

Asset Tangibility, Aggregate Risks, and the Diversification Discount

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Abstract

This paper develops a structural model of the firm that features endogenous diversification and refocusing in a two sector economy, where each sector is characterized by a different level of asset tangibility. The estimated model is able to generate the average diversification discount as well as its substantial decrease during recessions and credit crunches as observed in the data. This decrease in the discount can be attributed to tighter collateral constraints of single-segment firms with low asset tangibility. The paper highlights the role of organizational flexibility in liquidity management in the presence of aggregate productivity and financial shocks. Counterfactual experiments show that the value of collateral and cash flow pooling adds 5% to Tobin's q of an average conglomerate while the value of organizational flexibility –the ability to diversify and refocus– accounts for 8.5% of firm value.

Keywords: Asset Tangibility, Credit Crunch, Liquidity, Conglomeration, Diversification Discount, Tobin's q , Investment, Capital Structure.

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1 Introduction

Recent empirical literature has documented a substantial increase in intangible capital accumulation of U.S. firms. However, capital with lower tangibility reduces the amount a firm can pledge as collateral. Therefore, lower asset tangibility can make firms more sensitive to adverse aggregate shocks such as a recession or a credit crunch. The difficulty in raising funds in such events could lead to costly external financing or even the inability to undertake profitable investment opportunities. Firms can manage liquidity not only by adjusting their debt and cash holding policies¹, but also by their choice of organizational structure. Specifically, firms can choose to operate as single-segments or as conglomerates and borrow against their pooled physical assets. This paper builds a structural model of the firm in order to investigate how organizational structure can mitigate the effect of adverse macroeconomic shocks.

We first document new stylized facts on asset tangibility and firm valuation. Using a panel of single-segment firms, we find that Tobin's q of firms with higher asset tangibility are less affected by credit crunches and recessions, which confirms the intuition that lower asset tangibility may have a negative impact on firm value in bad aggregate states. Consistent with existing empirical evidence², we find that the percentage of firms entering our sample dataset with low asset tangibility has increased steadily over time. Finally, we also find that the diversification discount, defined as the difference between the mean Tobin's q of single-segment firms and conglomerates, decreases during credit crunches and recessions. These decreases in the discount seem to be driven mostly by the decreases in Tobin's q of low tangibility firms, indicating the importance of the collateral channel in bad times. Moreover, these time-series variations are economically sizable and highlight that the organizational structure of firms is an important channel to consider for liquidity management.

¹See recent paper by Falato, Kadyrzhanova, and Sim (2014) that studies the connection between cash holdings and the rise in intangible capital.

²Jovanovic and Rousseau (2005), Corrado, Hulten, and Sichel (2009), Corrado and Hulten (2010) provide extensive documentation of the recent trend in increasing accumulation of intangible capital.

We then develop a structural model that builds on a partial equilibrium environment with heterogeneous firms. On the real side, firms are subject to aggregate and idiosyncratic productivity shocks and choose to invest in physical capital facing adjustment frictions. They can operate in either one or two sectors, as in the framework of Gomes and Livdan (2004), thus choosing diversification and refocusing endogenously. In contrast to Gomes and Livdan (2004), sectors in this model are characterized by different levels of asset tangibility. Asset tangibility does not impact the marginal productivity of capital, but determines the value of assets that can be pledged. On the financing side, there are financial frictions and firms fund investment using debt and equity financing, following the work of Hennessy and Whited (2005). Firms also face sectoral shocks to the collateral value of their assets in the intraperiod loan market, similar to Jermann and Quadrini (2012).

The model is quantitatively disciplined by the data through calibration of the shocks and some institutional parameters and through estimation of the rest of the model parameters using the Simulated Method of Moments (SMM). These model parameters are chosen such that the distance between a set of moments in the data –including the new stylized facts– and the corresponding set of moments in the model simulated data is minimized.

The first result of our estimated model is that it can generate the average diversification discount (0.27) that is similar in magnitude to the one in the data. As in Maksimovic and Phillips (2002) and Gomes and Livdan (2004), it is the self-selection of firms that generates this discount. Small single-segment firms tend to be high growth firms and thus have high Tobin’s q . Once they exhaust their growth options, they find it optimal to diversify into a new sector. These conglomerate firms tend to be slower growing and thus have low Tobin’s q .

The second result is that our estimated model is able to reproduce the empirical fact regarding the effect of asset tangibility on Tobin’s q for single-segment firms. Regressions in the simulated data show that firms in the low tangibility sector see an additional value decrease in the event of a recession or a credit crunch. The reason for this result is that

the adverse aggregate shocks tighten the collateral constraint of the low tangibility firms more than that of the high tangibility firms. Tighter collateral constraint leads to lower investment and costly external financing for low tangibility firms. This in turn reduces Tobin's q differentially.

The third result is that our estimated model can replicate the time series variations of the diversification discount. In particular, the latter decreases during recessions and credit crunches, just as in the data. Firm values of single-segments with low asset tangibility decrease significantly while those of conglomerates do not decrease as much due to their ability to pool collateral and financing across divisions. Although both type of firms – single-segments and conglomerates – suffer a reduction in credit, single-segment firms see a stronger impact in their valuation because they are the more productive firms in the economy. In other words, one unit of forgone investment has different effects on the valuation of these two type of firms. Therefore, self-selection is also responsible for this result.

Our study contributes to a large literature on diversification discount. There has been a long standing debate on whether conglomerates are valued at a discount compared to a portfolio of similar single-segment firms. While many empirical papers such as Lang and Stulz (1994) and Berger and Ofek (1995) show that there is indeed such a discount, others such as Campa and Kedia (2002) and Villalonga (2004) question these findings. At issue is the endogeneity of firm decision to diversify, and hence, constructing a proper set of comparable single-segment firms. Other empirical papers, Dittmar and Shivdasani (2003) and Ahn and Denis (2004) among others, employ a different approach by looking at changes in organization structure and subsequent improvements in investment efficiency and valuation of firms. However, as pointed out by Whited (2001) and Colak and Whited (2007), endogeneity of firm restructuring decisions and measurement errors in q as a proxy for investment opportunities also confound these empirical results. The structural dynamic framework proposed in our paper allows us to properly evaluate the link between firm valuation and organizational structure. The estimated model allows us to perform various counterfactual exercises and

disentangle the value of organizational flexibility from self-selection effect by constructing ideal treatment groups using simulated data.

Recent papers look at the time series performance and investment patterns of firms to extract the time-varying financial pooling benefit of conglomeration. Dimitrov and Tice (2006) shows that bank-dependent single-segment firms see higher drops in sales and inventory growth rates during recessions compared to bank-dependent conglomerates. Yan (2006), Kuppuswamy and Villalonga (2010), and Hovakimian (2011) also show that excess value of conglomerates is related to credit market conditions. More recently, Matvos and Seru (2014) estimates that 16% to 30% of the valuation improvement in conglomerates during the recent financial crisis is due to their ability to pool resources across divisions. Our paper complements these studies by showing explicitly the full dynamics of firms' optimal policies – investment, financing and organizational choice – in response to aggregate productivity and financial shocks and how such policies are related to differential firm valuations of single-segments and conglomerates in the time series.

Our paper is also related to a much more recent but growing literature on asset tangibility and liquidity management. Almeida and Campello (2007) investigates the link between asset tangibility and investment while Falato, Kadyrzhanova, and Sim (2013) explores the link between corporate cash holdings and the intangible capital accumulation of firms. Our paper links the asset tangibility of firms to their performance during recessions and credit crunches and shows that organizational choice is also a relevant tool in liquidity management. Merger or conglomeration as a tool to manage liquidity even in the absence of operation synergies has also been noted by Almeida, Campello and Hackbarth (2011). They show that liquidity mergers are more likely to occur in industries where assets are easily transferable across firms.

The rest of the paper is organized as follows. Section 2 presents new stylized facts that motivates the model, which is described in Section 3. The estimation strategy is presented in Section 4 and the numerical results are in Section 5. Section 6 concludes.

2 New Stylized Facts

This section presents some new stylized facts on time series variations of diversification discount. While there has been some previously documented evidence linking the time series variations of conglomerate values to external capital market conditions, the evidence covers exclusively the recent financial crisis as in Kuppuswamy and Villalonga (2012) or a shorter time frame excluding the crisis as in Yan (2006) and Hovakimian (2011). The stylized facts presented in this section covers data from 1979 to 2012, and they suggest that aggregate risks such as productivity and liquidity shocks affect the relative values of conglomerates.

2.1 Data Description

Our data comes from COMPUSTAT Industry Annual database and COMPUSTAT Segment files. Segment level information such as sales, assets, capital expenditures and operating profits are matched to the firm level financial information from the Annual database. Following standard practice in the literature, we exclude segments in regulated industries: Transportation (SIC codes 4000-4799), Telecommunication Service (4800-4899), Utilities (4900-4999), Financial Services (6000-6999). However, for the purpose of the time series analysis, the annual frequency of Segment files makes for a limited sample. Moreover, some recessions last only for a few quarters. In order to obtain Tobin's q of firms at a quarterly frequency, we use firm level financial information from COMPUSTAT Industry Quarterly database and identify firms as either a single-segment or a conglomerate based on the number of segments reported at fiscal year end in the Segment files.

Recent empirical work has shown that COMPUSTAT segment data may be unreliable for estimating diversification discount due to poor industry classification of segments³. However, this issue is irrelevant to our methodology as we do not construct the market value of a conglomerate by imputing the value of each segment from single-segment firm values in the same industry. We use observed Tobin's qs of conglomerate and single-segment firms and

³Denis, Denis, and Sarin (1997), Hyland and Diltz (2002), and Villalonga (2004)

compare them to simulated data from our structural model.

2.2 Cross-Sectional Fact: Capital Tangibility

In this subsection, we describe a new fact regarding the effect of capital tangibility on single-segment firms valuation responses to a credit crunch or a recession. The asset tangibility ratio of a firm is denoted by $TANG$ and is constructed as the ratio the firm's property, plant and equipment, $PP\&E$ (item $ppent$ in COMPUSTAT), to total assets (item at). This measure of asset tangibility is commonly employed in the capital structure literature and most recently in Campello and Giambona (2014).

Table 1 reports the regression results for 3 different specifications of Tobin's q on firm level tangibility, aggregate risks, and their interactions. $CRUNCH$ is a dummy variable that is equal to 1 if the TED spread is greater than 1 percent⁴. The definition for recessions follows the identification of recession quarters by National Bureau of Economic Research (NBER).

The first salient feature of the data is that Tobin's q decreases with tangibility ratio. This is consistent with the view that high-growth firms are high Tobin's q firms, as they tend to be in technology and human-capital intensive sectors and therefore have low physical capital to assets ratios. The second regression specification shows the response of Tobin's q to aggregate risks. As can be expected, coefficients on credit crunch and recessions are negative. Both credit crunches and recessions lower Tobin's q for all firms, given that they correspond to bad macroeconomic times. The last column shows that the interaction terms of credit crunch and recessions with tangibility ratio are positive. This means that firms with a lot of tangible physical capital are not affected negatively as much by the adverse aggregate states. The difference in the tangibility ratio between the top and bottom 25% (10%) of firms in our sample is 0.28 (0.56). That means that Tobin's q decreases by an extra 0.08 (0.17) in the event of a credit crunch and by extra 0.03 (0.06) in the event of a recession for the bottom

⁴The results are robust to redefining the crunch period as the TED spread higher than 1.5 percent.

firms, compared to the top firms.

Table 1: Cross-Sectional Regression Results.

	Tobin's q		
<i>constant</i>	1.839 (0.003)	1.891 (0.003)	1.911 (0.003)
<i>TANG</i>	-0.722 (0.008)	-0.709 (0.008)	-0.784 (0.009)
<i>CRUNCH</i>		-0.192 (0.004)	-0.281 (0.007)
<i>CRUNCH * TANG</i>			0.298 (0.019)
<i>RECESSION</i>		-0.107 (0.006)	-0.131 (0.009)
<i>RECESSION * TANG</i>			0.102 (0.025)
R^2	0.033	0.044	0.045
Observations	248,230	248,230	248,230

NOTE: The dependent variable is Tobin's q . The sample is restricted to single-segment firms. The frequency of data is quarterly. *TANG* is the ratio of firm *PP&E* to its total assets. *CRUNCH* is a dummy variable that is equal to 1 if the TED spread is greater than 1 percent. *RECESSION* is an indicator for a recession quarter as identified by the NBER.

This fact – Tobin's q of firms are affected differentially by adverse macroeconomic shocks depending on their levels of asset tangibility– is incorporated into the model by assuming that industries have different levels of asset tangibility.

2.3 Time Series Fact: Firm Entry

New firms enter the economy, and as a result new firms enter our sample of firms. We find that on average 6.2% of new single-segment firms enter the sample each year over the 1980-2012 period. In addition, we find that on average 64% of new firms entering the sample have a tangibility ratio below the median of the overall sample. This is an important stylized

fact that is consistent with the evidence offered in Falato, Kadyrzhanova, and Sim (2013). The authors show a dramatic rise in the ratio of intangible capital to total assets from 1970 to 2010. Figure 1 plots the entry rate, as well as the composition of new firms, over the 1980-2012 time period.

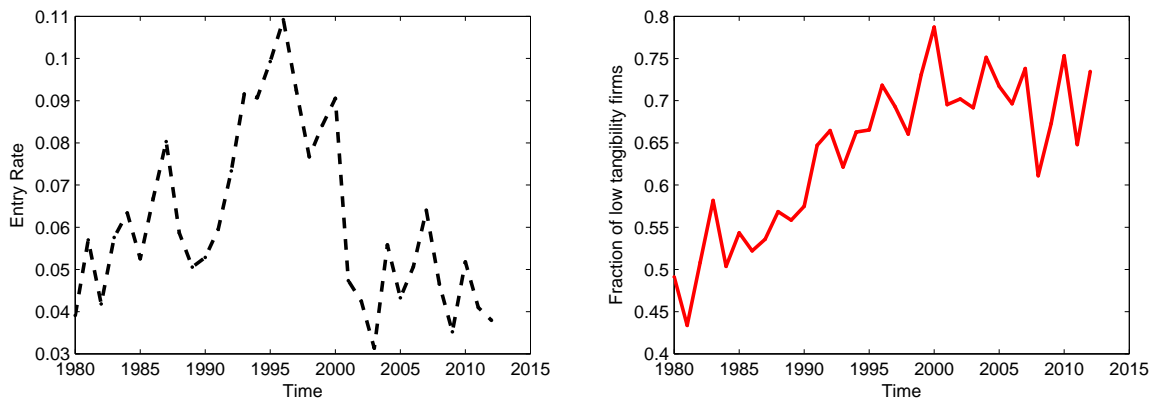


Figure 1: **Firm Entry.** The left panel shows the entry rate. The right panel shows the fraction of new firms that have a tangibility ratio lower than the sample median.

This fact –entry of low asset tangibility firms into the economy– is incorporated into the model by simulating firm entry according to the facts described above.

2.4 Aggregate Fact: Diversification Discount

In this paper, the diversification discount is defined as the in-sample difference between the mean Tobin’s q of single-segments and conglomerates. Unlike other measures found in the literature, this measure makes no attempt to control for or match characteristics between single-segment and conglomerate firms. Instead we describe the properties of the data in sample and compare them to a panel of simulated data, which is produced by the model. The typical problem of selection that plagues empirical work is therefore circumvented by comparing the data to model-generated data, where the variables of interest are endogenously determined.

In this subsection, we investigate the time series properties of the diversification discount. Figure 2 plots the diversification discount with the TED spread (top panel) and with the

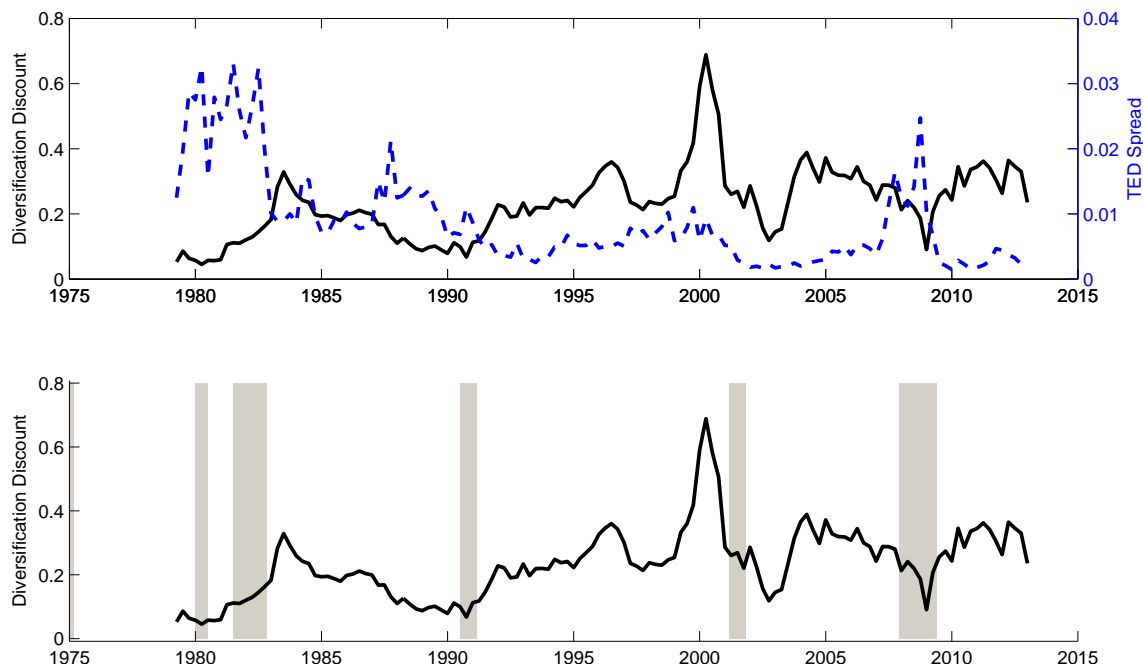


Figure 2: **Diversification Discount and Aggregate Risks.**

NBER recessions (bottom panel) over the period 1979-2012, all at the quarterly frequency. As can be seen, the diversification discount varies quite substantially over time. In our sample period, the average discount is 0.23 with the volatility of 0.11. The negative correlation between the TED spread and diversification discount is most apparent during the recent financial crisis.

Table 2 reports the time series regression results of diversification discount on the credit crunch and recession dummies. The coefficients on *RECESSION* show that diversification discount is only marginally and insignificantly affected by recessions. The regression results also show that the diversification discount is significantly reduced during credit crunches, and that with a magnitude of 0.11, the reduction is economically important.

These results broadly confirm the view that credit conditions have significant impact on the firm values of conglomerate and single-segment firms whereas productivity slow-downs do not. A recent empirical analysis regarding the sources of this discount has been studied by Kuppuswamy and Villalonga (2012) in the context of the recent financial crisis.

The stylized facts presented here serve as a motivation for our model: financial shocks

Table 2: Time Series Regression Results

	Diversification Discount		
<i>constant</i>	0.248 (0.010)	0.272 (0.010)	0.276 (0.010)
<i>CRUNCH</i>		-0.116 (0.019)	-0.111 (0.020)
<i>RECESSION</i>	-0.069 (0.029)		-0.038 (0.027)
R^2	0.039	0.210	0.222
Observations	137	137	137

NOTE: The dependent variable is diversification discount, defined as the difference between the mean Tobin's q of conglomerate and single-segment firms. *CRUNCH* is defined as the quarters where TED spreads are above 1%.

have differential impact on conglomerate and single-segment firms.

3 Model

The following section describes the details of the model and discusses the dynamics of conglomeration and refocusing in lights of aggregate risks. The focus is on understanding how firms make diversification or refocusing decisions jointly with their investment and financing decisions in response to the productivity and financial shocks, and how their valuations are affected.

3.1 Production

Time is discrete and firms solve an infinite horizon problem. It is assumed that there are two industries or sectors in the economy. Firms can operate in either one of the two sectors or both. The model can easily be extended to include more industries. However, the goal of this paper is to understand how firms choose to diversify or refocus in response to exogenous

(productivity and financial) shocks and to understand its effects on firm performance. A two sector framework can adequately capture the costs and benefits of diversifying or refocusing. Moreover, as documented in Lang and Stulz (1994), there is statistically and economically significant drop in firm value as firms expand from one to two sectors whereas there is weak marginal effect of diversification on firm performance as they expand from two or more sectors.

The two industries are denoted by $j \in \{1, 2\}$. Firms face idiosyncratic productivity shocks in each industry, denoted by z_1 and z_2 ⁵. In addition, all firms in the economy face an aggregate shock denoted by z_a . Both idiosyncratic and aggregate productivity shocks are assumed to follow an AR(1) process:

$$\begin{aligned}\log z'_j &= \rho_j \log z_j + \sigma_j \epsilon_j, & j \in \{1, 2\}, \\ \log z'_a &= \rho_a \log z_a + \sigma_a \epsilon_a,\end{aligned}$$

where ϵ_1 , ϵ_2 , and ϵ_a are i.i.d. with standard deviations σ_1 , σ_2 , and σ_a , respectively.

For simplicity, firm level productivity shocks in each industry are assumed to have no correlation. Relaxing this assumption could introduce non-trivial implications for the product markets. In particular, it could introduce strategic motives for firms to diversify in industries with less or negatively correlated productivity shocks or cash-flows in order to obtain better financing terms as shown theoretically in Inderst and Muller (2003). However, the focus of this paper is on the dynamics of diversification and refocusing and how such dynamics change over the business and credit cycles rather than on what type of industries firms choose to diversify in.

A firm is said to be “single-segment” or a “stand-alone” if it operates only in one industry

⁵It is assumed that each firm observes its productivity shocks in both industries, regardless of whether it currently operates in one or both industries. The model could be extended to incorporate learning about productivity in a prospective industry for a single-segment firm. Introducing learning does not change the strategic motive of a diversifying firm besides lowering the expected payoff from diversification and thereby delaying entry into new industries. However, this would come at the cost of substantial complexity and is not the main focus of the paper.

and “diversified” or a “conglomerate” if it operates in both. A firm that operates in sector j produces final good y_j . Production in each sector requires capital k_j and labor n_j and is assumed to have a Cobb-Douglas production possibility frontier. Cash flow in sector j is given by $y_j = F(z_a z_j, k_j, n_j)$, where the production function is:

$$F(z, k, n) = z k^{\alpha_k} n^{\alpha_n}, \quad 0 < \alpha_k + \alpha_n < 1.$$

Firms hire labor at a constant wage rate W , i.e., the supply of labor is assumed to be infinitely elastic. Firms invest in physical capital every period, investment in sector j is defined as:

$$i_j = k'_j - (1 - \delta)k_j,$$

where k_j is the physical capital installed in sector j , which depreciates at rate δ .

Firms face quadratic adjustment costs in each sector in accumulating capital specified by the functional form:

$$\phi(k, k') = a_1 (i/k)^2 k \mathbf{1}_{\{i \geq 0\}} + a_2 (i/k)^2 k \mathbf{1}_{\{i < 0\}}.$$

Special cases arise when firms are shutting down or acquiring a division. It is assumed that firms pay a premium ϕ_B for each unit of capital acquired in order to diversify into a new sector:

$$\phi(0, k') = (1 + \phi_B)k'$$

Similarly, firms sell at a discount ϕ_S for each unit of capital divested when shutting down a division:

$$\phi(k, 0) = (1 - \phi_S)k.$$

Firms pay a fixed cost f to operate in each sector. Due to the adjustment costs of capital, ϕ , and fixed costs, f , associated with running a division, firms reallocate capital

gradually. In other words, after observing the productivity shocks in each industry, firms do not reshuffle capital to the more productive sector every period right away. Therefore, despite the observability of the firm's idiosyncratic productivity shocks in both industries, capital reallocation among divisions and entry and exit of firms in each industry are non-trivial decisions.

The firm enters every period with pre-allocated capital in each sector, so both k_1 and k_2 are state variables. In order to have a parsimonious notation, the set of all shocks are collected in the exogenous state vector s . Operating income of the firm is thus denoted by:

$$\pi(k_1, k_2, n_1, n_2, s) \equiv \sum_{j=1,2} \left(F(z_a z_j, k_j, n_j) - W n_j - f \right). \quad (1)$$

3.2 Financing

Firms have access to defaultable one-period debt, priced by risk-neutral competitive lenders. Denoting by $\mathbf{1}_{DEF}$ the indicator for default where $\mathbf{1}_{DEF} = 1$ if the firm defaults, the bond price is given by:

$$\tilde{q}'(k'_1, k'_2, b', s) = \beta \mathbb{E}[(1 - \mathbf{1}'_{DEF}) + \chi(1 - \phi_S) \min((k'_1 + k'_2)/b', 1) \mathbf{1}'_{DEF}]$$

where $\chi \leq 1$ is the recovery rate on the physical capital in the event of default. Debt interest payments are tax-deductible, so the effective bond price is given by:

$$q' = \frac{1}{1 + (1 - \tau)(\tilde{q}'^{-1} - 1)}$$

The budget constraint of the firm is given by equating the sources of funds: after-tax profits and new debt issue, to the uses of funds: financial payouts and investments.

$$(1 - \tau)\pi(k_1, k_2, n_1, n_2, s) + q'b' = d + b + i_1 + i_2 + \phi(k_1, k'_1) + \phi(k_2, k'_2) \quad (2)$$

Liquidity risk is introduced via intra-period loan as in Jermann and Quadrini (2012). Central to this intra-period loan, l , is the assumption that revenue is realized at the end of the period, but the firm must borrow intra-period in order to finance its working capital, which includes operating costs and financial payouts (including taxes). Since the firm starts the period with outstanding debt, b , and chooses the new debt, b' , it must pay its bondholders $b - q'b'$. The firm must also pay for labor and investments, and distribute dividends to its shareholders. Therefore, the intraperiod loan is given by:

$$l = W(n_1 + n_2) + i_1 + i_2 + \phi(k_1, k'_1) + \phi(k_2, k'_2) + f(1 + \mathbf{1}_{\{k_1 k_2 > 0\}}) + d + b - q'b' + \tau\pi(k_1, k_2, n_1, n_2, s).$$

Given the budget constraint of the firm in Equation 2, it follows that

$$l = F(z_a z_1, k_1, n_1) + F(z_a z_2, k_2, n_2).$$

The total amount of intraperiod the firm needs to borrow is equal to its revenue. Using the same set up as in Jermann and Quadrini (2012), we also assume the presence of limited enforceability in debt contracts and financial shocks to liquidation value.

In the event of default, the intraperiod lender can only recover the funds by liquidating the physical capital, as the firm can always divert its current period cashflow. Given that the intraperiod loan are assumed to be junior to intertemporal debt, intraperiod lender could only recover physical capital net of current debt outstanding in the event of default. In addition, this net recovery value is affected by current macroeconomic conditions. Such liquidity considerations are introduced into the model using financial shocks, denoted by ξ . With probability ξ , physical capital can be fully recovered, but with probability $1 - \xi$ the recovery value is zero.

A sector heterogeneity is introduced in the form of different recovery value of capital for each sector. Sector j faces an exogenous sector-specific financial shock denoted by ξ_j . A

single-segment firm faces the following enforcement constraint:

$$\xi_j (k'_j - q'b') \geq l, \quad j \in \{1, 2\}.$$

On the other hand, a conglomerate firm faces:

$$\xi_1 \left(k'_1 - \left(\frac{k'_1}{k'_1 + k'_2} \right) q'b' \right) + \xi_2 \left(k'_2 - \left(\frac{k'_2}{k'_1 + k'_2} \right) q'b' \right) \geq l.$$

Notice that debt is naturally allocated to each sector based on next-period collateral. Regardless of which sector(s) a firm operates in, it faces the following enforcement constraint:

$$\xi (k'_1 + k'_2 - q'b') \geq F(z_a z_1, k_1, n_1) + F(z_a z_2, k_2, n_2), \quad (3)$$

where $\xi = \xi_1 \frac{k'_1}{k'_1 + k'_2} + \xi_2 \frac{k'_2}{k'_1 + k'_2}$ is the asset-weighted financial shock that firms face. ξ_1 and ξ_2 are exogenous processes that will be mapped to the data in the estimation section. The larger the ξ , the higher is the total debt capacity of the firm. Higher intertemporal debt, b' , also makes the enforcement constraint tighter and hence lowers the amount of intra-period loan l the firm can borrow. On the other hand, higher physical capital relaxes the enforcement constraint. In other words, having higher collateral to pledge allows the firm to borrow more either intertemporally or intratemporally. The financial shock is also collected in the exogenous state vector: $s = (z_a, z_1, z_2, \xi)$.

Financial frictions are modeled by assuming that firms face quadratic cost for issuances of equity financing. Equity issuances are defined as negative dividend payouts. Hence net equity issuances are given by,

$$\psi(d) = (1 + L_1 \mathbf{1}_{\{d < 0\}}) d - \frac{1}{2} L_2 d^2 \mathbf{1}_{\{d < 0\}}, \quad (4)$$

where $L_1, L_2 \geq 0$ are parameters that govern the severity of financial frictions.

3.3 Firm's Problem

The timing of the firm problem is as follows:

- Firms begin the period with capital, k_j , in each sector, and debt, b .
- Firms observe productivity shock in each sector, z_j , aggregate shock, z_a , and financial shock, ξ .
- Contingent on no default, firms simultaneously make decisions on how much labor to hire, n_1 and n_2 , how much to invest (thereby whether to diversify or refocus), k'_1 and k'_2 , and how much intertemporal debt to issue, b' .
- If the firm value upon continuation is less than 0, firm decides to default.

The firm problem can be recursively stated as follows. Given the bond price schedule $q'(k'_1, k'_2, b', s)$, firms maximize:

$$V(k_1, k_2, b, s) = \max_{\mathbf{1}_{DEF}} \left\{ 0, \max_{k'_1, k'_2, b', n_1, n_2} \psi(d) + \beta \mathbb{E}[V(k'_1, k'_2, b', s')] \right\},$$

subject to,

$$\begin{aligned} (1 - \tau)\pi(k_1, k_2, n_1, n_2, s) + q'b' &= d + b + i_1 + i_2 + \phi(k_1, k'_1) + \phi(k_2, k'_2), \\ \xi(k'_1 + k'_2 - q'b') &\geq F(z_a z_1, k_1, n_1) + F(z_a z_2, k_2, n_2). \end{aligned}$$

There are no analytical solutions to this problem, therefore numerical methods are used to solve a discretized version. The estimation strategy is explained in Section 4 and the numerical results are reported in Section 5.

4 Model Estimation

This section presents the estimation strategy in detail. The model is calibrated at the annual frequency. Shocks are calibrated using macroeconomic data for the US. A set of model parameters are chosen to replicate the institutional features. All the remaining model parameters are estimated using the simulated method of moments (SMM).

4.1 Calibration of Shocks

Aggregate Productivity. The aggregate productivity process is estimated using the annual series of detrended US GDP. The calibrated values are given by $\rho_a = 0.8$, and $\sigma_a = 0.02$. The aggregate cost process is discretized into a three-state Markov chain⁶.

Idiosyncratic Productivity. The idiosyncratic productivity processes are assumed to also be persistent. Following Gomes and Livdan (2004), the calibrated values are given by $\rho_j = 0.95$, and $\sigma_j = 0.02$ ⁷. Each idiosyncratic cost process is discretized into an eight-state Markov chain.

Financial Shock. The aggregate financial shock process is discretized into a three-state Markov chain. The grid is chosen such that it represents a tightening of credit. The first grid point represents normal credit times such that pledgeability of collateral is the highest. The second grid point corresponds to a mild credit tightening, whereas the third grid point represents a large reduction in collateral value. The grid is formally denoted by $\xi = (\xi_H, \xi_M, \xi_L)$, where $\xi_H > \xi_M > \xi_L$ represent the level of physical capital pledgeability.

In this model, sector 1 and 2 are mapped into the “high” and “low” tangibility sectors (described in the data section), respectively. The ability to pledge more tangible assets during a credit crunch is valuable for intraperiod borrowing. This fact will guide the calibration of

⁶All exogenous shocks are discretized using the quadrature based procedure of Hussey and Tauchen (1991).

⁷The value for the persistence parameter is in line with many prior studies. The corporate finance literature has often assumed that idiosyncratic measures of productivity are very persistent, e.g., Cooley and Quadrini (2001), Gomes (2001), and Hennessy and Whited (2005).

the sectoral shocks: ξ_1 and ξ_2 . The fact that “high” tangibility firms can pledge capital more effectively in bad credit states than “low” tangibility firms leads to the following conditions: $\xi_{1,p} > \xi_{2,p}$ for $p \in \{M, L\}$. The grids are parameterized as follows⁸:

$$\begin{aligned}\xi_1 &= \bar{\xi} (1, 1 - \theta\Delta, 1 - \Delta), \\ \xi_2 &= \bar{\xi} (1, 1 - \theta\Delta, 1 - \Delta)^\omega,\end{aligned}$$

where $\bar{\xi} < 1$, $\theta < 1$, $\Delta < 1$, and $\omega > 1$ are credit shock parameters that can be estimated to best fit the data. The parameter Δ represents the (percentage) loss in collateral value in the credit crunch state, whereas the parameter θ controls the size of the mild credit tightening. It is important to note that in good credit times, physical capital is pledged equally for “high” and “low” tangibility firms, that is $\xi_{1,H} = \xi_{2,H} = \bar{\xi}$. It is only when credit tightens in the economy that firms are differentially affected, based on the level of asset tangibility.

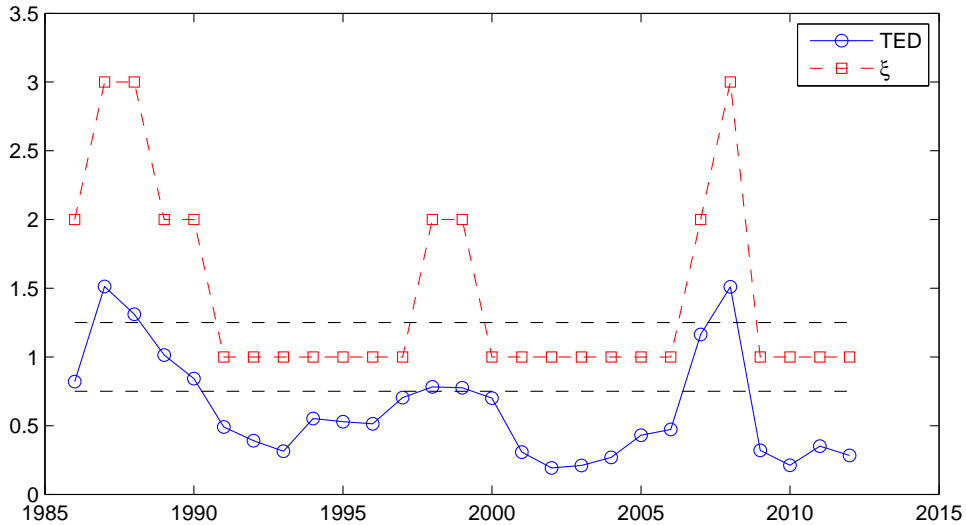


Figure 3: **TED Spread and Financial Shock Grid.**

The transitions between these states is estimated using the series of TED spread⁹, described in Section 2. Annual TED spreads can be mapped into a ξ state using the following

⁸This implementation is not unique and was chosen for transparency and parsimony.

⁹The quarterly spreads are averaged to obtain an annual figure.

rules: (i) $\xi = \xi_H$ if $\text{TED} \leq 0.75\%$, (ii) $\xi = \xi_M$ if $0.75\% < \text{TED} \leq 1.25\%$, and (iii) $\xi = \xi_L$ if $1.25\% < \text{TED}$. Figure 3 shows the TED spread along with the mapping to the financial shock grid. The converted TED spread data is used to estimate the historical transition probabilities for Markov chain ξ .

4.2 Exogenously Chosen Parameters

The time preference parameter β is set to 0.976, which corresponds to a 2.5% annual risk-free real interest rate. The corporate tax rate is set to 30%. Debt recovery rate is set to 90%. The equity issuance parameters are set to $L_1 = 0.15$ and $L_2 = 1.5$. The buying and selling frictions rate are set to 5%. The wage rate is set to 0.5. The returns to scale in capital α_k is set to 0.3, and the returns to scale in labor α_n is set to 0.6, such that production exhibits decreasing returns to scale. The depreciation rate is set to 7%. All these parameters are in line with previous corporate studies and are not crucial to obtaining the main results of the paper. Calibration of these parameters seems appropriate here. The exogenous parameters are summarized in Panel A of Table 4.

4.3 Simulated Method of Moments

Many parameters are not directly observable and cannot be readily calibrated. The approach taken here is to estimate these parameters using the simulated method of moments, which target moments of the data obtained from the dataset of firms described in the data section.

Single-Segment Tobin's q Regression. One important stylized fact described in the data section is the differential effect of a credit crunch on firm valuation, depending on capital tangibility. This effect can be tested in our model by running regressions in a panel of simulated data. Asset tangibility in the data, measured by *TANG*, is a continuous variable whereas the model only has 2 levels of asset tangibility, that is sector 1 and sector 2. We map the data to the model by categorizing single segment firms into 2 types. Firms with

tangibility greater (lower) than the sample average are mapped to sector 1 (2). Thus a dummy variable for firms operating in sector 2, denoted by $I_{2,it}$, can be used to denote the firms operating in the “low tangibility” sector.

A regression of Tobin’s q for single-segment firms on aggregate risks and can help isolate the differential effect of a credit crunch on firm valuations. A credit crunch is denoted by $CRUNCH_t$ and is an indicator variable defined as the lowest grid point of the financial shock. Similarly a recession is denoted by $RECESSION_t$ and is an indicator variable defined as the lowest grid point of the aggregate productivity. We run the following regression specification in the subset of single-segment firms:

$$\begin{aligned} TOBIN\ Q_{it} = & \beta_0 + \beta_1 I_{2,it} + \beta_2 CRUNCH_t + \beta_3 CRUNCH_t * I_{2,it} \\ & + \beta_4 RECESSION_t + \beta_5 RECESSION_t * I_{2,it} + \epsilon_{it}. \end{aligned}$$

The sample estimates from our dataset are reported in Table 3.

Diversification Discount Regression. The same regression ran in the data can be ran in the simulated data. We run the following regression in time series:

$$DIV\ DISCOUNT_t = \beta_0^{DD} + \beta_1^{DD} CRUNCH_t + \beta_2^{DD} RECESSION_t + \epsilon_t.$$

The sample estimates from our dataset are reported in Table 2 and in Table 3.

Estimation Strategy. The vector of parameters to be estimated include technology and credit shock related parameters: fixed production cost f , positive capital adjustment cost a_1 , negative capital adjustment cost a_2 , financing shock in normal credit time $\bar{\xi}$, size of the credit crunch Δ , size of the intermediate credit crunch θ , and the differential impact on low tangibility capital ω . This vector is denoted by $\Theta \equiv (f, a_1, a_2, \bar{\xi}, \Delta, \theta, \omega)$.

These model parameters are chosen such that the distance between a set of moments in the data and the corresponding set of moments in the artificial simulated data is minimized.

The set of data moments include: (i) the fraction of conglomerates, (ii) mean leverage and Tobin’s q , for both single-segment and conglomerates, (iii) 6 Tobin’s q regression coefficients, and (iv) 3 diversification discount regression coefficients. The estimation problem is to choose 7 model parameters that maximizes the fit with 14 moments of the data.

5 Quantitative Analysis

This section presents the quantitative implications of the model. First the estimation results are presented. Simulations of the estimated model are used to understand the dynamics of diversification and refocusing, and the impact of a recession and a credit crunch. Next, we perform a sensitivity analysis in order to understand the identification and how model parameters impact the results. Finally, we use counterfactual experiments to quantify the various economic channels at work in the model.

5.1 Estimation Results

The model economy is simulated for an expanding panel of firms. The initial cross-section is composed of 20 firms and the number of periods is set to 120. New single-segment firms are added at a 6% rate each time period. Out of these new single-segment firms, one third are set to operate in sector 1, and two thirds in sector 2. This mix is similar to the 64% figure for low tangibility firms entering our dataset. Moments are computed in the panel of simulated data, composed of 12,092 firms over 120 periods¹⁰. Table 3 reports data moments and simulated moments.

Most of the simulated moments are fairly close to the data moments. Tobin’s q is somewhat higher than in the data, highlighting the fact that more parameters could be estimated or more realistic features could be added to the model to help the fit. However, the diversification discount is successfully matched as well as the impact of a recession and a credit

¹⁰The first 70 periods in the simulated sample are discarded to mitigate the effect of the initial conditions and obtain a cross-section that is large enough.

Table 3: Target Moments for the Estimation and Model Outputs

Moment	Data	Model
Panel A. Targeted Moments		
<u>All Firms:</u>		
1. Fraction of conglomerates, %	50.2	50.9
<u>Single-segments:</u>		
2. Debt/Assets	0.240	0.343
3. Tobin's q	1.572	1.659
<u>Conglomerates:</u>		
4. Debt/Assets	0.267	0.263
5. Tobin's q	1.277	1.394
<u>Single-Segment Tobin's q regression:</u>		
6. β_0	1.509	1.689
7. β_{I_2}	0.330	0.010
8. β_{crunch}	-0.126	-0.013
9. $\beta_{crunch*I_2}$	-0.123	-0.138
10. $\beta_{recession}$	-0.085	-0.075
11. $\beta_{recession*I_2}$	-0.037	-0.030
<u>Diversification Discount regression:</u>		
12. β_0^{DD}	0.270	0.269
13. β_{crunch}^{DD}	-0.107	-0.082
14. $\beta_{recession}^{DD}$	-0.037	-0.057
Panel B. Additional Moments		
<u>Single-segments:</u>		
Cashflow/Assets		0.450
Capital expenditure/Assets		0.333
Dividend/Assets		-0.181
<u>Conglomerates:</u>		
Cashflow/Assets		0.406
Capital expenditure/Assets		0.109
Dividend/Assets		-0.011
<u>All Firms:</u>		
Standard deviation Tobin's q		0.382
Default rate, %		0.2
Transition rate from single to conglomerate, %		5.3
Transition rate from conglomerate to single, %		5.2

crunch. The signs of all regression coefficients for the single-segment Tobin's q regressions are also correctly estimated. That means that the model is able to replicate not only first moments but also the dynamics of firm valuations, both in the cross-section and in the time series.

Table 4: Parameter Values

Panel A. Exogenously-fixed parameters			
Preference	β	0.976	Subjective discount rate
Institutional	τ	0.300	Average Tax Rate
	χ	0.900	Recovery rate in event of bankruptcy
	L_1	0.150	Linear Cost of Issuing Equity
	L_2	1.500	Quadratic Cost of Issuing Equity
	ϕ_B	0.050	Linear Cost of Selling a Segment
	ϕ_S	0.050	Linear Cost of Buying a Segment
	W	0.500	Wage Rate
Technology	α_k	0.300	Returns to Scale in Capital
	α_n	0.600	Returns to Scale in Labor
	δ	0.070	Depreciation Rate
Panel B. Estimated parameters			
Technology	f	2.530	Fixed Production Cost
	a_1	0.150	Positive Capital Adjustment Cost
	a_2	0.450	Negative Capital Adjustment Cost
Credit Shock	$\bar{\xi}$	0.180	Financing Shock
	Δ	0.540	Reduction in Collateral Value in a Crunch
	θ	0.287	Intermediate Credit Crunch
	ω	2.000	Differential Impact on Low Tangibility Capital

Panel B of Table 4 reports parameter estimates. The financing shock is estimated to be $\bar{\xi} = 0.18$, thus physical capital can be pledged for 18 cents on the dollar in the intraperiod loan market during normal credit conditions. The magnitude of the credit shock is estimated to $\Delta = 0.54$, which means that a credit crunch reduces collateral value by 54%. The intermediate credit shock is estimated to be $\theta = 0.287$ of the total credit crunch, which means that an intermediate credit crunch reduces collateral value by 15.5%. The differential

effect of a credit crunch on low tangibility firms is pinned down by $\omega = 2$, which means that a credit crunch reduces collateral value of low tangibility firms by 79%.

5.2 Dynamics of Diversification and Refocusing

Using simulations, this section describes firms' decision to diversify or refocus. As shown in the optimization problem of the firm, firm's decision on optimal organizational form is determined jointly with other variables such as investment and debt. The transition dynamics of these variables can also be studied surrounding diversification and refocusing events using simulations.

Decision to Diversify or Refocus. Simulated data shows that the probability of becoming a conglomerate increases as the productivity of operating in the other industry is high. Once a single-segment firm has installed enough capital and its marginal productivity is low enough, installing capital in another division becomes attractive and diversification is more likely.

Conversely, conglomerates are more likely to refocus and shed the division with relatively low productivity. This is due to the presence of a fixed cost of operating. When this fixed cost is high compared to current profits, it is valuable for the conglomerate to shut it down and not incur an expected stream of negative cash flows.

Transition Dynamics. To illustrate the transition dynamics, we use simulated data to construct a "typical" diversification and refocusing. Figures 4 and 5 show sector productivity, physical capital, profitability, investment rate, labor, leverage, dividend payout rate, and Tobin's q surrounding firm diversification and refocusing, which happens at time 0.

Figure 4 shows that firms choose to diversify as productivity in the other sector surpasses that of the current sector of operation. Upon diversification, investment rates spike up as firms invest aggressively in the new and more productive sector. Firms also increase labor accordingly to complement a higher capital stock. These new installments of capital are financed by increasing leverage as well as issuing equity. Figure 4 also shows that Tobin's q

steadily decreases after diversification. As conglomerates grow, their marginal productivity of capital slowly decreases until they reach steady state. The absence of growth options at that point leads to a lower Tobin's q , compared to a fast growing single-segment firm.

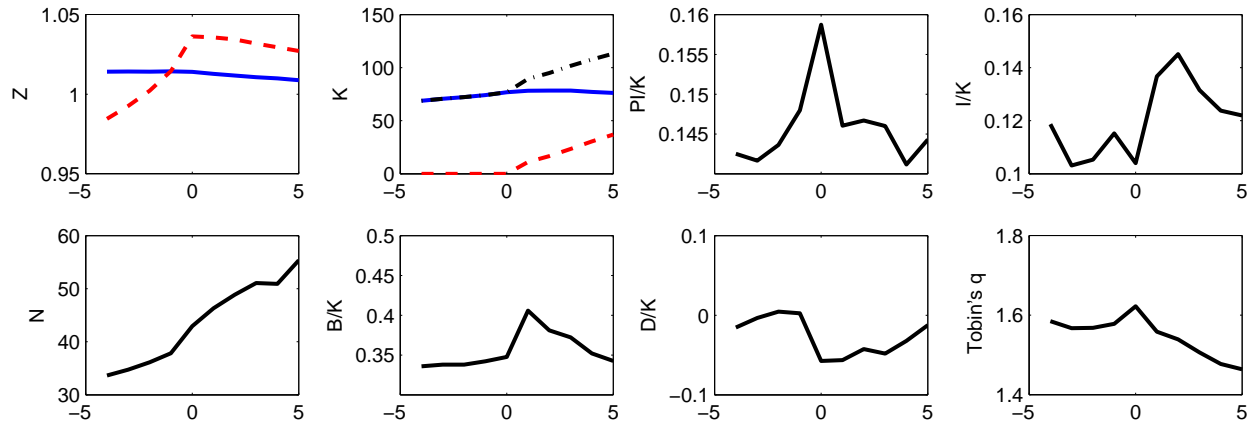


Figure 4: **Transition Dynamics: Single-Segment to Conglomerate.** The top row shows the dynamics of productivity, physical capital, profitability, and investment rate. The bottom row shows labor, leverage, dividend payout rate, and Tobin's q .

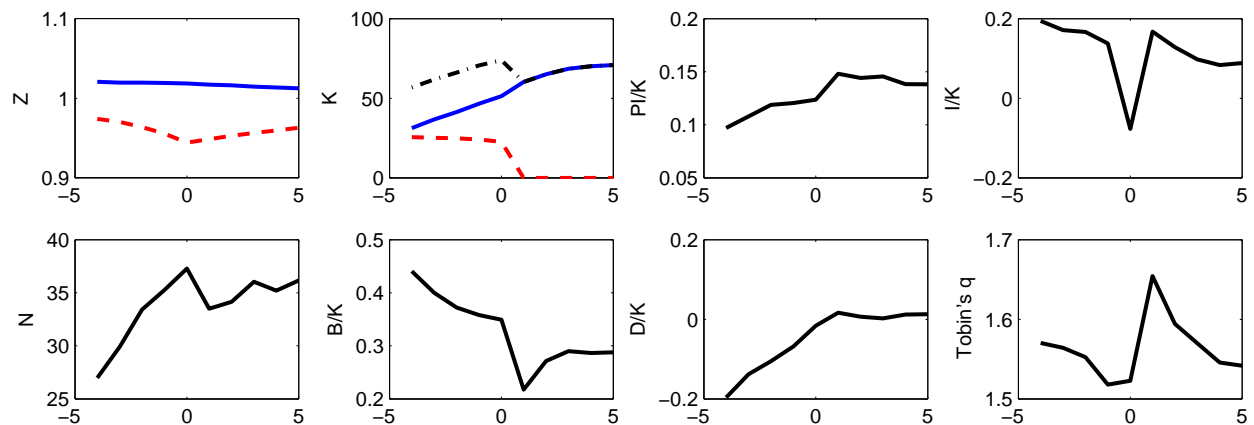


Figure 5: **Transition Dynamics: Conglomerate to Single-Segment.** The top row shows the dynamics of productivity, physical capital, profitability, and investment rate. The bottom row shows labor, leverage, dividend payout rate, and Tobin's q .

Figure 5 shows that conglomerates choose to refocus when one of their divisions become significantly unproductive. By selling off a division, firms decrease leverage and distribute dividends. Notice that Tobin's q is increased upon refocusing as capital is allocated more

efficiently. That means that a conglomerate has the option to sell a division, reallocate capital, reduce leverage, and thus become a less financially constrained single-segment firm.

5.3 Recession and Credit Crunch Dynamics

We can study the impact of adverse aggregate shocks on the economy by using simulations. We construct a panel dataset and feed in a specific time path for the aggregate shocks. We can generate a recession by setting the aggregate productivity shock z_a to its lowest value at times 0 and 1, and at their steady state otherwise. Similarly, we can generate a credit crunch by setting the financial shock ξ to its lowest value at times 0 and 1, and at their steady state otherwise. These typical crisis are shown in the left panels of Figure 6. We can then observe how the economy responds as well as how it recovers. The diversification discount is connected to the response of single-segments and conglomerates to recessions and credit crunches. Therefore this section builds intuition toward understanding the dynamics of the diversification discount.

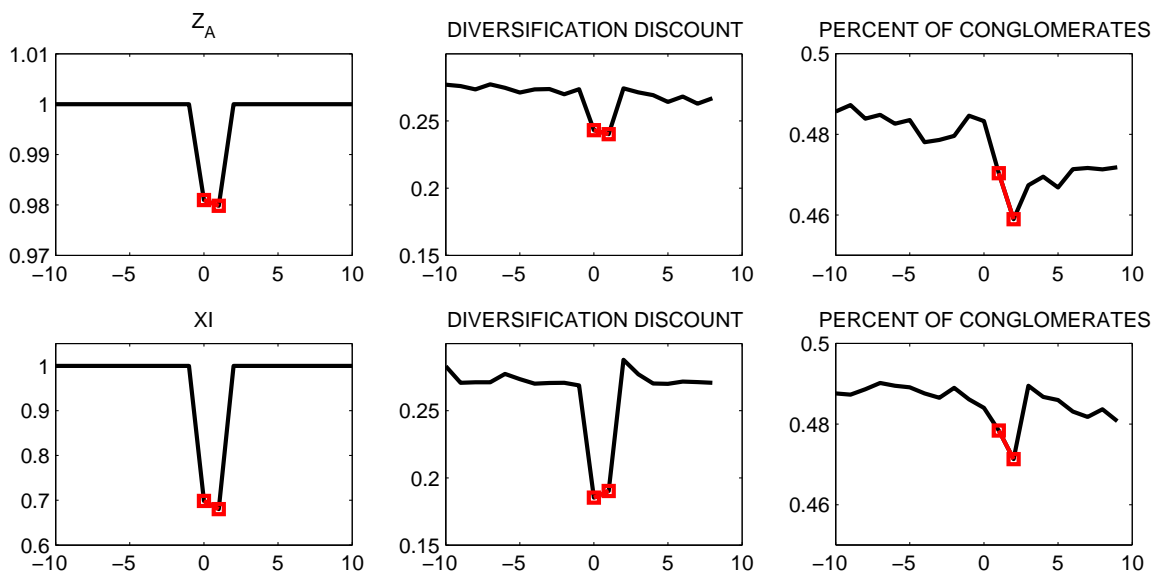


Figure 6: **Simulations Results.** The top row shows the effect of a recession, and the bottom row shows the effect of a credit crunch. The left panels show the aggregate shocks z_A and ξ used to feed the simulations. The middle panels show the diversification discount and the right panels show the percentage of conglomerates in the economy.

Effect of a recession. Figure 7 shows the simulation results for both single-segment firms and conglomerates. During a recession, productivity decreases, thus both profits and investment decrease, leaving leverage unchanged, for both single-segment and conglomerate firms. Given that single-segments are the more productive and fast growing firms in the economy, a decline in aggregate productivity has a larger adverse impact on firm values. Tobin's q of single-segment firms decreases by 0.06 while that of conglomerates decreases by 0.04, resulting in a small 0.02 decrease in diversification discount. The discount quickly recovers when the recession ends, as it is mostly driven by temporary decrease in output.

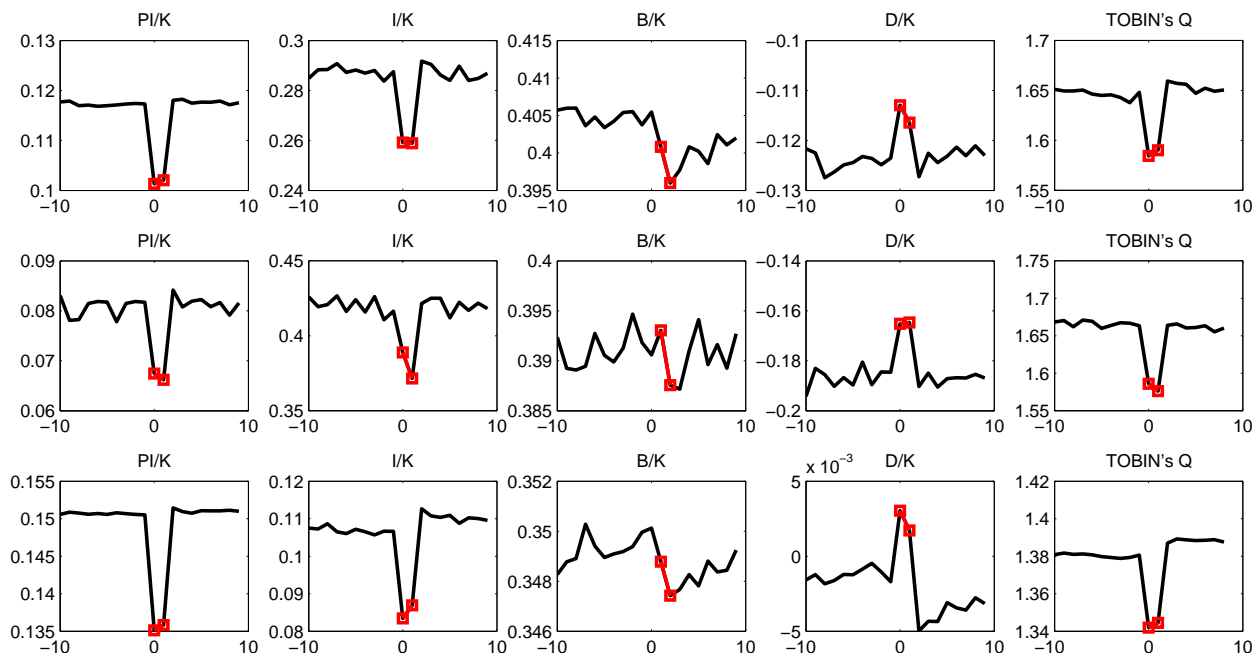


Figure 7: **Simulations Results: Typical Recession.** The top row shows the dynamics of profitability, investment rate, leverage, dividends payout, and Tobin's q for single-segment firms in sector 1 during a recession, the middle row for single-segment firms in sector 2, and the bottom row for conglomerates.

As shown in the top right panel of Figure 6, the percentage of conglomerates decreases slightly. A recession thus triggers some refocusing, however it is quantitatively small as it is about 3% of the cross-section.

Effect of a credit crunch. A credit crunch –lowest ξ – effectively tightens the enforcement constraint, which can be relaxed by either decreasing intraperiod loan l or debt b' . In order

to lower its intraperiod loan l , a firm has to reduce output F by decreasing labor n . However this will greatly decrease current profits π and tighten the budget constraint. Reducing debt b' will also tighten the budget constraint. Firms can lower investment and issue equity in order to increase the sources of funds, which are sorely needed to relax the enforcement constraint.

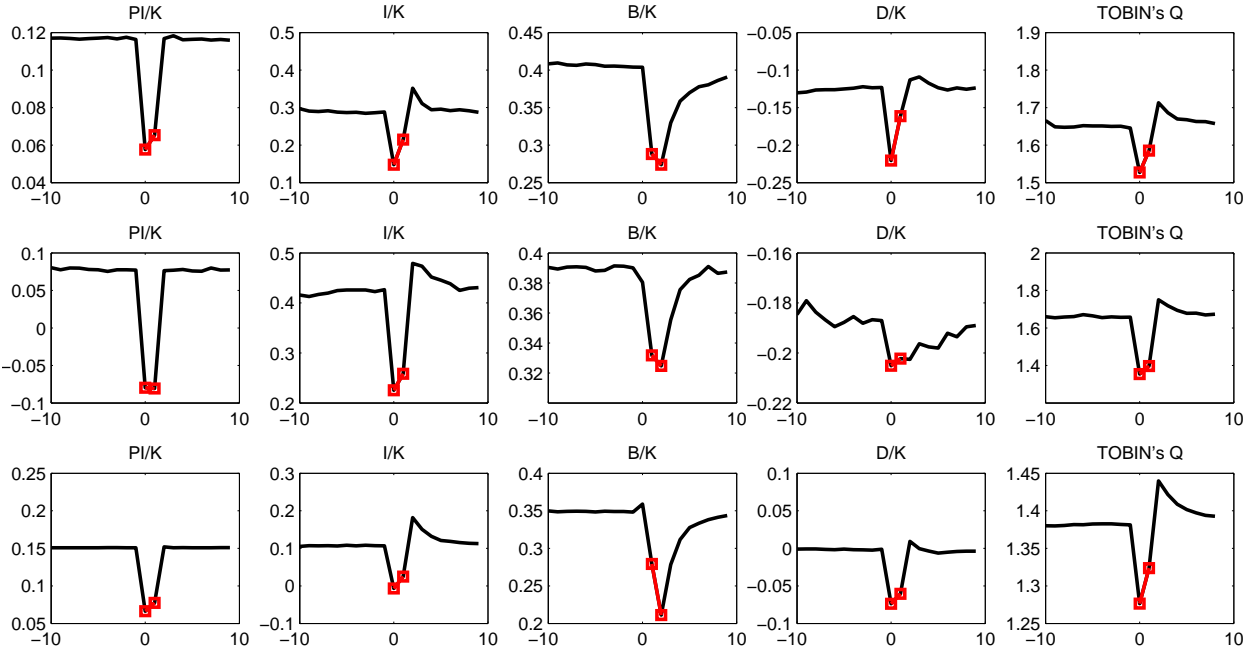


Figure 8: **Simulations Results: Typical Credit Crunch.** The top row shows the dynamics of profitability, investment rate, leverage, dividends payout, and Tobin's q for single-segment firms in sector 1 during a credit crunch, the middle row for single-segment firms in sector 2, and the bottom row for conglomerates.

Figure 8 shows the simulation results. As expected all firms reduce their investment, issue equity, decrease debt, and reduce profits as a way to satisfy their enforcement constraint upon tightening of credit. Although the responses of single-segments and conglomerates are qualitatively similar, they are quantitatively very different.

Single-segments are the more productive firms in the economy and therefore their opportunity cost of funds is much higher than the conglomerates'. This leads Tobin's q of single-segment firms to be reduced by 0.19 on average (0.13 in sector 1 and 0.32 in sector 2), and by 0.10 for conglomerates. This in turn generates a 0.09 decrease in the diversification

discount.

As shown in the bottom right panel of Figure 6, the percentage of conglomerates decreases very slightly. A credit crunch thus triggers some refocusing, however it is quantitatively very small as it is about 1.5% of the cross-section.

5.4 Sensitivity Analysis

This section analyzes the sensitivity of the simulated moments to the estimated parameters, which determines our structural identification. Table 5 reports the simulated moments for different values of the model parameters in Θ . For each of the estimated parameters, we consider two values equidistant from the baseline estimation in either direction. For f and $\bar{\xi}$, we choose a 10% window, and for a_1 , a_2 , Δ , θ , and ω , we choose a 25% window. Our discussion focuses on the key effect of each of parameters, quantifying the difference in various moments between the lower value and higher value of each parameter.

Production cost f . An increase in the fixed costs of production drastically lowers the percentage of conglomerates in the economy. More conglomerates shed unproductive divisions as the cost of keeping one division in operation is higher. We also observe more default in the economy (up to 0.7% when f is high) as the cost of operation is higher. Leverage is reduced by 4% for both types of firms as precautionary motives are stronger. When default risk is high, so is the risk sharing benefit of conglomerates and thus the diversification discount turns into a premium in the case where f is high. The β_{crunch}^{DD} and $\beta_{recession}^{DD}$ coefficients indicate that the discount decrease is lower as higher operating costs of divisions hamper a conglomerate's ability to make better use of its financing advantage.

Positive investment adjustment costs a_1 . In general, increasing capital adjustment costs affects single-segment firms more adversely. As more productive firms, they need to invest more in order to grow fast. Higher adjustment costs hampers their growth, and as a result, leverage, investment and dividends are all lower for single-segment firms. Slower growth leads

Table 5: Sensitivity Analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Baseline	f	a_1	a_2	$\bar{\xi}$	Δ	θ	ω								
Panel A. Targeted Moments															
<u>All Firms:</u>															
1. Fraction of conglomerates, %	50.9	76.4	40.5	51.2	50.2	50.7	51.1	36.6	58.0	56.1	44.9	51.2	50.6	52.0	49.9
<u>Single-segments:</u>															
2. Debt/Assets	0.343	0.377	0.328	0.351	0.334	0.344	0.343	0.176	0.433	0.370	0.314	0.350	0.336	0.350	0.341
3. Tobin's q	1.659	4.011	1.370	1.715	1.616	1.672	1.648	1.342	1.990	1.946	1.431	1.677	1.635	1.756	1.607
<u>Conglomerates:</u>															
4. Debt/Assets	0.263	0.287	0.250	0.264	0.263	0.263	0.264	0.098	0.389	0.304	0.230	0.279	0.247	0.278	0.256
5. Tobin's q	1.394	1.791	1.282	1.403	1.383	1.398	1.390	1.291	1.447	1.455	1.304	1.398	1.388	1.415	1.376
<u>Single-Segment q Regression:</u>															
6. β_0	1.689	3.710	1.414	1.733	1.650	1.701	1.679	NaN	1.971	1.942	1.484	1.705	1.668	1.773	1.647
7. β_{I_2}	0.010	0.785	-0.084	0.037	-0.000	0.010	0.006	NaN	0.140	0.084	-0.111	0.014	-0.001	0.036	-0.027
8. β_{crunch}	-0.013	-0.099	-0.033	-0.005	-0.030	-0.010	-0.020	NaN	-0.021	0.007	-0.073	-0.020	-0.016	-0.021	-0.020
9. $\beta_{crunch*I_2}$	-0.138	0.110	-0.036	-0.135	-0.131	-0.139	-0.137	NaN	-0.122	-0.068	-0.077	-0.130	-0.142	-0.067	-0.195
10. $\beta_{recession}$	-0.075	-0.215	-0.075	-0.074	-0.076	-0.075	-0.074	NaN	-0.090	-0.094	-0.069	-0.076	-0.073	-0.081	-0.071
11. $\beta_{recession*I_2}$	-0.030	0.049	0.029	-0.034	-0.029	-0.026	-0.030	NaN	-0.038	-0.025	0.002	-0.029	-0.035	-0.025	-0.041
<u>Div. Discount Regression:</u>															
12. β_{DD}^{DD}	0.269	2.385	-0.176	0.333	0.257	0.282	0.258	-0.697	0.601	0.537	0.004	0.290	0.244	0.363	0.218
13. β_{crunch}^{DD}	-0.082	-0.152	-0.034	-0.082	-0.136	-0.081	-0.083	0.024	-0.111	-0.065	-0.060	-0.085	-0.084	-0.071	-0.084
14. $\beta_{recession}^{DD}$	-0.057	-0.221	-0.029	-0.061	-0.043	-0.058	-0.055	0.038	-0.088	-0.078	-0.049	-0.060	-0.057	-0.062	-0.055
Panel B. Additional Moments															
<u>Single-segments:</u>															
Cashflow/Assets	0.450	0.463	0.454	0.443	0.457	0.449	0.450	0.431	0.473	0.451	0.452	0.450	0.449	0.449	0.451
Capital expenditure/Assets	0.333	0.499	0.327	0.344	0.314	0.334	0.333	0.262	0.370	0.358	0.311	0.333	0.332	0.341	0.318
Dividend/Assets	-0.181	-0.280	-0.169	-0.169	-0.188	-0.182	-0.181	-0.167	-0.176	-0.199	-0.156	-0.179	-0.182	-0.187	-0.171
<u>Conglomerates:</u>															
Cashflow/Assets	0.406	0.409	0.406	0.405	0.407	0.407	0.406	0.401	0.405	0.406	0.405	0.407	0.406	0.406	0.406
Capital expenditure/Assets	0.109	0.122	0.102	0.110	0.108	0.109	0.109	0.097	0.114	0.110	0.102	0.110	0.109	0.109	0.108
Dividend/Assets	-0.011	-0.017	-0.000	-0.009	-0.012	-0.010	-0.011	0.002	-0.012	-0.010	-0.004	-0.011	-0.011	-0.010	-0.012
<u>All Firms:</u>															
Standard deviation Tobin's q	0.382	1.880	0.225	0.451	0.335	0.393	0.374	0.222	0.743	0.626	0.244	0.400	0.362	0.458	0.350
Default rate, %	0.2	0.0	0.7	0.1	0.3	0.2	0.2	0.9	0.0	0.0	0.6	0.1	0.2	0.1	0.3
Transition single to cong, %	5.3	12.3	2.7	5.4	5.4	5.3	5.3	1.8	6.5	6.0	4.3	5.4	5.3	5.4	5.6
Transition cong to single, %	5.2	1.7	3.5	5.3	5.8	5.3	5.2	1.4	4.3	4.2	6.3	5.3	5.3	4.9	6.3

to lower Tobin's q for single-segments. However, since conglomerates are slower-growing and less constrained, higher adjustment costs of capital do not have as much of an effect on their leverage, investment, and Tobin's q . Therefore, the lower diversification discount is mostly due to lower valuation of single-segment firms. Similarly, during a credit crunch, diversification discount shrinks due to poorer performance of single-segment firms as higher adjustment costs make recovery in investment slower.

Negative investment adjustment costs a_2 . In contrast, increasing negative capital adjustment costs has little effect on firms as they do not disinvest very often. The impact on the diversification discount is therefore extremely small.

Financing shock $\bar{\xi}$. The value of collateral in the intraperiod loan market is higher when the financing shock parameter $\bar{\xi}$ rises. Naturally leverage increases for both single-segments and conglomerates. This expansion of credit leads to an increase in the investment rate, which is a slight 1.5% for conglomerates and a dramatic 11% for single-segments. The intensive margin is also affected: single-segment firms diversify much faster as they see a 4.5% increase in their transition rate, thus leading to an economy with more conglomerates overall. This result arises from an expansion of credit due to the collateral channel and the fact that single-segment firms are more productive due to self-selection.

Credit crunch Δ . The credit contraction is larger when the size of the credit crunch Δ rises. As the crunch gets deeper, firms insure against it by decreasing leverage, about 6% on average. In addition, single-segment firms reduce issuance of equity and investment, to further insure against a greater tightening of credit. A deeper credit crunch generates precautionary motives that are greater for single-segments because they are limited in their ability to insure against a credit crunch, unlike conglomerates that can pool collateral across divisions. This effect is reflected by an increase in the diversification discount.

Intermediate credit crunch θ . The intermediate credit crunch parameter θ has a small

effect on firm policies. A higher intermediate credit crunch leads to tighter credit in the economy overall. Firms reduce their leverage slightly, by about 2% on average, and their investment and dividend policies are virtually unchanged. Similar to an increase in Δ , an increase in θ reduces the diversification discount.

Differential credit crunch impact ω . The differential credit crunch impact parameter ω controls the strength of the tangibility channel. Increasing this parameter leads to a deeper credit shock for the low tangibility firms. Similarly to an increase in the size of the credit crunch, firms with a division in the low tangibility sector self insure by decreasing leverage, about 1.5% on average. However single-segments are the most affected, as they need to curb investment by 2%, whereas conglomerates investment is unchanged. As a result Tobin's q for single-segments decreases by more than for conglomerates, thus reducing the diversification discount. The ability to pool cashflow and collateral gives conglomerates financial flexibility, which is also more valuable during bad aggregate times. Therefore an increase in ω leads to higher magnitudes for both β_{crunch}^{DD} and $\beta_{recession}^{DD}$.

5.5 Counterfactual Experiments

Counterfactual experiments can be used to quantitatively evaluate the various economic forces at work in the model. Understanding these effects is important to uncover the channels critical to obtain the main results as well as to quantify the value of firms' organizational form. All the results are reported in Table 6.

Effect of asset tangibility. The effect of asset tangibility is explored by solving a different version of the baseline model, in which sector 2 has similar asset tangibility as sector 1. The mix of new firm entry in this economy is set to half and half between the two sectors. Sectors are thus fully symmetric in this specification.

The increase in collateral value during credit crunches for divisions operating in sector 2 leads to an increase in leverage of about 5% for the average firm in the economy. This

Table 6: Counterfactual Experiments

	(1)	(2)	(3)	(4)	(5)
	Baseline	Equal tang	No entry	Single only	Cong only
Panel A. Targeted Moments					
<u>All Firms:</u>					
1. Fraction of conglomerates, %	50.9	52.7	81.3	0.0	100.0
<u>Single-segments:</u>					
2. Debt/Assets	0.343	0.384	0.286	0.285	
3. Tobin's q	1.659	1.909	1.488	1.366	
<u>Conglomerates:</u>					
4. Debt/Assets	0.263	0.327	0.239		0.303
5. Tobin's q	1.394	1.446	1.329		1.430
<u>Single-Segment q Regression:</u>					
6. β_0	1.689	1.919	1.489	1.469	
7. β_{I_2}	0.010	-0.003	0.046	-0.195	
8. β_{crunch}	-0.013	-0.017	-0.067	-0.014	
9. $\beta_{crunch*I_2}$	-0.138	-0.004	-0.130	-0.048	
10. $\beta_{recession}$	-0.075	-0.060	-0.100	-0.089	
11. $\beta_{recession*I_2}$	-0.030	-0.005	-0.056	-0.003	
<u>Div. Discount Regression:</u>					
12. β_0^{DD}	0.269	0.469	0.098		
13. β_{crunch}^{DD}	-0.082	-0.027	0.027		
14. $\beta_{recession}^{DD}$	-0.057	-0.025	-0.001		
Panel B. Additional Moments					
<u>Single-segments:</u>					
Cashflow/Assets	0.450	0.461	0.447	0.453	
Capital expenditure/Assets	0.333	0.357	0.128	0.135	
Dividend/Assets	-0.181	-0.186	-0.032	-0.026	
<u>Conglomerates:</u>					
Cashflow/Assets	0.406	0.414	0.401		0.445
Capital expenditure/Assets	0.109	0.110	0.082		0.247
Dividend/Assets	-0.011	-0.007	0.020		-0.131
<u>All Firms:</u>					
Standard deviation Tobin's q	0.382	0.615	0.163	0.235	0.238
Default rate, %	0.2	0.0	0.2	0.4	0.3
Transition single to cong, %	5.3	5.7	4.2	0.0	
Transition cong to single, %	5.2	4.2	1.1		0.0

increase in credit results in more investment for the single-segments, as these are the more productive and more financially constrained firms. This expansion of the balance-sheet leads to an increase in Tobin's q for all firms, but single-segments benefit the most with an increase of 0.35, compared to an increase of 0.05 for conglomerates.

As expected the diversification discount is much higher, as it almost doubles. In contrast, its sensitivity to aggregate shocks is drastically reduced. In other words, the value of collateral pooling is less valuable when all sectors in the economy have similar asset tangibility. This fact highlights that the collateral pooling channel that conglomerates enjoy is particularly valuable during bad aggregate times, especially during credit crunches.

Effect of new firm entry. The effect of new firm entry can be analyzed by not adding firms to the initial cross-section in the simulations. The new stationary distribution has a lot fewer young fast growing firms, which yields a lot lower demand for investment. This effect is particularly strong for single-segments with a large 20% drop, compared to conglomerates with a smaller 3% drop. In turn, these decreases in investment lead to a reduction in leverage for all firms (about -4%), as well as an increase in dividend for single-segments (about $+15\%$). In other words, single-segment firms are more mature in the no entry economy, and thus need not to issue equity to finance their fast growth, compared to an economy with entry of new young firms.

This reduction in productivity of single-segments relative to conglomerates translates into a lower relative performance, thus reducing the diversification discount. In addition, more mature firms are better able to hedge against aggregate risks in the steady state. Therefore the absence of new single-segment firm entry into the economy reduces the sensitivity of the diversification discount to aggregate risks.

Option value of conglomerating. The value of conglomerating can be evaluated by solving a different version of the baseline model, in which single-segment firms are not allowed to conglomerate. In this specification, the economy is populated solely by single-segment

firms.

Because single-segment firms do not have the option to diversify, they are limited in sharing sector-specific and idiosyncratic risks. Precautionary motives lead firms to self insure by reducing their leverage by about 6%. Single-segments in the baseline economy are mostly young and high growth firms, however they are more mature in the economy without conglomerates making them less productive on average. This selection effect leads firms to invest about 20% less than single-segments in the baseline. Equity issuance is also reduced by 16%, given the decreased need for funds.

Both the decrease in risk-sharing ability, via cashflow pooling and collateral pooling, and the decrease in productivity translate into a substantial decrease in the Tobin's q of single-segment firms, from 1.66 in the baseline to 1.37.

Option value of refocusing. The value of refocusing can be evaluated by solving a version of the model where firms are not allowed to operate as single-segment firms. In this specification, the economy is populated solely by conglomerates.

Conglomerates benefit from pooling cashflows as well as from pledging collateral of both their divisions. Such financial benefit is a clear advantage over two segments operating separately. However conglomerates face the risk of not allocating capital efficiently as, in this version of the model, they are not allowed to shed an unproductive division and refocus. This could prove costly if productivity of a division is very low and would not warrant paying the fixed cost of operation. The value of refocusing is thus related to inefficient capital allocation that prevents a conglomerate to shed an unproductive division.

The financial pooling benefits allow conglomerates to increase their leverage by 4%. Given that this economy features entry of young conglomerates, conglomerates invest 14% more and issue 12% more equity than their counterpart in the baseline economy.

In this counterfactual, young conglomerates that enter the economy are very productive and fast growing, essentially increasing the average productivity. This selection effect lead to a small increase in the Tobin's q of conglomerates, from 1.39 in the baseline to 1.43.

5.6 Discussion

In this section, we exploit the results from the counterfactual experiments to quantify the value of financial pooling and the value of organizational structure flexibility. A structural model of the firm is particularly useful to extract such quantities as self-selection can be cleanly separated from the other economic forces using counterfactuals.

Value of financial pooling. The value of financial pooling is computed as the difference in average Tobin's q between a single-segments only economy and a conglomerates only economy as described in columns (4) and (5) of Table 6. This difference can be interpreted as the "treatment" effect of being a conglomerate versus a single-segment. This measure is free of selection as the organizational structure is exogenously fixed in both of these economies.

Our numerical results find that the value of financial pooling for the estimated model is 0.07, which corresponds to 5% of average Tobin's q . In other words, randomly paring and operating two single-segment firms yield a 5% increase in firm value due to the risk sharing benefits.

Value of organizational structure flexibility. In the baseline model, firms endogenously choose to diversify or refocus in response to aggregate and idiosyncratic shocks. An average firm in this economy has a Tobin's q of 1.52. In an economy where firms do not have the option to diversify or refocus, the average firm has a Tobin's q of 1.4. This is obtained by using average Tobin's q from counterfactuals (4) and (5), weighted by percentage of conglomerates in the baseline model. The difference between the baseline economy and an economy with fixed organizational structure is estimated to 0.13 or 8.5% of average Tobin's q .

6 Conclusion

This paper proposes a dynamic model of the firm in a two sector economy where each sector has different collateral value of assets and firms choose to diversify or refocus in response to productivity and financial shocks in the economy.

The model is structurally estimated to the data and is able to rationalize the time-series dynamics of the diversification discount with respect to aggregate states. Specifically, the decrease in the discount during recessions and credit crunches are caused by single-segment firms with low asset tangibility that experience a larger decrease in value compared to conglomerates due to tighter financial constraints. The model also shows that new firm entry in the economy is crucial in generating the patterns observed in the data.

Our quantitative results show that financial pooling and organizational flexibility are value-creating and their magnitude are economically important. Our model shows that such value creation for firms can be attributed to better liquidity management through dynamically adjusting their organizational form.

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