star(X_2)$ because of concavity. Thus, if the payout threshold increases, then $\xi^\star$ increases. Towards a contradiction, suppose that an increase in n leads to a decrease in $\xi^\star$. Since the payout threshold is monotone increasing in n, the claim would mean that the monotonicity of $\xi^\star$ with respect to the dividend boundary would not be satisfied, contradicting our result above. Analogous arguments can be extended to the other parameters of interest. ■

C. Probability of an equity issue.

We are interested in computing the probability that $\tau_0 \leq T$, with $\tau_0 = \inf\{t \geq 0 : C_t = 0\}$. This probability is defined by

$$\mathbb{P}_0\left(t; T, c\right) \equiv \mathbb{E}\left[1_{\tau_0 \leq T} \middle| C_t = c\right] = H(t; T, c),$$

Using the Feynman-Kac formula, we have that $H(t; T, c)$ solves

$$H_t(t; T, c) + H_c(t; T, c)(rc + \pi^*) + H_{cc}(t; T, c)\frac{\sigma^2}{2} = 0,$$

subject to $H(t, T, 0) = 1$, $H_c(t; T, C^\star) = 0$, and $H(T; T, c) = 0$, $\forall c \in (0, C^\star]$, where the second boundary condition is due to the fact that the cash reserves process is reflected at the payout threshold $C^\star$.

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Table 1: Data Definitions

Variable	Variable Definition
Dependent Variables	
Cash	Cash and Short-Term Investments (CHE)/ Assets - Total (AT)
Cash alternate	log(Cash and Short-Term Investments (CHE)/ (Assets - Total (AT) - Cash and Short-Term Investments (CHE))
Equity Issuance	(Sale of Com. & Pref. Stock (SSTK)-Purchase of Com. & Pref. Stock (PRSTKC))/ Assets- Total (AT)
Equity Issuance alternate	Sale of Com. & Pref. Stock (SSTK)/Assets - Total (AT)
Intensity of Competition	
EPCM	PCM - Industry Value-Weighted PCM
Fluidity	Hoberg and Phillips Library
HHI TNIC	Hoberg and Phillips Library
Import Penetration	See Section 3.3
Tariff	See Section 3.3
Foreign Exchange Rate Index	See Section 3.3
Intensity of Financial Constraint	
Payout	(Dividends - Common (DVC) + Purchase of Com. & Pref. Stock (PRSTKC))/ Operating Income Before Deprec. (OIBDP)
Size	log(Sales net (SALE))
Bond Rating	Dummy variable equal to 1 if (SPLTICRM) missing or non-investment grade 0 otherwise
Whited & Wu index	See Section 3.4
Control Variables	
Volatility	See Section 3.2
Book Debt	Long term debt (DLTT) + Debt in current liabilities (DLC)
Book Equity	Assets total (AT) - Book debt
MB	(Market value (CSHO * PRCC) + Book debt)/Assets - Total (AT)
Cash Flow	(EBITDA - Interest - Taxes - Common Dividend)/Assets- Total (AT)
Net Working Captial	(Working Capital (WCAP) - Cash and Short-Term Investments (CHE)/ Assets - Total (AT)
Capex	Capital Expenditures (CAPX)/Assets - Total (AT)
Leverage	Book Debt/(Assets Total (AT) - Book equity + Market value (CSHO * PRCC))
R&D	Research and development expenses (XRD)/Assets total (AT)
Aquisitions	Acquisitions (AQC)/Assets - Total (AT)
Dividends	Dummy variable equal to 1 if Dividends - Common (DVC) reported
Loss Dummy	Dummy variable equal to 1 if net income is negative, 0 otherwise
Tangibility	Property, Plant and Equipment - Net (PPENT)/Assets - Total (AT)
IPO1 through IPO5	Dummy variable equal to 1 if the firm went public 1, 2, 3, 4, 5 years ago

Table 2: Constraint Type Cross-Correlations

Table 2 reports constraint type cross-correlations. We use four criteria to classify firm-year observations as constrained (C) or unconstrained (U). The sample is based on Compustat Annual Industrial files over the 1980-2007 period.

		Payout Policy		Firm Size		Bond Rating		WW index	
		(C)	(U)	(C)	(U)	(C)	(U)	(C)	(U)
Payout Policy									
Constrained Firms	(C)	45,044							
Unconstrained Firms	(U)		33,036						
Firm Size									
Constrained Firms	(C)	20,128	3,306	23,434					
Unconstrained Firms	(U)	6,280	17,154		23,434				
Bond Rating									
Constrained Firms	(C)	44,315	27,279	23,428	17,098	71,594			
Unconstrained Firms	(U)	729	5,757	6	6,336		6,486		
WW index									
Constrained Firms	(C)	20,979	2,455	19,047	35	23,432	2	23,434	
Unconstrained Firms	(U)	4,632	18,802	110	19,439	17,040	6,394		23,434

Table 3: Descriptive Statistics

Table 3 presents descriptive statistics for the main variables used in the estimation. The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Table 1 provides a detailed definition of the variables.

	Mean	S.D.	25%	50%	75%	Obs
Dependent Variable						
Cash	0.17	0.20	0.03	0.09	0.25	78,080
Cash alternate	-2.37	1.86	-3.62	-2.31	-1.08	77,523
Equity Issuance	0.04	0.13	0.00	0.00	0.01	71,502
Equity Issuance alternative	0.04	0.12	0.00	0.00	0.02	76,497
Intensity of Competition						
EPCM	-0.17	0.59	-0.14	-0.04	0.02	78,080
HHI TNIC	0.18	0.20	0.06	0.11	0.23	28,667
Fluidity	7.30	3.38	4.79	6.84	9.34	26,239
Import Penetration: Industry	0.13	0.13	0.04	0.08	0.18	17,430
Tariff: Industry	0.04	0.03	0.01	0.04	0.05	14,402
Foreign Exchange Index: Industry	1.66	0.99	0.87	1.62	2.57	17,430
Import Penetration: Firm	0.10	0.12	0.02	0.05	0.13	17,430
Tariff: Firm	0.03	0.03	0.01	0.02	0.04	14,402
Foreign Exchange Index: Firm	1.24	1.00	0.38	0.98	1.96	17,430
Intensity of Financial Constraint						
Payout	0.10	0.22	0.00	0.00	0.11	78,080
Firm Size	4.72	2.37	3.09	4.63	6.27	78,080
Bond Rating	0.08	0.28	0.00	0.00	0.00	78,080
Whited & Wu index	-0.21	0.12	-0.29	-0.20	-0.12	78,080
Control Variables						
Volatility	0.08	0.03	0.05	0.08	0.10	78,080
Market-to-Book	1.71	1.66	0.78	1.15	1.94	78,080
Cash Flow	0.04	0.20	0.00	0.08	0.14	78,080
Net Working Captial	0.09	0.21	-0.03	0.09	0.24	78,080
Capex	0.07	0.07	0.02	0.05	0.09	78,080
Leverage	0.23	0.24	0.02	0.15	0.37	78,080
R&D	0.05	0.09	0.00	0.00	0.07	78,080
Aquisitions	0.02	0.06	0.00	0.00	0.00	78,080
Dividends Dummy	0.30	0.46	0.00	0.00	1.00	78,080
Loss Dummy	0.25	0.43	0.00	0.00	0.00	78,080
Tangibility	0.30	0.23	0.11	0.23	0.43	78,080
IPO1	0.09	0.29	0.00	0.00	0.00	78,080
IPO2	0.10	0.30	0.00	0.00	0.00	78,080
IPO3	0.09	0.29	0.00	0.00	0.00	78,080
IPO4	0.08	0.27	0.00	0.00	0.00	78,080
IPO5	0.07	0.26	0.00	0.00	0.00	78,080

Table 4: Cash holdings and Competition

Table 4 reports coefficient estimates of regressions that examine the effect of competition and financing constraints on cash holdings. The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Robust standard errors are reported under the coefficients in parenthesis. Fama-MacBeth standard errors are adjusted for first-order autocorrelation. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1) No fixed effects	(2) Fixed effects	(3) Fama-MacBeth	(4) No fixed effects	(5) Fixed effects	(6) Fama-MacBeth	(7) No fixed effects	(8) Fixed effects	(9) Fama-MacBeth
Competition: EPCM	-0.058***	-0.055***	-0.044***						
	(0.002)	(0.002)	(0.008)						
Competition: HHI TNIC				-0.100***	-0.117***	-0.106***			
				(0.005)	(0.006)	(0.010)			
Competition: Fluidity							0.009***	0.011***	0.009***
							(0.000)	(0.000)	(0.001)
Size	-0.003***	-0.006***	-0.005***	-0.013***	-0.018***	-0.015***	-0.012***	-0.017***	-0.013***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Dividend	-0.012***	-0.008***	-0.011**	-0.021***	-0.016***	-0.017***	-0.013***	-0.006*	-0.010**
	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Bond Rating	-0.052***	-0.047***	-0.035***	-0.043***	-0.038***	-0.039***	-0.045***	-0.036***	-0.044***
	(0.002)	(0.002)	(0.006)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.004)
Volatility	0.715***	0.783***	0.660***	0.751***	0.782***	0.746***	0.595***	0.605***	0.586***
	(0.025)	(0.032)	(0.077)	(0.043)	(0.056)	(0.109)	(0.046)	(0.060)	(0.121)
Market-to-Book	0.012***	0.011***	0.011***	0.014***	0.014***	0.017***	0.013***	0.012***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Cash flow	0.106***	0.112***	0.125***	0.015	0.028***	0.019	0.029***	0.042***	0.034
	(0.006)	(0.006)	(0.012)	(0.008)	(0.008)	(0.017)	(0.008)	(0.008)	(0.016)
Net working capital	-0.196***	-0.197***	-0.180***	-0.254***	-0.279***	-0.240***	-0.231***	-0.263***	-0.222***
	(0.003)	(0.004)	(0.006)	(0.006)	(0.008)	(0.016)	(0.007)	(0.008)	(0.017)
Capex	-0.453***	-0.400***	-0.432***	-0.594***	-0.481***	-0.563***	-0.580***	-0.504***	-0.554***
	(0.008)	(0.009)	(0.016)	(0.016)	(0.017)	(0.035)	(0.017)	(0.019)	(0.039)
Leverage	-0.212***	-0.213***	-0.208***	-0.248***	-0.248***	-0.237***	-0.249***	-0.250***	-0.244***
	(0.003)	(0.003)	(0.009)	(0.005)	(0.005)	(0.010)	(0.005)	(0.005)	(0.009)
R&D	0.473***	0.434***	0.389***	0.485***	0.396***	0.494***	0.467***	0.375***	0.483***
	(0.013)	(0.013)	(0.030)	(0.019)	(0.020)	(0.047)	(0.019)	(0.020)	(0.049)
Acquisitions	-0.265***	-0.243***	-0.261***	-0.347***	-0.290***	-0.348***	-0.369***	-0.301***	-0.373***
	(0.008)	(0.008)	(0.022)	(0.013)	(0.013)	(0.031)	(0.013)	(0.014)	(0.032)
Year fixed effects	No	Yes	No	No	Yes	No	No	Yes	No
Industry fixed effects	No	Yes	No	No	Yes	No	No	Yes	No
Observations	67,123	67,123	67,123	23,599	23,599	23,599	21,461	21,461	21,461
Adjusted R^2	0.43	0.44	0.40	0.51	0.53	0.52	0.52	0.54	0.53

Table 5: Cash holdings and Competition: Robustness

Table 5 reports coefficient estimates of regressions that examine the effect of competition and financing constraints on cash holdings. The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Robust standard errors are reported under the coefficients in parenthesis. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1) Log(Cash/ Assets-Cash)	(2) Additional Controls	(3) Between regression	(4) Log(Cash/ Assets-Cash)	(5) Additional Controls	(6) Between regression	(7) Log(Cash/ Assets-Cash)	(8) Additional Controls	(9) Between regression
Competition: EPCM	-0.287***	-0.054***	-0.069***						
	(0.019)	(0.002)	(0.003)						
Competition: HHI TNIC				-0.710***	-0.112***	-0.125***			
				(0.055)	(0.006)	(0.013)			
Competition: Fluidity							0.072***	0.010***	0.013***
							(0.004)	(0.000)	(0.001)
Size	-0.005	-0.005***	0.006***	-0.081***	-0.016***	-0.014***	-0.072***	-0.016***	-0.014***
	(0.004)	(0.000)	(0.001)	(0.007)	(0.001)	(0.002)	(0.007)	(0.001)	(0.002)
Dividend	-0.096***	-0.005***	-0.019***	-0.163***	-0.011***	-0.022**	-0.105***	-0.003	-0.007
	(0.015)	(0.001)	(0.005)	(0.026)	(0.002)	(0.007)	(0.028)	(0.003)	(0.008)
Bond rating	-0.544***	-0.044***	-0.103***	-0.465***	-0.037***	-0.055***	-0.435***	-0.035***	-0.056***
	(0.022)	(0.002)	(0.010)	(0.036)	(0.003)	(0.011)	(0.038)	(0.003)	(0.011)
Volatility	7.603***	0.765***	0.639***	8.586***	0.780***	0.446***	7.418***	0.626***	0.337***
	(0.320)	(0.032)	(0.061)	(0.532)	(0.056)	(0.092)	(0.559)	(0.060)	(0.094)
Market-to-Book	0.063***	0.010***	0.011***	0.090***	0.013***	0.018***	0.077***	0.011***	0.017***
	(0.004)	(0.001)	(0.001)	(0.005)	(0.001)	(0.002)	(0.005)	(0.001)	(0.002)
Cash flow	0.786***	0.129***	0.134***	0.231***	0.067***	0.038**	0.317***	0.069***	0.059***
	(0.044)	(0.007)	(0.010)	(0.058)	(0.010)	(0.013)	(0.061)	(0.011)	(0.014)
Net working capital	-1.809***	-0.193***	-0.209***	-2.292***	-0.271***	-0.294***	-2.146***	-0.258***	-0.250***
	(0.040)	(0.004)	(0.008)	(0.068)	(0.008)	(0.014)	(0.072)	(0.008)	(0.014)
Capex	-3.351***	-0.415***	-0.563***	-3.468***	-0.501***	-0.767***	-3.589***	-0.517***	-0.783***
	(0.098)	(0.009)	(0.023)	(0.180)	(0.018)	(0.039)	(0.192)	(0.019)	(0.040)
Leverage	-2.461***	-0.210***	-0.270***	-2.789***	-0.245***	-0.312***	-2.800***	-0.247***	-0.301***
	(0.032)	(0.003)	(0.009)	(0.057)	(0.005)	(0.014)	(0.060)	(0.005)	(0.014)
R&D	3.157***	0.436***	0.576***	2.570***	0.401***	0.490***	2.463***	0.382***	0.403***
	(0.096)	(0.013)	(0.022)	(0.134)	(0.019)	(0.030)	(0.135)	(0.020)	(0.030)
Acquisitions	-2.518***	-0.255***	-0.516***	-2.732***	-0.305***	-0.602***	-2.851***	-0.312***	-0.642***
	(0.102)	(0.008)	(0.038)	(0.145)	(0.013)	(0.048)	(0.152)	(0.014)	(0.048)
Loss dummy		0.010***			0.020***			0.014***	
		(0.002)			(0.004)			(0.004)	
IPO1		0.032***			0.061***			0.036***	
		(0.003)			(0.007)			(0.009)	
IPO2		0.034***			0.042***			0.039***	
		(0.002)			(0.005)			(0.006)	
IPO3		0.024***			0.036***			0.031***	
		(0.002)			(0.005)			(0.005)	
IPO4		0.015***			0.018***			0.012*	
		(0.002)			(0.005)			(0.005)	
IPO5		0.013***			0.014**			0.008	
		(0.002)			(0.005)			(0.005)	
Year fixed effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Industry fixed effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Observations	66,638	67,123	67,123	23,437	23,599	23,599	21,317	21,461	21,461
Adjusted R^2	0.38	0.45	0.55	0.50	0.54	0.60	0.51	0.55	0.61

Table 6: CASH HOLDINGS AND COMPETITION: SAMPLE SPLITS

Table 6 reports estimates of *Competition* from a set of estimations of equation (9). The dependent variable is the cash to assets ratio. The sample is split with respect to the intensity of financing constraint. We use four criteria to classify firm-year observations as constrained (C) or unconstrained (U). The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Robust standard errors are reported under the coefficients in parenthesis. We test for differences in coefficients across equations. The associated p-values are reported in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Payout	Size	Rating	WW index
EPCM				
Unconstrainted (U)	-0.010	-0.082***	-0.066***	-0.122***
	(0.010)	(0.008)	(0.016)	(0.012)
Constrainted (C)	-0.153***	-0.150***	-0.128***	-0.136***
	(0.005)	(0.007)	(0.005)	(0.006)
(C) - (U)	[0.000]	[0.000]	[0.000]	[0.586]
HHI TNIC				
Unconstrainted (U)	-0.062***	-0.056***	-0.041***	-0.057***
	(0.007)	(0.006)	(0.009)	(0.007)
Constrainted (C)	-0.144***	-0.154***	-0.122***	-0.127***
	(0.008)	(0.013)	(0.006)	(0.009)
(C) - (U)	[0.000]	[0.000]	[0.000]	[0.006]
Fluidity				
Unconstrainted (U)	0.004***	0.003***	0.001*	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Constrainted (C)	0.014***	0.018***	0.012***	0.015***
	(0.001)	(0.001)	(0.000)	(0.001)
(C) - (U)	[0.000]	[0.000]	[0.000]	[0.000]

Table 7: Cash holdings and Import Penetration

Table 7 presents results of IV regressions of cash holdings on the intensity of competition, the severity of financing constraints, and control variables. The intensity of competition is measured by import penetration. Import penetration is instrumented with the level of tariffs and the foreign exchange rate. The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Robust standard errors are reported under the estimates in parenthesis. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Second Stage Estimation			First Stage Estimation	
	Cash (1)	Cash (2)		IP (1)	IP (2)
IP: Industry	0.498***		Tariff: Industry	-0.432***	
	(0.143)			(0.071)	
IP: Firm		0.201***	FX rate: Industry	0.014***	
		(0.061)		(0.002)	
			Tariff: Firm		-0.337***
					(0.077)
			FX rate: Firm		0.038***
					(0.002)
Size	-0.014***	-0.013***		-0.000	-0.002
	(0.002)	(0.002)		(0.001)	(0.001)
Dividend	-0.009***	-0.009***		0.005	0.002
	(0.002)	(0.003)		(0.005)	(0.004)
Bond Rating	-0.009	-0.009		-0.001	-0.000
	(0.005)	(0.005)		(0.003)	(0.003)
Volatility	0.910***	0.778***		-0.197	0.027
	(0.144)	(0.139)		(0.112)	(0.100)
Market-to-Book	0.010***	0.010***		-0.000	-0.001*
	(0.002)	(0.002)		(0.000)	(0.001)
Cash flow	0.077***	0.075***		-0.001	0.006
	(0.015)	(0.015)		(0.004)	(0.005)
Net working capital	-0.138***	-0.138***		-0.005	-0.015*
	(0.014)	(0.014)		(0.005)	(0.006)
Capex	-0.236***	-0.241***		-0.005	0.002
	(0.021)	(0.021)		(0.007)	(0.009)
Leverage	-0.109***	-0.109***		-0.003	-0.002
	(0.009)	(0.009)		(0.004)	(0.005)
R&D	0.184***	0.179***		-0.024	-0.019
	(0.046)	(0.046)		(0.012)	(0.016)
Acquisitions	-0.141***	-0.137***		-0.004	-0.012
	(0.019)	(0.019)		(0.007)	(0.009)
Year fixed effects	Yes	Yes		Yes	Yes
Industry fixed effects	Yes	Yes		Yes	Yes
Observations	12,510	12,510		12,510	12,510
Adjusted R^2	0.33	0.33		0.52	0.53
Hansen J-stat (p-value)	0.30	0.27	F-test that instruments jointly equal zero (p-value)	0.00	0.00

Table 8: Equity Issuance and Competition

Table 8 reports coefficient estimates of regressions that examine the effect of competition on equity issuance. The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Robust standard errors are reported under the coefficients in parenthesis. Fama-MacBeth standard errors are adjusted for first-order autocorrelation. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1) No fixed effects	(2) Fixed effects	(3) Fama-MacBeth	(4) No fixed effects	(5) Fixed effects	(6) Fama-MacBeth	(7) No fixed effects	(8) Fixed effects	(9) Fama-MacBeth
Competition: EPCM	-0.020***	-0.020***	-0.019***						
	(0.002)	(0.002)	(0.003)						
Competition: HHI TNIC				-0.014***	-0.015***	-0.015***			
				(0.004)	(0.004)	(0.003)			
Competition: Fluidity							0.003***	0.003***	0.003***
							(0.000)	(0.000)	(0.001)
Size	-0.007***	-0.008***	-0.007***	-0.011***	-0.011***	-0.011***	-0.010***	-0.011***	-0.011***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Cash flow	-0.089***	-0.092***	-0.078***	-0.146***	-0.147***	-0.156***	-0.137***	-0.137***	-0.148***
	(0.005)	(0.005)	(0.013)	(0.008)	(0.008)	(0.017)	(0.008)	(0.008)	(0.017)
Market-to-Book	0.022***	0.022***	0.024***	0.019***	0.019***	0.019***	0.018***	0.018***	0.017***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tangibility	0.011***	0.009**	0.009*	0.016***	0.012*	0.017**	0.017***	0.022***	0.019**
	(0.002)	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
Leverage	0.003	-0.001	0.007*	0.009**	0.009**	0.011	0.009**	0.009*	0.010
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.006)	(0.003)	(0.004)	(0.006)
Year fixed effects	No	Yes	No	No	Yes	No	No	Yes	No
Industry fixed effects	No	Yes	No	No	Yes	No	No	Yes	No
Observations	63,035	63,035	63,035	21,150	21,150	21,150	19,274	19,274	19,274
Adjusted R^2	0.16	0.17	0.17	0.19	0.20	0.19	0.20	0.20	0.20

Table 9: Equity Issuance and Competition: Robustness

Table 9 reports coefficient estimates of regressions that examine the effect of competition on equity issuance. The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Robust standard errors are reported under the coefficients in parenthesis. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1) Gross Issue	(2) Additional Controls	(3) Between regression	(4) Gross Issue	(5) Additional Controls	(6) Between regression	(7) Gross Issue	(8) Additional Controls	(9) Between regression
Competition: EPCM	-0.025***	-0.019***	-0.015***						
	(0.002)	(0.002)	(0.002)						
Competition: HHI TNIC				-0.014***	-0.014***	-0.005			
				(0.004)	(0.004)	(0.008)			
Competition: Fluidity							0.003***	0.003***	0.003***
							(0.000)	(0.000)	(0.000)
Size	-0.005***	-0.008***	-0.005***	-0.008***	-0.011***	-0.008***	-0.008***	-0.011***	-0.009***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Cash flow	-0.126***	-0.098***	-0.134***	-0.181***	-0.149***	-0.170***	-0.173***	-0.140***	-0.146***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Market-to-Book	0.020***	0.022***	0.022***	0.019***	0.019***	0.019***	0.018***	0.018***	0.018***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tangibility	0.016***	-0.013***	0.011*	0.020***	-0.010	0.020**	0.027***	0.001	0.017*
	(0.003)	(0.003)	(0.005)	(0.005)	(0.006)	(0.007)	(0.005)	(0.006)	(0.007)
Leverage	-0.007***	0.003	-0.013*	-0.010**	0.011***	0.002	-0.011***	0.011**	0.007
	(0.002)	(0.002)	(0.006)	(0.003)	(0.003)	(0.008)	(0.003)	(0.004)	(0.008)
Capex		0.134***			0.130***			0.120***	
		(0.010)			(0.020)			(0.021)	
Acquisitions		0.097***			0.074***			0.064***	
		(0.010)			(0.013)			(0.013)	
, Year fixed effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Industry fixed effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Observations	67,213	63,035	63,035	23,684	21,150	21,150	21,543	19,274	19,274
Adjusted R^2	0.23	0.17	0.28	0.26	0.20	0.29	0.26	0.21	0.29

Table 10: Equity Issuance and Competition: Sample Splits

Table 10 reports estimates of *Competition* from a set of estimations of equation (10). The dependent variable is equity issuance. The sample is split with respect to the intensity of financing constraint. We use four criteria to classify firm-year observations as constrained (C) or unconstrained (U). The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Robust standard errors are reported under the coefficients in parenthesis. We test for differences in coefficients across equations. The associated p-values are reported in brackets. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Payout	Size	Rating	WW index
EPCM				
Unconstrainted (U)	-0.041***	-0.038***	-0.023*	-0.047***
	(0.009)	(0.008)	(0.009)	(0.012)
Constrainted (C)	-0.064***	-0.087***	-0.073***	-0.088***
	(0.010)	(0.010)	(0.011)	(0.009)
(C) - (U)	[0.002]	[0.000]	[0.000]	[0.000]
HHI TNIC				
Unconstrainted (U)	-0.010**	-0.008*	-0.009*	-0.004
	(0.004)	(0.003)	(0.004)	(0.003)
Constrainted (C)	-0.015*	-0.036***	-0.018***	-0.019**
	(0.007)	(0.010)	(0.005)	(0.007)
(C) - (U)	[0.090]	[0.002]	[0.005]	[0.000]
Fluidity				
Unconstrainted (U)	0.002***	0.002***	0.001***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Constrainted (C)	0.004***	0.008***	0.004***	0.006***
	(0.001)	(0.001)	(0.000)	(0.001)
(C) - (U)	[0.016]	[0.000]	[0.000]	[0.000]

Table 11: Equity Issuance and Import Penetration

Table 11 presents results of IV regressions of equity issuance on the intensity of competition and control variables. The intensity of competition is measured by import penetration. Import penetration is instrumented with the level of tariffs and the foreign exchange rate. The sample is based on Compustat Annual Industrial files over the 1980-2007 period. Robust standard errors are reported under the estimates in parenthesis. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Second Stage Estimation			First Stage Estimation	
	Equity Issuance (1)	Equity Issuance (2)		IP (1)	IP (2)
IP: Industry	0.057**		Tariff: Industry	-0.439***	
	(0.017)			(0.070)	
IP: Firm		0.044**	FX rate: Industry	0.014***	
		(0.012)		(0.002)	
			Tariff: Firm		-0.346***
					(0.077)
			FX rate: Firm		0.038***
					(0.002)
Size	-0.009***	-0.010***		-0.001	-0.003**
	(0.001)	(0.001)		(0.001)	(0.001)
Cash flow	-0.055***	-0.054***		0.001	0.006
	(0.014)	(0.014)		(0.004)	(0.005)
Market-to-Book	0.027***	0.027***		-0.001	-0.001
	(0.002)	(0.002)		(0.000)	(0.001)
Tangibility	0.053***	0.053***		-0.011	-0.003
	(0.012)	(0.012)		(0.007)	(0.009)
Leverage	0.006	0.006		0.001	0.002
	(0.006)	(0.006)		(0.004)	(0.005)
Year fixed effects	Yes	Yes		Yes	Yes
Industry fixed effects	Yes	Yes		Yes	Yes
Observations	11,725	11,725		11,725	11,725
Adjusted R^2	0.16	0.16		0.52	0.53
Hansen J-stat (p-value)	0.47	0.51	F-test that instruments jointly equal zero (p-value)	0.00	0.00

Table 12: Equity Issuance Hazard Model Estimates

Table 12 reports estimates of proportional hazard models for equity issuance. An equity issuance spike occurs if equity issuance deflated by total assets is greater than 3%, 5%, or 7%. The sample is based on Compustat Annual Industrial files over the 1980-2007 period. s^2 is the variance of the gamma distribution that accounts for unobserved heterogeneity. Standard errors are reported in parenthesis. The symbols ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Issuance Threshold: 3%			Issuance Threshold: 5%			Issuance Threshold: 7%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Competition: EPCM	-0.094***			-0.089***			-0.068**		
	(0.021)			(0.022)			(0.024)		
Competition: HHI TNIC		-0.178*			-0.226*			-0.228*	
		(0.083)			(0.097)			(0.115)	
Competition: Fluidity			0.040***			0.047***			0.051***
			(0.005)			(0.006)			(0.007)
Size	-0.036***	-0.064***	-0.065***	-0.079***	-0.119***	-0.127***	-0.101***	-0.159***	-0.162***
	(0.006)	(0.009)	(0.009)	(0.007)	(0.012)	(0.012)	(0.008)	(0.014)	(0.014)
Cash Flow	-0.896***	-0.802***	-0.605***	-1.092***	-1.143***	-0.895***	-1.186***	-1.300***	-1.047***
	(0.065)	(0.078)	(0.083)	(0.069)	(0.092)	(0.098)	(0.077)	(0.109)	(0.115)
Market-to-Book	0.269***	0.207***	0.195***	0.229***	0.204***	0.190***	0.209***	0.204***	0.181***
	(0.011)	(0.011)	(0.011)	(0.010)	(0.012)	(0.012)	(0.010)	(0.014)	(0.014)
Tangibility	-0.061	-0.016	0.044	0.147**	0.216*	0.270**	0.252***	0.277*	0.346**
	(0.052)	(0.079)	(0.083)	(0.057)	(0.093)	(0.098)	(0.064)	(0.110)	(0.113)
Leverage	-0.454***	-0.809***	-0.864***	-0.210***	-0.341**	-0.385***	-0.227**	-0.124	-0.164
	(0.058)	(0.098)	(0.103)	(0.062)	(0.111)	(0.116)	(0.070)	(0.128)	(0.133)
s^2	0.435***	0.101*	0.110*	0.268***	0.128*	0.142*	0.171*	0.159*	0.104
	(0.057)	(0.045)	(0.049)	(0.060)	(0.059)	(0.065)	(0.067)	(0.079)	(0.079)
Observations	62,711	22,163	20,212	59,813	21,374	19,500	54,922	19,892	18,151
Log-likelihood	26,557.82	-9,707.11	-8,981.33	-21,501.96	-7,703.64	-7,057.94	-17,082.84	-6,008.38	-5,476.84

Figure 2: **Cash holdings, Competition and Financing Constraints**

Figure 2 plots the optimal amount of cash and the optimal issue size, $C^{\star}$ and $\xi^{\star}$, as a function of the intensity of competition, n, for low, medium and high intensity of financial constraint, f (Left Panel), and the intensity of financial constraint, f, for low, medium and high intensity of competition, n (Right Panel). The dotted solid line represents an environment in which product market competition and financing constraints are the highest. The dashed line represents an environment with intermediate product market competition and financing constraints. The solid line represents an environment with low product market competition and financing constraints. Parameter values are set as in the base case environment.

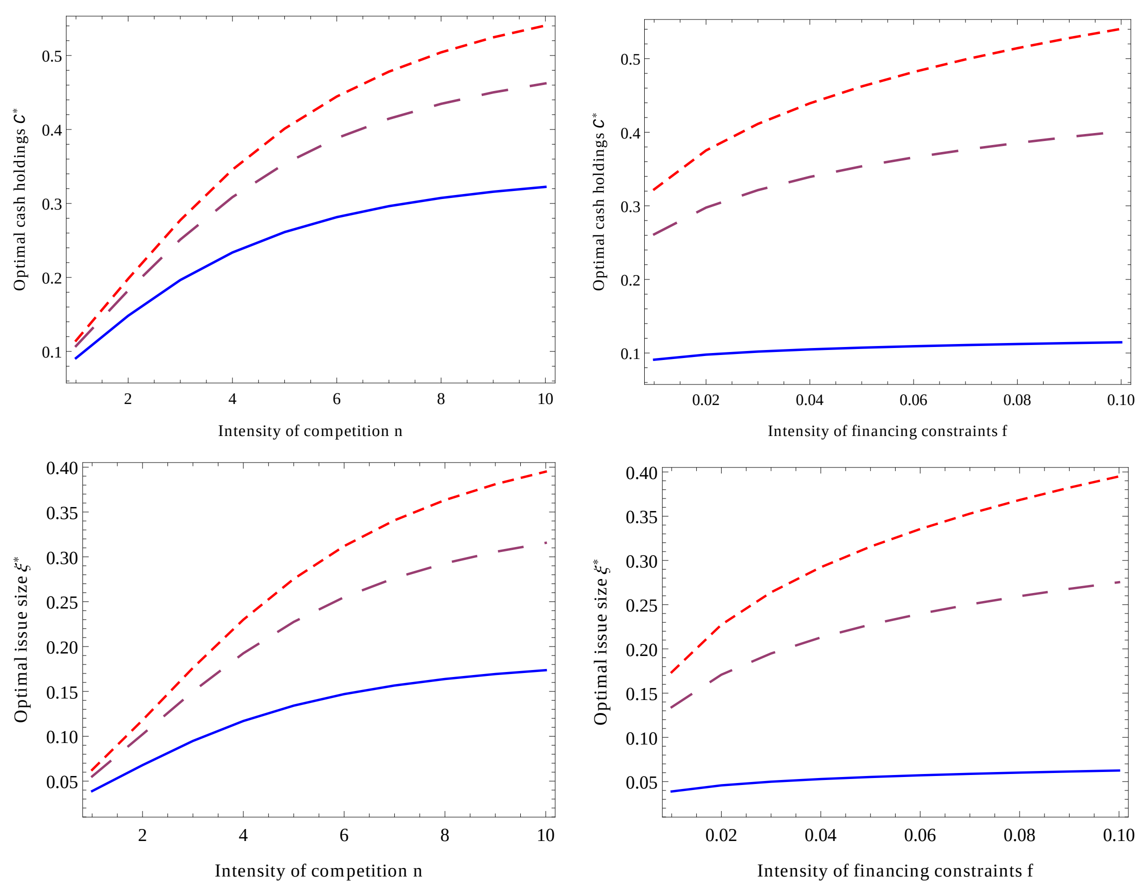

Figure 3: **Probability of an Equity Issue**

Figure 3 plots the probability of an equity issuance as a function of the initial level of the cash buffer ($C \in [0.01, C^{\star}]$) over a finite horizon of two years (left panel) and five years (right panel). The solid line plots this probability for a monopolist ($n = 1$) while the long-dashed and short-dashed lines plot this probability for oligopolistic industries with $n = 5$ and $n = 10$ firms, respectively.

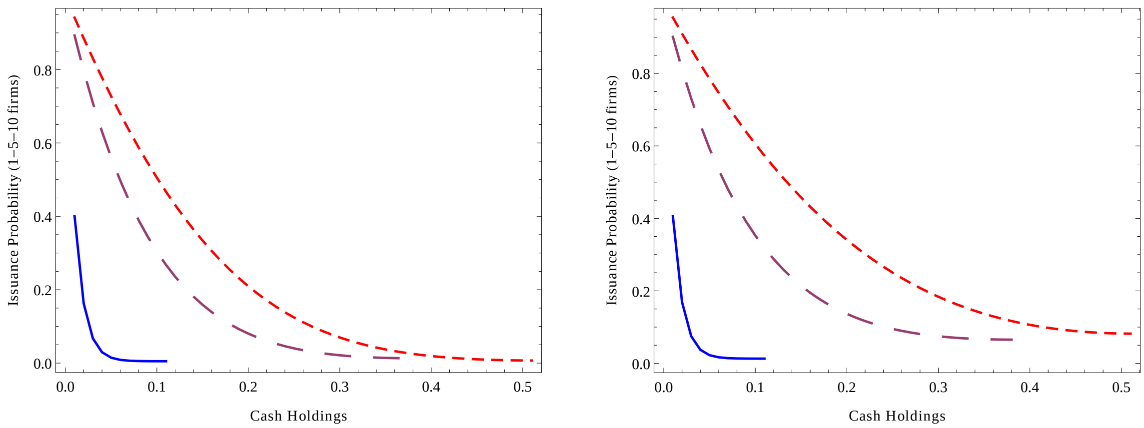

Figure 4: **Cash Holdings and Intensity of Competition Time Trend**

Figure 4 plots: (a) the average cash ratio through time and (b) the intensity of competition through time as measured by the excess price-cost margin, EPCM.