Firm Financing over the Business Cycle

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Data from U.S. public firms show that in booms large firms finance with debt and payout equity, whereas small firms issue both equity and debt. Therefore, large firms generally substitute between debt and equity financing over the business cycle, whereas small firms adhere to a procyclical financing policy for debt and equity. We explain these cyclical financing patterns quantitatively using a heterogeneous firm model with endogenous firm dynamics. We find that cross-sectional differences in investment returns and, therefore, funding needs and exposures to financial frictions are essential to understanding how firms' financing policies respond to macroeconomic shocks. (*JEL* E32, G32)

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Introduction

What is the effect of financial frictions on firms' financing choices over the business cycle? When do firms borrow, and when do firms raise equity capital? Using a cash-flow measure of equity and debt financing of U.S. public firms, we find that the answer depends on firm size. The 25% largest firms finance with debt in booms and payout equity in booms, while small firms issue equity and debt in booms. Therefore, large firms generally substitute

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between debt and equity financing over the business cycle, whereas small firms' financing policy is procyclical. Viewed through the lens of the trade-off theory of capital structure, our results suggest that firm characteristics interact with the business cycle, generating cross-sectional differences in the strength of financial constraints that shape firms' cyclical financing choices.

In this paper, we show how the trade-off theory in conjunction with a simple investment model is able to replicate these cross-sectional financing differences over the business cycle. In a nutshell, our mechanism suggests that business-cycle differences in firms' external-financing behavior are determined by differences in funding needs and funding capacities. The funding capacity is a function of financial frictions. At the optimal capital structure, a reduction in debt financing costs during good times entices firms without large funding needs (i.e., firms that are close to their optimal size) to reshuffle their capital structure towards more debt and less equity, hence issuing debt and paying out equity. Firms with relatively large funding needs, such as small firms, will need to issue equity if they cannot fund their investment projects internally or with debt alone. We analyze this mechanism in a heterogeneous firm 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 quantitatively explore how firm size interacts with investment and financial frictions to generate the cross-sectional differences in cyclical-financing behavior.

We define our external financing variables *equity payout* (net flow of funds from the firm to shareholders) and *debt repurchases* (net flow of funds from the firm to creditors) like in Jermann and Quadrini (2012) and compute their business-cycle correlations using quarterly Compustat data from 1984 Q1 to 2014 Q4. Sorting firms based on their asset positions—controlling for firm industry—into four size portfolios, we document that firms in the bottom quartile of the asset size distribution obtain more funds through equity than through debt. They also increase both debt and equity financing during booms. In contrast, we show that firms in the top quartile payout equity and substitute between debt and equity financing over the cycle. The pattern in the data suggests that large firms finance equity payouts with debt in booms. Interestingly, the same pattern can be observed in the aggregate Flow of Funds data as documented by Jermann and Quadrini (2012). Aggregating the positions across size portfolios reveals that the data in the Flow of Funds are dominated by the behavior of large firms, that is, firms in the top 25th percentile.

To get a sense for the economic magnitude of the effect of aggregate fluctuations on firm financing, we run ordinary least squares (OLS) regressions of the external-financing variables (aggregated to their size portfolio level and HP-filtered) on the business-cycle component of corporate gross domestic product (GDP). These results demonstrate that for the first three size quartiles (i.e., small firms) a 1% increase in GDP *decreases* equity payout (scaled by assets) by about 0.012%. In contrast, for the largest firm size quartile, a 1%

increase in GDP *increases* equity payout by 0.318%. In the regression with debt repurchases as the independent variable, all size-GDP interactions have negative coefficients. However, the strength of the cyclicality monotonically increases in size. While the smallest size portfolio *decreases* its debt repurchases (scaled by assets) by 0.003% in response to a 1% increase in GDP, the largest size portfolio *decreases* debt repurchases by about 0.545%.

A deeper look into the data reveals a channel wherein funding needs and funding capacities interact to determine the financing behavior of firms over the cycle. Defining profitability quartiles according to firm assets quartiles, we double sort firms into size and profitability portfolios in order to better identify firms with external funding needs. We find that the lowest profitability rates are more common in smaller firms and even within an asset quartile, lower profitability is associated with a smaller firm size. Smaller, less profitable firms tend to increase both equity and debt during a boom while larger, more profitable firms tend to substitute between debt and equity financing, that is, paying out equity and financing with debt in booms. This suggests a differential exposure to financial constraints.

To better understand why the trade-off theory operates differently in the cross-section over the business cycle, we build a model based on Gomes (2001), Hennessy and Whited (2007), and Hopenhayn (1992). Our model features firms that are different in terms of capital, leverage, and idiosyncratic productivity. Each quarter 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 equity payouts to shareholders. Firm dynamics are endogenous, that is, firms choose to enter and exit (default) the sample.

Our model possesses two key features that affect firms' financing choice. First, we assume that firms operate with a decreasing returns to scale technology, implying an optimal scale (depending on each firm's idiosyncratic productivity) and investment patterns that are negatively correlated with firm size. That is, large firms are close to their efficient scale and have low investment needs, and small firms are far away, and thus have high investment needs. The smaller and farther away a firm is from its efficient scale, the larger its return to investment and incentives to grow. To generate slow convergence to the efficient scale, we introduce adjustment costs to capital.

Second, firms can finance investments either internally through accumulated earnings or externally through debt and equity. Firms face frictions when they resort to external financing. Equity financing entails issuance costs that are motivated by underwriting fees and adverse selection costs. Debt financing is costly because repayment is not enforceable and a fraction of the principle is lost in default. However, debt is also tax advantaged. Firms choose to default and exit if they cannot generate enough cash flows to pay their current liabilities and the fixed cost of operation. Holding leverage fixed, the fixed costs of operation makes small firms generally less profitable and, therefore, more likely to default. Hence, small firms are riskier and, consequently, face higher debt financing costs that lead them to be less levered. In sum, firm size is informative about a firm's investment opportunities and its riskiness. The profitability of a firm is informative about a firm's internal funding and debt capacity. Higher profitability improves financing due to (1) higher cash flows and (2) a higher expected recuperation value.

Cross-sectional differences over the business cycle are driven by the interaction between firms' funding needs and funding capacities. Good times lower the default risk of all firms and increase the recuperation value on firm debt, reducing debt financing costs for all firms. Holding funding needs fixed, all firms are expected to use more debt financing during a boom. However, investment opportunities also improve during good times. Firms solve two questions: (1) Should they invest? (2) And how should they fund the investment? Firms should invest if the return on the investment exceeds their cost of capital. If the funds required for a valuable investment opportunity exceed the funds that the firm can raise internally, or via debt financing, it may find it optimal to raise equity, despite equity issuance costs. In booms, the investment needs of smaller firms increase more than their internal funds and debt capacities. Relative to their funding needs small firms cannot issue enough debt without substantially increasing their risk of default, and therefore debt financing costs. So they need to tap into equity financing. In booms, larger firms—close to their optimal size—use the increase in internal funds and debt financing to pay out more to shareholders.

Our mechanism produces the following predictions: (1) equity payout is increasing in size; (2) leverage is increasing in size; (3) payout during booms is increasing in size and profitability; (4) small, unprofitable firms increase equity financing during booms; (5) large, profitable firms pay out during booms; and (6) all firms finance more with debt during booms.

Endogenous entry dynamics are important for modeling time variation in the number and in the size of entrants. We model firm entry like in Clementi and Palazzo (2016), where each quarter a mass of private firms chooses whether to enter (become public) upon receiving a signal. Entrants are typically of smaller size and have high-growth opportunities given the decreasing returns to scale technology and mean reversion in productivity shocks. When aggregate investment opportunities improve, it becomes economically feasible even for smaller, less profitable firms to enter. This mechanism helps us to match the size distribution because the time-varying inflow of small firms means that not all firms grow out of their financing and investment constraints. In addition, the increase in entry of smaller firms in booms amplifies the effect of the procyclical financing activity of small firms.

We calibrate the model by matching moments of Compustat data for U.S. public firms. Because of endogenous entry and exit, the firm size distribution is endogenous and varies with the business cycle. Like the data, our definition of small and large firms is also endogenous and state dependent.

When we run the same regression analyses on model-generated data (organized in size portfolios) on Compustat data, our model produces quantitatively consistent regression coefficients. Namely, equity financing is procyclical for small firms and countercyclical for large firms, and the strength of the cyclicality increases over firm size. Debt repurchases are countercyclical for all, but more strongly so for larger firms. Sorting firms into size and profitability portfolios delivers qualitatively consistent regression coefficients. In particular, our model also reveals that small, unprofitable firms use both debt and equity financing, whereas larger or profitable firms pay out equity during booms.

Finally, to understand the effect of financial frictions on the cross-sectional cyclical patterns we study the model under two counterfactual parametrizations: no frictions and high levels of frictions. In the nonfriction case, we set the financial friction parameters—the bankruptcy loss during default and the equity issuance cost—to 0. In the high friction case, bond holders will not be able to recuperate anything from the firm after default. In addition, we set the equity issuance cost to be 10 times higher than its benchmark value. Comparing the results across these three cases allows us to better understand the importance of financial frictions for our results. First, we find that frictions cause firms to be smaller on average, because they increase costs and lower funding capacity. Absent financial frictions, but in the presence of a debt tax advantage, firms invest more and tend to be financed entirely with debt. Effectively, it is less risky to take risks. The investment rate of small firms is particularly large in this counterfactual parameterization, suggesting that financial frictions impose significant constraints on the growth of small firms. The business-cycle correlations of equity payout in the nonfriction case display procyclical payout patterns for small firms, that is, all firms behave like large firms. In the high friction case, firms are more constrained—leverage is lower—and equity payout is countercyclical for firms above the medium size but below the top quartile. In other words, the cyclicality patterns of the benchmark extend to a larger share of firms. These results lead us to conclude that financial frictions are important for explaining the cross-sectional differences in the financing behavior of firms over the business cycle.

Firms' financial positions are important for understanding business cycle fluctuations. Financial frictions can amplify the effects of productivity shocks (e.g., Bernanke and Gertler 1989; Carlstrom and Fuerst 1997; 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 data.[1] Gomes (2001) builds a theory to study the effects of firms' investment

[1] For an excellent overview on the research in dynamic corporate finance, see Strebulaev and Whited (2012).

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; Dittmar and Dittmar 2008). Jermann and Quadrini (2012) propose a quantitative 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) develop a quantitative model of firms' capital structure in which financing decisions depend on the business cycle through its effect on default policies. Our approach differs because we focus on the heterogeneous effects of macroeconomic shocks.

In a paper close to our empirical section, Covas and Den Haan (2011) study the cross-sectional differences in the financing behavior of firms using an annual Compustat sample. Covas and Den Haan (2011) state that most firms' financing choices respond similarly to the business cycle. During booms, most firms issue more debt and equity. Only firms in the top 1st percentile of assets finance with debt in booms and equity in recessions. Because the aggregate equity financing series is acyclical in Covas and Den Haan (2011), the top 1% is seen to have an outsized impact. We find more pronounced cross-sectional differences in firms' cyclical financing behavior. Our analysis shows that firms in the top 25% and in the aggregate issue debt during booms and finance with equity in recessions. This is consistent with Jermann and Quadrini (2012), who used aggregate Flow of Funds data. The difference between our results is based on the variable definition of equity financing as we show in Appendix A. Our definition uses cash flow variables in Compustat that represent a comprehensive measure of firms' *external* financing and that control (using an adjustment suggested by McKeon (2013)) for stock-based compensation. Motivated by Fama and French (2005), Covas and Den Haan (2011) define equity financing as the change in stockholders' equity. However, differently from Fama and French (2005), Covas and Den Haan (2011) do not remove the change in retained earnings from the change in equity so their measure confounds internal equity with external.[2] We show in Appendix A that our facts are consistent with measuring equity financing by the change in stockholders' equity less the change in cumulative retained earnings, as suggested by Fama and French (2005).

Covas and Den Haan (2012) build a model to target the cyclical behavior of small firms in Covas and Den Haan (2011). To generate procyclical equity financing of small firms, in their model, they require strongly countercyclical equity issuance costs. In contrast, our paper shows that this assumption is unnecessary and proposes a mechanism that generates the cyclical behavior of small and *large* firms.[3]

[2] Fama and French (2005) define equity financing as the change in stockholders' equity less the change in retained earnings (REs). In Compustat the variable *RE* refers to cumulative retained earnings on the balance sheet.

[3] See the Online Appendix Section 3.4 for a discussion of their results.

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; Crouzet 2018). Our model allows us to study the role of firm dynamics, financial frictions, and aggregate shocks for the financing choices of firms quantitatively.[4]

1. Cyclical Properties of Firm Financing

This section analyzes the cross-sectional differences in the external-financing behavior of firms over the business cycle. We use quarterly data from the Compustat/CRSP-merged database following standard sample-selection criteria.[5] Our sample is from 1984 Q1 to 2014 Q4, which is consistent with the quantitative business-cycle literature.[6] For robustness, we report in the Online Appendix the main results for 1975 onward.[7] To measure business-cycle variations, we download data from NIPA on real quarterly GDP, real quarterly corporate sector GDP, and real quarterly consumption. To adjust the nominal Compustat series for inflation, we compute a price index based on the ratio of the real gross value added to nominal gross value added of businesses, that is, NIPA tables 1.3.6 and 1.3.5., respectively. We download a time series of NBER recession indicators from FRED.

1.1 Portfolio sort

To abstract from idiosyncratic shock responses that add noise to the data, we analyze firms' financing behavior by sorting firms in portfolios. The main sorting variable is size as measured by assets.[8] In our benchmark portfolios, firms are sorted into quarter and sector-specific asset quartiles. The composition of firms in each portfolio may therefore change from one quarter to the next.[9]

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4 Our paper relates to a series of papers that embeds a quantitative asset pricing model into a heterogeneous firm model with a dynamic capital structure choice to study how credit spreads and the equity premium are determined (e.g., Bhamra, Kuehn, and Strebulaev (2010); Belo, Lin, and Yang (2014); Gomes and Schmid (2010); Gomes and Schmid (2012)). In these papers, firm size is oftentimes fixed after entry and therefore not used as a dimension of heterogeneity like in this paper. Also, we focus on the flow of financial positions rather than on prices.

5 The sample selection is described in the Online Appendix Section 1.

6 For instance, Jermann and Quadrini (2012), among others, note that the period after 1984 saw major changes in the U.S. financial markets. We use data until 2016 Q4. However, because the HP filter is not consistent at the beginning and at the end of a time series, we end our analysis in 2014 Q4.

7 Before 1975, the quarterly Compustat data are not sufficiently populated to form firm portfolios (see Online Appendix Table 10). In Table 11 in the Online Appendix, we show that the main result does not materially change if we compute the correlations for the 1975 Q1 to 2015 Q4 period.

8 Section 2.2 discusses why we choose size as the sorting variable.

9 Refer to Section 1 in the Online Appendix. Table 1 in the Online Appendix presents the transition probabilities from moving from one size portfolio to another over a quarter. These probabilities imply that the portfolio composition is very persistent.

1.2 External financing measures

Following Jermann and Quadrini's (2012) definition of external financing, we base our measure on the cash flows between external capital providers and the firm. In defining our two financial variables, we take the perspective of a creditor and equity owner.

An equity owner receives cash flow in the form of *equity payout*, defined as the sum of cash dividends and equity repurchases less equity issuances. Because firms may simultaneously (within a quarter) issue and repurchase, we focus on the net equity repurchase position. Cash dividends (Compustat variable *dvy*) represent the total amount of cash dividends paid for common capital, preferred capital and other share capital. Equity repurchases (Compustat variable *prstkcy*) are defined as any use of funds that decrease common and/or preferred stock. Equity issuances (Compustat variable *sstky*) are all funds received from the issuance of common and preferred stock. This variable includes the exercise of stock options or warrants for employee compensation. Therefore, this measure may overstate equity issuances for financing reasons.[10] We address this concern by adjusting equity issuances according to the procedure by McKeon (2013).[11] At the same time, Sun and Zhang (2016) argue that some firms use intangible financing sources, that is, funds indirectly provided by employees in the form of delayed compensation. That is, by following McKeon (2013) we may actually understate equity issuances for financing reasons. This is less of a concern for our study with its focus on external financing. Arguably, an employee-financed investment project (through stock based compensation) faces less financial frictions (e.g., asymmetric information) than a project that is externally financed. Nevertheless, we check for and find no differential cyclicality in the measure for intangible financing that Sun and Zhang (2016) propose.[12]

While our equity financing measure focuses on cash flows, the equity financing definition in Covas and Den Haan (2011) is based on changes in stockholders' equity. As we discuss in detail in Appendix A, the measure by Covas and Den Haan (2011) includes changes in equity positions due to changes

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[10] Based on a comparison of SEO data and Compustat equity issuance measures, Toni Whited documents that SEO data closely match Compustat measures of equity issuances for small firms, but not for large firms (http://toni.marginalq.com/discussions/Whited_discussion_EFEL_2015.pdf), because large firms tend to use stock options to compensate employees.

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

[12] Sun and Zhang (2016) measure intangible financing with the ratio of stock-based compensation expense (Compustat variable *stkcoq*), which they interpret as a form of debt that can be used to finance intangible investments. This variables becomes available in 2002, but until 2006 only a minority of firms report it. Thus, we do not have a long enough time series to properly study its business-cycle pattern. Over this very short horizon (2006 Q1–2014 Q4) that featured one cycle, we find procyclical business-cycle correlation in intangible financing across firms of all sizes (see Appendix B). Our results are robust if we subtract equity issuances due to employee compensations from equity issuances and add them to debt financing. The idea is that stock-based employee compensation is debt provided by employees.

in accumulated retained earnings, mixing up internal (retained earnings) with external funds. Because retained earnings are highly procyclical, large firms that tend to be more profitable retain more earnings during booms. Without adjusting for this, the change in stockholders' equity appears procyclical for a larger segment of the firm size distribution. For this reason, Covas and Den Haan (2011) arrive at a different conclusion regarding the cyclicality of equity payout of firms in the top 25th percentile. Our definition of equity financing captures precisely what we want: the trade-offs behind firms' decision to finance investments with external funds.

We define *debt repurchases* as the funds creditors receive from their claim on a firm, that is, the negative sum of the change in long- (*dlttq*) and short-term (*dlcq*) debt. In Compustat, long-term debt comprises debt obligations due more than 1 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 sum of long-term debt due in 1 year and short-term borrowings. Equity payout and debt repurchase are defined for each firm-quarter observation.

We sum the financial variables *equity payout* and *debt repurchases* up to the asset quartile level. Our empirical results are constructed by applying the HP filter to the deflated log variable at the asset quartile level. Next, we scale this variable by the trend component of assets also measured at the asset quartile level. This ensures that all variables in the regressions are expressed in per dollar unit of assets. We use the trend component of assets as opposed to level assets in order to avoid inducing cyclicality with the scaling variable. Because the financing variables can be negative, we add the absolute value of the minimum observation to ensure positive values before we take logs. Adding a constant to a time series does not change its cyclical properties. For time-series averages, we use the level (not HP-filtered) values divided by assets.

1.3 Equity payout and debt repurchases over the business cycle

Figure 1 plots debt repurchases and equity payout for firms belonging to the smallest (top-left panel) and largest (top-right panel) asset quartile. The bottom panel presents the aggregate equity payout and debt repurchases time series together with the time series of HP-filtered real GDP. The NBER recessions are represented by the gray bars. In the aggregate (bottom panel), equity payout and debt repurchases are negatively correlated. Equity payout rises and falls with GDP. The opposite holds for debt repurchases. This pattern is identical to the behavior of large firms (top-right panel). They seem to substitute between debt and equity instruments as Jermann and Quadrini (2012) demonstrated for the aggregate firm. In contrast, small firms (top-left panel) do not show a clear substitution pattern between equity payout and debt repurchases. If anything, equity payout and debt repurchases move more closely together. Because the

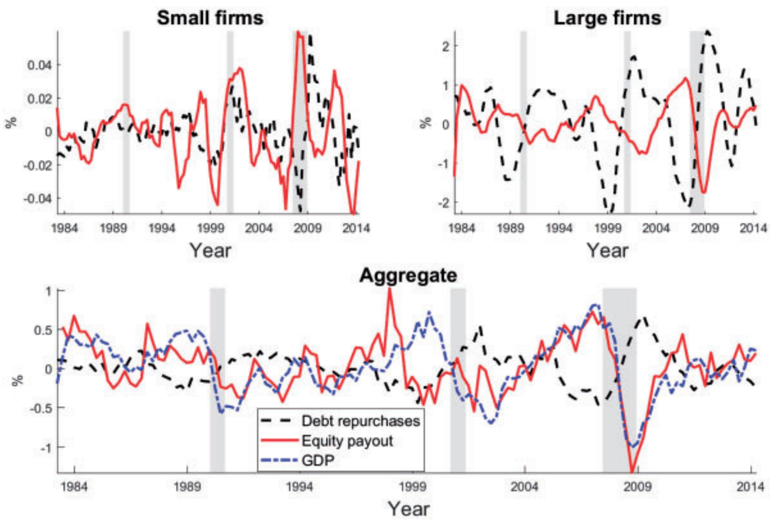

Figure 1
Debt repurchases and equity payout (business-cycle frequency)
This figure presents HP-filtered series of the external-financing variables (aggregated to their size portfolio level) from 1983 Q1 to 2014 Q4. The financing variables are equity payout and debt repurchases, logged (rescaled for negative values) and HP filtered and scaled by the HP-filtered trend component of assets. The top-left panel depicts firms in the bottom quartile. The top-right panel depicts firms in the top quartile. The bottom figure presents the financing variables at the aggregate level, together with the HP-filtered Corporate GDP series. *Source:* Compustat/CRSP.

Table 1
External financing facts: Equity payout and debt repurchases

Asset percentile	Equity payout		Debt repurchases	
	Mean 1	BC corr 2	Mean 3	BC corr 4
0%–25%	−2.30	**−0.29**	−1.10	**−0.34**
25%–50%	−1.18	**−0.23**	−1.37	**−0.61**
50%–75%	−0.16	−0.06	−1.94	**−0.44**
75%–100%	0.80	**0.73**	−1.74	**−0.65**
Aggregate	−0.71	**0.63**	−1.53	**−0.65**

This table presents external financing facts of firms. Columns 1 and 3 present the average of equity payout and debt repurchases expressed as a percentage of assets. Columns 2 and 4 present their business-cycle correlations. We compute the correlations of quarterly real log corporate GDP with the deflated HP-filtered components of log equity payout and log debt repurchases, scaled by the trend of assets at the asset quartile level. The numbers in bold are significant at the 5% level. *Source*: Compustat/CRSP 1984 Q1–2014 Q4.

aggregate patterns are governed by large firms, focusing on aggregate data conceals the financing behavior of a large fraction of firms in the economy.

Table 1 presents the average level and business-cycle correlations of firms' external-financing choices across firm asset quartiles. Two notable points emerge from this table. First, Columns 1 and 3 show that in the aggregate, firms finance with equity and debt. The numbers in Columns 1 and 3 represent time-series averages as a percentage of assets. A positive number means that firms in this size group disburse cash to investors. A negative number means that firms receive cash from investors. Firms in the smallest size group receive more funds from equity than from debt financing (2.30% vs. 1.10%). Equity financing is decreasing in firm size. In fact, large firms on net do not finance at all with equity. All external financing sources are from debt instruments. Next, looking at business cycle correlations in Columns 2 and 4, the aggregate firm substitutes between debt and equity financing over the business cycle as equity payout is procyclical and debt repurchases are countercyclical, as borne out by the bottom panel in Figure 1. This pattern at the aggregate level describes the cyclical financing behavior of large firms, that is, firms in the top 25th percentile.[13] The behavior of small firms is quite different. As suggested by Figure 1, small firms appear to use good times to finance with debt *and* equity. These correlations are similar whether we measure the business cycle with corporate or total GDP.[14]

To get a sense of the economic magnitude of the correlations reported in Table 1, we run pooled OLS regressions of the following type:

$$\tilde{Y_{t,s}} = \alpha + \sum_{s=2}^{S} \beta_{0,s} Size_s + \beta_1 G\tilde{D}P_t + \sum_{s=2}^{S} \gamma_s Size_s \times G\tilde{D}P_t + \varepsilon_{t,s}\,, \tag{1}$$

where $G\tilde{D}P_t$ and $\tilde{Y_{t,s}}$ are the HP-filtered components of log real GDP and our financing variables, respectively. $Size_s$ represents an indicator variable equal to 1 if the observation belongs to size group s and is 0 otherwise. Detrending further implies that α and $\beta_{0,s}\,\forall s \in \{2,3,4\}$ must equal 0 and thus can be omitted from the regression.

Table 2 reports the results. The β_1 coefficient measures how firms in the first size quartile change their equity or debt financing behavior over the business cycle. The interactions γ_s tell us how much more (or less) equity or debt financing of firms in the second, third, or fourth size bin adjusts with the business cycle. Column 1 and 2 show that small firms finance with both equity and debt over the business cycle. Moving across size quartiles one, two, or three does not change the magnitude of equity financing over the cycle (Column 1). However, when we consider large firms, their size interaction with GDP is positive and an order of magnitude larger. Thus, equity payout of large firms is procyclical. In contrast, debt repurchases (Column 2) are countercyclical for all firms, but the strength of the cyclicality increases in size, in terms of both the coefficient (−0.003 and −0.542) and statistical significance (−3.02

[13] Though these results are similar to those of 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, like in their analysis. See Appendix A.

[14] In unreported results we checked the appropriate size cutoff by sorting firms into less-coarse asset bins. We found that the switch from countercyclical to procyclical equity payout occurs around the top 25th percentile, that is, the 75th percentile is not an arbitrary cutoff for defining large firms.

Table 2
Measuring the economic magnitude of cyclical-financing activity

	Equity payout 1	Debt repurchases 2
$G\tilde{D}P_t$	−0.012**	−0.003**
	(−3.16)	(−3.02)
$\text{Size}_{25-50} \times G\tilde{D}P_t$	−0.020	−0.019***
	(−1.47)	(−5.21)
$\text{Size}_{50-75} \times G\tilde{D}P_t$	−0.003	−0.055***
	(−0.11)	(−4.30)
$\text{Size}_{>75} \times G\tilde{D}P_t$	0.330***	−0.542***
	(10.47)	(−8.65)
Observations	672	656
R^2 (%)	37	42

This table reports the regression coefficients from running a panel of external-financing variables (aggregated to their size portfolio level) on the business-cycle component of corporate GDP from 1984 Q1 to 2014 Q4. The external-financing variables are equity payout and debt repurchases. We logged the financing variables (rescaled for negative values) and HP filtered them. Next, we scaled them by the trend component of HP-filtered assets. The GDP interactions are with size group dummies (e.g., dummy equals 1 if observations belongs to size group 2, assets are within the 25th–50th percentiles). *t*-statistics are reported in parentheses. We calculate robust standard errors. *Source:* Compustat/CRSP and NIPA. * p<.05; ** p<.01; and *** p<.001.

vs. −8.65). This suggests that large firms have more flexibility to respond to cash flow shocks and changes in funding conditions over the cycle, consistent with the idea that they are less constrained.

In sum, these results suggest that most firms use good times to raise funds from creditors and equity owners.[15] Larger firms however seem to prefer to substitute between debt and equity financing over the business cycle.[16] The next section digs deeper into the mechanism behind the cross-sectional variation in the cyclical-financing behavior.

1.4 What mechanism does size capture?

Since Fama and French (1992), sorting firms into size portfolios has become a standard way to abstract from idiosyncratic, firm-level variation. Depending on market exposure, smaller firms tend to be riskier than larger firms as expressed by higher expected returns. Berk (1995) argues that size and thus the size premium reflects the inherent riskiness of firms. That is, small firms are risky because their marginal productivity is high and/or because they are currently unprofitable and therefore more exposed to negative cash flow shocks.

The marginal productivity of a firm and its profitability can have different implications for its financing behavior. While highly productive firms want to invest and thus have high funding needs, profitable firms have more

15 Our results do not depend on the specific measure of cyclicality, nor are they only driven by recessions (see the Online Appendix Sections 2.2 and 2.3, respectively).

16 Do firms pay out equity and finance with debt at the same time? Table B6 shows that on average 18% of the firms issue debt and pay out equity at the same time (last column). This is more common for large firms for which we find procyclical equity payout and countercyclical debt repurchases.

Table 3
Size and profitability

Asset percentile	Profit percentile	Assets	Profit.	BC corr EP	BC corr DR
<25%	<25%	17	−20.2%	**−0.26**	**−0.17**
	25%–50%	24	−5.3%	**−0.26**	**−0.28**
	50%–75%	27	0.0%	−0.00	−0.07
	>75%	27	4.9%	0.07	−0.15
25%–50%	<25%	100	−6.9%	**−0.18**	**−0.34**
	25%–50%	109	−0.3%	−0.06	**−0.42**
	50%–75%	112	2.1%	0.09	**−0.23**
	>75%	111	5.9%	**0.23**	**−0.20**
50%–75%	<25%	362	−2.6%	−0.16	−0.13
	25%–50%	390	1.2%	**0.20**	**−0.24**
	50%–75%	397	2.8%	**0.27**	**−0.41**
	>75%	387	6.0%	**0.24**	**−0.42**
>75%	<25%	4,091	−0.4%	**0.30**	−0.03
	25%–50%	5,959	1.8%	**0.60**	−0.11
	50%–75%	6,189	3.0%	**0.54**	**−0.22**
	>75%	5,656	5.6%	**0.60**	**−0.20**

This table reports average firm-level assets holdings and profitability for each size and profitability portfolio over the period from 1984 Q1 to 2014 Q4 using quarterly data from Compustat/CRSP. Our size portfolios (first columns) are built by sorting firms into quarter and sector-specific asset quartiles. Profitability quartiles are built analogously based on size and quarter-specific quartiles. Assets (atq) are measured in millions and profitability is measured as operating income relative to lagged assets. The last two columns show the business-cycle correlations of the HP-filtered equity payout and debt repurchases series with HP-filtered corporate GDP. Numbers in bold are significant at the 5% level.

internal funds.[17] Hence, whereas marginal productivity speaks to investment opportunities, profitability speaks to internal funding capacities. In addition, firms that are not profitable face larger debt-financing constraints as debt covenants often stipulate profitability measures (e.g., Chava and Roberts 2008). Therefore, profitability may also indicate the severity of debt-financing frictions. In sum, the marginal productivity drives investments and thus funding needs, whereas the profitability of a firm determines how it can meet its funding needs, for example, with internal resources and debt and/or equity financing.

How is size related to all this? As our model shows, size is related to two different drivers of external-financing behavior, that is, the funding need (high marginal productivity) and the external funding capacity (profitability and size-dependent financing frictions). Smaller firms tend to invest more (indicative of high marginal productivity) and tend to be less profitable (see Table 3) compared to larger firms. In addition, size tells us something about the risk of a firm, which affects its external funding capacity through higher funding costs

[17] In the data, accounting profits do not equal cash flows. In practice operating income measures are commonly used as a proxy for a business's cash flow.

and has therefore been widely used (e.g., Hennessy and Whited 2007) as an indicator of a firm's exposure to financial constraints.[18]

Why do we not use a measure of marginal productivity? Marginal productivity is difficult to observe in the data. While Tobin's q and marginal productivity are theoretically linked, measuring Tobin's q properly in the data is not trivial (see the discussion in Erickson and Whited 2000). Size and profitability, on the other hand, can be measured transparently. Indeed, size is a good indicator of a firm's marginal productivity when the production technology exhibits decreasing returns to scale. When productivity shocks revert to the mean, small and unprofitable firms today are likely more profitable in the future. Hence, small, unprofitable firms are likely firms with high marginal productivity that lack internal funds. Appendix B.1 shows that firms' external-financing behavior moves with variations in their size and profitability, not with variations in Tobin's q once we control for size and profitability.

To shed light on the mechanism behind the cross-sectional variation in cyclical-financing patterns, we double sort firms into size and profitability portfolios. To this end, we define profitability quartiles based on time (quarter) and firm assets quartiles. Profitability is measured as quarterly operating income after depreciation (Compustat variable *oiadpq*) over lagged assets. Table 3 presents the average size (in millions of USD), the average profitability rate, and the business-cycle correlations for equity payout and debt repurchases for each asset and profitability quartile. These correlation results show that low profitability rates are more common in smaller firms. Even within an asset quartile, lower profitability is associated with a smaller firm size. Smaller, less profitable firms tend to increase both equity and debt during a boom; larger, more profitable firms tend to substitute between debt and equity financing. Consistent with Table 3, Table 8 in the result section presents regression results based on double sorting firms according to size and profitability.[19]

To summarize, equity payout is procyclical for larger, profitable firms and countercyclical for smaller, less profitable firms. Thus, the data points to a mechanism in which funding needs and funding capacity interact to determine the financing behavior of firms over the cycle. The following section presents a model that captures such a mechanism.

---

[18] Without risk, most financial frictions have no bite. After all, standard motivations for financial frictions (e.g., asymmetric information, moral hazard) are related to the uncertainty over risky outcomes. Thus, firms' funding costs depend on how financial frictions interact with risk.

[19] Section 2.7 of our Online Appendix discusses the results from firm-level regressions. Therein, we present the estimated marginal effect of a change in real corporate GDP growth on equity payout conditional on firm characteristics. It shows that all firms, except large and profitable firms, pay out less during booms. This is particularly true for small and unprofitable firms that issue more during booms.

2. Firm Dynamics Model with Financial Frictions

In this section, we present a model that generates these cross-sectional business-cycle facts. That is, small, unprofitable firms tend to finance with equity and debt during booms, while large firms finance with debt and pay out equity during booms.

In the model, firms produce with a decreasing returns to scale technology and are hit with idiosyncratic and aggregate technology shocks. They can choose to finance with equity and/or debt. Debt has a tax benefit but is not enforceable so firms can choose to default and incur a bankruptcy cost. Equity financing is also costly, which we capture with linear equity issuance costs. After observing the shocks firms make optimal capital and financing decisions that balance the costs and benefits of these instruments. Finally, our model captures firm dynamics through endogenous entry (entry decision) and exit (default decision).

2.1 Environment

There is a continuum of heterogeneous incumbent firms that own a decreasing returns to scale technology ($\alpha < 1$). Each firm's gross revenue is $F(z,s,k) = zsk^{\alpha}$, where z is the aggregate shock common to all firms and s is the firm-specific 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 $\epsilon_s \sim N(0,1)$. $G_s(s',s)$ is going to denote the conditional distribution of s_t. The shocks are independent.

Firms also differ with regard to their capital stock k and their current debt levels b. The capital stock depreciates at the rate δ each period. To generate slow convergence to the optimal firm size implied by the decreasing returns to scale assumption and idiosyncratic productivity, we introduce adjustment costs for capital. Adjustment costs are also important to break the connection between firm size and idiosyncratic shocks. In the absence of adjustment costs and financial frictions, the firm size distribution would be only determined by firms' idiosyncratic shocks. In other words, adjustment costs, together with financing frictions, are critical to generate a more realistic firm size distribution. We follow a standard (e.g., Zhang 2005) quadratic adjustment cost function specification

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

where

$$c_t \equiv c_0 \cdot \Xi_{(k'-(1-\delta)k)<0} + c_1 \cdot \left(1 - \Xi_{(k'-(1-\delta)k)<0}\right),$$

and $\Xi_{(k'-(1-\delta)k)<0}$ is an indicator that equals one when the firm divests. When $0 < c_1 < c_0$, investments are not only costly to reverse (Abel and Eberly 1996) but also more risky, because firms cannot act on positive shocks without taking into account that a future negative shock may make it very expensive to divest. Finally, capital adjustment costs also imply that taking on leverage is riskier because firms hit by bad shocks cannot easily downsize. Corporate taxable income is equal to operating revenue 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, δk represent the economic depreciation and τ_c is the corporate tax rate.[20]

2.1.1 External financing and financial frictions. The leverage choice is governed by the trade-off theory. That is, if leverage is not too high, the tax advantage of debt over equity, that is, $\tau_i < (1+r)\tau_c$, where τ_i is the individual tax rate, implies that firms prefer debt over equity financing. Effectively, they must pay a higher risk-adjusted interest rate on equity than on debt. However, raising too much debt is costly due to bankruptcy losses in case of default. The optimal level of leverage is determined by trading-off its benefit and cost.

Firms can issue one-period bonds at a discount. That is, firms raise $q^b b'$, where $q^b < 1$, in the current period and pay back the face value in the next period, b'. Bond and equity investors use a stochastic discount factor $M(z,z')$ to discount future cash-flow streams.[21] Firms choose to default if the firm value falls below a threshold, which we normalize to 0. In this case, the firm is liquidated and exits our sample. Upon default shareholders receive the threshold value, for example, 0. Bondholders receive the recuperation value

$$RC(k,b) = \min\left(\frac{(1-\varepsilon)[(1-c_0)(1-\delta)k]}{b}, 0.75 \right), \tag{3}$$

where ε represents bankruptcy costs, for example, any costs related to the liquidation and renegotiation of the firm after default. The recuperation value is capped at 75%. Otherwise debt would never be risky for large firms regardless of their leverage.

A firm can also issue equity $e < 0$ to finance itself. In this case, it incurs an issuance costs. These costs are motivated by underwriting fees and adverse selection costs. To keep the model tractable, we do not consider costs of

[20] We deduct only the risk-free interest rate for tractability reasons. To deduct the risky interest rate expenses, we would need to keep track of the previous period bond price (or productivity shocks) which would make the problem more difficult to solve. With a countercyclical credit spread, allowing for tax deductibility of the risky interest rate would smooth firm profits a bit more compared to the present specification. However, the effect is too small quantitatively to affect our results because firms tend to choose leverage in the risk-free range. Thus, firms pay close to risk-free rates.

[21] The discount factor is also adjusted by the individual tax rate τ_i, where $M = 1/(1+((1-\widetilde{M})./\widetilde{M}) \times (1-\tau_i))$.

external equity as the outcome of an asymmetric information problem. Instead, like 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, λ, like in Gomes and Schmid (2012):

$$\Lambda(e) \equiv 1_{e<0} \lambda e, \tag{4}$$

with $\lambda \geq 0$ and where $1_{e<0}$ equals 1 if $e<0$ and 0 otherwise.[22]

If equity is positive ($e>0$), it represents a distribution (payout) to the shareholder. Investors receive equity distributions either through repurchases or dividends. Farre-Mensa, Michaely, and Schmalz (2015) argue that tax consideration matter less for how firms choose to payout. Historically, dividends are rather smooth, whereas repurchases are quite lumpy. The sum of the two is fairly volatile in the data. Because our model does not distinguish between the two forms of equity payout, we assume a flat payout tax τ_e, leading to payout costs:

$$\Psi(e) = 1_{e>0} \tau_e e,$$

where $1_{e>0}$ equals 1 if $e>0$ and 0 otherwise.

Finally, we assume a reduced form stochastic discount factor (SDF) proposed by Zhang (2005). Investors discount future payoffs by $M(z_t, z_{t+1})$ where

$$\log M(z_t, z_{t+1}) = \log \beta + \gamma_t (z_t - z_{t+1}) \text{ and}$$

$$\gamma_t = \gamma_0 + \gamma_1 (z_t).$$

Setting $\gamma_1 < 0$ results in a countercyclical SDF: it is high in recessions and low in booms. The countercyclical discount leads to a risk-free rate that is high in booms and low in recessions like in the data.[23]

2.2 Firm optimization

2.2.1 Incumbent firm problem. Each quarter the incumbent firm has the option to default on its outstanding debt and exit. Therefore, each quarter the value of the firm is the maximum between the value of repayment and 0, the value of default

$$V = max\left\{V^{ND}, V^{D} = 0\right\}. \tag{5}$$

The repayment value is

$$V^{ND}(z,s,k,b) = \max_{k' \in K, b' \in B, e} \begin{cases} \underbrace{e}_{\text{Equity Payout}} + \underbrace{\Lambda(e)}_{\text{Eq.Iss.Cost}} - \underbrace{\Psi\,(e)}_{\text{Eq.Pay.Tax}} \ldots \\ + E_{s,z}\left[M(z,z')V\left(z',s',k',b'\right)\right] \end{cases}, \tag{6}$$

[22] The equity cost parameter is positive and is multiplied by the equity generated cash flow ($e<0$), making $\Lambda(e)<0$.

[23] Note that a time-varying SDF is not necessary for the cross-sectional differences in cyclical-financing patterns. Previous versions of this paper showed similar results with risk-neutral investors.

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 in the next period, b'. Both decisions determine equity payout

$$e=(1-\tau_c)zsk^{\alpha}-\big(k'-(1-\delta)k\big)-g(k,k')-c_f+\tau_c(\delta k+rb)+q^b b'-b. \quad (7)$$

Equity payout is thus defined as the residual of the after-tax firm revenue less investment and investment adjustment costs $g(k,k')$, less the 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 the principal amount of debt that is repaid b.

The time line for the incumbents in the model is as follows. At the beginning of each quarter, incumbents carry debt to be repaid and capital for current quarter production. Upon observing the productivity shocks, a firm receives gross revenues $F(z,s,k)$. The firm then decides its equity payout by choosing capital and debt for the next quarter b' and k'. At the same time it must pay its operating cost and its previous quarter debt. Every quarter the firm faces the decision whether or not to repay its debt. Debt is repaid if the firm's value is positive; otherwise, it defaults and exits.[24]

2.2.2 Debt contract and debt pricing. We assume that investors discount their cash flows with the stochastic discount factor $M\left(z,z'\right)$. Define $\Delta(k,b)$ as the combination of aggregate and idiosyncratic states such that a firm finds it optimal to default:

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

Using the discount factor on risky claims, the price of debt adjusts such that investors break even in expectations:

$$q^b\left(z,s,k',b'\right)=\iint_{\left(s',z'\right)\notin\Delta(k,b)} M(z,z')\,dzds \quad (8)$$
$$+\iint_{\left(s',z'\right)\in\Delta(k,b)} M(z,z')RC(k,b)\,dzds\,.$$

The price of debt is equal to the discounted value of the bond that pays back the face value of a unit in the states of no default $\notin\Delta(k,b)$ and pays the recuperation $RC(k,b)$ in case of default $\Delta(k,b)$. If the firm is not expected to default, the price is $E_z(M(z,z'))$.

The probability of default depends on the two endogenous states: how much debt the firm has to repay and how much capital it holds. Moreover, the higher the recuperation value of each unit of the bond, the higher the bond price.

24 When a firm is about to default, it may not divest capital and use the funds to pay out equity. This assumption is borne out in the data.

The more debt a firm needs to repay and the lower its stock of capital, the higher the probability of default and, therefore, the lower the price of the bond. Note that a change in the price of debt affects the entire loan amount, not only the marginal increase that caused the price change.

2.2.3 Entrant problem. We model entry in line with Clementi and Palazzo (2016). Every quarter a constant mass P of potential entrants receives a signal υ about their productivity. This signal follows a Pareto distribution, $\upsilon \sim \Upsilon(\upsilon)$ with parameter ω, which enables heterogeneous entrants. Firms have to pay an entry fee ($c_e > 0$) so 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 quarter after the entry decision, but must decide today with which capital stock they want to start production tomorrow given starting capital k^{priv}.[25] Investment is subject to adjustment costs. Entrants need funds to start

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

which equal investment plus adjustment costs expenditure less funds raised through debt financing. Investments can be financed with debt and equity; H is the amount financed with equity.[26] The entrant also faces the same linear issuance cost as an incumbent firm. We assume that the expected continuation value depends on the signal, which determines the probability distribution of the next quarter's idiosyncratic shock. The value function of the entrant is

$$V_e(z,\upsilon) = \max_{k',b'} \left\{ \begin{array}{c} -H - I_{-H<0} \underbrace{\Lambda(H)}_{Eq.Iss.cost} + E_{\upsilon,z}[M(z,z')V(z',s',k',b')] \\ s.t.\ E_{\upsilon,z}[\Delta(k',b')] = 0 \end{array} \right\}. \quad (9)$$

An entrant invests and starts operating if and only if the value of entry exceeds the entry fee. Let $\Pi(z,\upsilon)$ represent the entry decision, then $\Pi(z,\upsilon) = 1$ if $V_e(z,q) \geq c_e$. Entrants cannot choose a debt position that has a positive probability of default in the next quarter.[27]

Because firms exit the sample in case of default, not incorporating entry would generate a firm size distribution that is more strongly shaped by survival bias contrary to the data, because only large, productive firms would exist.

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25 Firm entry in our model is equivalent to a decision of going public, therefore it is natural that firms enter with some initial capital. We calibrate ω such that we match the ratio of entrants' average size (i.e., their initial size) to incumbents' average size in the data.

26 We set the initial leverage of entrants to 0, this is without loss of generality. Freeing up initial leverage as an additional parameter would help keep firm entrants' size small; doing so restricts investment because more cash flow must cover interest payments. However, in our calibration, we can pin down the average entrant's size without using its initial leverage.

27 The positive default probability in entry restriction prevents firms from entering, borrowing large levels of debt, paying out equity, and exiting (by defaulting), a behavior we do not observe in the data.

Hence, it is important to also model firm entry. We model and calibrate entry such that, like the data, entry is dominated by smaller firms. Also, the presence of aggregate shocks means that the continuation value of entry is procyclical, that is, firm valuations are generally procyclical. Therefore, in booms even less productive, smaller firms find it worthwhile to pay the entry fee and choose to enter.

2.2.4 Stationary firm distribution. Given an initial firm distribution and a SDF $M(z,z')$, a recursive competitive equilibrium consists of (1) value functions $V(z,s,k,b)$, $V_e(z,\upsilon)$, (2) policy functions for incumbents $\Delta(k,b)$, $b'(z,s,k,b)$, $k'(z,s,k,b)$, e, (3) policy functions for entrants $\Pi(z,\upsilon)$, $k'(z,\upsilon)$, $b'(z,\upsilon)$, H, and (iv) bounded sequences of the incumbents measures $\{\Gamma_t\}_{t=1}^{\infty}$ and entrants measures $\{\varepsilon_t\}_{t=0}^{\infty}$.

1. Given $M(z,z'), V(z,s,k,b), \Delta(k,b), b'(z,s,k,b), k'(z,s,k,b)$, and e solve the incumbents problem.
2. $V_e(z,\upsilon), \Pi(z,\upsilon), k'(z,\upsilon), b'(z,\upsilon)$, H solve the entrants' problem.
3. For all Borel sets $S\times K\times B\times\Re\times\Re^+$ and $\forall t\geq 0$,
$$\varepsilon_{t+1}(S\times K\times B)=P\int_S\int_{B_e(K,B,z)} d\Upsilon(\upsilon)d(G_s(s'\mid\upsilon)$$
$$B_e(K,B,z)=\left\{\upsilon \text{ s.t. } k'(z,\upsilon)\in K,\ b'(z,\upsilon)\in B \text{ and } V_e(z,\upsilon)\geq c_e\right\}.$$
4. For all Borel sets $S\times K\times B\times\Re\times\Re^+$and $\forall t\geq 0$,
$$\Gamma_{t+1}(S\times K\times B)=\int_S\int_{B(K,B,z)} d\Gamma_t(s,k,b)d(G_s(s'\mid s)+\varepsilon_{t+1}(S\times K\times B)$$
$$B(K,B,z)=\left\{(s,k,b)\ s.t.\ V(z,s,b,k)>0 \text{ and } b\in B,\ g(k',k)\in K\right\}.$$

The firm distribution evolves in the following way. A mass of entrants receives a signal and some decide to enter. The signal υ defines firms' next quarter idiosyncratic shock s and their policy functions define their next quarter capital and debt. As long as they are not exiting, incumbent firms follow the policy functions for next quarter's capital and debt and their next shocks follow the Markov distribution. Each quarter, the decisions of incumbents and entrants define how many firms inhabit each s,k, and b combination.

3. Parametrization

There are three categories of parameters. The first category consists of parameters that we set according to the literature, such as the decreasing returns to scale, bankruptcy cost, the tax rate, and the idiosyncratic shock parameters. The second group has a natural data counterpart, such as the depreciation rate, and the parameters that govern the aggregate shock and the SDF.[28] Panel A of Table 4 displays the values for parameters within the first two groups.

28 Note that given our SDF structure the risk-free rate is a function of the aggregate shock z and of the parameters $(\beta,\gamma_0,\gamma_1)$. See Zhang (2005) for the formula.

Table 4
Parametrization

A. Set parameters Parameter	Description	Target		
$\alpha=0.65$	Decreasing returns to scale	Hennessy and Whited 2007		
$\varepsilon=0.1$	Bankruptcy cost	Hennessy and Whited 2007		
$\tau_i=0.29$	Individual tax rate			
$\tau_c=0.3$	Corporate tax rate	Graham 2000		
$\tau_e=0.12$	Payout tax rate			
$\delta=0.025$	Depreciation	NIPA depreciation		
$\rho_s=0.9147$	Idiosy. shock persistence	İmrohoroğlu and Tüzel 2014		
$\sigma_s=0.1486$	Idiosy. shock vol			
$\rho_z=0.8857$	Agg. shock persistence	U.S. quarterly GDP		
$\sigma_z=0.0093$	Agg. shock SD	U.S. quarterly GDP vol		
$\beta=0.9885$		Avg. risk-free rate		
$\gamma_0=3.1$	Stochastic discount factor	Sharpe ratio		
$\gamma_1=-2,700$		Vol. risk-free rate		
B. Calibrated parameters Parameter	Description	Target	Data	Model
$\lambda=0.20$	Equity issuance cost	Avg. leverage	23%	28%
$c_0=4$	Divestiture adj. costs	Size 1 inv. rate / average inv. rate	0.98	0.87
$c_1=0.6$	Investment adj. costs	Avg. investment rate	3.65%	2.70%
$c_f=11$	Fixed cost of operation	exit rate	1.7%	1.7%
$\omega=3$	Pareto: Entrant productivity	Entrants relative size	23%	33%
$c^e=5.18$	Fixed cost of entry	Exit = entry	1.7%	1.7%

Panel A presents the parameters chosen based on previous literature and direct data counterparts. Panel B features the calibrated parameters, their corresponding data moment, and the corresponding moment in the model.

The last group of parameters is calibrated to jointly target moments in the data. To find these parameters, we first need to solve this heterogeneous firm dynamics model with endogenous entry and default globally under a specific set of parameters.That is, given a parametrization, we find the policies and the value functions of entrants and incumbents by value function iterations. We discretize the shocks using Tauchen (1990). Then we simulate model-implied moments derived from this specific parameter combination using the realized aggregate shocks (z) between 1984 Q1 and 2014 Q4, and compare these moments to the data. We repeat this procedure until the difference between the data and the model implied targeted moments has been minimized.

Panel B of Table 4 presents the calibrated parameter values as well as the calibration targets and the model response. Our calibration targets are fairly standard except for the divestiture adjustment costs.[29] Here, we use the ratio of the investment rate of the smallest size quartile to the average investment rate. The divestiture adjustment cost has a larger impact on smaller firms because the presence of fixed costs makes them riskier. If the divestiture adjustment cost was too low, it would cause small firms to increase investment too much relative to the average.

29 In the Online Appendix Section 3.3 we discuss the importance of our parameter choices for the results. Specifically, we test different values for c_f, c_0, and τ_c.

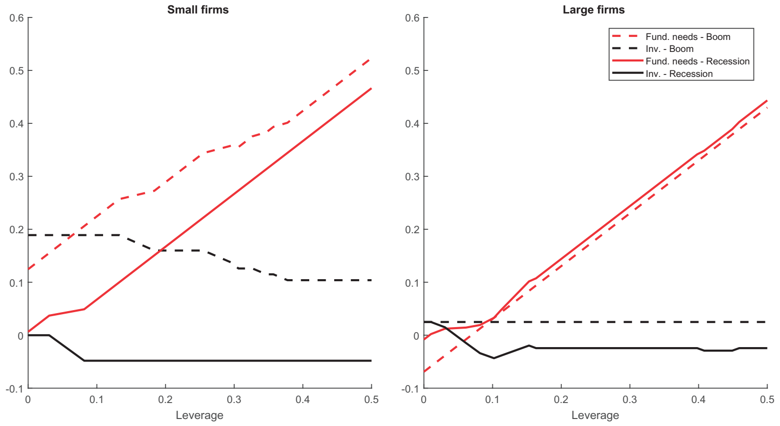

Figure 2
Need for funds (red) and investment policy (blue)
This figure shows the need of funds in red (upward sloping) for small firms (left panel) and large firms (right panel) and firm's investment policies for both booms (dashed line) and recession (solid line) for different levels of leverage.

4. Results

This section explains the model mechanism, followed by a comparison of financing moments in the model and the data.

4.1 Mechanism in the quantitative model

The decreasing returns to scale technology assumption implies that firms, conditional on their draw of the idiosyncratic and aggregate shock, have an optimal scale. Because of adjustment costs firms can only grow slowly towards their efficient scale. Moreover, the expected return on investment depends negatively on the size of the firm. Consequently smaller firms should have higher funding and investment needs relative to their assets compared to large firms.

Figure 2 plots external funding needs,

$$\big((1-\tau_c)zsk^{\alpha}-\big(k'-(1-\delta)k\big)-g(k,k')-c_f+\tau_c(\delta k+rb)-b\big),$$

in red, together with the investment policy $\big(k'-(1-\delta)k\big)$ in black against leverage for above-average shocks (dashed line) and below-average shocks (solid line). The left panel depicts small firms (i.e., firms in the first quartile), and the right panel depicts large firms (i.e., firms in the top quartile).[30] We fixed the idiosyncratic shock at the average to illustrate the behavior of firms that have the same productivity level but differ by their distance to the efficient size scale. Large firms are closer but above their efficient scale, and small firms are further away and below their efficient scale.

[30] The need of funds is a function of leverage. So it is displayed on the x-axis.

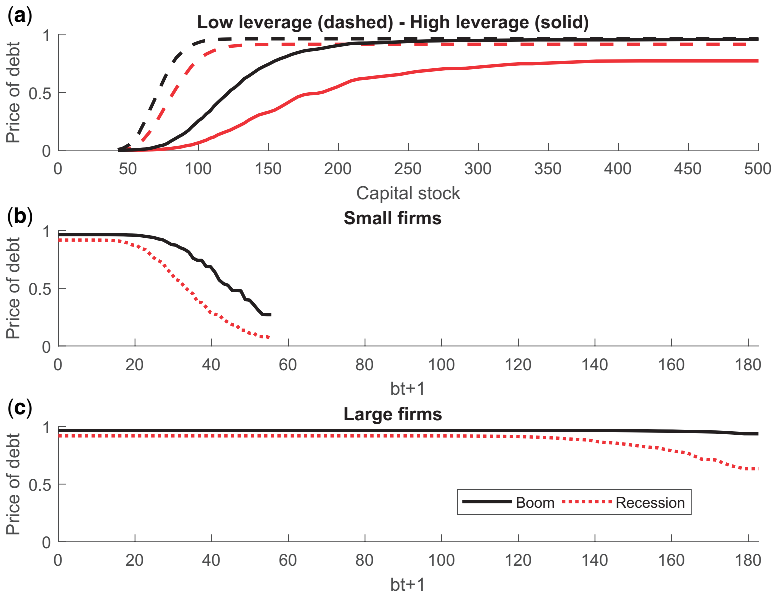

Figure 3
Price of debt
Panel A reports the price of debt as a function of the capital stock (x-axis) for different levels of the aggregate shock conditional on having above average or below average leverage. In panel A, the darker line marks good aggregate shocks and the lighter line marks bad aggregate shocks. Panel B (C) plots the bond price for small (large) firms for different choices of debt for boom and recession shocks.

Figure 2 highlights two facts. First, a firm that is further away from its efficient scale has higher funding and higher investment needs relative to its size compared to a larger firm. Second, booms increase funding needs and optimal investment needs, in particular for small firms. Together, these two points drive the model mechanism over the business cycle: small firms' funding needs are more responsive to the business cycle compared to large firms. Small firms are also more financially constrained but less so during booms, generating procyclical financing (countercyclical payout) patterns.

Figure 3 shows how the price of debt modulates the debt capacity of firms. Panel A plots the price of debt as a function of the capital stock for different aggregate shocks, holding leverage constant. Firms can raise less funds with debt when they are small and have high leverage. The state of the economy matters as well. Booms allow firms to raise more funds with debt (higher price) than recessions. Panel B conditions on small firms and varies their ex ante leverage. Given the aggregate state of the economy, small firms with higher ex ante leverage are constrained by a low debt capacity (endogenous debt ceiling) that operates through the price of debt on the funds that firms generate from borrowing, that is, price times the face value of debt (b'). In contrast, large firms have a large debt capacity regardless of the state of the economy or their current levels of debt, as shown in panel C of Figure 3.

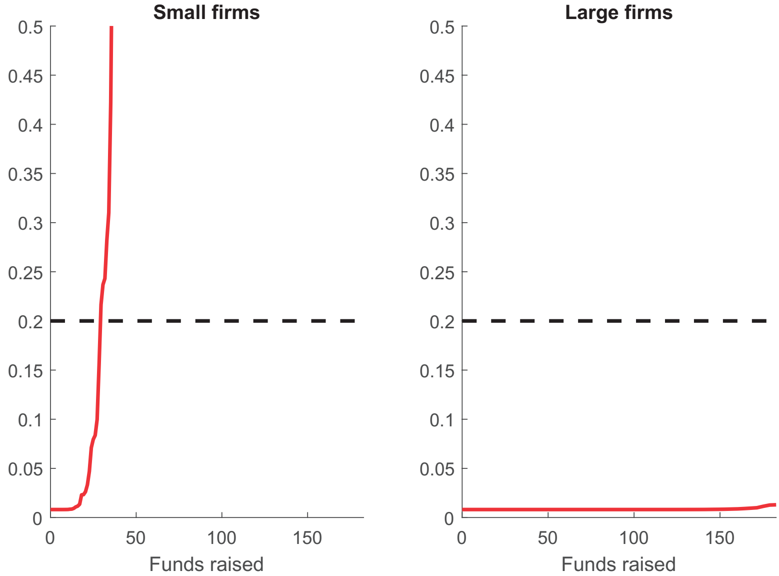

Figure 4
Additional unit costs of debt and equity financing
This figure shows a proxy for the marginal cost of raising funds though debt (solid line) and equity (dashed line) for small (left panel) and large (right panel) firms.

The debt choice is determined by the trade-off between the tax advantage and the cost of financial distress caused by default. 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 because equity payout is taxable. What matters are the marginal costs of debt and equity for the funds raised conditional on firm size. Firms with high funding needs but low debt capacity (small, growing firms) may find it cheaper to finance with equity.

Figure 4 compares the cost of financing one unit of funds with equity against the cost of debt for small (left panel) and large firms (right panel).[31] This graph tells us two things. First, large firms find debt financing always more attractive. They can borrow at rates close to the risk-free rate instead of raising equity that would incur 20% issuance costs. Also, they will even find it optimal to raise equity to pay out their shareholders.[32] In contrast, small firms have higher relative funding needs and, therefore, get closer to the endogenous debt ceiling. This makes equity financing more attractive. Second, the marginal cost of debt

[31] This measure is a proxy for the marginal costs of each type of fund. Note that the equity cost calculation does not account for the change in the return to shareholders.

[32] Many firms borrow to pay out equity because they issue at the default-free rate. This is consistent with the data as documented by Farre-Mensa, Michaely, and Schmalz (2015), and our evidence in Table B6.

Table 5
Cross-sectional moments

Asset	Profitability		Investment		Leverage		Equity payout		Debt repurch.	
%tile	Data	Model	Data	Model	Data	Model	Data	Model	Data	Model
0%–25%	−2.49	−9.74	3.63	2.30	0.19	0.14	−2.30	−0.25	−1.10	−0.85
25%–50%	0.74	−6.50	4.05	2.98	0.20	0.24	−1.18	0.55	−1.37	−0.65
50%–75%	1.95	−5.21	3.87	2.88	0.24	0.34	−0.16	0.10	−1.94	−0.14
75%–100%	2.57	−4.00	3.07	2.66	0.30	0.43	0.80	1.40	−1.74	0.41
Aggregate	0.69	−6.36	3.65	2.70	0.23	0.28	−0.71	0.45	−1.53	−0.30

This table presents the cross-sectional untargeted fit of the model. All numbers are calculated as time-series averages of asset percentile level. Except for leverage, all numbers are expressed as a percentage. *Source:* Compustat/CRSP and model.

increases rapidly. Thus, productive firms with very high funding needs and low internal funding capacities will resort to equity financing.

Small firms play a key role for the cross-sectional financing patterns. This suggests a major role for endogenous entry because entrants tend to be smaller, and endogenous entry dynamics thus amplify our mechanism.

The business cycle amplifies the cross-sectional differences in financing pattern. During booms (recessions) large firms have higher (lower) internal funds; therefore, they will pay out more (less). Good (bad) 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.

4.2 Cross-sectional financing differences in levels

Table 5 displays the cross-sectional averages of key variables. Note that our calibration strategy has not targeted these moments; not doing this allows us to use these moments to get a good sense of the model fit. The model generates investment rates that are hump shaped in size, like in the data. As we showed in the previous section, although decreasing returns to scale incentivize smaller firms to invest more, financially they are more constrained. Our model also captures the cross-sectional patterns of leverage. In particular, larger firms have higher levels of leverage compared to smaller firms. Equity payout relative to assets is increasing in size in both the data and the model. The model generates equity issuance by the smallest firms. We are able to match the cross-sectional patterns of equity payout, although the model generates higher levels compared to the data.

4.3 Cross-sectional differences in business-cycle correlations

Our optimization model generates policies for every firm. We simulate each firm for the period between 1947 Q1 and 2016 Q4, allowing for endogenous entry and exit according to the time-varying, stationary firm distribution. We discard the simulated periods before 1980 and treat the data the same way as

Table 6
Business-cycle correlation of equity payout and debt repurchases

Asset	Equity payout		Debt repurchases	
percentile	Data	Model	Data	Model
0%–25%	**−0.29**	**−0.33**	**−0.34**	**−0.28**
25%–50%	**−0.23**	**−0.17**	**−0.61**	**−0.35**
50%–75%	−0.06	0.03	**−0.44**	**−0.34**
75%–100%	**0.73**	**0.23**	**−0.65**	**−0.33**

This table reports the correlation coefficients of the business-cycle component of firms' external-financing variables (aggregated to their size portfolio level) with the business-cycle component of corporate GDP. The data sample is from Compustat/CRSP 1984 Q1 to 2014 Q4 and described in Table 1. The numbers in bold are significant at the 1% level. The model correlation numbers stem from simulating a panel of firms and computing the business cycle correlation of firms' external-financing variables with the GDP measure (the aggregate shock) in the model. *Source:* Compustat/CRSP and model.

we treated the Compustat/CRSP data. That is, we sort firms into bins based on their capital, calculate debt repurchases and equity payouts at the firm level, and then form cross-sectional bin aggregates. We HP-filter bin-aggregated variable, and preserve the sample between 1984 Q1 to 2014 Q4 and scale it by the trend component of the sum of assets within each size class. Finally, we calculate the correlations with the HP-filtered aggregate shock.

Table 6 compares the business-cycle correlations of equity payout and debt repurchases in the model with the data. The model generates fairly similar cyclical-financing patterns as the data without imposing exogenously time-varying financing costs. Equity payout is countercyclical for the first two bins and procyclical for large firms. Debt repurchase is countercyclical across all bins like 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 countercyclical equity payout. In recessions, the growth opportunities decrease and so do the need for funds. Consequently, firms issue less. In good aggregate times, large firms have more internal funds and are able to use them to increase payout. Large firms always finance with debt and finance more (repurchase less) in booms.

Next we check whether our model captures also the strength of the cyclical-financing relationship in the cross-section. To this end, we employ the same regression analysis on a model-generated panel as we did with the data panel. We simulate the model to generate a panel of the same number of firms over the same time horizon and sort them into asset quartiles. Table 7 presents the results. Without targeting any of these moments, our simulated data produces similar regression coefficients for equity payout of the same order of magnitude like in the data. Notably, equity payout is countercyclical for small firms and procyclical for larger firms. And the procyclicality increases with size like in the data. The strength of countercyclical debt repurchases is larger in the model compared to the data, but it increases with firm size as in the data.

Table 7
Measuring the economic magnitude of cyclical-financing activity

	log equity payout / trend log assets		log debt repurchases / trend log assets	
	Data	Model	Data	Model
	1	2	4	V
$G\tilde{D}P_t$	−0.012**	−0.024**	−0.003**	−0.031**
	(−3.16)	(−2.67)	(−3.02)	(−2.56)
$Size_{25-50} \times G\tilde{D}P_t$	−0.020	0.0847	−0.019***	−0.202
	(−1.47)	(0.59)	(−5.21)	(−0.92)
$Size_{50-75} \times G\tilde{D}P_t$	−0.003	0.278	−0.055***	−0.363
	(−0.11)	(1.61)	(−4.30)	(−1.28)
$Size_{>75} \times G\tilde{D}P_t$	0.330***	0.508**	−0.542***	−0.337**
	(10.47)	(2.82)	(−8.65)	(−2.66)
Observations	672	672	656	656
R^2 (%)	37	14	42	11

This table compares the data regression results with the model. It reports the regression coefficients from running a panel of external-financing variables (aggregated to their size portfolio level) on the business-cycle component of corporate GDP over 1984 Q1 to 2014 Q4 The external-financing variables are equity payout and debt repurchases, logged (re-scaled for negative values) and HP filtered as well as scaled by the trend component (after HP filter) of assets. The interactions are with size group dummies (e.g., a dummy equal to 1 if observations belong to size group 2 and assets are within the 25th–50th percentiles). t-statistics are reported in parentheses. We calculate robust standard errors. *Source:* Compustat/CRSP and model. * p<.05; ** p<.01; and *** p<.001.

We also check the quantitative performance of the model for size and profitability double-sorted portfolios. The regression results are presented in Table 8. This table shows that the model captures the cross-sectional cyclical financing patterns in the data. In particular, small, unprofitable firms drive procyclical equity financing, while larger firms as well as profitable firms drive procyclical payout. Debt repurchases are countercyclical for all firms, like in the data.[33] The model explains these cross-sectional cyclical patterns with differences in funding needs and funding capacity. Because of mean reversion in productivity shocks and decreasing returns to scale, small firms can realize higher returns on their investments. Conditional on investment needs and a positive shock that relaxes external financing constraints, more unprofitable firms have a larger propensity to fund investments externally. This is consistent with the responses in the data. Quantitatively however, the model generates stronger responses. That is, in the model, the issuances of debt and equity of small and unprofitable firms is more procyclical compared to the data and payout of profitable firms is more strongly procyclical.

What explains these different magnitudes? From Table 5, we can see that our model overshoots the degree of firms' unprofitability. These are moments that we did not target. This means that our model also slightly overshoots the

33 All but the smallest and most unprofitable firms' GDP interaction coefficient in Table 8 have to be read relative to the baseline $G\tilde{D}P_t$ coefficient. For example, the debt repurchases net interaction coefficient for firms in the size quartile 50%–75% and the profitability quartile >75% is $-.732+0.579=-0.153$ in the model and $-0.002+-0.023=-0.025$ in the data.

Table 8
Magnitude of cyclical-financing activity: Size and profitability

			log equity payout / trend log assets		log debt rep. / trend log assets	
6-7			Data	Model	Data	Model
$G\tilde{D}P_t$			−0.006**	−0.314*	−0.002***	−0.732***
			(−2.59)	(−2.20)	(−3.30)	(−4.06)
Int. $G\tilde{D}P_t$ with	Size	Proftbl.				
	<25%	25%–50%	0.004	0.00	−0.001	0.487**
			(1.59)	(0.03)	(−0.80)	(2.45)
		50%–75%	0.006**	0.09	0.000	0.692***
			(2.51)	(0.51)	(0.59)	(3.56)
		>75%	0.007**	0.22	0.000	0.767***
			(2.68)	(1.35)	(0.14)	(3.91)
	25-50%	<25%	−0.005	0.058	−0.006**	−0.385
			(−0.85)	(0.29)	(−3.18)	(−1.18)
		25%–50%	0.005*	0.069	−0.008***	0.261
			(1.78)	(0.38)	(−3.83)	(1.02)
		50%–75%	0.008**	0.158	−0.004*	0.467*
			(2.83)	(0.85)	(−2.10)	(1.92)
		>75%	0.015***	0.271	−0.002	0.694***
			(3.53)	(1.50)	(−1.30)	(3.02)
	50-75%	<25%	−0.009	0.163	−0.008	−0.339
			(−0.98)	(0.80)	(−0.92)	(−0.95)
		25%–50%	0.016**	0.384**	−0.013**	−0.0416
			(3.28)	(2.01)	(−2.79)	(−0.14)
		50%–75%	0.020***	0.320	−0.022***	0.292
			(4.00)	(1.52)	(−5.15)	(1.00)
		>75%	0.023**	0.327*	−0.023***	0.579*
			(2.85)	(1.78)	(−3.94)	(1.87)
	>75%	<25%	0.091**	0.482**	−0.022	−0.261
			(3.02)	(2.41)	(−0.44)	(−0.80)
		25%–50%	0.192***	0.604***	−0.116	0.0451
			(7.49)	(2.91)	(−1.45)	(0.15)
		50%–75%	0.179***	0.663***	−0.229**	0.183
			(8.54)	(2.98)	(−3.27)	(0.62)
		>75%	0.170***	0.456*	−0.127	0.487
			(9.13)	(1.74)	(−1.67)	(1.48)
Observations			2,176	2,176	2,112	2,112
R^2 (%)			27	20	3	11

This table reports the regression coefficients from running a panel of external-financing variables (aggregated to their size and profitability portfolio level) on the cyclical component of corporate GDP over 1984 Q1 to 2014 Q4 (data) and model-simulated time series of equity and debt repurchase. The external-financing variables are the cyclical component of equity payout and debt repurchases scaled by assets defined as described in Table 2. The interactions are with size/portfolio group dummies. t-statistics are reported in parentheses. We calculate robust standard errors. *Source:* Compustat/CRSP, NIPA, and model-simulated variables. * p<.10; ** p<.05; and *** p<.001.

business-cycle sensitivity of firms' external financing behavior.[34] We place more weight on the good quantitative performance of the size based portfolio regressions because they explain 37% and 42% of the data variation in cyclical

[34] Another, less quantitatively strong reason for the model differences is that our model abstracts from fixed costs of external financing. Although this appears to be a minor factor given the good performance of the size sorted model, it may matter for the double-sorted portfolio in the following sense. Fixed costs of external financing may especially deter small and unprofitable firms financing because they tend to issue smaller amounts.

equity payout and debt repurchases, respectively, while the size-profitability based portfolios explain only 27% and 3%. Note that, debt repurchases are countercyclical for most firms and thus slicing the sample up further did not improve the explanatory power of the regression. The size based portfolio sort, however, captures (see Table 7) the increasing response in size of firms' debt repurchases over the business cycle.

In sum, our parsimonious model captures a significant piece of the cross-sectional patterns in the cyclicality of firms' external financing behavior. Like in the data, debt financing is more attractive to all firms during booms, but equity payout seems to be particularly driven by profitable and large firms and issuances by small and unprofitable firms.

4.3.1 Relationship to capital structure theories. The neoclassical model captures the first order issue of the cross-sectional differences in a firm's financing behavior over the business cycle. The financing patterns of large firms is well described by the trade-off theory (see, e.g., 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 encouraging firms to increase leverage.

The behavior of small firms is consistent with the pecking-order paradigm, according to which internal funds are preferred over debt and debt is preferred over equity.[35] 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 moral hazard cause these patterns.

In this paper, we highlight that external financing patterns are driven by two forces: funding needs and funding capacity. Capital structure theories speak to the funding capacity, while investment theories speak to the funding need of firms. The cross-sectional dynamic patterns can only be understood by analyzing the two jointly.

4.4 What are the effects of financial frictions?

In this section we perform counterfactual exercises to understand the impact of financial frictions in cross-sectional cyclicality of firm financing. To that end, we solve and simulate the model without frictions and with a high level of frictions. In the model without frictions, firms face no equity issuance costs ($\lambda = 0$) and no losses in case of bankruptcy ($\varepsilon = 0$ and not capped at 0.75). In the

35 Myers (1984) contrasts the static trade-off paradigm with the pecking-order paradigm.

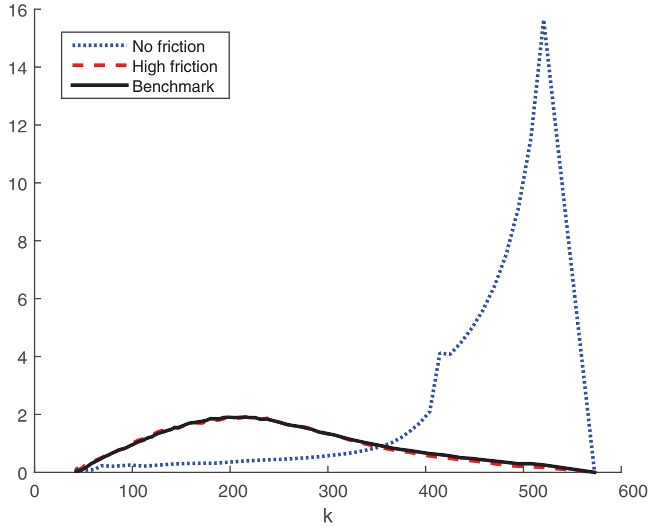

Figure 5
Impact of frictions on size distribution
This figure plots the average size distribution implied by the model-generated data for the benchmark model, the high friction model, and the no friction counterfactuals.

model with high frictions, we set the equity issuance cost parameter 10 times higher ($\lambda = 2$) and the fraction lost in default to 1 ($\varepsilon = 1$).

Figure 5 plots the average size distribution using the benchmark calibration (solid black), the "no financial friction" calibration (dotted blue) and the "high financial friction" calibration (dashed red). The benchmark and "high friction" cases are relatively similar. The starkest difference can be seen in the size distribution in the "no friction" case, in which firms tend to be larger. With no financial frictions firms are not financially constrained and rely heavily on debt to grow faster to their efficient scale.

Table 9 compares the results of these three calibrations (benchmark, high friction, and no friction) on key variables in the model. Absent financial frictions, smaller firms can seize productivity opportunities by levering up and investing more. This leads to substantially higher investment rates compared to the benchmark model. The business-cycle correlations of equity payout for the "no friction" case displays procyclical payout patterns; that is, firms do not have to resort to equity financing because debt-financing frictions have been lifted. Firms almost exclusively use debt to fund investment projects.

The "high friction" case is similar to the benchmark case with an important difference. Because of higher debt- and equity-financing costs even larger firms, that is, firms in the 50% to 75% percentiles, use equity to fund investments in good times. Moreover, leverage is significantly lower when financing costs are large.

Table 9
Effect of financial frictions

	Asset %tile	Benchmark	High financial friction	No financial friction
Leverage	0%–25%	0.14	0.11	0.99
	25%–50%	0.24	0.17	0.98
	50%–75%	0.34	0.26	0.98
	75%–100%	0.43	0.35	0.99
Investment rate	0%–25%	2.30%	2.40%	23%
	25%–50%	2.98%	2.80%	6.8%
	50%–75%	2.88%	2.80%	4.8%
	75%–100%	2.66%	2.60%	4.0%
EP BC corr.	0%–25%	−0.33	−0.36	0.26
	25%–50%	−0.17	−0.20	0.09
	50%–75%	0.03	−0.12	0.10
	75%–100%	0.23	0.26	0.12
DR BC corr.	0%–25%	−0.28	−0.30	−0.24
	25%–50%	−0.35	−0.34	−0.22
	50%–75%	−0.34	−0.30	−0.20
	75%–100%	−0.33	−0.33	−0.28

This table presents a comparison of leverage (debt to assets), investment, business-cycle correlation of equity payout, and debt repurchases computed like in Table 6 for three different calibrations (benchmark, high level of financial frictions, and no financial frictions). In the model with no frictions, firms have no equity issuance cost ($\lambda = 0$) and no losses in bankruptcy ($\varepsilon = 0$ and not capped at 0.75). In the model with high frictions, equity issuance costs are 10 times higher ($\lambda = 2$) and recuperation post-default is equal to 0 ($\varepsilon = 1$).

5. Conclusion

This paper examines how financial frictions—summarized by the trade-off theory—affect different firms differently over the business cycle. We document rich cross-sectional differences in the cyclical financing behavior of public firms and explain these facts in a dynamic firm financing model with the interaction of firms' funding capacity and funding needs. Smaller, unprofitable firms must deal with higher financing frictions because they are riskier. At the same time, they tend to be more productive and thus have higher funding needs. A boom loosens financial constraints, but not sufficiently to enable frictionless financing of an improved investment opportunity set. Larger firms tend to have lower investment needs. In addition, they have higher internal resources as do profitable firms. During a boom, higher internal funds and lower debt-financing constraints lead to a higher funding capacity. With lower funding needs, excess funds are paid out.

Our analysis reveals how the interplay between firm dynamics (funding needs) and financial frictions (funding capacities) jointly drive firms' financial positions and investment behavior over the business cycle. Understanding this interaction matters for the question of how aggregate shocks are transmitted and amplified. In other words, a direct consequence of our findings is that the use of aggregate data and a representative firm model, conceals the fact that firms vary in their investment demand and financing capacity. When investment-hungry and cash-flow-poor small firms run into binding financing constraints, aggregate shocks that move these constraints can have an effect. An exciting future avenue for research is to embed our model into a general equilibrium framework that studies the quantitative effects of various simulative policy measures, such as credit guarantees for small firms.

Appendix A. Discussion of Covas and Den Haan (2011)

To understand the empirical differences from Covas and Den Haan (2011) (CDH2011), we replicate their results using annual Compustat/CRSP-merged data. Our main focus is on the empirical differences in equity financing. The debt financing results are similar.

CDH2011 use annual Compustat data (1980–2006) and construct various measures of firm equity financing. We follow their definitions, sample selection criteria—as described by their AER online appendix—and compare the resultant summary statistics to their summary statistics (CDH2011, table 1). We find that they are overall very similar.[36,37]

In their paper, the cyclicality of equity financing is examined for several measures of equity financing in the data. In particular, they use the change in stockholder equity with (1) and without subtracting dividends (2), the sale of stock (3), and the net sale of stock (4). The headline result of CDH2011, namely, that only the top 1% of firms reduce equity financing in booms, is based on the change in total shareholder equity (with or without dividends) calculated for all firms (i.e., including initial public offerings (IPOs)) using the level approach (see the panel columns indicated by ***CDH Definition*** in Table A.1).[38] According to this measure, equity financing is procyclical for most firms; that is, unless one focuses on the top 1%, financing behaviors do not contain a lot of cross-sectional variation.

In our replication, equity measured by the change in stockholders' equity is procyclical for most firms, consistent with their results. However, we cannot replicate their headline result that only the top 1% pay out equity during booms.[39] Instead, we find that the change in stockholders' equity is acyclical for the largest firms.

CDH2011 also report results for other measures of equity financing, which we are able to replicate. Among these, the net sale of stock less dividends is just the negative of our definition. The correlations show a very similar cross-sectional pattern like in our benchmark result (see Columns ***Close to our Def*** of Table A.1 and compare it to Table 1 by flipping the sign on equity payout). Despite reporting results for other measures, CDH2011 draw their conclusions by only focusing on the change in stockholders' equity measure.

A.1 What Causes the Differences between Our Results and CDH2011's?

Citing Fama and French (2005), CDH2011 claim that equity financing is best measured by the change in the book value of stockholders' equity. However, the definition by Fama and French (2005) is different from the one applied in CDH2011. Fama and French (2005) calculate equity financing as the change in book equity less the change in retained earnings, because they want to differentiate between external and internal equity financing.

In their online appendix, CDH2011's claim that "in Compustat, retained earnings are recorded in a separate account and, thus, do not become part of the book value of equity" is not correct.

[36] https://assets.aeaweb.org/assets/production/articles-attachments/aer/data/pril2011/20070104_app.pdf

[37] Smaller differences could be due to the differences over the period in which the sample statistics were calculated (we used 1980–2006) as well as potential differences in the annual files because we downloaded the compm/funda files in October 2017.

[38] CDH2011 calculate the cyclical properties using a "level" approach and "flow" approach for each financing variable, but state that the flow approach leads to too much volatility.

[39] It is of course possible to replicate their results with the aggregated data provided by CDH2011's AER data appendix.

Table A.1
Covas and Den Haan (2011) business-cycle correlations of equity financing

Size	*CDH Definition*		*FF Def*	*Close to our Def*
%tile	Δ Eq.	Δ Eq. - DV	Δ Eq. - Δ RE	Net sale of Stocks - DV
<25th	0.42	0.42	0.40	0.36
25th–50th	0.41	0.40	0.11	0.11
50th–75th	0.42	0.42	0.03	−0.11
75th–90th	0.31	0.28	−0.30	−0.36
90th–95th	0.26	0.25	−0.28	−0.47
95th–99th	0.27	0.26	−0.22	−0.38
>99th	0.02	0.01	−0.27	−0.49
All firms	0.18	0.18	−0.20	−0.31

This tables presents our replication results of CHD2011's tables 3, 4, and 5 for all firms. Δ Eq. denotes the change in equity. DV denotes dividends. We applied the sample selection criteria of CDH2011 and formed HP-filtered time series of these variables using the level approach outlined in their paper. All variable definitions are from CDH2011, except for the columns headlined by "FF def." This column presents the correlations of the change in stockholders' equity variable as defined by Fama and French (2005), that is, the change in stockholders' equity (SEQ) less the change in retained earnings (REs) (item 36).

Even though Compustat *also* keeps track of retained earnings in a separate account, it does not mean that retained earnings are not part of the book value of equity.[40] In fact, the law of motion for stockholders' equity E_t is

$$E_t = E_{t-1} + \Delta\text{Retained Earnings}_t + \text{Funds obtained via equity financing}_t.$$

By taking the difference,

$$\Delta E_t = E_t - E_{t-1} = \Delta\text{Retained Earnings}_t + \text{Funds obtained via equity financing}_t.$$

Therefore, this includes funds from internal (e.g., retained earnings) and external (e.g., stock issuances) equity. Even though CDH2011 cite Fama and French (2005) to justify their variable choice, they did not adjust their variable for the change in retained earnings as Fama and French (2005) did.[41] This choice is not innocuous as we show in columns ***FF Definition*** of Table A.1. It leads CDH2011 to draw counterfactual conclusions about the cross-sectional differences in cyclical financing behavior. When using the correct Fama and French (2005) equity financing measure, that is, the change in stockholders' equity (SEQ) less the change in retained earnings (REs) (item 36), we find correlations that are consistent with our results and inconsistent with CDH2011's results. That is, our results do not depend on using the cash flow based definition favored by Jermann and Quadrini (2012) or a stockholders' equity based definition favored by Fama and French (2005), as long as one differentiates between internal (i.e., retained earnings) and external sources of equity financing within stockholders' equity.

Both in the model and in the data, we focus on an equity financing variable that captures precisely what we want. We study the mechanisms behind firms' decision to finance investment

40 The Compustat (XPRESSFEED) data description for SEQ (the mnemonic for Compustat item #216 (total stockholder's equity) used by CDH) states: "Total Parent Stockholders' Equity Note: Prior to SFAS 160 - Noncontrolling Interests in Consolidated Financial Statements, this item was labeled "Stockholders' Equity's Total." This item includes: (a) Capital surplus, (b) Common/Ordinary Stock (Capital), (c) Nonredeemable preferred stock, (d) Redeemable preferred stock, (e) Retained earnings, and (f) Treasury Stock.

41 Fama and French (2005) use dSB = dSE - dRE as their book measure of equity financing ($\Delta E_t - \Delta RE_t$ in our notation). They say "the change in stockholders" equity, dSE, combines (1) issues and repurchases of equity, (2) retained earnings, and (3) "dirty surplus" transactions, such as foreign currency translation adjustments. Because dirty surplus transactions do not flow through the income statement, they do not affect a firm's reported value of retained earnings. However, these transactions are typically incorporated in Compustat's adjusted value of retained earnings (data item 36), so we use this measure to compute dSB."

decisions with external funds. For this reason, we focus on outside equity and debt. Our outside equity measure is a cash-flow measure and thus less affected by accounting quirks as stockholders' equity. In the data, we drop firms that were involved in major mergers and we use the method outlined by McKeon (2013) to differentiate firm-initiated from employee-initiated stock issuance. We also verify that our results are robust to adjusting our equity financing measure to more recently available data on stock-based employee compensation (e.g., Sun and Zhang (2016)). We believe that these adaptions make cash-flow-based measures of equity financing superior for our purpose.

Appendix B. Robustness

This section presents the argument why we sort firms into size and profitability portfolios, as well as additional empirical robustness results.

B.1 Why Form Size and Profitability Portfolios?

In the main text, we present results on size as well as size and profitability as main sorting variables to better understand the drivers of firms' external-financing behavior. Alternatively, and consistent with the theory, we might have also sorted firms into size and Tobin's q portfolios or profitability and Tobin's q portfolios. So why did we choose size and profitability as a sorting variable? Tables B.2 and B.3 make our case. Both report OLS regression results from regressing external-financing variables (the HP-filtered equity payout and debt repurchases series normalized by the trend of assets at the portfolio level) on the cyclical component of corporate GDP and its interactions with portfolio dummies.

Table B.2 compares these different combinations. Sorting firms by size and profitability is our preferred specification. Sorting firms into profitability and Tobin's q portfolios leads to lower explanatory power, whereas a size and profitability sort leads to the same R^2 as one based on size and Tobin's q. This suggests that a combination of size with Tobin's q or size with profitability captures more variations in the data compared to Tobin's q and profitability, as the latter two are fairly correlated.

How did we decide between size and profitability and size and Tobin's q? Table B.3 presents the regressions coefficients of the OLS regression of our external-financing variables on cyclical GDP and 64 portfolio GDP interaction terms. These portfolios sort firms into size, profitability, and Tobin's q quartiles. Studying the coefficients in Table B.3 leads to two interesting observations. First, holding size and profitability quartiles fixed, a movement along Tobin's q quartiles rarely changes firms' external-financing patterns. The statistical power of these regressions is quite low, particularly for debt repurchases, but qualitatively they suggest a clear pattern. In particular for equity payout, the results show that the cyclicality changes over size and profitability groups, but not over Tobin's q. Changing Tobin's q does not materially change this pattern. This suggests that the negative correlation between Tobin's q and profitability is the reason regression 2 in Table B.2 had a similar explanatory power as the one based on our benchmark sort. Therefore, it's not size and Tobin's q that drive firms' external-financing behavior but size and profitability.

B.2 Equity Financing Adjusted for Stock-Based Compensation

Table B.4 documents the effects of adjusting our baseline financing variables by stock-based employee compensation that has become available for some firms since 2002 and consistently across firms since 2006. Panel A shows that stock-based employee compensation is procyclical over this short sample for all firms. In addition, it shows that the results related to the cyclical differences and financing patterns in Table 1 are not changed by a different definition of equity payout. The numbers do change slightly relative to our benchmark results as this sample is quite short. Panel B presents the effect of an alternative definition on the mean of the financing variables. It shows that employee stock compensation is a bigger deal for smaller firms.

Table B.2
Comparing the effects of different sorting variables

GDP w/ size & profit.				GDP w/ size & Tobin's q				GDP w/ profit. & Tobin's q			
		EP	DR			EP	DR			EP /A	DR
Size	Profit.	Coef	Coef	Size	Profit.	Coef	Coef	Size	Profit.	Coef	Coef
1	1	−0.006**	−0.002***	1	1	−0.001	0.000	1	1	0.009	0.014
	2	0.004	−0.001		2	−0.002	−0.001		2	−0.012	−0.048
	3	0.006*	0.000		3	−0.00433*	0.000		3	−0.0316**	−0.029
	4	0.007**	0.000		4	−0.00531*	−0.001		4	−0.0482*	−0.046
2	1	−0.005	−0.006**	2	1	0.001	−0.003	2	1	0.0792***	0.016
	2	0.005	−0.008***		2	−0.001	−0.00720***		2	0.0375*	0.226**
	3	0.008**	−0.004*		3	−0.00967**	−0.00470*		3	0.005	0.013
	4	0.015***	−0.002		4	−0.0237*	−0.00893***		4	−0.014	−0.0885*
3	1	−0.009	−0.008	3	1	0.006	−0.0136*	3	1	0.0765***	−0.048
	2	0.016**	−0.013**		2	0.0111***	−0.0143**		2	0.133***	−0.088
	3	0.020***	−0.022***		3	0.007	−0.010		3	0.111***	−0.149
	4	0.023**	−0.023***		4	−0.038	−0.0252***		4	−0.004	−0.059
4	1	0.091**	−0.022	4	1	0.151***	−0.016	4	1	0.016	−0.041
	2	0.192***	−0.116		2	0.141***	0.009		2	0.0476**	−0.111
	3	0.179***	−0.229**		3	0.203***	−0.308***		3	0.134***	−0.202**
	4	0.170***	−0.127		4	0.118***	−0.123		4	0.0602*	−0.136
Obs		2,176	2,112	Obs		2,176	2,112	Obs		2,176	2,112
R^2 (%)		26	3	R^2 (%)		26	3	R^2 (%)		15	2

This table reports the regression coefficients from running a panel of external-financing variables on the cyclical component of corporate GDP over 1984 Q1 to 2014 Q4. The interactions are with portfolio group dummies. We calculate robust standard errors. * p<.10; ** p<.05; and *** p<.001.

Table B.3
GDP interaction coefficients: Size, profitability, and Tobin's q

Prft.	Tobin's	Size 1		Size 2		Size 3		Size 4	
%tile	%tile	EP	DR	EP	DR	EP	DR	EP	DR
1	1	−0.001	0.000	0.000	−0.001	0.003	−0.002	0.024***	0.042
	2	−0.001	0.000	−0.002	−0.001	0.002	−0.005	0.042***	−0.019
	3	−0.001	0.000	−0.004	−0.003*	−0.006	0.006	0.035**	−0.017
	4	0.000	0.000	−0.001	−0.003	−0.011	−0.006	0.009	0.005
2	1	0.001	0.000	0.002	−0.001	0.005**	−0.002	0.041***	0.013
	2	0.000	0.000	0.002*	−0.002*	0.005***	−0.006*	0.063***	0.025
	3	0.000	0.000	0.000	0.000	0.003*	−0.003	0.049***	0.019
	4	0.001	0.000	0.000	−0.007***	0.002	0.000	0.100***	−0.130*
3	1	0.001	0.000	0.002**	0.000	0.004**	−0.004	0.045***	0.025
	2	0.001	0.000	0.002*	−0.002**	0.006**	−0.006	0.081***	−0.098
	3	0.001	0.000	0.001	−0.001	0.009***	−0.010***	0.089***	−0.052
	4	0.001	0.000	0.002	0.000	0.003	−0.003	0.042*	−0.077
4	1	0.001	0.000	0.002*	0.000	0.006*	−0.005	0.049**	−0.081
	2	0.001	0.000	0.003*	0.000	0.011***	−0.007*	0.070***	−0.010
	3	0.002	0.000	0.003*	−0.001	0.008*	−0.011**	0.113***	−0.047
	4	0.002	0.000	0.007*	−0.001	0.000	−0.002	0.036*	−0.021

This table reports the regression coefficients from running a panel of external-financing variables on the cyclical component of corporate GDP over 1984 Q1 to 2014 Q4. The interactions are with portfolio group dummies. We calculate robust standard errors. The observation number and R^2 for the equity payout regressions is 8,448 and 11%, and for the debt repurchases 8,192 and 1%, respectively. * p<.10; ** p<.05; and *** p<.001.

Table B.4
Effect of employee stock compensation sample, 2006 Q1–2014 Q4

		Equity payout		Debt repurchases	
A. Business-cycle correlation					
Asset quartile	SBC	Benchmark	EP+SBC	Benchmark	DR−SBC
0%–25%	**0.58**	**−0.34**	**−0.33**	**−0.35**	**−0.36**
25%–50%	**0.54**	−0.21	−0.21	**−0.73**	**−0.72**
50%–75%	**0.48**	**0.33**	**0.35**	**−0.68**	**−0.68**
75%–100%	**0.31**	**0.89**	**0.89**	**−0.68**	**−0.68**
B. Means relative to assets (%)					
0%–25%		−2.00	−1.36	−0.97	−1.60
25%–50%		−0.68	−0.28	−1.62	−2.03
50%–75%		0.46	0.72	−2.34	−2.60
75%–100%		1.24	1.38	−1.37	−1.52

Panel A presents the correlations of the financing variables with the GDP under the benchmark definition. We also compute the correlation of stock-based employee compensation *stkcoq* relative to assets (SBC), and equity payout as defined above less *stkcoq* (EP + SBC) and debt repurchases as defined above less *stkcoq* (DR - SBC). The numbers in bold are significant at the 5% level. Panel B presents the average values for each size portfolio for the 2006 Q1 to 2014 Q4 period for equity payout as defined in the benchmark, equity payout less stock-based employee correlations, debt repurchases as defined in the benchmark, and debt repurchases less stock-based employee correlations.

B.3 Is Size a Proxy for Age?

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 could be in place for young firms versus old firms. To test this idea, we match firms in Compustat to the Field-Ritter data set of company founding dates. Table B.5 presents the business cycle correlations of the financial variables when firms are binned according to their age. Through the matching procedure we lose around 60%

Table B.5
Business-cycle correlation based on age

Age percentile	Equity payout	Debt repurchases
0%–25%	**−0.35**	**−0.22**
25%–50%	0.10	**−0.57**
50%–75%	0.41	**−0.53**
75%–100%	0.63	**−0.40**
Aggregate	0.31	**−0.61**

We compute the correlations based on age portfolios. Numbers in bold are significant at the 5% level.

Table B.6
Debt issuance and equity payout incidence

	Freq. of debt/equity fin. activity	Fin. activity with debt iss. and eq. pay.	Fin. activity with debt iss. and excl. div
mean	40	34	18
<25%	36	12	7
25%−−50%	36	23	13
50%−−75%	40	39	20
>75%	47	64	34

Units are expressed as a percentage. Column 1 represents the percentage of any external-financing activity. Column 2 represents the percentage of firms that issue debt and payout equity in the same quarter. Column 3 is similar to Column 2, but excludes dividends in the equity payout definition.

of the data from the original sample. The correlation coefficients are nevertheless qualitatively similar. 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 because it maximizes the number of observations, and asset size and age tend to be negatively correlated in the data. The Online Appendix shows that the size results are qualitatively the same when we use the matched Field-Ritter data sample.

B.4 Do Firms Pay Out Equity and Finance with Debt at the Same Time?

Table B.6 shows that on average 18% of the firms issue debt and pay out equity (not counting dividend distributions) at the same time. It is much more common for large firms to simultaneously issue debt and payout equity. This is consistent with the fact that large firms payout equity in booms and repurchase debt in recessions.

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