# Firm Financing over the Business Cycle

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**Abstract**

In the data, large public firms substitute between debt- and equity financing over the business cycle whereas small firms' financing policy is pro-cyclical for debt and equity. This paper proposes a mechanism that explains these cyclical patterns. Small firms grow faster and need therefore more funds compared to large firms. During times with high aggregate productivity, they quickly exhaust their endogenous debt limit and must turn to equity financing. In contrast, large firms are close to their efficient scale and want to payout to shareholders. Good times lower the probability of default, decreasing the costs of debt financing for large firms so that debt is used to payout to shareholders. We embed this mechanism in a quantitative firm industry model with endogeneous firm dynamics and explore how macroeconomic shocks get amplified.

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# 1 Introduction

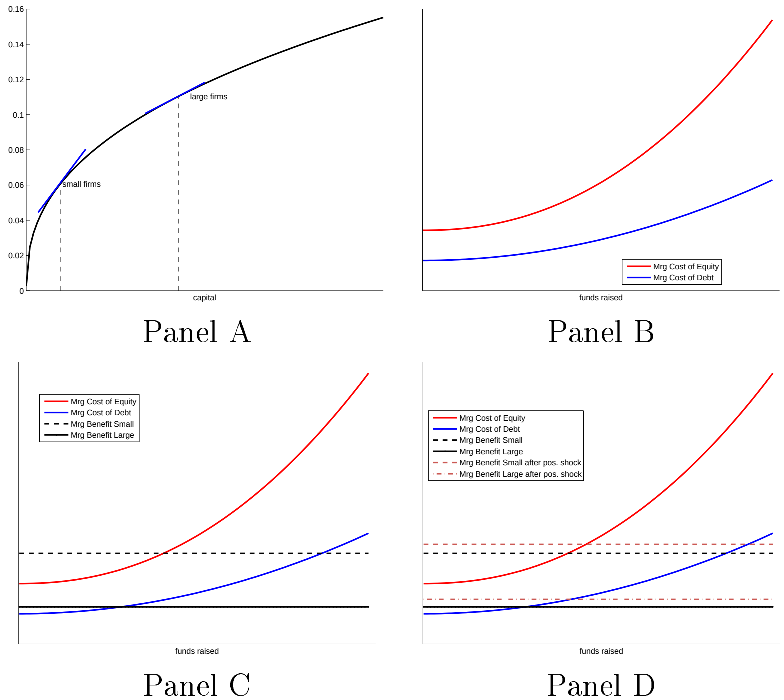
Disruptions in macroeconomic and financial market conditions have large and persistent effects on non-financial firms both in terms of their financing (e.g. Hackbarth, Miao, and Morellec (2006)) and in their investment decisions affecting the real economy (e.g. Jermann and Quadrini (2012) ). In a world where the Modigliani-Miller (MM) theorem holds, investment decisions are independent from the way firms finance themselves. With financial frictions however, firms must jointly choose investment and financing policies in order to maximize firm value, potentially amplifying aggregate shocks (Bernanke and Gertler (1989)). Covas and Den Haan (2011) document that large public firms substitute between debt- and equity financing over the business cycle whereas small firms' financing policy is pro-cyclical for debt and equity. The mechanism through which aggregate shocks and financial frictions generate differences in firm behavior and lead to amplifications is still unknown.

In this paper, we propose a mechanism that generates these cross-sectional financing differences over the business cycle. The mechanism is described in figure 1.First, firms enter small and decreasing returns to scale imply an efficient scale given a firm specific productivity level. When the firms are small the return on investments is high (see panel A of figure 1). However, capital adjustment costs allow only for a slow convergence to the optimal size. For small firms, the return on investment is higher relative to the return on payout to shareholders[1]. Small firms have therefore a higher funding need. All firms have access to debt and equity as external funding sources. Equity financing is subject to convex adjustment cost, which can be motivated with adverse selection premia. The choice of debt financing is determined by trading off the tax-advantage of debt against the bankruptcy cost in case of default. Due to the latter, debt is issued at a premium which is higher for firms with low collateral and a high likelihood of default. This generates an endogenous debt limit that becomes binding when a firm's funding needs exceed its debt funding cost. Panel B of figure 1 illustrates how the marginal cost of equity and debt depend on the amount of funds raised. In Panel C we add the marginal benefit of investment into the plot. Since small firms have a higher marginal return on capital, they find it optimal to finance their funding needs with both debt and equity. Large firms on the other hand find equity financing too costly. Panel D of figure 1 depicts what happens when a positive shock occurs. The marginal benefit of both, small and large, firms increases. Large firms, however, find it still too costly to finance their increased funding need with equity. Instead, they increase debt financing. Small firms, increase both debt and equity financing. We embed this mechanism in a quantitative firm

[1]Shareholders are sufficiently patient to wait for larger payouts in the future when the firm has attained its efficient scale.

industry model with endogenous firm dynamics and explore how macroeconomic shocks get amplified.

Figure 1: Mechanism




Panel A Panel B

Panel C Panel D

Firms decreasing returns to scale production technology is hit by idiosyncratic and aggregate shocks. The decreasing returns to scale setup allows us to study firm dynamics with entry and exit. Moreover, this assumption generate patterns of investment that are negatively correlated with firm size. Each period firms make a capital structure choice (debt and equity) and an investment decision to maximize equity payout. Adjustments to capital are subject to adjustment costs which we introduce to generate slow convergence to the efficient scale. Each period potential entrants receive a signal about their future productivity and decide whether to enter. Entrants are typically small in terms of size.

While making the capital structure choice firms face the following trade-offs. Debt is preferred over equity because of the tax advantage of debt. At the same time, debt financing is costly because debt repayment is not enforceable. The price of debt adjusts to reflect the likelihood of default. The default decision depends on the firm's internal funds, the debt that it needs to repay as well as on the shocks. Given the shocks and the loan amounts, it is more costly for small firms than for large firms to issue debt because their default probability is higher. We subject equity financing to convex adjustment costs. The objective of firms is to maximize equity payout.

We present empirical results similar to Covas and Den Haan (2011). Unlike them, we focus on quarterly firm level data from Compustat to analyze the firm financing behavior over the business cycle. To this end, we sort firms based on their sector specific asset positions into four firm size portfolios. External financing comes either from debt- or equity holders. Therefore, we define two financing variables, equity payout and debt repurchase, that describe all funds an investor receives from the firm. These definitions are based on cash flow variables in Compustat that represent a comprehensive measure of firms' external financing.

With regard to business cycle moments, we find that the largest firm size portfolio exhibits counter-cyclical debt repurchase and pro-cyclical equity payout. That is, large firms finance with debt in booms and with equity in recessions. We observe a strong negative correlation between these two series, indicating substitution between means of external financing over the business cycle. This fact has been established on a macro level by Jermann and Quadrini (2012) who used aggregate Flow of Funds data to establish this result. When we aggregate the positions across size portfolios, the correlation statistics are very similar to the Flow of Funds correlations in Jermann and Quadrini (2012).

For the small firm size portfolio, we find that small firms do not substitute between external financing methods. In booms small firms increase external financing whereas in recessions external financing is reduced. Moreover on average, small firms obtain more funds through equity than through debt financing. Our interpretation of this fact is that small firms are constrained to obtain funds through debt which motivates them to turn to equity. Finally we also study sales growth of small versus large firm portfolios. It shows that small firms display higher growth rates on average than large firms. This is intuitive because most small firms in Compustat are young firms with respect to their age since IPO; they went public to obtain capital for growth.

The empirical evidence suggests that models with a single type firm and only one financing source, is not suitable to understand the relevance of financial frictions over the business cycle for the real economy. Instead a heterogeneous firm model with endogeneous firm dynamics and aggregate shocks is needed where firms must decide between debt and equity financing.

*Related Literature*

Firms' financial positions are important for understanding business cycle fluctuations. In the presence of financial frictions, they amplify the effects of productivity shocks (e.g. Bernanke and Gertler (1989), Carlstrom and Fuerst (1997), and Kiyotaki and Moore (1997)) by altering firms' investment behavior. In finance, the literature investigates what determines firms' financial positions and what matters for matching them quantitatively. For example, Hennessy and Whited (2005) and Strebulaev (2007) show that dynamic trade-off models rationalize the behavior of corporate financial data[2]. Gomes (2001) builds a theory to study the effects of firms' investment and financing behavior to shed light on the importance of financial frictions for firms.

Macroeconomic shocks are important determinants of firms' capital structure choice (e.g. Korajczyk and Levy (2003), Jermann and Quadrini (2006), and Dittmar and Dittmar (2008)). Jermann and Quadrini (2012) build a theory to show that financial shocks (in addition to productivity shocks and financial frictions) are necessary to rationalize cyclical external financing choices. Hackbarth, Miao, and Morellec (2006) build a quantitative model of firms' capital structure in which financing decisions depend on the business cycle through its effect on default policies. Our paper is different because we focus on the heterogeneous effects of macroeconomic shocks.

The fact that different firms react differently to aggregate shocks has been documented, see for example Korajczyk and Levy (2003)[3]. Covas and Den Haan (2011) show that the largest firms dominate the cyclical behavior of aggregate flow of funds data - as used in Jermann and Quadrini (2012). They find that equity issuance is pro-cyclical except for the largest firms and debt issuance counter-cyclical. We present similar business cycle facts using quarterly Compustat data.

Our firm industry equilibrium is based on Hopenhayn (1992) in which entry and exit are modeled similar to Clementi and Palazzo (2013). Hennessy and Whited (2007) estimate a simulated dynamic model based on Gomes (2001) to infer the costs of external financing. They find that the costs of external financing differs mostly between small and large firms. We base our choice of size as the essential dimension of heterogeneity on their analysis.

Our paper relates to a recent strand of papers that embeds a quantitative asset pricing models into a heterogeneous firm models with a dynamic capital structure choice (as in Hackbarth, Miao, and Morellec (2006)) to study how credit spreads and the equity premium get determined (e.g. Bhamra, Kuehn, and Strebulaev (2010a), Belo, Lin, and Yang (2014), and Gomes and Schmid (2012)). In these papers, firm size is oftentimes fixed after entry and therefore not used as a dimension of heterogeneity as in this paper. Our focus is on the business cycle flow of financial positions rather than prices. Covas and Den Haan (2012) share our focus and generate pro-cyclical equity issuance with exogenous, counter-cyclical

[2] An excellent overview over two decades of research in dynamic corporate finance is provided by Strebulaev and Whited (2012).

[3] The results of Korajczyk and Levy (2003) and Jermann and Quadrini (2006) are inconsistent. Please refer to the discussion in Covas and Den Haan (2011) who show how aggregate data can lead to non-robust results.

equity issuance costs. Our model generates pro-cyclical equity financing for all but the largest firms with a mechanism: endogenous default and endogenous firm dynamics.

We join a growing literature that study the effects of endogenous firm dynamics and its interplay with financial frictions (e.g. Cooley and Quadrini (2001)) and the transmission of aggregate shocks (e.g. Bergin et al. (2014) and Clementi, Khan, Palazzo, and Thomas (2014a)). Our model allows us to study the role of firm dynamics, financial frictions, and aggregate shocks for firms' choice between equity and debt financing and the transmission of aggregate shocks. Firm dynamics are important because they determine funding needs and therefore the financing needs of firms. Understanding these relationships can improve our understanding about how aggregate shocks affect firms financing decisions and how shocks get amplified.

The paper is structure as follows. Section 2 presents the stylized fact on firm financing over the business cycle. Section 3 describes the firm optimization model. Section 4 presents the conditions for a stationary firm distribution and discusses the calibration. Section 5 explains the mechanism of the model that derive the results described in section 6.

# 2 Stylized facts

We document stylized facts that motivate the heterogeneous firm financing model presented in this paper.

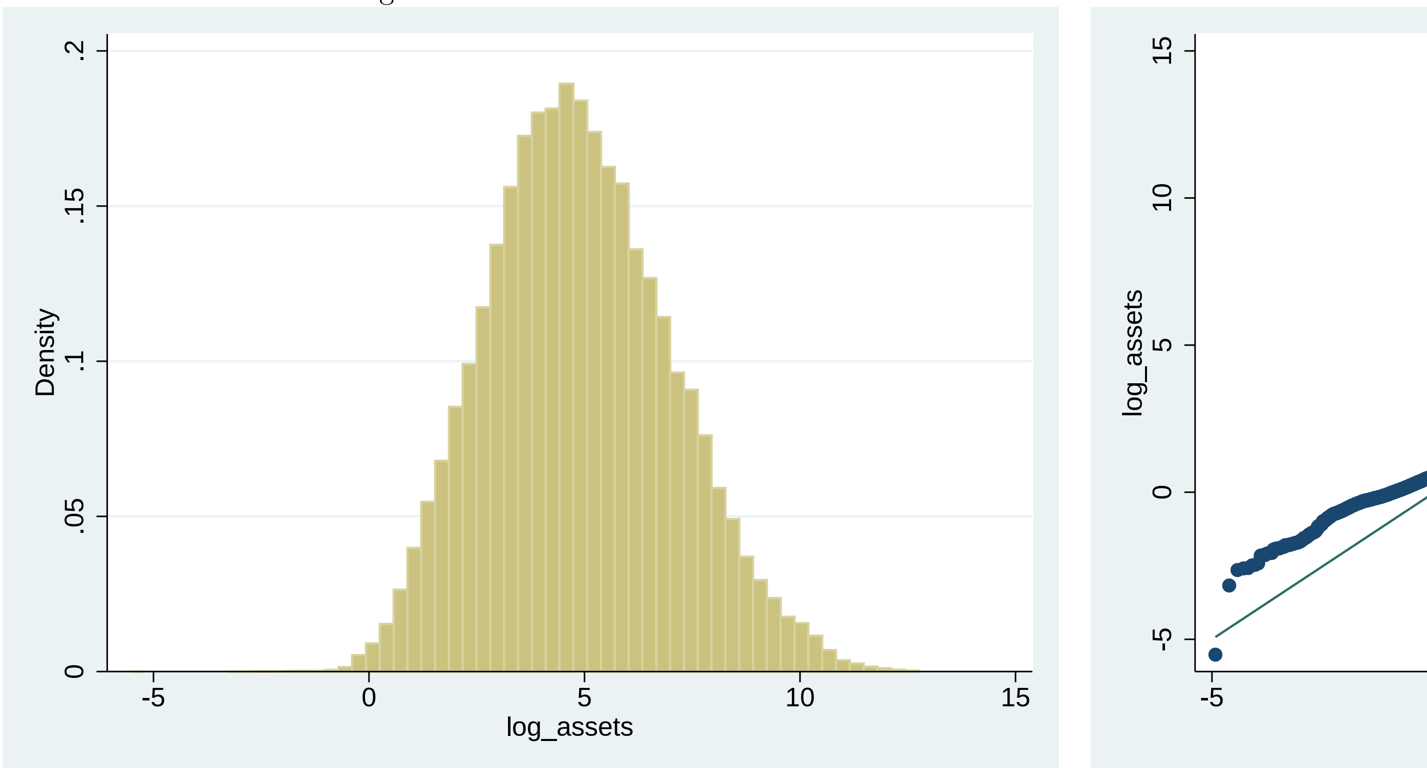
The main stylized fact is that small firms issue more debt and equity in booms whereas large firms issue more debt in booms but more equity in recessions. We use quarterly Compustat data from 1984-2013. A similar empirical analysis has been conducted by Covas and Den Haan (2011) that arrives at a similar conclusion. Using a book-value measure for equity and *annual* Compustat data up to 2006, they find that all but the top 1 percentile of the asset distribution have counter-cyclical equity payout and counter-cyclical debt repurchase.

## 2.1 Data

We use data[4] from CRSP/Compustat Merged (CCM) Fundamentals Quarterly from the first quarter of 1984 to the last quarter of 2013. The Compustat data set is the most comprehensive with financial firm-level data available over a long time span. Moreover, Compustat firms cover a large part of the US economy. We choose to focus on the period after 1984 to be consistent with the quantitative business cycle literature. Jermann and Quadrini (2006) also show that the period after 1984 saw major changes in the U.S. financial markets.

[4] The sample selection is described in section A.1.

Figure 2: Firm Size Distribution Data




Panel A

*Sample Description*

We report several facts about the sample that are informative about the nature of firm dynamics. We will use these facts to compare our model to the data. Panel A of figure 2 presents the density of logged assets, which approximately follows a log-normal distribution, except for the tails. This can be better seen in panel B of the table.

We focus on firm size as a dimension of heterogeneity. This is justified by the work of Hennessy and Whited (2007) who find that external financing costs differ mostly by size. We build size portfolios by sorting firms into quarter and sector specific asset quartiles which we henceforth call bins. The composition of firms may therefore change from one quarter to the other. Table 2 presents the transition probabilities from moving from one bin size to another over a quarter. The transition probabilities are fairly symmetric and indicate a higher (per quarter) chance for a small firm to move across bins than for large firm.

Table 2 presents the panel characteristics before we aggregate the data up to asset percentiles. It shows in column "between" that smaller firms are more numerous. To put it differently, there are far fewer firms that ever have been classified as a firm in the largest asset percentile than in the smaller asset percentiles. The table furthermore shows that

Table 1: Transition Probabilities

| Asset Percentile | 0-25% | 25-50% | 50-75% | 75-100% |
|---|---|---|---|---|
| 0-25% | 95.80 | 4.13 | 0.06 | 0.01 |
| 25-50% | 4.01 | 91.54 | 4.41 | 0.03 |
| 50-75% | 0.02 | 3.64 | 93.40 | 2.93 |
| 75-100% | 0.00 | 0.02 | 2.34 | 97.64 |

Table 2: Panel Characteristics

| | Overall | | Between | | Within |
|---|---|---|---|---|---|
| Asset Percentile | Freq. | % | Freq. | % | % |
| 0-25% | 132340 | 25 | 6988 | 51 | 65 |
| 25-50% | 132305 | 25 | 7689 | 57 | 49 |
| 50-75% | 132329 | 25 | 6166 | 45 | 50 |
| 75-100% | 132322 | 25 | 3429 | 25 | 64 |
| Total | 529296 | 100 | 24272 | 179 | 56 |

firms move quite a bit across firm size over their observed life span as shown in the "within" column. This column shows that conditional on ever being a firm in the smallest bin, this firm spents 65% of its observed life span in the first bin, implying that it is categorized as a different bin size in the other 35% of its observations.

In terms of sales growth rates, we find that smaller firms outpace large firms. However, this relationship is not monotonic. Growth rates vary much more for smaller firms. These facts are summarized in table 3. It presents the mean and standard deviation of sales. We compute the financial variables described below at the firm level and aggregate the result for each of the four bins.

Table 3: Sales Growth

| Asset Percentile | Mean in % | | Std | |
|---|---|---|---|---|
| | Sales | Asset | Sales | Asset |
| 0-25% | 1.47 | -0.47 | 0.60 | 0.22 |
| 25-50% | 2.55 | 2.43 | 0.42 | 0.17 |
| 50-75% | 2.71 | 3.15 | 0.30 | 0.15 |
| 75-100% | 2.37 | 2.97 | 0.24 | 0.14 |

Mean and standard deviation of the growth rate for log sales and log assets per quarter computed per firm, aggregated to bin.

*Variable Definitions*

We use data on real quarterly GDP and price levels from NIPA. For the financial variables, we focus on funds obtained by firms from all available external sources: debt- and equity. In particular we look at quarterly cash flows that flow between investors and firms. In defining the two financial variables we take the perspective of a claim holder and ask what are the cash flows she receives when investing in the firm.

An equity holder has a claim to the cash flow of a firm in the form of *equity payout* that we define as the sum of cash dividends and equity repurchases less equity issuances. Since firms may simultaneously (within a quarter) issue and repurchase we can look at the net equity repurchase position. Cash dividends (dvy) represent the total amount of cash dividends paid for common capital, preferred capital and other share capital. Equity repurchases (prstkcy) are defined as any use of funds which decrease common and or preferred stock. Equity issuances (sstky) are all funds received from the issuance of common and preferred stock. They include among others the exercise of stock options or warrants as well as stocks issued for an acquisition. These variables are defined on a year-to-date basis. They are converted to quarterly frequency variables by subtracting the past quarter from the current observation for all but the first quarter[5] of the firm.

We define *debt repurchases* as the funds debt holders receive from their claim on a firm. More precisely, debt repurchases are defined as the negative sum of the change in long (dlttq) and short term (dlcq) debt. In Compustat, long term debt comprises debt obligations that are due more than one year from the company's balance sheet date. Debt obligations include long term lease obligations, industrial revenue bonds, advances to finance construction, loans on insurance policies, and all obligations that require interest payments. Short term debt is defined as the the sum of long term debt due in one year and short term borrowings. Equity payout and debt repurchase are defined for each firm-quarter observation.

For the correlation statistics, we apply the band-pass filter to the deflated bin variable and scale it by the trend component of assets aggregated to the specific bin level. For means and pictures, we use the seasonally smoothed variables and scale it by assets.

## 2.2 Facts

*Equity payout and debt repurchases over the business cycle*

Table 4 documents the facts on the business cycle correlations of financial variables across firm size bins and on the aggregate level for comparison. The substitutability between debt and equity financing over the business cycle is displayed by the largest firms but not by

[5]Since the year-to-date variables are defined over the fiscal year of a firm we use the fiscal quarter definition in the conversion from year-to-date to quarterly variables.

Table 4: Business Cycle Correlation of Equity Payout and Debt Repurchases

| Asset Percentile | Equity Payout | Debt Repurchases |
|---|---|---|
| 0-25% | **−0.21** | **−0.53** |
| 25-50% | **−0.24** | **−0.72** |
| 50-75% | −0.03 | **−0.63** |
| 75-100% | **0.75** | **−0.76** |
| Aggregate | **0.68** | **−0.77** |

We compute the correlations of quarterly real GDP with the deflated band-passed filtered components of equity payout and debt repurchases, scaled by the trend of assets. The numbers in bold are significant at the 5% level.

the smaller firms. The correlations for the aggregate level are very similar to the top quartile of firms. Though these results are very similar to Covas and Den Haan (2011), we find that the substitutability between equity and debt financing over the business cycle matters for the top size quartile not just the top 1% largest firms as in their analysis. However, the fact that Covas and Den Haan (2011) compute their statistics for annual data whereas we compute the correlations for quarterly data[6] makes it hard to directly compare our numbers.

Table 5 shows that all but the largest firms finance on average with both equity and debt. In contrast, large firms payout to shareholders with both dividends and share repurchases and finance with debt. These facts suggest that most firms use good times to raise funds from both debt and equity claim holders. Large firms prefer debt financing in booms and equity financing in recessions.

Figure 3 plots debt repurchase and equity payout (red) for the smallest (left panel) and largest (right panel) asset bin firms from the first quarter in 1984 to the last quarter 2013. The NBER recessions are represented by the yellow bars. The smallest firms finances increase equity payout and debt repurchases in recessions with equity than with debt and equity payout and there is no clear substitution pattern over the business cycle. Firms in the large bin repurchase debt counter-cyclically and tend to payout during booms. That is, they seem to substitute between debt and equity instruments as shown by Jermann and Quadrini (2012).

The aggregated time series (see figure 4) of debt repurchases and equity payout is almost identical to the right panel of figure 3. That is, as shown in table 4, the aggregate firm financing patterns are governed by large firms. Focusing on aggregate data only conceals the financing behavior of the majority of firms. A representative firm model fitted to aggregate data is therefore representative of large firms. The financing behavior of small and large firms,

[6] This is the standard periodicity for computing business cycle statistics.

Table 5: Means

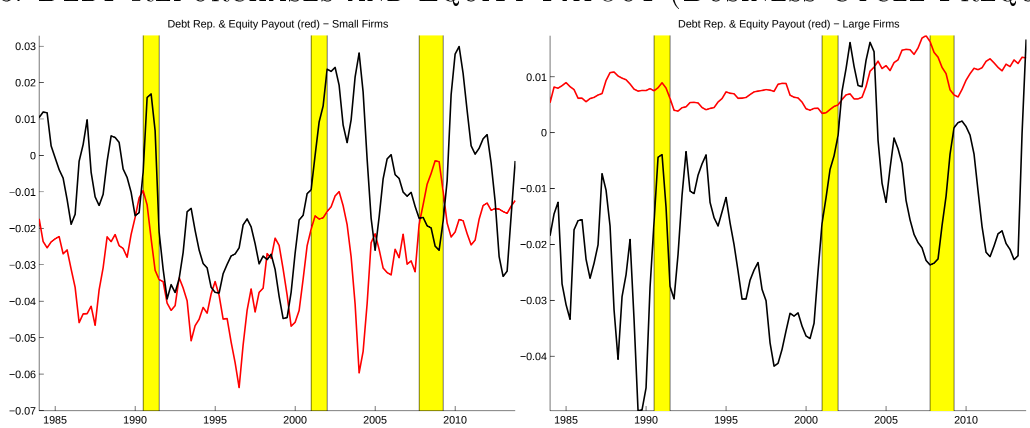
| Asset Bin | Equity | | | | Debt |
|---|---|---|---|---|---|
| | Issuance | Dividends | Repurchase | Payout | Repurchase |
| 0-25% | 2.44 | 0.19 | 0.21 | −2.04 | −0.2 |
| 25-50% | 1.57 | 0.21 | 0.28 | −1.08 | −0.73 |
| 50-75% | 0.85 | 0.24 | 0.36 | −0.25 | −1.57 |
| 75-100% | 0.26 | 0.47 | 0.52 | 0.74 | −1.83 |

The variables equity payout and debt repurchases are deflated with the PPI and scaled by $100 of assets.

| Asset Bin | Assets∗ | Invest. | Leverage |
|---|---|---|---|
| 0-25% | 242 | 5.69 | 0.21 |
| 25-50% | 1090 | 5.35 | 0.23 |
| 50-75% | 3914 | 4.63 | 0.27 |
| 75-100% | 57241 | 3.55 | 0.27 |

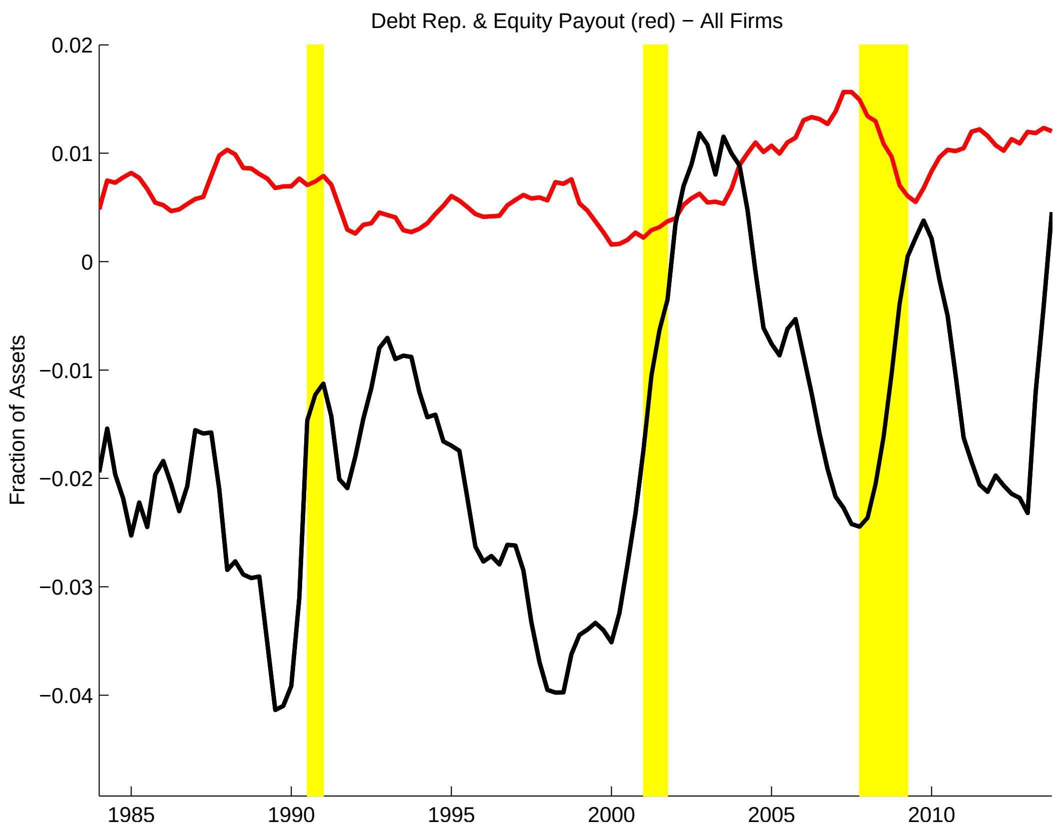
Units of variables marked by∗ are in millions. Investment is the percentage investment rate where investment rate is defined as capital expenditure over lagged assets. Leverage is defined as total debt over lagged assets.

Figure 3: Debt Repurchases and Equity Payout (Business Cycle Frequency)




Source: Compustat

Figure 4: Aggregate Debt Repurchases and Equity Payout At Business Cycle Frequency




Source: Compustat

however, differs significantly over the business cycle, suggesting that firms of different sizes face different or differently strong financing frictions. For this reason, we find a heterogeneous firm financing model more suitable in explaining the impact of financial markets on firm finances and eventually their real behavior. Our model advances a mechanism to explain these financing differences and therefore sheds a light on the nature of the financing frictions firms face.

# 3 The Model

In this section we describe the model environment as well as the problem of incumbent and entrant firms.

There is a continuum of heterogeneous incumbent firms with gross revenue $F(z,s,k) = zsk^{\alpha}$, where $z$ is the aggregate shock common to all firms and $s$ is the firm specific shock. Firms differ not only with regard to their idiosyncratic productivity $s$, but also with respect to their capital stock $k$ and debt levels $b$. Capital depreciates at the rate $\delta$ each period. Firms own a decreasing returns to scale technology $(\alpha < 1)$. The assumption of decreasing returns to scale implies that given the stochastic state, there exists an optimal firm size. The common component of productivity $z$ is driven by the stochastic process

$$\log\, z' = \rho_z \log\, z + \sigma_z \epsilon'_z$$

where $\epsilon_z \sim N\,(0,1)$. The dynamics of the idiosyncratic component $s$ are described by

$$\log\, s' = \rho_s \log\, s + \sigma_s \epsilon'_s$$

with $\epsilon_s \sim N\,(0,1)$. Both shocks are independently of each other distributed.

Each period a firm maximizes equity payout to their shareholders by making an investment and a capital structure decision. A firm can finance its operations using debt or equity. Both entail costs which we specify later. When the firm is paying out equity our model does not distinguish between dividends and repurchases explicitly.

## 3.1 Tax environment

We introduce two different taxes: individual and corporate income taxes. Shareholders are risk neutral and therefore use $\tilde{r}\,(1-\tau_i) = r$ to discount future cash flow streams, where $\tilde{r}$ is the risk-free rate and $\tau_i$ is the income tax rate for an investor. Corporate taxable income is equal to operating profits less economic depreciation and interest expense. In our setup the corporate tax bill amounts to

$$T^c(k,b,z,s) \equiv \tau_c \underbrace{\left[zsk^\alpha - \delta k - (1 - \frac{1}{1+r})b\right]}_{TX=\text{taxable income}}$$

where $(1-\frac{1}{1+r})b$ are the default free interest expenses and $\delta k$ represent the economic depreciation. The tax advantage of debt over equity means that the return on equity is larger than the return on debt. From the perspective of the firm, it has to pay a higher risk-adjusted interest rate on equity than on debt.

## 3.2 Adjustment costs

The model features three adjustment cost functions (capital, equity issuance, equity payout) whose specific role and form we discuss now.

We introduce the adjustment costs for capital to generate slow convergence to the optimal firm size implied by the decreasing returns to scale assumption and idiosyncratic productivity. Inspired by the empirical investment literature (see Cooper and Haltiwanger (2006)) we have both fixed and smooth capital adjustment costs:

$$g(k,k') = \Phi_i c_0 k + \frac{c_1}{2}\left(\frac{k'-(1-\delta)k}{k}\right)^2 k \tag{1}$$

where $\Phi_i = 1$ if investment equals non zero. The functional form is standard in the empirical investment literature and encompasses both fixed and smooth adjustment costs (convex and non convex costs). The first component is only active if investment is non-zero. The fixed cost is proportional to the capital stock so that the firm has no incentive to grow out of the fixed cost. The smooth component is captured by the second term. It is responsible to smooth investment over time. The fix part is multiplied by the size of the firm which reflects that large firms usually invest in larger projects, such as building a whole new factory rather than buying an additional machine.

If equity is positive ($e > 0$) it represents a distribution (payout) to the shareholder. Equity payout to shareholders can arise either through repurchase or dividends. Our model does not explicitly distinguish between these two. The payout literature (see the survey by Farre-Mensa, Michaely, and Schmalz (2014)) finds that tax consideration contribute little to the way firms choose to payout. Historically, dividend payout is rather smooth whereas payout with repurchases can be quite lumpy. The equity payout variable in the model is the sum of the two and does appear relatively volatile in the data. For this reason, we abstract from equity payout costs.

If equity is negative ($e < 0$), the firm is issuing shares and therefore finances. In this case, the firms incurs an issuance costs of $\Lambda(e)$. This costs is motivated with underwriting fees and adverse selection premia. For the model to stay tractable, we do not model costs of external equity as the outcome of an asymmetric information problem. Instead, as in Hennessy and Whited (2007) we capture adverse selection costs and underwriting fees in a reduced form fashion. The external equity cost function is linear and quadratic:

$$\Lambda(e(k,k',b,b',z)) \equiv 1_{e<0}\left[-\lambda_0 + \lambda_1 e - \frac{1}{2}\lambda_2 e^2\right] \tag{2}$$

$$\lambda_i \geq 0 \; i = 0,1,2$$

where $1_{e<0}$ equals 1 if $e < 0$ and zero otherwise. This functional form is consistent with Altinkilic and Hansen (2000) who find that the cost is U shaped due to fixed costs and increasing marginal fees for large offers. That is, at first average costs are falling because of the fixed cost part dominates the marginal fees. At higher offers the higher fees take over and increase average costs. These parameters are estimated by Hennessy and Whited (2007). They are equivalent to the firm acting as if it faces a fee equal to \$83,410 on the first million and \$616 for every additional million, amounting to an average fee of \$86,109.

## 3.3 Incumbent Firm Problem

Each period the incumbent firm has the option to default on its outstanding debt and exits. The default value is normalized to zero. Therefore, each period the value of the firm is the maximum between the value of repayment and zero, the value of default.

$$V = max\left\{V^{ND}, V^{D} = 0\right\} \tag{3}$$

The repayment value can be represented as a Bellman equation which is composed of equity, $e$, that is either positive or negative, and the equity issuance cost plus the expected continuation value. The states of the repayment value are the two stochastic shocks as well as capital and debt brought in from the last period. The value function is

$$V^{ND}(z,s,k,b) = \max_{k'\in K, b'\in B, e} \begin{cases} \underbrace{e}_{\text{Equity}} + \underbrace{\Lambda(e)}_{\text{Eq.Iss.Cost}} \; \ldots \\ \\ +\frac{1}{1+r} E_{s,z}\left[V\left(z',s',k',b'\right)\right] \quad . \end{cases} \tag{4}$$

The firm maximizes the repayment value by choosing capital and debt to be repaid next period. Both decisions determine equity which is defined as

$$e = (1-\tau_c)\, zsk^{\alpha} - (k' - (1-\delta)\, k) - g(k,k') - c_f + \tau_c \left( \delta k + b(1 - \frac{1}{1+r}) \right) + p^b b' - b. \quad (5)$$

Equity is thus defined as the residual of the after-tax firm revenue less investment and investment adjustment costs $g(k, k')$ less fixed cost of operation $c_f$ plus tax rebates from capital depreciation and interest payments, plus funds raised through debt $p^b b'$ and less debt to repay $b$.

The time line for the incumbents in the model can be summarized as follows. At the beginning of each period, incumbents carry debt to be repaid and capital for current period production. Upon observing the productivity shocks, the firm receives gross revenues $F(z, s, k)$. A firm then chooses equity payout by choosing capital and debt for the next period $b'$ and $k'$. At the same time it must pay its operation cost and its previous period debt. Every period the firm faces the decision whether or not to repay its debt. It repays if the value of the business is positive. Otherwise it defaults and exits.

## 3.4 Debt Contract and Debt Pricing

In this section we layout the specifics of the debt contract. A firm can issue a one-period bond at a discount. That is, it can raise funds in the current period $q^b b'$ where $q^b < 1$. Next period, the firm pays back the face value of the bond $b'$. However, a firm can also choose to default on its debt obligation. It may default when its firm value falls below a threshold, which we normalized to zero. In this case the firm is liquidated and exits the firm universe.

Upon default shareholders receive the threshold value, e.g. zero. Bondholders receive the residual recuperation value. We follow Hennessy and Whited (2007) by assuming that bondholders obtain the profits for the last operation period, as well as the remaining assets of the company less a deadweight bankruptcy cost. The recuperation value is

$$RC(k', s', z') = (1-\varepsilon)[(1-\delta)k' + (1-\tau_c)\, z's'k'^{\alpha} + \tau_c \delta k'] \quad (6)$$

where $\varepsilon$ are interpreted as bankruptcy costs, e.g. any costs related to the liquidation and renegotiation of the firm after default.

We assume that investors are risk neutral, the price of debt adjusts such that investors break even in expectations. Define $\Delta(k, b)$ as the combination of aggregate and idiosyncratic states such that a firm finds it optimal to default. That is $\Delta(k, b) = \big\{ (s, z)\ s.t.\ V^{ND}(z, s, k, b) \leq 0 \big\}$.

Risk neutral investors price debt in the following way:

$$(1+r)b' = (1 - Pr_{s,z}(\Delta(k',b')))\left(1+r^b\right)b' + Pr_{s,z}(\Delta(k',b'))\,E_{s,z}(RC(k',s',z'))$$

$$q^b \equiv \frac{1}{1+r^b}$$

$$q^b(z,s,k',b') = \frac{1 - Pr_{s,z}(\Delta(k',b'))}{1 + r - Pr_{s,z}(\Delta(k',b'))\,\frac{RC(k',s',z')}{b'}} \tag{7}$$

If the firm does not default for sure the price is just $\frac{1}{1+r}$ . Note that the price of debt is forward looking as opposed to many classical models, see for instance Kiyotaki and Moore (1997).

The probability of default depends on the two stochastic exogenous states, on how much debt the firm has to repay and how much capital it holds. Moreover the higher the recuperation value on each unit of loan, the lower the discount. The more debt to be repayed and the lower the stock of capital, the higher the probability of default and therefore the lower the price of the bond. At the same time, given the persistence of the shocks, the higher the shocks the higher the debt capacity of the firm for a given amount of capital. It is important to point out that a change in the price of debt affects the entire loan amount, not only the marginal increase in doubt that caused the price change.

## 3.5 Entrant Firm Problem

The entry decision in this model amounts to the decision of a firm to go public. Every period there is a constant mass $M$ of potential entrants who receive a signal $q$ about their productivity. We specify this signal as Pareto, $q \sim Q(q)$, with parameter $\omega$ that makes entrants heterogeneous. Firms have to pay an entry fee ($c_e > 0$) that ensures that not all firms find it optimal to enter. Consequently it helps to pin down the size distribution of the entering firms.

The entrant only starts operating next period but must decide today with which capital stock it wants to start production tomorrow. This initial investment can only be financed with equity. Investment is subject to adjustment costs. Define

$$H = k' - (1-\delta)\,k^{min} + g(k^{min}, k'),$$

as investment plus adjustment costs expenditure. The entrant then incurs the same issuance cost as the incumbent firm. We assume that the expected continuation value depends on the signal, which determines the probability distribution of the next period idiosyncratic shock.

The value function of the entrant is

$$V_e(z,q) = \max_{k'} \left\{ -H + I_{H<0} \underbrace{\phi(H)}_{Eq.\ Iss.\ cost} + \frac{1}{1+r} E_{q,z}[V(z',s',k',0)] \right\}. \tag{8}$$

Upon entering, entrants have to pay a fixed entry cost $c_e$. Entrant invests and starts operating if and only if $V_e(z,q) \geq c_e$.

# 4 Optimization, Stationary Firm Distribution and Calibration

This section defines the optimality condition, the stationary distribution for the firm optimization problem, and the parametrization.

*Optimality Conditions*

The incumbent solves the problem described in 3. Define

$$^{-} = \eta \left(1_{e<0}(-\bar{1}) + 1_{e>0}(1)\right)\eta.$$

We state first order conditions with respect to equity:

$$1 + 1_{e<0} \left(\lambda_1 - \lambda_2 e\right) - \bar{\eta} = 0 \tag{9}$$

where $\eta$ is the Lagrange multiplier on firms' budget constraint. The first order condition with respect to capital tomorrow is

$$-\bar{\eta}\left(1 + \frac{\partial g\left(k',k\right)}{\partial k'} + b'\frac{\partial {q^b}'}{\partial k'}\right) + \frac{1}{1+r}E\left[V_k\left(z',s',k',b'\right)\right] = 0, \tag{10}$$

and with respect to debt to be repaid tomorrow:

$$\bar{\eta}\left(q^b + b'\frac{\partial q^b}{\partial b'}\right) + \frac{1}{1+r}E\left[V_b\left(z',s',k',b'\right)\right] = 0. \tag{11}$$

The two envelope conditions are:

$$V_k(z,s,k,b) = \bar{\eta}\left[(1-\tau_c)\,F_k(z_t,s_{t,}k_t) - \frac{\partial g(k',k)}{\partial k} + 1 - \delta(1-\tau_c)\right]$$
$$V_b(z,s,k,b) = -\bar{\eta}\,(1-\tau_c(1-\overline{q}))\,.$$

Summarizing the optimality condition at an interior solution are

$$\bar{\eta} = 1 + 1_{e<0}(\lambda_1 - \lambda_2 e) \tag{12}$$

$$\left(1 + \frac{\partial g(k',k)}{\partial k'} + b'\frac{\partial q^{b\prime}}{\partial k'}\right) = E\left(\frac{\bar{\eta}'}{\bar{\eta}(1+r)}\right)\left[(1-\tau_c)\,F_k(z',s'_,k') - \frac{\partial g(k'',k')}{\partial k'} + 1 - \delta(1-\tau_c)\right] \tag{13}$$

$$\left(q^b + b'\frac{\partial q^b}{\partial b'}\right) = \frac{(1-\tau_c(1-\overline{q}))}{1+r}E\left(\frac{1+1_{e<0}(\lambda_1-\lambda_2 e')}{1+1_{e<0}(\lambda_1-\lambda_2 e)}\right). \tag{14}$$

Equation 12 says that a payout tightens firms' budget constraint by $\eta$ but increases the value of the firm by one at the margin. Issuing equity relaxes the constraint by $\eta$ but reduces the marginal benefit to the firm. Equation 13 presents the marginal cost of investing in capital on the left hand side and compares this to the marginal benefits of capital − the return on capital for the next period − on the right hand side. Equation 14 describes the marginal benefit of raising debt this period on the left hand side and compares that to the marginal cost of repaying the debt next period on the right hand side.

*Stationary Firm Distribution*

Given an initial firms distribution, a recursive competitive equilibrium consists of (i) value functions $V(z,s,k,b)$, $V_e(z,q)$, (ii) policy functions $b'(z,s,k,b)$, $k'(z,s,k,b)$, $e$, and (iii) bounded sequences of incumbents' measure $\{\Gamma_t\}_{t=1}^{\infty}$ and entrants' measures $\{\varepsilon_t\}_{t=0}^{\infty}$

1. Given $r$, $V(z,s,k,b)$, and $b'(z,s,k,b)$, $k'(z,s,k,b)$, $e$ solve the incumbents problem

2. $V_e(z,q)$ and $k'(z,q)$ solve the entrants problem

3. For all Borel sets $S \times K \times B \times \Re \times \Re^+$ and $\forall t \geq 0$,

$$\varepsilon_{t+1}(S \times K \times B) = M\int_S \int_{Be(K,B,z)} dQ(q)d(H(s'/q))$$

$$Be(K,B,z) = \left\{p^b \text{ s.t. } k'(z,q) \in K,\ b'(z,q) \in B\text{and } V_e(z,q) \geq c_e\right\}$$

4. For all Borel sets $S \times K \times B \times \Re \times \Re^{+}$and $\forall t \geq 0$,

$$\Gamma_{t+1}(S \times K \times B) = \int_S \int_{B(K,B,z)} d\Gamma_t(k,b,s)dH(s'/s) + \varepsilon_{t+1}(S \times K \times B)$$

$$B(K,B,z) = \{(k,b,s)s.t.V(z,s,b,k) > 0 \text{ and } b \in B \; g(k',k) \in K\}$$

The firm distribution evolves in the following way. A mass of entrants receives a signal and some decide to enter. The signal $q$ defines firms' next period $s$ and their policy function defines their next period capital. Conditional on not exiting, incumbent firms follow the policy function for next period's capital and debt and their next shocks follow the Markov distribution. Each period, the decisions of incumbents and entrants define how many firms inhabit each s, k and b combination. Given a parametrization, we find the policies and the value functions of entrants and incumbents using value function iteration

*Parametrization*

The choice of parameters can be divided in three different categories. The first category consists of parameters that are picked according to the literature such as the decreasing returns to scale parameter. The second group of parameters has a natural data counterpart such as the volatility of the aggregate shock. The last group of parameters is calibrated to jointly target moments in the data. To find these parameters, we first solve the model under a specific set of parameters. Then we simulate data using the policies of the model and compute the target moments. Next, we compare the model implied moments implied by this specific parameter combination. We repeat this procedure until the difference between the data and the model implied target moments has been minimized. Table 6 presents the parametrization. The targets are shown in the last column.

Table 7 shows the data targets of the calibration and the corresponding model counterpart. The model is nonlinear which is why we cannot match all moments exactly.

# 5 Mechanism

This section describes the mechanism of the model that rationalizes the cross-sectional external financing patterns observed in the data. The three important features are firm dynamics, decreasing returns to scale with adjustment costs of investment, and the endogenous default premium on debt.

Endogenous entry and exit affect the firm size distribution over time. Figure 5 plots the average firm size distribution over the normalized assets for different states in the economy. Firms tend to enter small and more firms enter in good economic times during which the

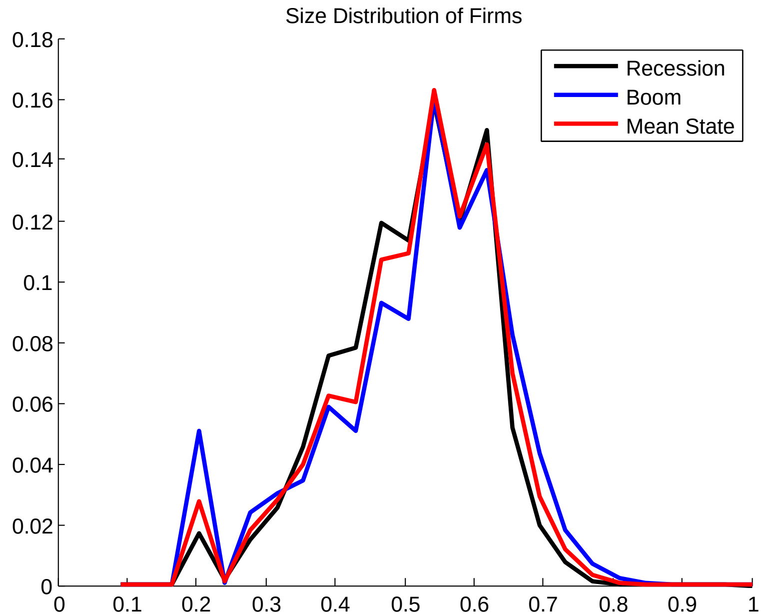
Table 6: Parametrization

| **Parameter** | **Function** | **Target** |
|---|---|---|
| $\alpha = 0.627$ | Decreasing returns to scale | Hennessy and Whited (2007) |
| $\varepsilon = 0.1$ | Bankruptcy cost | Hennessy and Whited (2007) |
| $\tau_i = 0.29$ | Individual tax rate | Graham (2000) |
| $\tau_c = 0.25$ | Corporate tax rate | |
| $\lambda_0 = 0.389$ | Cost for equity issuance | Hennessy and Whited (2007) |
| $\lambda_1 = 0.053$ | | |
| $\lambda_2 = 0.0002$ | | |
| $\rho_z$=0.8857 | Agg. shock persistence | U.S. quarterly GDP |
| $\sigma_z$=0.0093 | Agg. shock std | U.S. quarterly GDP vol |
| $\delta = 0.025$ | Depreciation | NIPA depreciation |
| $r = 0.01$ | riskless rate | 4% annualized return |
| $\omega = 15$ | Pareto distribution | 18% entrants rel. size |
| $c_0 = 0.04$ | Inv. adj. cost | Investment rate |
| $c_1 = 0.15$ | Inv. adj. cost | Investment autocorr. |
| $c_f = 0.032$ | Fixed cost of operation | Exit equals entry of 2% |
| $\rho_s = 0.875$ | Idiosy. shock persistence | Stay bin transition prob. |
| $\sigma_s = 0.05$ | Idiosy. shock vol | Investment rate vol. |

Table 7: Model Fit

| Calibrated Moments | Data | Model |
|---|---|---|
| Entrants relative size | 18.3% | 22.4% |
| Investment rate | 3.9% | 2.9% |
| Investment autocorr. | 0.31 | 0.45 |
| Investment rate vol. | 0.06 | 0.04 |
| Exit equals entry | 2% | 2% |
| Stay bin transition prob. | 0.94 | 0.74 |

Figure 5: Size Distribution



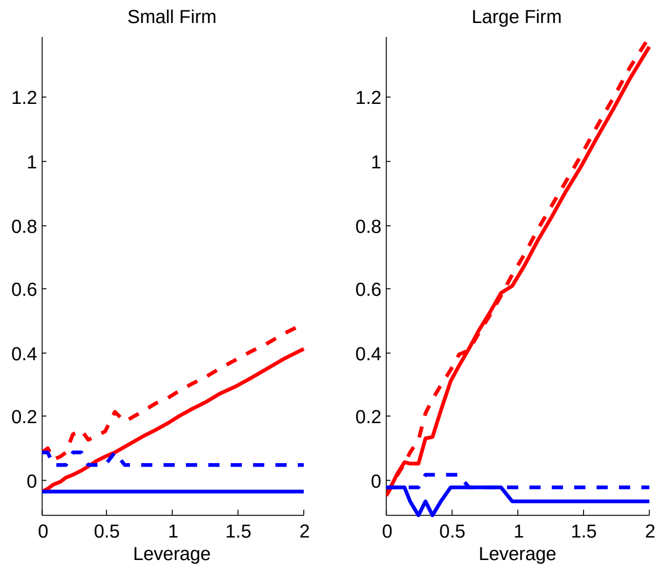

distribution gets flatter: the large firms are larger compared to bad states during which the size distribution is more concentrated and shifts to the left. Given the idiosyncratic and aggregate shock, decreasing returns to scale technologies imply an efficient scale. Moreover, the expected return on investment depends negatively on the size of the firm. With adjustment costs firms can only grow slowly towards their efficient scale. In our setting, shareholders are sufficiently patient to wait for future payouts once the firm has attained its efficient scale. During a boom, as more small firms enter far away from their efficient scale, the funding needs of small firms increase.

Debt is issued at a premium that depends on the likelihood of default and the recuperation value of the bond. The likelihood of default is higher, the lower internal revenues, the higher the loan, and the worse the aggregate and idiosyncratic productivity.

Because of their high funding needs, small firms want to take on as much debt as they can. This pushes them closer to the default region at which the cost of debt spikes up. That is, they are effectively borrowing constrained and must resort to equity financing. Once a firm has attained its efficient scale they payout and finance mostly with debt. Many firms borrow to payout because they issue at the default free rate. We see that feature in the data too. In 2011, AT&T issued debt in order to repurchase shares which is just another form of payout.

Over the business cycle, the effect described above is amplified. In booms (recession) large firms have higher (lower) internal funds, therefore they will payout more (less). Good

Figure 6: NEED FOR FUNDS (RED) AND INVESTMENT POLICY (BLUE)



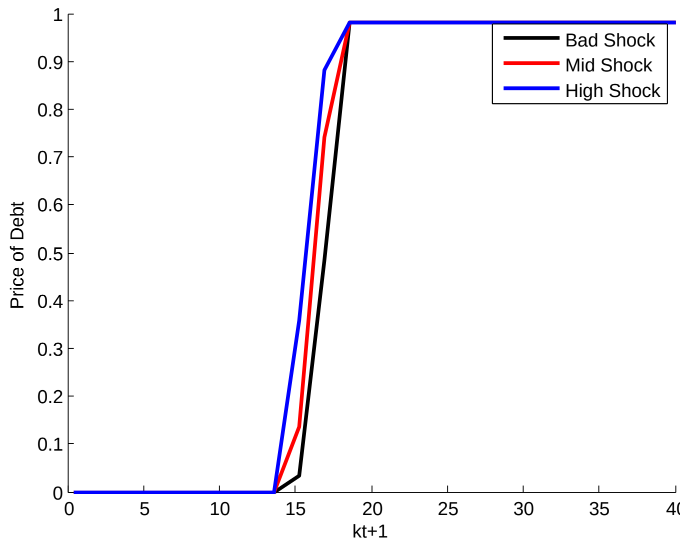

This graph depicts the need of funds in red for small firms (left panel) and large firms (right panel) as well as firms' investment policies for both booms (dashed line) and recession (solid line).

aggregates times means better (worse) growth opportunities for small firms and that means higher (lower) financing needs. Therefore small firms issue more (less) in booms (recessions).

We show now how the mechanism plays out in the model. To this end, we examine external needs of funds and investment decisions for small and large firms. Figure 6 plots external needs of funds $((1-\tau_c)\,zsk^{\alpha}-(k'-(1-\delta)\,k)+\tau_c\delta k-g(k,k')-c_f-b\left(1-\tau_c(1-\overline{p^b})\right))$ in red and investment policy in blue over current leverage. The solid line shows the funding needs and investment policies in a recession and the dashed line in a boom. Since the idiosyncratic shock has been fixed, these firms are essentially the same, except that the small is farther away and below its efficient scale and the large firm is closer but above its effcient scale. Figure 6 further shows that the more leveraged a firm is the higher are its need of funds.

Figure 6 highlights the first part of our mechanism. Smaller firms have higher needs of funds than large firms in a boom due to their higher return on investment. In this example the large firm must even deinvest to return to its optimal size. This can happen when the firm had a higher idiosyncratic productivity in the previous period. The graph also shows how the business cycle amplifies the mechanism of the model: small firms' needs of funds is much more responsive to the business cycle compared to the large firm. This suggests that most of the action in this model is derived by the entry and financing behavior of small

Figure 7: Price of Debt




firms.

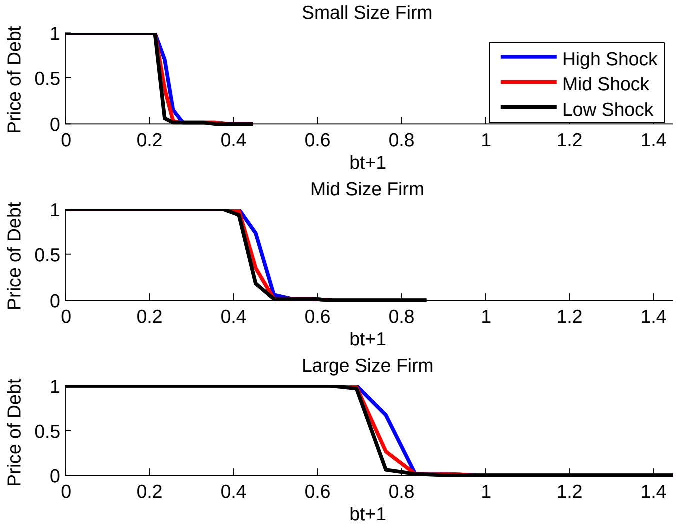
How do firms decide between their two external funding sources? Suppose a firm intends to increase capital by one unit and must decide how to finance it. If it increases debt it may increase its probability of default in case the firm is close to the default region. Then the price of the entire debt stock decreases. This means that it becomes *more* costly to issue debt. However if it finances with equity the firm incurs issuing cost which decreases the value of the firm.

The Euler equation for capital (equation 13) shows the benefit from investing an additional unit of capital: the return on production next period and additional internal funds available that could be used to pay off future debt. This is because $\frac{\partial q^b}{\partial k'} > 0$. That is, the higher $k'$ the lower the probability of default and thus the higher the price. Further, the probability of default depends on aggregate conditions. Figure 7 depicts the price of debt as a function of collateral (firm assets) for different aggregate shocks. The better the aggregate condition, the less collateral (capital) is needed for the same price of debt.

The Euler equation for debt (14) determines how the firm chooses its debt financing . If the firm wants to increase the funds received by promising to repay an extra unit tomorrow it raises $\left(q^b + b'\frac{\partial q^b}{\partial b'}\right)$ today. Since $\frac{\partial q^b}{\partial b'} \leq 0$, an upward change in the loan amount may decrease the total amount of funds received from debt today. It will depend on the sensitivity of the price of debt to the amount borrowed. The default premium generates an endogenous debt ceiling that depends on size.

Each panel in figure 8 plots the price of debt for a firm of a given size (from the top panel

Figure 8: Price of Debt




to the bottom panel we depict small to large firms) with the same idiosyncratic productivity. These firms have the same optimal size. The price of debt is plotted as a function of the promised repayment amount during a boom, recession, and normal times. The amount of funds firms receive for their promise today is the price times the promise. The small firm in the top panel is affected by the endogenous debt ceiling. That is, even if this firm were to promise to repay a lot, a lender anticipates a default with certainty and thus effectively refuses to provide any funds by charging a price of 0. In contrast, the debt ceiling of a large firm is higher and therefore gives the firm cheaper access to debt financing for larger amounts of debt funds.

Firms with high funding needs but relatively low debt ceilings may find it cheaper to finance with equity. Figure 9 plots the marginal costs of equity and debt financing for small (left panel) and large firms (right panel). Since small firms have relatively high funding needs and hit the endogenous debt ceiling faster, equity becomes relatively more attractive. As the marginal cost of debt slopes up after the debt ceiling is reached, the marginal cost of equity becomes lower than the marginal cost of debt. Large firms only finance with equity if they need a lot of funds which is rarely the case. In booms small firms have even higher needs of funds, hence they will issue even more equity.

# 6 Matching the Data

The optimization generates policies for every firm. We simulate these firms for a large number of periods, allowing for entry and exit according to the firm distribution discussed in section

Figure 9: Marginal Costs of Debt and Equity Financing

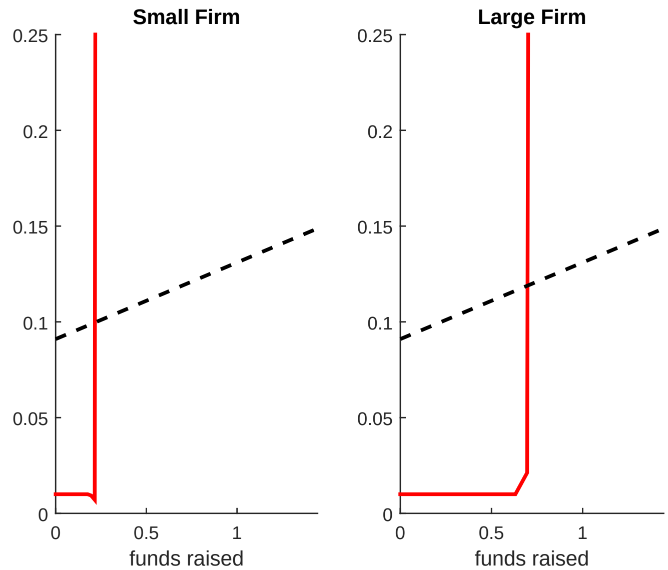



Table 8: Business Cycle Correlation of Financial Variables

| | Correlation with quarterly GDP | | | |
|---|---|---|---|---|
| | Data | | Model | |
| Bin | Equity Pay | Debt Rep | Equity Pay | Debt Rep |
| 0-25% | **−0.21** | **−0.53** | −0.67 | −0.80 |
| 25-50% | **−0.24** | **−0.72** | −0.59 | −0.73 |
| 50-75% | −0.03 | **−0.63** | −0.03 | −0.80 |
| 75-100% | **0.75** | **−0.76** | 0.35 | −0.67 |

4. We discard the first half of the simulated periods and treat the data the same way as we treat the Compustat data. That is, we sort firms into bins based on their capital, calculate debt repurchase and equity payout for each firm, and form cross-sectional bin sums. Then we band-pass the bin aggregated variable and scale it by the bin sum of assets. Finally, we obtain the correlations with the aggregate shock (also band-passed). We repeat the simulation and moments calculation multiple times and form averages of the moments. Table 8 compares the data against the untargeted simulated moments of the model. It shows that our mechanism can generate similar cyclical financing patterns as the data without exogenously time-varying adjustment costs. Equity payout is counter-cyclical for the first three bins and pro-cyclical for the last bin (large firms). Debt repurchase is counter-cyclical across all bins as in the data.

Our mechanism rationalizes these cyclical patterns in the following way: small firms need more funds in booms and cannot satisfy their funding needs with debt alone. This

Table 9: Cross-sectional moments

| | Means | | | |
|---|---|---|---|---|
| | Data | | Model | |
| Bin | Investment | Leverage | Investment | Leverage |
| 0-25% | 5.69 | 0.21 | 2.67 | 0.38 |
| 25-50% | 5.35 | 0.23 | 1.89 | 0.39 |
| 50-75% | 4.63 | 0.27 | 1.77 | 0.38 |
| 75-100% | 3.55 | 0.27 | 1.58 | 0.39 |

motivates them to issue equity, generating counter-cyclical equity payout. In recessions, the growth opportunities decrease and so do the needs of funds. Consequently firms issue less. In good aggregate times, large firms have more internal funds and are able to use those to increase pay out. Large firms always finance with debt and finance more (repurchase less) in booms.

Table 9 shows other cross-sectional moments that have not been targeted by the calibration such as the average investment rate per bin and leverage.

# 7 Amplification

Firm dynamics and financial frictions matter for the macro-economy only in so far they lead to amplifications and propagation of shocks. In order to get a sense for the model's amplification potential we compare the full benchmark model with an economy that has no financial frictions aside of a tax-advantage of debt. That is, there are no bankruptcy or equity issuance costs in this model.

We obtain the stationary distribution of the model with financial frictions and without financial frictions. This is shown in figure 10. The size distribution of the economy with financial frictions is skewed to the left and has a fat tail on the right which is similar to the data. The size distribution of the economy without financial frictions is highly concentrated around the optimal scale of firms and lacks skewness to the left. In our model economy, financial frictions in the form of external financing costs prevent firms from attaining their efficient scale quickly.

How do these two different economies react differently to a bad aggregate shock? In order to answer this questions, we start from the stationary distribution of each economy. We simulate each economy for four quarters with a shock that is one standard deviation lower than the mid-sized aggregate shock. After that the aggregate shock returns back to its mid-size level. Last, we compute aggregate output growth for each economy. Figure 11 presents the percentage difference of output growth in the financial friction economy and the

Figure 10: Firm Size Distribution

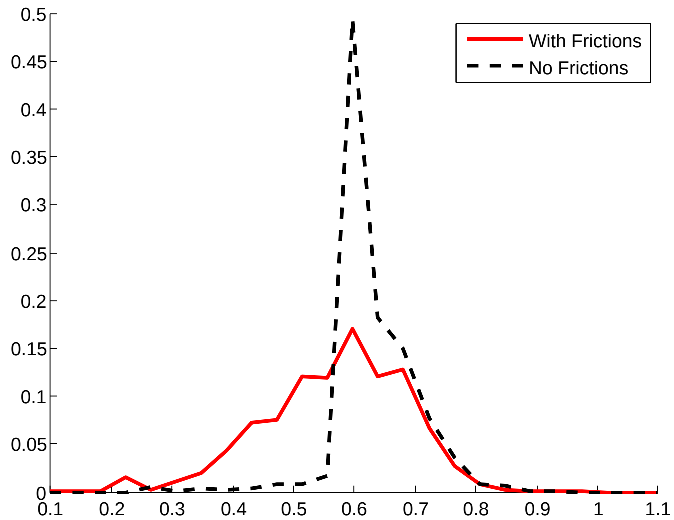
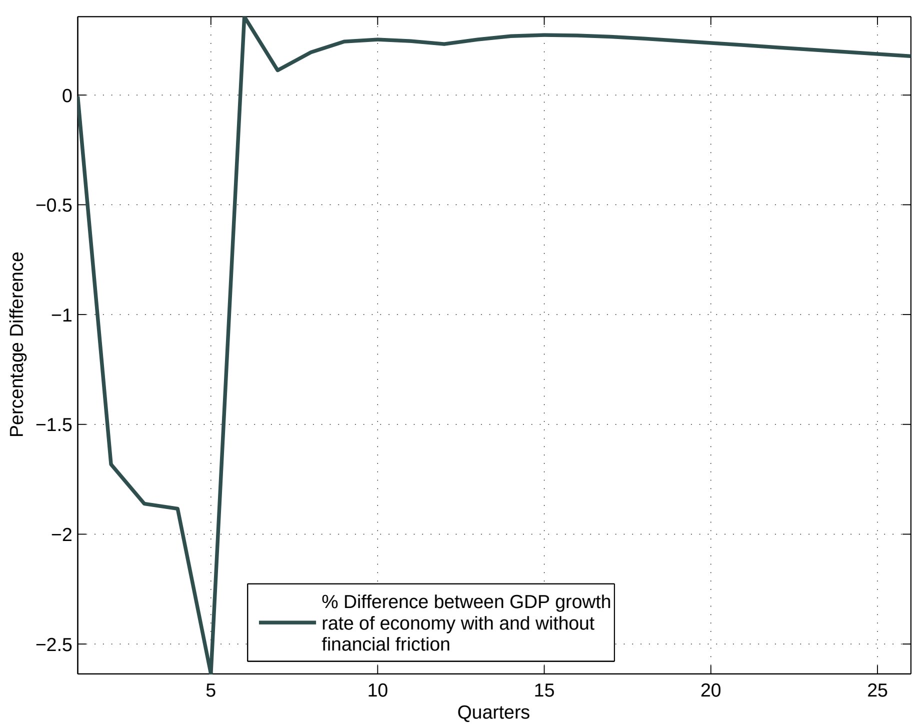



Figure 11: Amplification



economy without financial frictions. It shows that the recession has a stronger impact on the economy with financial frictions. This is because financial frictions make it harder to buffer economic shocks and are forced to exit. A bad aggregate shock discourages firms to enter in particular when external funds are expensive, leading to a worse recession in that case.

# 8 Conclusion

We show that aggregate shocks and endogenous firm dynamics in conjunction with external equity financing costs and defaultable debt pricing affect how the cross-section of firms finances investment over the business cycle. In the data, large firms make more extensive use of equity instead of debt financing during economic downturns. In good times, they pay out to their shareholders. In contrast, smaller firms appear not to substitute external financing sources over the business cycle. They use more debt and equity financing during booms.

The model proposes an explanation for the cyclical movements and the cross-sectional differences of firm financing. Smaller firms have higher funding needs because they are farther away from their efficient scale. At the same time, debt financing is relatively more costly to them since they can pledge less collateral. Booms represent good investment opportunities and therefore higher funding needs. These higher investment needs cannot be financed with debt alone, small firms turn to equity financing. Large firms are closer to their efficient scale and have lower funding needs relative to the collateral that can be pledged to bond holders. This allows them to borrow cheaply, in particular during booms. Large firms' borrowing costs are so low that they can borrow to finance payouts to shareholders.

Endogenous firm dynamics and financial frictions amplify aggregate shock and increase firm heterogeneity. Our analysis underscores that the interplay between firm dynamics and financial frictions are important to understand firms' financial positions and investment behavior over the business cycle.

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# A Appendix

## A.1 Data

We download the Compustat/CRS merged data file from the first quarter in 1978 until the last quarter in 2013 from WRDS. We keep firms that are incorporated in the United States and drop financial (SIC codes 6000-6999), utility (SIC codes 4900-4949), and quasi-government (SIC codes 9000-9999) firms. We drop observations with missing or negative values of assets (atq), sales (saleq), and cash and short term investment securities (cheq). We also discart observations with missing liabilities (ltq) and observations where cash holdings are larger than assets. Firms must have at least 5 observations (5 quarters) to be included into our sample. We convert year-to-date into quarterly values of the sale and purchase of common and preferred stock, cash dividends, and capital expenditures on the company's property, plant and equipment. We delete observations for which the year-to-date into quarterly observations results in negative values. Moreover, we drop GE, Ford, Chrysler and GM from the sample because those firms were most affected by the accounting change in 1988.

Following the business cycle literature, we compute correlations for the time period starting with the first quarter of 1984 until the last quarter of 2013. In the main text, we show our empirical results excluding the first quarter from each firm's time series to focus on non-IPO effects. In the appendix we present results for the case when the first quarter is included in the sample, and results for the case when the entire first year is excluded from the sample.

## A.2 Definitions

Following Dunne et al. (1988) we define entrants' relative size as the average size of entering firms relative to incumbents (in the sense of being a public firm).

## A.3 Empirical Results

In this section we present the empirical results after excluding the first year and the first three years of new firms respectively. The surviving firms are larger and therefore behave more as the largest bin in the full sample. The more firms we exclude from the sample the stronger becomes the positive correlation of equity payout with the business cycle.

Table A1: Include first quarter of new firms

| | [7] Mean | | | Correlation with quarterly GDP ( real log )[8] | | |
|---|---|---|---|---|---|---|
| Asset Percentile | Equity Payout | Debt Repurchase | Default in % | Equity Payout | Debt Repurchase | Default |
| 0-25% | −0.0309 | −0.0103 | 4.83 | −0.16 | **−0.38** | 0.10 |
| 25-50% | −0.0158 | −0.0142 | 5.43 | **−0.19** | **−0.70** | **0.24** |
| 50-75% | −0.0040 | −0.0192 | 4.49 | −0.06 | **−0.61** | −0.10 |
| 75-100% | 0.0082 | −0.0165 | 2.13 | **0.67** | **−0.53** | 0.11 |

Table A2: Excluding first year of new firms

| | [9] [3] Mean | | | Correlation with quarterly GDP ( real log )[10] | | |
|---|---|---|---|---|---|---|
| Asset Percentile | Equity Payout | Debt Repurchase | Default in % | Equity Payout | Debt Repurchase | Default |
| 0-25% | −0.0309 | −0.0103 | 4.83 | −0.16 | **−0.38** | 0.10 |
| 25-50% | −0.0158 | −0.0142 | 5.43 | **−0.19** | **−0.70** | **0.24** |
| 50-75% | −0.0040 | −0.0192 | 4.49 | −0.06 | **−0.61** | −0.10 |
| 75-100% | 0.0082 | −0.0165 | 2.13 | **0.67** | **−0.53** | 0.11 |

Table A3: Excluding first two years of new firms

| | [11] Mean | | Correlation with quarterly GDP ( real log )[12] | |
|---|---|---|---|---|
| Asset Percentile | Equity Payout | Debt Repurchase | Equity Payout | Debt Repurchase |
| 0-25% | -0.0057 | -0.0013 | **−0.2436** | 0.1584 |
| 25-50% | -0.0018 | -0.0026 | -0.0167 | **-0.2746** |
| 50-75% | 0.0021 | -0.0044 | **0.4117** | **-0.3563** |
| 75-100% | 0.0084 | -0.0048 | **0.5850** | **-0.2576** |

## A.4 Additional Facts

Table A4: Business Cycle Correlations

| Asset Percentile | $\Delta$Cash | Equity Issu. | Sale[13] |
|---|---|---|---|
| 0-25% | 0.05 | **0.30** | **0.38** |
| 25-50% | 0.03 | **0.34** | **0.61** |
| 50-75% | $-0.17$ | **0.34** | **0.72** |
| 75-100% | $\mathbf{-0.38}$ | **0.44** | **0.63** |
| Aggregate | $\mathbf{-0.36}$ | **0.43** | **0.65** |

We compute the correlations of quarterly real log GDP with the deflated band-passed filtered components of of changes in cash and marketable securities, book leverage (debt/assets) and equity issuance. All variables are scaled by the trend of assets. The numbers in bold are significant at the 5% level.