Firm Financing over the Business Cycle

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Abstract

We study the investment and financing policies of public U.S. firms. Large firms substitute between debt- and equity financing over the business cycle whereas small firms’ financing policy for debt and equity is pro-cyclical. This paper proposes a novel mechanism that explains these cyclical patterns in a quantitative heterogeneous firm industry model with endogenous firm dynamics. We find that cross-sectional differences in investment policies and therefore funding needs as well as exposure to financial frictions are key to understand how firms’ financing policies respond to macroeconomic shocks. Financial frictions cause firms to be larger with lower valuations and less investments.

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1 Introduction

Macroeconomic shocks and financial market conditions affect how firms choose to invest and finance themselves (e.g. Bernanke and Gertler (1989) and Jermann and Quadrini (2012)). In a world in which the conditions for Modigliani-Miller (MM) theorem do not hold, firms must jointly choose their investment and financing policies. Investment decisions by firms may also depend on whether they are large and mature or small and growing. This is borne out in the data: 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 both. In this paper, we study the mechanism that generates these cross-sectional financing differences over the business cycle and propose an explanation for why small firms behave so differently compared to large firms. We further use the model to shed light on how financial frictions affect the firm size distribution as well as firms’ investment behavior and market valuation.

Our mechanism, in a nutshell, explains the business cycle differences in firms’ external financing behavior based on differences in funding needs and financial frictions. We analyze this mechanism in a heterogeneous firm industry model with endogenous firm dynamics that we match to the standard sample of public U.S. firms using Compustat data. Armed with the model we explore quantitatively how investment and financial frictions generate the differences in financing behavior and may contribute to an amplification of aggregate shocks.

External financing comes either from debt- or equity holders. We define our financing variables equity payout (net flow of funds from the firm to shareholders) and debt repurchases (net flow of funds from the firm to debt holders) as in Jermann and Quadrini (2012) and compute their cross-sectional business cycle correlation using quarterly Compustat data from 1984Q1 until 2014Q4. These definitions are based on cash flow variables in Compustat that represent a comprehensive measure of firms’ external financing. For example, equity payout is defined as dividends plus repurchases less issuance. When equity payout is positive, the firm returns capital to shareholders. When equity payout is negative, the firm is financed with capital by shareholders.

Sorting firms based on their sector specific asset positions into four size portfolios, we document that firms in the bottom three-quartiles of the asset size distribution (small firms) obtain more funds through equity than through debt financing. They also increase both debt and equity financing during booms. In contrast, firms in the top quartile (large firms) payout equity and substitute between debt and equity financing over the cycle. The pattern in the

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1 Covas and Den Haan (2011) first made the point on the cross-sectional differences in firm financing behavior over the business cycle using annual Compustat data. Instead, we focus on quarterly firm level data from Compustat, allowing us to compare our results with aggregate studies on business cycle fluctuations.
data suggests that large firms finance equity payouts with debt in booms. Interestingly, the same pattern can be observed in aggregate Flow of Funds data as documented by Jermann and Quadrini (2012). Aggregating the positions across size portfolios shows that Flow of Funds data is dominated by the behavior of large firms.

The model, based on Gomes (2001) and Hennessy and Whited (2007), has two key features that affect firms’ financing choice over the business cycle. First, each point in the firm size distribution can be related to a different stage of business maturity. Our decreasing returns to scale technology assumption implies an optimal scale (conditional on firms’ idiosyncratic productivity) and investment patterns that are negatively correlated with firm size. That is, there are large mature firms that seize to grow and small firms that grow. We introduce adjustment costs to capital to generate slow convergence to the efficient scale. The smaller and farther away a firm is from its efficient scale the larger its return to investment and incentives to grow. In other words, small firms have high funding needs to finance their growth.

Second, firms can finance investment either internally through accumulated earnings or externally through debt or equity. Debt is preferred over equity because of a tax advantage. At the same time, debt financing is costly because repayment is not enforceable and a fraction of the principle is lost in default. Firms choose to default if they cannot generate enough sustainable cash flows going forward to pay their fixed cost of operation. Intuitively, smaller firms generally lack the means to fund their growth internally. They are also more affected by the fixed cost of operation that makes them riskier. A firm is also riskier when it is highly levered. The riskier the firm, the costlier it is to finance with debt because the price of debt adjusts endogenously to the likelihood of default.

This is how the model generates endogenous differences in firms’ financing behavior: smaller firms are farther away from their efficient scale and have thus larger incentives to invest and grow. When debt funding becomes too expensive, they resort to equity financing. During booms firms become less risky and have better growth opportunities. The latter is particularly true for small firms that respond by investing and raising more funds, first from debt because it is marginally preferred and then from equity if their investment need cannot be quenched with debt financing alone. Large firms are closer to their efficient scale, lessening their funding needs. Given their objective to maximize equity payout (subject to a payout tax), large firms choose internal funds and debt financing to payout to shareholders.

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2 In the model firms differ in capital, leverage, and idiosyncratic productivity. Each period they face aggregate and idiosyncratic shocks and decide whether to default or to continue. Conditional on not defaulting, firms decide how much to invest and how to finance their operations in order to maximize the distributions to shareholders. Investors are risk-neutral. Firm dynamics are endogenous, i.e. a mass of private firms chooses each period whether to enter. Defaulting firms exit.
During booms internal cash flow is higher and debt financing costs are lower, increasing the payout to shareholders.

Endogenous entry dynamics are key to allow for time variation in the number and size of entrants. Each period a mass of private firms chooses whether to enter (become public) upon receiving a signal (see Clementi and Palazzo (2013)). They are typically of smaller size and given the decreasing returns to scale technology have high growth opportunities. When aggregate investment opportunities improve, it becomes profitable for even smaller firms to enter, amplifying the effect of the pro-cyclical financing activity of small firms.

The model is parametrized to the universe of U.S. publicly listed firms. Because our interest is on the cross sectional financing behavior, we focus on the entire firm size distribution instead of on an individual firm. Due to entry and exit, the firm size distribution is endogenous and business cycle dependent. As in the data the definition of small and larger firm is also endogenous and shock dependent.

Our quantitative results show how frictions affect firms financing and investing decisions differently depending on their size. First, we find that frictions cause firms to be larger on average because size lowers debt financing costs. Absent financial frictions, firms not only tend to be smaller but also default more. This is plausible because it is less risky to take risks. Smaller firms can seize productivity opportunities by leveraging up and investing more. This causes them to have substantially higher market to book valuations compared to the benchmark calibration. The business cycle correlations of equity payout for the non-friction cause displays either a-cyclical or pro-cyclical payout patterns, i.e. firms do not have to resort to equity financings since debt financing frictions have been lifted and firms use almost exclusively debt to fund investment projects.

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 the determinants of firms’ financial positions and what matters to match them quantitatively. For example, Hennessy and Whited (2005) show that dynamic trade-off models rationalize the behavior of corporate financial data3. 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.

3An excellent overview over two decades of research in dynamic corporate finance is provided by Strebulaev and Whited (2012).
Macroeconomic shocks are important determinants of firms’ capital structure choice (e.g. Korajczyk and Levy (2003), ?, 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 differs in the sense that we focus on the heterogeneous effects of macroeconomic shocks.

The fact that different firms react differently to aggregate shocks has been widely documented, see for example Korajczyk and Levy (2003)\(^4\). 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 is 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 strand of papers that embeds a quantitative asset pricing models into a heterogeneous firm models with a dynamic capital structure choice to study how credit spreads and the equity premium get determined (e.g. Bhamra, Kuehn, and Strebulaev (2010), Belo, Lin, and Yang (2014), Gomes and Schmid (2010) 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. Also we focus on the 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 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 studies 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)). 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

\(^4\)The results of Korajczyk and Levy (2003) and ? are inconsistent. Please refer to the discussion in Covas and Den Haan (2011) who show how aggregate data can lead to non-robust results.
relationships can improve our understanding about how aggregate shocks are transmitted and amplified in the cross-section of firms.

The paper is structured as follows. Section 2 presents the stylized fact on firm financing over the business cycle. Section 3 describes the firm optimization model that defines the stationary firm distribution. Section 4 describes the parametrization strategy. Section 5.1 explains the mechanism behind the results presented in section 5.2.

2 Facts about the Cross-Section of Firm Financing Behavior

In this section, we document stylized facts about the cross-section of public firms that motivate our heterogeneous firm financing model.

The main stylized fact that we seek to explain is the pro-cyclical debt- and equity financing of small firms and the substitution across financing sources of large firms. We use quarterly Compustat data from 1984-2014. An empirical analysis has been conducted by Covas and Den Haan (2011) that arrives at a similar conclusion, albeit with annual Compustat data up to 2006. In their sample all but the top 1 percentile of the asset distribution have counter-cyclical equity payout and counter-cyclical debt repurchase. Using quarterly business cycle statistics, we arrive at a analogous conclusion. However, we find that the top 25% percentile firms of the asset distribution substitute across debt and equity over the business cycle and not just firms in the top 1 percentile.

2.1 Data

We use data\textsuperscript{5} from CRSP/Compustat Merged (CCM) Fundamentals Quarterly from the first quarter of 1984 to the last quarter of 2014. 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.\textsuperscript{6}

Sample Description

We begin by reporting 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.

\textsuperscript{5}The sample selection is described in section A.

\textsuperscript{6}For instance, Jermann and Quadrini (2012) among others note that the period after 1984 saw major changes in the U.S. financial markets.
Table 1: Transition Probabilities

<table>
<thead>
<tr>
<th>Asset Percentile</th>
<th>0-25%</th>
<th>25-50%</th>
<th>50-75%</th>
<th>75-100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>96.51</td>
<td>3.44</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>25-50%</td>
<td>3.81</td>
<td>92.60</td>
<td>3.56</td>
<td>0.03</td>
</tr>
<tr>
<td>50-75%</td>
<td>0.02</td>
<td>3.29</td>
<td>94.36</td>
<td>2.33</td>
</tr>
<tr>
<td>75-100%</td>
<td>0.00</td>
<td>0.01</td>
<td>2.05</td>
<td>97.94</td>
</tr>
</tbody>
</table>

Table presents the % likelihood of moving from bin (in row) into another bin (column).

In the model, we focus on firm size as a dimension of heterogeneity because external financing costs differ mostly by size (see Hennessy and Whited (2007)). We interpret size as a proxy of the maturity and profitability level of a firm. In the appendix, we show in Table 2 how our interpretation of size dove-tails with the cyclical financing pattern of firms sorted by Tobin’s Q.

We build size portfolios by sorting firms into quarter and sector specific asset quartiles. We assign one of the four values (1 - 4) to the variable “sector” depending on the SIC code (we explain the details of defining “sector” in the Appendix A). The composition of firms may therefore change from one quarter to the next. Table 1 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.

Variable Definitions

We use data on real quarterly GDP and the price level from NIPA. For the financial variables, we focus on funds obtained by firms from all available external sources: debt- and equity. In particular, we consider quarterly cash flows that flow between investors and firms. In defining the two financial variables, we take the perspective of a debt and equity 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, which is defined as the sum of cash dividends and equity repurchases less equity issuance. 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

7The appendix (see section A) contains more information on the panel characteristics of the sample.
preferred stock. This variable includes the exercise of stock options or warrants for employee compensation as well as stocks issued for an acquisition. For this reason, the Compustat variable sstky may overstate equity issuances for financing reasons. We address this concern by adjusting the Compustat variable sstky according to the procedure suggested by McKeon (2013).\(^8\)

Variables ending in “y” in Compustat are stated as year-to-date. We convert them into quarterly frequency by subtracting the past quarter from the current observation for all but the first quarter\(^9\) 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 (dltti) and short term (dlcqi) 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.

We compute the financial variables equity payout and debt repurchases at the bin level. The correlation statistics are constructed by applying the band-pass filter to the deflated bin variable and scaling it by the trend component of assets, where assets have been aggregated to the specific bin level. For means and pictures, we use the seasonally smoothed variables and scale it by assets.

### 2.2 Stylized Facts of Firms’ External Financing Patterns

*Equity payout and debt repurchases over the business cycle*

Table 2 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 present in the firms in the top 25\(\%\)tile but not in the smaller bins.\(^10\) The correlations for the aggregate level are very similar to

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\(^8\)McKeon (2013) shows how following his data adjustment corrects for compensation based equity issuance. He finds that equity issuance that are larger than 3\% of total market value are almost certainly firm initiated while issuances between 2\% to 3\% of market capitalization are predominantly firm initiated. Therefore, we consider only equity issuance that are larger than 2\% of market value. The results are virtually unchanged if we focus only on issuance larger than 3\% of market value.

\(^9\)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.

\(^10\)In unreported results we checked what the appropriate size cut-off should be by sorting firms in less coarse asset bins. We found that the switch from counter- to pro-cyclical equity payout occurs around the top 25\(\%\)tile, i.e. the 75\(\%\)tile cut-off for the largest bin has not been arbitrarily chosen.
Table 2: **Business Cycle Correlation of Equity Payout and Debt Repurchases**

<table>
<thead>
<tr>
<th>Asset Percentile</th>
<th>Equity Payout</th>
<th>Debt Repurchases</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>-0.33</td>
<td>-0.44</td>
</tr>
<tr>
<td>25-50%</td>
<td>-0.24</td>
<td>-0.68</td>
</tr>
<tr>
<td>50-75%</td>
<td>-0.02</td>
<td>-0.61</td>
</tr>
<tr>
<td>75-100%</td>
<td>0.71</td>
<td>-0.67</td>
</tr>
<tr>
<td>Aggregate</td>
<td>0.68</td>
<td>-0.70</td>
</tr>
</tbody>
</table>

We compute the correlations of quarterly real log GDP with the deflated band-passed filtered components of log equity payout and log debt repurchases, scaled by the trend of assets. The numbers in bold are significant at the 1% level. Sample: Compustat 1984q1-2014q4

the top quartile of firms.\textsuperscript{11,12} Altogether these facts suggest that most firms use good times to raise funds from both debt and equity claim holders. Large firms however seem to prefer debt financing and equity payout in booms.

Do firms payout equity and finance with debt at the same time? Table 3 shows that on average 18% of the firms issue debt and payout equity at the same time (last column). This phenomenon occurs in particular in large firms (34%) for which we find pro-cyclical equity payout and counter-cyclical debt repurchases.

Table 4 presents averages per size bin for equity payout and its components: equity issuance, dividends, and equity repurchases. Further the table lists the means of debt repurchases, assets (stated in 2009 billion dollars), investment rate, and leverage. All averages are time-series averages from 1984Q1 until 2014Q4 of cross-sectional averages. The table shows that the all firms finance with debt and that most but the largest firms finance with equity. Investment (capital expenditures over lagged assets) is decreasing in size bin while leverage is increasing. In the appendix, we also report the mean and volatility of sales- and asset growth. Typically, smaller firms are more volatile.

\textsuperscript{11} 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 makes it hard to directly compare our numbers.

\textsuperscript{12} In the appendix section A we present how other financing variables such as cash, dividends (included in payout etc), and so forth differ over the business cycle. Furthermore, table 11 in the appendix presents the cyclical external financing patterns of firms sorted by Tobin’s Q. We show that small firms and firms with high Tobin’s Q finance pro-cyclical while large firms with low Tobin’s Q tend to substitute between debt and equity over the business cycle. This affirms our interpretation of the stylized fact as a being driven by the behavior of firms at a different stage of their life-cycle. We perform a similar exercise by sorting firms according to age (see Table 13). Younger firms show the same external financing pattern over the business cycle as small firms and old firms show a similar behavior over the business cycle as large firms. We focus on size because it is a more tractable sorting measure in the model.
**Table 3: Debt Issuance & Equity Payout Incidence**

<table>
<thead>
<tr>
<th></th>
<th>Freq. of any debt/equity fin. activity</th>
<th>Fin. activity with debt issuance</th>
<th>Fin. activity with debt issuance &amp; equity payout</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>40</td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td>&lt; 25%tile</td>
<td>36</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>25 – 50%tile</td>
<td>36</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>50 – 75%tile</td>
<td>40</td>
<td>39</td>
<td>20</td>
</tr>
<tr>
<td>&gt; 75%tile</td>
<td>47</td>
<td>64</td>
<td>34</td>
</tr>
</tbody>
</table>

Sample: Compustat 1984Q1-2014Q4; units are in %
1. column: % of any external financing activity (debt or equity financing)
2. column: % issuance & equity payout in same quarter within financing activities
3. column: similar to 2. column but excl. dividend in equity payout definition

**Table 4: Cross-sectional Financing and Investment Means**

<table>
<thead>
<tr>
<th></th>
<th>0-25%</th>
<th>25-50%</th>
<th>50-75%</th>
<th>75-100%</th>
<th>Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equity Issuance</td>
<td>2.94</td>
<td>1.75</td>
<td>0.85</td>
<td>0.16</td>
<td>1.42</td>
</tr>
<tr>
<td>Dividends</td>
<td>0.23</td>
<td>0.24</td>
<td>0.27</td>
<td>0.54</td>
<td>0.32</td>
</tr>
<tr>
<td>Equity Repurchases</td>
<td>0.23</td>
<td>0.32</td>
<td>0.41</td>
<td>0.62</td>
<td>0.39</td>
</tr>
<tr>
<td>% of Assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equity Payout</td>
<td>-2.39</td>
<td>-1.16</td>
<td>-0.15</td>
<td>0.99</td>
<td>-0.67</td>
</tr>
<tr>
<td>Debt Repurchases</td>
<td>-1.12</td>
<td>-1.51</td>
<td>-2.11</td>
<td>-1.76</td>
<td>-1.62</td>
</tr>
<tr>
<td>$ Billions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assets</td>
<td>22</td>
<td>106</td>
<td>380</td>
<td>5,578</td>
<td></td>
</tr>
<tr>
<td>Investment rate</td>
<td>3.91</td>
<td>4.17</td>
<td>3.82</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Leverage</td>
<td>0.19</td>
<td>0.2</td>
<td>0.25</td>
<td>0.3</td>
<td></td>
</tr>
</tbody>
</table>

Sample: Compustat 1984Q1-2014Q4; assets are in billions & deflated [BEA producer index 2009]
Investment rate = capx/lagged assets; leverage is debt over lagged assets
Figure 1 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 2014. 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 2) of debt repurchases and equity payout is almost identical to the right panel of figure 1. That is, as shown in table 2, the aggregate firm financing patterns are governed by large firms. Focusing on aggregate data only conceals the financing behavior of the majority of firms. The financing behavior of small and large firms differs significantly over the business cycle. For this reason, we use a heterogeneous firm financing model to explain the impact of financial markets on firms’ financing decisions. Our model advances a novel mechanism to explain these financing differences and therefore sheds a light on the nature of firms’ financial behavior.

3 Quantitative firm dynamics model with financial frictions

In this section we describe the model environment as well as the problem of incumbent and entrant firms. Justification for the various assumptions follows in section 3.3.
3.1 Environment

There is a continuum of heterogeneous incumbent firms that own a decreasing returns to scale technology \((\alpha < 1)\). Gross revenue is \(F(z, s, k) = zsk^\alpha\), where \(z\) is the aggregate shock common to all firms, \(s\) is the firm specific transitory shock. 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.

Firms also differ with regard to the capital stock \(k\) they own and current debt levels \(b\). The capital stock depreciates at the rate \(\delta\) each period. The purchase of new capital stock is subject to quadratic adjustment costs. We follow Zhang (2005) when we assume quadratic adjustment costs

\[
g(k, k') = \frac{c_t}{2} \left( \frac{k' - (1 - \delta)k}{k} \right)^2 k
\]

where

\[
c_t \equiv c_0 \cdot \Xi(k' - (1 - \delta)k < 0) + c_1 \cdot (1 - \Xi(k' - (1 - \delta)k < 0))
\]
and \( \Xi_{(k^r - (1-\delta)k) < 0} \) is an indicator that equals one when the firm divests and \( 0 < c_1 < c_0 \) capturing costly reversibility Abel and Eberly (1996)

Corporate taxable income is equal to operating profits less economic depreciation and interest expense:

\[
T^c(k, b, z, s) \equiv \tau_c \left[ zsk^\alpha - \delta k - rb \right],
\]

where \( rb \) are the default free interest expenses and \( \delta k \) represent the economic depreciation.

**External Financing and Financial Frictions**

The model features frictions in both equity and debt financing.

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 \( q^b < 1 \) and promises to pay back the face value \( b' \) next period. Debt is preferred over equity due to a tax-advantage of debt. Investors are risk neutral and therefore use \( r = \tilde{r} (1 - \tau_i) \) 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. 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 recuperation value:

\[
RC(k) = \min \left( (1 - \varepsilon)[(1 - \delta)k] - cf, 0.75 \right),
\]

where \( \varepsilon \) represents bankruptcy costs, e.g. any costs related to the liquidation and renegotiation of the firm after default. The recuperation value is lowered by the fixed cost of operation and capped at 75%.

The firm can also issue equity \( e \) to finance itself, where \( e < 0 \). In this case firms incur a linear issuance costs (see also Gomes and Schmid (2010)):

\[
\Lambda(e) \equiv 1_{e<0} \lambda e
\]

\[
\lambda \geq 0
\]

where \( 1_{e<0} \) equals 1 if \( e < 0 \) and zero otherwise.

Also the firm can payout equity \( e \) to the shareholders, where \( e > 0 \). In this case, the payout is taxed:

\[
\Upsilon(e) = 1_{e>0} \tau_e
\]
where $1_{e>0}$ equals 1 if $e > 0$ and zero otherwise.

### 3.2 Firm optimization

This section describes the problem of incumbents and entrants.

**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:

$$ V = \max \{ V^{ND}, V^D = 0 \} . $$

The repayment value is

$$ V^{ND}(z, s, k, b) = \max_{k' \in K, b' \in B, e} \left\{ \begin{array}{l}
e + \Lambda(e) - \Upsilon(e) \ldots \\
\text{Equity} \quad \text{Eq. Iss. Cost} \quad \text{Eq. Pay. Tax}
\end{array} \right. 
+ \frac{1}{1+r} E_{s,z} [ V(z', s', k', b') ] , $$

where $e$ represents equity payout if $e > 0$ or equity issuance if $e < 0$. The firm maximizes the repayment value by choosing capital $k'$ and debt to be repaid next period $b'$. Both decisions determine equity which is defined as

$$ e = (1 - \tau_c) zsk^\alpha - (k' - (1 - \delta) k) - g(k, k') - c_f + \tau_c (\delta k + rb) + q^b b' - b. $$

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 $q^b b'$ and less debt to repay $b$.

The timeline 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.\textsuperscript{13}

**Debt Contract and Debt Pricing**

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:

$$
\Delta(k, b) = \{ (s, z) \text{ s.t. } V^{ND}(z, s, k, b) \leq 0 \}.
$$

Risk neutral investors price debt such that they are indifferent between the investment in a riskless asset and the investment in the bond of the firms:

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

Defining the price of the bond as

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

the no-arbitrage condition from risk-neutral debt pricing results in the following expression for the price on the bond

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

If the firm is not expected to default the price is $1/(1 + r)$. 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 repaid 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 productivity the higher the debt capacity of the firm for a given amount of capital. Note 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.

**Entrant Problem**

\textsuperscript{13}We restrict firms from choosing debt and equity combination that have an annual probability of more than 75%. Further, we do not allow firms to payout equity if they have a positive probability of default.
The data parallel for entry in the model is the decision of a firm to go public. Every period a constant mass $M$ of potential entrants receives a signal $q$ about their productivity. We specify this signal as Pareto, $q \sim Q(q)$, with parameter $\omega$, allowing for heterogeneous entrants. Firms have to pay an entry fee ($c_e > 0$) that ensures that not all firms find it optimal to enter. This parameter helps us to pin down the size distribution of the entering firms.

Entrants only start operating in the period after the entry decision but must decide today with which capital stock it wants to start production tomorrow conditional on a starting capital $k^\text{priv}$. Entrants also start out with an initial level of leverage $b^\text{priv}/k^\text{priv}$. Investment is subject to adjustment costs. Entrants need funds amounting to

$$H = k^' - (1 - \delta) k^\text{priv} + g(k^\text{priv}, k^') - q^b b^,'$$

i.e. investment plus adjustment costs expenditure minus funds raised through debt financing. Investment can be financed with debt and/or equity. $H$ is the share finance with equity. 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

$$V_e(z, q) = \max_{k'} \left\{ -H + I_{H<0} \Lambda(H) + \frac{1}{1 + r} E_{q,z} \left[ V(z', s', k', b') \right] \right\}.$$  \hspace{1cm} (8)

Upon entering, entrants have to pay a fixed entry cost $c_e$. Entrant invests and starts operating if and only if $V_e(z, q) \geq c_e$. Also, the entrant firm can not choose a debt position that has positive probability of default in the next period.

**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 incumbent’s measure $\{\Gamma_t\}_{t=1}^\infty$ and entrant’s 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 $S \times K \times B \times \mathbb{R} \times \mathbb{R}^+$ and $\forall t \geq 0$,

$$\varepsilon_{t+1}(S \times K \times B) = M \int_S \int_{B_e(K, B, z)} dQ(q) d(H(s'/q))$$
\[ B_c(K, B, z) = \{ q \text{ s.t. } k'(z, q) \in K, \ b'(z, q) \in B \text{ and } V_c(z, q) \geq c_c \} \]

4. For all Borel sets \( S \times K \times B \times \mathbb{R} \times \mathbb{R}^+ \) and \( \forall t \geq 0 \),

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

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

The firm distribution evolves in the following way. A mass of entrants receives a signal and some decide to enter. The signal \( q \) defines firm’s 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.

### 3.3 Discussion of Assumptions

This section describes why we make each assumption.

**Technology**

The assumption of decreasing returns to scale implies that given the stochastic state, there exists an optimal firm size and it allows us to model a distribution of firms. Firm’s productivity has an aggregate and an idiosyncratic part. The idiosyncratic shocks give an extra layer of firm heterogeneity, which is necessary to generate a non-degenerate the firm size distribution.

**Adjustment Costs of Capital**

We introduce adjustment costs for capital to generate slow convergence to the optimal firm size implied by the decreasing returns to scale assumption and idiosyncratic productivity. The adjustment costs are also important to break the connection between firm size and idiosyncratic shock. In absence of adjustment costs and financial frictions size would be pinned down by idiosyncratic shock. In other words, adjustment costs are critical to generate a more realistic firm size distribution. We use asymmetric adjustment costs as in Zhang (2005). When \( c_1 > c_0 \) (i.e. it is more costly to divest than to invest) investment is more risky because firms cannot react to positive shocks without taking into account that a future negative shock can make it very expensive to become smaller. This assumption also means that firms have to sit out a few negative shocks without immediately choosing
to downsize. Finally, capital adjustment costs also make leverage riskier a firm hit by a bad shock with large debt obligations cannot easily downsize.

Financial Frictions

Each period a firm maximizes equity payout to their shareholders by making an investment and a capital structure decision. The tax advantage of debt over equity, i.e. \( \tau_i < (1 + r)\tau_c \), 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. For this reason, debt is preferred over equity. Raising too much debt though is also costly due to firm’s default option and a deadweight loss through bankruptcy costs.

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 Farre-Mensa, Michaely, and Schmalz (2015)) 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, have a flat payout tax \( \tau_e \).

If equity is negative \((e < 0)\), the firm raises funds using equity. We assume that equity issuance is costly. These costs are 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 Cooley and Quadrini (2001) we capture adverse selection costs and underwriting fees in a reduced form. We adopt a very simple formulation by choosing a linear equity payout costs, \( \lambda \) as in Gomes and Schmid (2012).

4 Parametrization and Model Fit

This section presents how we parametrize the model and how it fits the data.

Parametrization The model period is quarterly. Parameters can be divided in three different categories. The first category consists of parameters where we follow 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. Table 5 displays the values for parameters within the first two groups. 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 calibration as well as the calibration targets and the model response.

**Solution technique** We are solving a heterogeneous firm dynamics model with endogenous entry and default. That is, we need to solve this non-linear model globally. We discretize the shocks using the standard method by Tauchen (1990). Given a parametrization, we find the policies and the value functions of entrants and incumbents by value function iterations. We simulate data by simulating a sequence of shocks and model variables using the policy functions.

**Model fit** Table 7 shows cross-sectional moments that our calibration strategy has not targeted. The model generates investment rates that are broadly increasing in size. Decreasing returns to scale incentivize smaller firms to invest more.
The model also captures the cross-sectional patterns of leverage. In particular, larger firms have higher levels of leverage compared to smaller firms, even though the overall levels are too high. However, for the cross-sectional differences in the business cycle patterns of firms’ financing behavior the precise level of leverage is less critical. What does matter is the relative difference between leverage across size groups, where the model is able to replicate the pattern in the data.

Equity payout relative to assets is increasing in size in the data and the model. In our calibration strategy we only targeted the negative equity payout, i.e. equity issuance, of small firms. But even the untargeted mean equity payout to asset ratios are quantitatively close to the data.

Endogenous entry and exit affect the firm size distribution over time. Figure 3 plots the average firm size distribution over the normalized assets (capital stock) for different states in the economy. Firms tend to enter small and more firms enter in good economic times during which the distribution gets flatter. Large firms are larger compared to bad states during which the size distribution is more concentrated and shifts to the left.

5 Results

5.1 Mechanism in the quantitative model

This section summarizes the mechanism of the model that rationalizes the cross-sectional external financing patterns observed in the data. Three key features of the model are firm dynamics, decreasing returns to scale with asymmetric adjustment costs of investment, and the endogenous debt ceiling.

The decreasing returns to scale technology assumption (conditional on the idiosyncratic and aggregate shock) means that firms have an efficient scale. With adjustment costs firms can only grow slowly towards their efficient scale.\footnote{In our setting, shareholders are sufficiently patient to wait for future payouts once the firm has attained} Moreover, the expected return on in-
Figure 3: Size Distribution

Size Distribution of Firms

- Recession
- Boom
- Mean State
Figure 4: Need for Funds (Red) and Investment Policy (Blue)

This graph shows the need of funds in red for small firms (left panel) and large firms (right panel) as well as firm’s investment policies for both booms (dashed line) and recession (solid line). We plot these against the average asset size of small firms (left) and large firms (right).

Investment depends negatively on the size of the firm. Table 7 in section 4 shows that this holds in the model. Consequently smaller firms should have higher funding and investment needs compared to large firms, relative to their assets.

Figure 4 plots external needs of funds $- \left( (1 - \tau_c) z s k^\alpha - \left( k' - (1 - \delta) k \right) - g(k, k') - c_f + \tau_c (\delta k + r b) \right)$ in red and investment policies $(k' - (1 - \delta) k)$ in blue against the state leverage levels of small firms (i.e. firms in the first quartile - left panel) and large firms (i.e. firms in the last quartile - right panel). The solid lines denote recessions while the dashed lines denote booms. We fixed the idiosyncratic shock to illustrate the behavior of firms that share essentially the same productivity levels and leverage levels but differ by their distance to the efficient size scale. The large firms are closer but above their efficient scale, while the small firms are farther away and below their efficient scale.

Figure 4 highlights two things. First, a firm that is farther away from its efficient scale has higher needs of funds and higher investment needs relative to their size compared to large firms. Second, booms increase funding needs and optimal investment needs, in particular for small firms. Thus, business cycles amplify the mechanism of the model: small firm’s needs of funds is much more responsive to the business cycle compared to the large firm. It suggests that most of the action in this model is coming from the investment and therefore financing behavior of small firms.

**15** Moreover, investment is slightly decreasing in ex-ante leverage levels. This suggests an debt overhang problem at very high levels of leverage. At very high
Because of their high funding needs and the tax-advantage of debt, small firms want to take on as much debt as possible. This pushes them closer to the endogenous debt ceiling. The first panel of figure 5 plots the price of debt as a function of the capital stock for different aggregate shocks, holding leverage constant. Given the aggregate state of the economy, small firms with higher ex-ante leverage are constrained by an endogenous debt ceiling that operates through the price of debt on the funds that firms generate from borrowing, i.e. price × face value of debt (b’). In other words, the default mechanism generates an endogenous debt ceiling that particularly constraints small and highly levered firms during bad economic states. In contrast, large firms have a large debt capacity regardless of the economic state or their current levels of debt, as can be seen from the bottom panel of figure 6.

The debt choice is determined by the trade-off between the tax-advantage and the cost of financial distress caused by default. The bottom panel of figure 5 presents the probability of default for above average levered firms as a function of the capital stock. The probability
The top panel reports the price of debt as a function of the capital stock for different levels of the aggregate shock conditional on having above average or below average leverage. The bottom panels report the probability of default for firms with above average leverage as a function of the capital stock and different aggregate states.
of default is higher during bad economic states. The resulting default premium generates an endogenous debt ceiling as shown in the top panel of the figure.

How do firms decide between debt and equity financing? Debt has a tax-advantage but carries default risk, while equity issuance is costly due to linear issuance cost and equity payout is taxable. What matters are the marginal costs of debt and equity for the funds raised conditional on the size.

Firms with high funding needs but low debt capacity (small growing firms) may find it cheaper to finance with equity. Figure 7 plots the marginal costs of equity and debt financing for small (left panel) and large firms (right panel). This graph tells us two things. First, large firms find debt financing always more attractive. They can borrow at the risk free rate (at 1%) instead of raising equity for which they incur 2% issuance costs. They will even find it optimal to raise equity to payout their shareholders.\footnote{Many firms borrow to payout because they issue at the default free rate. This is consistent with the data as documented by Farre-Mensa, Michaely, and Schmalz (2015).} In contrast, small firms have relatively higher funding needs and therefore get closer to the endogenous debt ceiling which makes equity financing relatively more attractive. Second, the marginal cost of debt slopes up very steep. Thus only productive firms with very high funding needs will resort to equity financing.
As mentioned before, small firms play a key role for the cross-sectional financing patterns. This suggests a major role for endogenous entry since entrants tend to be smaller and endogenous entry dynamics amplify our mechanism. For example, good economic times incentivize more firms to enter and firms of smaller than usual size.

The business cycle amplifies the cross-sectional differences in financing patterns. During booms (recessions) large firms have higher (lower) internal funds, therefore they will pay out more (less). Good times mean better (worse) growth opportunities for small firms, increasing (decreasing) their financing needs. Therefore small firms issue more (less) equity in booms (recessions). In the next section, we show how this mechanism plays out in the model.

5.2 Cross-sectional differences in business cycle correlation of external financing variables

The optimization generates policies for every firm. We simulate each firm for many periods, allowing for entry and exit according to the firm distribution discussed in section 3.2. We discard the first half of the simulated periods and treat the data the same way as we treated the data in Compustat. 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 trend component of the sum of assets within each bin. Finally, we obtain the correlations with the aggregate shock (also band-passed). We repeat the simulation and moments calculation multiple times and then form averages of the moments. Table 8 presents the main result of the paper. It compares the cross-sectional business cycle correlation moments of equity payout and debt repurchases of the simulated model data with the actual data. It shows that our mechanism can generate similar cyclical financing patterns as the data without exogenous time-varying financing costs. Equity payout is counter-cyclical for the first two bins and pro-cyclical for large firms.

Table 8: BUSINESS CYCLE CORRELATION OF FINANCIAL VARIABLES

<table>
<thead>
<tr>
<th>Bin</th>
<th>Equity Payout Data</th>
<th>Equity Payout Model</th>
<th>Debt Repurchases Data</th>
<th>Debt Repurchases Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>-0.32</td>
<td>-0.94</td>
<td>-0.46</td>
<td>-0.84</td>
</tr>
<tr>
<td>25-50%</td>
<td>-0.23</td>
<td>-0.22</td>
<td>-0.67</td>
<td>-0.85</td>
</tr>
<tr>
<td>50-75%</td>
<td>0.04</td>
<td>0.36</td>
<td>-0.60</td>
<td>-0.83</td>
</tr>
<tr>
<td>75-100%</td>
<td>0.70</td>
<td>0.73</td>
<td>-0.65</td>
<td>-0.78</td>
</tr>
</tbody>
</table>

Business cycle correlation; band-passed filtered; deflated
Sample: Compustat 1984q1-2014q4
Debt repurchase is counter-cyclical across all bins as in the data.

Our model 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 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.

Relationship to capital structure theories

The neoclassical model captures the first order issue of the cross-sectional differences in firm’s financing behavior over the business cycle. Large firm’s financing pattern seem to be well described by the trade-off theory, see for example Myers (1984) for a static formulation, and Danis, Rettl, and Whited (2014) for empirical evidence. According to the trade-off theory, firms weigh the benefit of the tax-advantage of debt against the costs of financial distress. In booms the costs of financial distress are lower, thus relaxing the endogenous debt limit and allowing firms to increase leverage.

The behavior of small firms is consistent with the pecking order paradigm\textsuperscript{17}, according to which internal funds are preferred over debt and debt is preferred over equity. However, on a deeper level the observed cross-sectional business cycle correlations of small firms are silent on whether tax margins (less plausible), limited commitment or a moral hazard story cause these patterns.

5.3 What is the effect of financial frictions?

Financial frictions cause firms to be larger. Figure 8 plots the size distribution using the benchmark calibration (in blue), the no financial friction calibration\textsuperscript{18} (in red) and the high financial friction calibration\textsuperscript{19} (in yellow). The benchmark and high friction case are relatively similar. The starkest difference can be seen in the size distribution in the no-friction case, in which firms tend to be smaller. There is more mass for lower values of the capital stock and almost no firms are in the upper quintile of the firm size distribution. The reason is that high financial frictions make it more costly for firms to smooth out shocks across the business cycle. A larger size is protective as it lowers debt financing costs.

Table 9 compares the results of these three different calibrations (benchmark, high fric-

\textsuperscript{17}Myers (1984) contrasts the static trade-off paradigm with the pecking order paradigm.

\textsuperscript{18}For the case of non-financial frictions, we solve the benchmark model without equity issuance costs ($\lambda = 0$) and no deadweight losses in case of bankruptcy ($\varepsilon = 0$).

\textsuperscript{19}The high financial friction calibration has an equity issuance costs of $\lambda = 0.2$ and bankruptcy costs of $\varepsilon = 1$. 
Table 9: Effect of Financial Frictions on Leverage, Market-to-Book-Value,

<table>
<thead>
<tr>
<th></th>
<th>Size Quartile</th>
<th>Benchmark</th>
<th>High Financial Friction</th>
<th>No Financial Friction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-25%</td>
<td>0.32</td>
<td>0.12</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>25-50%</td>
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<td>4.43%</td>
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<tr>
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<td>BC Corr Equity Payout</td>
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<td>75-100%</td>
<td>−0.78</td>
<td>−0.71</td>
<td>−0.77</td>
</tr>
</tbody>
</table>

Model comparison leverage (debt to assets), market value to book (market value of equity + debt)/assets, investment, business cycle correlation of equity payout and debt repurchases computed as in Table 8.
tion, no friction) for leverage, market value of the firm to book value of the firm, investment, and the business cycle correlation for equity payout and debt financing in the distribution of firms. Absent financial frictions, smaller firms can seize productivity opportunities by leveraging up and investing more. This causes them to have substantially higher market to book valuations compared to the benchmark calibration. The business cycle correlations of equity payout for the non-friction cause displays either a-cyclical or pro-cyclical payout patterns, i.e. firms do not have to resort to equity financings since debt financing frictions have been lifted and firms use almost exclusively debt to fund investment projects.

The high friction case is similar to the benchmark case with an important difference. Due to higher debt financing costs (bankruptcy costs are equal to one) even very large firms use equity to fund investments in good times.

6 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 firm’s borrowing costs are so low that they can borrow to finance payouts to shareholders.

Financial frictions affect both the firm size distribution and the productive potential of the economy. Our analysis highlights that the interplay between firm dynamics and financial frictions are important to understand firms’ financial positions and investment behavior over the business cycle.
References


A Data

We download the Compustat/CRSP merged data file from the first quarter in 1975 until the last quarter in 2014 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 discard observations with missing liabilities (ltq) and observations where cash holdings are larger than assets. We also drop observations whose equity issuance (sstky) is negative. We also drop inconsistent data of multiple observations at the same date of data reporting to Xpressfeed (datadate) for the same company (gvkey) by keeping only one of them. Moreover, we drop GE (General Electric), Ford, Chrysler and GM (General Motors) from the sample because those firms were most affected by the accounting change in 1988 (GE: gvkey==005047, Ford: gvkey==004839, Chrysler: gvkey==003022, GM: gvkey==005073). Firms must have at least 5 observations (5 quarters) to be included in our sample. We drop the first observation of each firm. 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 drop observations with at least one of the following conditions: negative cash dividends (dvq), negative or missing close stock prices (prccq) and missing net number of outstanding common stocks (cshoq) which excludes treasury shares and scrip. We also take care of the data inconsistency of having multiple observations with the same calendar date (datacqtr) under the same company (gvkey) or with the same date of data reporting to Xpressfeed (datedate) under the same CRSP PERMCO link (lpermco). The quarters that are used for analysis are fiscal quarters (fqtr). Observations with missing fiscal year-quarter (datafqtr) are dropped. We delete observations for which the year-to-date into quarterly observations results in negative values.

Variable “sector” has the value of 1,2,3, or 4. Observations with SIC code from 100 (including) to 1799 (including) gets 1, ones with SIC code from 2000 (including) to 3999 (including) gets 2, ones with SIC code from 4000 (including) to 5999 (including) gets 3 and the ones with SIC code from 7000 (including) to 8999 (including) gets 4.

We replace missing values of capital expenditures (capxq), funds or cash from the sale of property, plant and equipment (sppeq), research and development expense (xrdq), selling, general and administrative expense (xsagaq) by 0. We follow the definition by Toni Whited for capital stock (ppegqtq). For a firm in a year, the missing value of ppegqtq is replaced by the maximum of ppegqtq in the year. Investment is defined as capital expenditure (capxq) minus the sale of property, plant and equipment (sppeq). We define investment rate as investment
Table 10: Panel Characteristics

<table>
<thead>
<tr>
<th>Asset Percentile</th>
<th>Overall Freq.</th>
<th>Overall %</th>
<th>Between Freq.</th>
<th>Between %</th>
<th>Within %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>121,929</td>
<td>25</td>
<td>6,444</td>
<td>47.91</td>
<td>67.52</td>
</tr>
<tr>
<td>25-50%</td>
<td>121,942</td>
<td>25</td>
<td>7,098</td>
<td>52.77</td>
<td>51.51</td>
</tr>
<tr>
<td>50-75%</td>
<td>121,920</td>
<td>25</td>
<td>5,808</td>
<td>43.18</td>
<td>53.55</td>
</tr>
<tr>
<td>75-100%</td>
<td>121,946</td>
<td>25</td>
<td>3,414</td>
<td>25.38</td>
<td>68.33</td>
</tr>
<tr>
<td>Total</td>
<td>487,737</td>
<td>100</td>
<td>22,764</td>
<td>169.25</td>
<td>59.08</td>
</tr>
</tbody>
</table>

Table: decomposes bin counts into between and within components in panel.

divided by capital stock. We drop the observations which has the magnitude (absolute value) of investment rate larger than 2 or the one quarter lagged value of investment rate larger than 2. Short term investment is defined as cash and short-term investments (cheq) minus cash (chq). Market equity is defined as the product of cshoq and prccq. We drop observations with missing values of market equity. Book debt is defined as the sum of long-term debt (dlttq) and short-term debt (dlcq). Leverage is defined as book debt divided by asset (atq). Differently from McKeon (2013), we define proceeds from equity issuance as the sum of proceeds from both common and preferred stock issuance (McKeon (2013) excludes the proceeds from preferred stock issuance).

Quarterly data for our variables of interest are not available before 1976. We follow the business cycle literature by computing correlations for the time period starting with the first quarter of 1984 until the last quarter of 2014.

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).

Table 10 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 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 spends two thirds of its observed life span in the first bin, implying that it is categorized as a different bin size in the other third of its observations.

Figure 9 presents the density of logged assets, which approximately follows approximately a log-normal distribution.
Figure 9: Firm Size Distribution Data

This graph presents the kernel density of logged assets.

B Size and Tobin’s Q

The cyclical financing patterns are not just different by size, but also Tobin’s Q as we show in Table 11. This table presents similar facts to Table 2 but sorts firms into both a portfolio based on size and on Tobin’s Q. Moving across columns keeps Tobin’s Q constant and changes asset size, while moving across rows varies Tobin’s Q and fixes asset size. The table shows that procyclical equity payout is particularly strong for large firms with low Tobin’s Q. The use of both forms of external financing sources in booms is particularly strong for small firms with high Tobin’s Q. In the appendix section A, we also show how the external financing behavior changes with firms of different ages. Young firms behave very similar to small firms here. That is, either size, age, or Tobin’s Q capture how firm’s financing behavior differs but for comparability with the literature, we focus on size here only.

C Sorting firms into age versus size based portfolios

In the main text (see section 2.2), we showed how the financing patterns of firms differs across different sizes. The mechanism, spelled out in the model, relies on the assumption that small firms want to grow more than large firms. Intuitively, the same mechanism should be in place for young firms versus old firms.

To test this idea, we match firms in Compustat to the data set of the Field-Ritter dataset\(^\text{20}\) of company founding dates. Table 13 presents the business cycle correlations of the financial variables when firms are binned according to their age. Through the matching

\(^{20}\)http://bear.warrington.ufl.edu/ritter/FoundingDates.htm
Table 11: **Business Cycle Correlations: Debt Repurchase**

<table>
<thead>
<tr>
<th>Tobin's Q</th>
<th>0-25%</th>
<th>25-50%</th>
<th>50-75%</th>
<th>75-100%</th>
<th>Aggreg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>−0.18</td>
<td>−0.24</td>
<td>−0.24</td>
<td>−0.09</td>
<td>−0.10</td>
</tr>
<tr>
<td>25-50%</td>
<td>−0.40</td>
<td>−0.51</td>
<td>−0.36</td>
<td>0.01</td>
<td>−0.01</td>
</tr>
<tr>
<td>50-75%</td>
<td>−0.50</td>
<td>−0.50</td>
<td>−0.12</td>
<td>−0.43</td>
<td>−0.42</td>
</tr>
<tr>
<td>75-100%</td>
<td>−0.29</td>
<td>−0.43</td>
<td>−0.57</td>
<td>−0.30</td>
<td>−0.33</td>
</tr>
<tr>
<td>Agg.</td>
<td>−0.48</td>
<td>−0.67</td>
<td>−0.61</td>
<td>−0.67</td>
<td>−0.70</td>
</tr>
</tbody>
</table>

Units: correlation with GDP; Columns: firms sorted according to industry specific asset percentiles. Rows: percentiles in terms of industry specific Tobin’s Q.

Table 12: **Business Cycle Correlations: Equity Payout**

<table>
<thead>
<tr>
<th>Tobin's Q</th>
<th>0-25%</th>
<th>25-50%</th>
<th>50-75%</th>
<th>75-100%</th>
<th>Aggreg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>−0.11</td>
<td>0.31</td>
<td>0.32</td>
<td>0.62</td>
<td>0.63</td>
</tr>
<tr>
<td>25-50%</td>
<td>−0.19</td>
<td>−0.09</td>
<td>0.18</td>
<td>0.66</td>
<td>0.66</td>
</tr>
<tr>
<td>50-75%</td>
<td>−0.29</td>
<td>−0.25</td>
<td>0.25</td>
<td>0.64</td>
<td>0.64</td>
</tr>
<tr>
<td>75-100%</td>
<td>−0.32</td>
<td>−0.23</td>
<td>−0.17</td>
<td>0.28</td>
<td>0.20</td>
</tr>
<tr>
<td>Agg.</td>
<td>−0.32</td>
<td>−0.22</td>
<td>0.04</td>
<td>0.71</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Units: correlation with GDP; Columns: firms sorted according to industry specific asset percentiles. Rows: percentiles in terms of industry specific Tobin’s Q.

Table 13: **Age Sample: Business Cycle Correlation of Equity Payout and Debt Repurchases**

<table>
<thead>
<tr>
<th>Age Percentile</th>
<th>Equity Payout</th>
<th>Debt Repurchases</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>−0.35</td>
<td>−0.22</td>
</tr>
<tr>
<td>25-50%</td>
<td>0.10</td>
<td>−0.57</td>
</tr>
<tr>
<td>50-75%</td>
<td>0.41</td>
<td>−0.53</td>
</tr>
<tr>
<td>75-100%</td>
<td>0.63</td>
<td>−0.40</td>
</tr>
<tr>
<td>Aggregate</td>
<td>0.31</td>
<td>−0.61</td>
</tr>
</tbody>
</table>

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. Sample is smaller as not all firms could be matched to the Jay Ritter data set that has the age of firms.
Table 14: Age Sample: Business Cycle Correlation of Equity Payout and Debt Repurchases

<table>
<thead>
<tr>
<th>Asset Percentile</th>
<th>Equity Payout</th>
<th>Debt Repurchases</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>−0.10</td>
<td>−0.50</td>
</tr>
<tr>
<td>25-50%</td>
<td>−0.29</td>
<td>−0.52</td>
</tr>
<tr>
<td>50-75%</td>
<td>−0.14</td>
<td>−0.60</td>
</tr>
<tr>
<td>75-100%</td>
<td>0.50</td>
<td>−0.56</td>
</tr>
<tr>
<td>Aggregate</td>
<td>0.40</td>
<td>−0.58</td>
</tr>
</tbody>
</table>

Firms in this sample could be matched to the Field-Ritter dataset. 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.

procedure we lose around 60% of the data from the original sample. The correlation coefficient are nevertheless qualitatively similar (see table 2 in the main text). Younger firms do not substitute between equity and debt financing over the business cycle whereas older firms do. We prefer the asset based binning process since this maximizes the number of observations and asset size and age tend to be negatively correlated in the data.

Using the same sample that has been matched to the Field-Ritter dataset, we show the qualitative equivalence between computing correlations for different age bins (see table 13) versus different size bins (see table (14)).

D Business cycle correlations of other financial variables

Table 15 presents business cycle correlations of changes in cash, equity issuance, and equity repurchases.

Table 16 presents the business cycle correlations of equity payout and debt repurchases for the sample starting in 1976q1. We cannot go further back in time because most firms do not report quarterly before that time. Interestingly, while the business cycle correlations for all but the largest firm quartile look very similar, large firms have pro-cyclical equity payout and a-cyclical debt repurchases. It would be interesting to study the reason for this quite significant difference. As before, the top quartile determines the behavior of the aggregate series.

E Mean and Volatility of Sales Growth

Table 17 presents the mean and standard deviation of sales and asset growth. Small firms
### Table 15: Business Cycle Correlation of other financial variables

<table>
<thead>
<tr>
<th>Asset Percentile</th>
<th>ΔCash</th>
<th>Equity Issu.</th>
<th>Equity Rep</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>0.18</td>
<td>0.41</td>
<td>0.64</td>
</tr>
<tr>
<td>25-50%</td>
<td>0.06</td>
<td>0.39</td>
<td>0.63</td>
</tr>
<tr>
<td>50-75%</td>
<td>−0.15</td>
<td>0.38</td>
<td>0.67</td>
</tr>
<tr>
<td>75-100%</td>
<td>−0.35</td>
<td>0.49</td>
<td>0.78</td>
</tr>
<tr>
<td>Aggregate</td>
<td>−0.32</td>
<td>0.49</td>
<td>0.78</td>
</tr>
</tbody>
</table>

We compute the correlations of quarterly real log GDP with the deflated band-passed filtered components 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.

### Table 16: Business Cycle Correlation of Equity Payout and Debt Repurchases: 1976q1 -2014q4

<table>
<thead>
<tr>
<th>Asset Percentile</th>
<th>Equity Payout</th>
<th>Debt Repurchases</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25%</td>
<td>−0.28</td>
<td>−0.34</td>
</tr>
<tr>
<td>25-50%</td>
<td>−0.20</td>
<td>−0.62</td>
</tr>
<tr>
<td>50-75%</td>
<td>−0.07</td>
<td>−0.43</td>
</tr>
<tr>
<td>75-100%</td>
<td>0.55</td>
<td>−0.03</td>
</tr>
<tr>
<td>Aggregate</td>
<td>0.50</td>
<td>−0.03</td>
</tr>
</tbody>
</table>

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. Sample is from 1976q1 until 2014 q4.

### Table 17: Mean Year-on-Year Change

<table>
<thead>
<tr>
<th>Asset Percentile</th>
<th>Mean in %</th>
<th>Std</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sales</td>
<td>Asset</td>
</tr>
<tr>
<td>0-25%</td>
<td>4.20</td>
<td>2.33</td>
</tr>
<tr>
<td>25-50%</td>
<td>5.50</td>
<td>3.66</td>
</tr>
<tr>
<td>50-75%</td>
<td>6.07</td>
<td>4.28</td>
</tr>
<tr>
<td>75-100%</td>
<td>6.85</td>
<td>4.98</td>
</tr>
</tbody>
</table>

Mean and standard deviation of year on year growth rates for sales and assets, per firm, averaged across bins and time.
Table 18: Leverage by size and Tobin’s Q

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>0-25%</th>
<th>25-50%</th>
<th>50-75%</th>
<th>75-100%</th>
<th>Agg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobin’s Q</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-25%</td>
<td>0.17</td>
<td>0.21</td>
<td>0.26</td>
<td>0.29</td>
<td>0.23</td>
</tr>
<tr>
<td>25-50%</td>
<td>0.22</td>
<td>0.26</td>
<td>0.30</td>
<td>0.33</td>
<td>0.29</td>
</tr>
<tr>
<td>50-75%</td>
<td>0.21</td>
<td>0.22</td>
<td>0.25</td>
<td>0.30</td>
<td>0.25</td>
</tr>
<tr>
<td>75-100%</td>
<td>0.21</td>
<td>0.16</td>
<td>0.17</td>
<td>0.23</td>
<td>0.19</td>
</tr>
<tr>
<td>Agg.</td>
<td>0.19</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Short term and long term debt relative to assets; Columns: firms sorted according to industry specific assets. Rows: percentiles in terms of industry specific Tobin’s Q.

Grow slower on average compared to large firms which is due to higher failure rates of small firms. Sales growth is also more variable for smaller firms. Asset growth rates tend to be larger for larger firms. This relationship is however not monotonic.

F Leverage by size and Tobin’s q