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While people are thinking about number of publications,
think about the quality of your work

Golden Advise from *Nicola Pavoni*

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Contents

Abstract

This thesis consists of three essays addressing different aspects of frictions and macroeconomics.

In Firm Size and Business Fluctuation: The Response of Small v.s. Large Firms to Credit Shocks, I study the response of firms in different sizes to credit shocks .This paper challenges the common view in the literature that small firms -with limited access to credit markets- are always more fragile to credit shocks. In this paper I develop a model, proposing that fragility, while depending on firm size will also depend on the state of the credit markets. To test the arguments, I check how firms, based on their size, respond differently to various credit shocks. First, I assess firms' response when states increase the tax on bank loans. As expected, constrained firms which rely more on intermediaries' fund are impacted while unconstrained show no impact. Then I interact this shock with the periods wher the bond market is also affected. The results suggest that when both intermediary and market rates increase, even unconstrained (typically large) firms are impacted significantly. The results suggest the state of credit markets an important determinant of the firms' fragility with respect to their size.

How Small and Large Firms Respond to Tax Changes: Evidence from US Manufacturing Data is the second chapter of the dissertation. This chapter provides evidence on the different effects of corporate taxation across small and large rms. We use a local projection model to estimate the dynamic effects of tax policy changes on firms real and financial variables. We distinguish between changes in personal and corporate income taxes by narratively identified tax policy changes in the United States over the post-WWII period. Our estimates show that small firms account for a major share of aggregate changes of investment and sales following a corporate tax cut. In addition, we find that while both firms increase their use of external financing, small firms rely much more heavily on debt to finance investment.

Firms' Composition, Investment Efficiency and Aggregate Output is the last chapter of this work. It is shown that any change in the price of this asset impacts production through three possible mechanisms. The first is channeling capital to the more productive investors via trading. Second, it could contract or relax the collateral constraint of the producer investors. Finally, grouping all investors into producers and non-producers, I show any change in the composition of the producers and non-producers affects the average investment efficiency and consequently the aggregate output. Moreover, I show that financial intermediaries could hinder aggregate output by making the tradable asset illiquid. When the tradable asset is pledged as collateral, the reallocation mechanism becomes less effective in the economy.

Chapter 1

Firm Size and Business Fluctuation: The Response of Small v.s. Large Firms to Credit Shocks

In this chapter, I study the response of firms in different sizes to credit shocks. Based on a two-period model, I incorporate the role of leverage in business fluctuations and show that large firms are more leveraged than small firms due to their access to a more diversified credit portfolio. This causes large firms to be more sensitive to specific credit shocks. The model compare the response of small v.s. large firms to different credit shocks. To test the arguments, I check how firms, based on their size, respond differently to various credit shocks. First, I assess firms' response when states increase the tax on bank loans. As expected, constrained firms which rely more on intermediaries' fund are impacted while unconstrained show no impact. Then I interact this shock with the periods when the bond market is also affected. The results suggest that when both intermediary and market rates increase, even unconstrained (typically large) firms are impacted significantly. The results suggest that the nature of the shock and the state of credit markets are important determinants of firms' fragility.

1.1 Introduction

A great deal of research has been conducted on how small and large firms respond to macroeconomic shocks. The common view in the literature is that small firms are more sensitive to credit shocks (Chari et. al., 2013). The underlying theory for this difference across firms is their respective access to capital market. The intuition is that smaller firms rely heavily on intermediary funds while large firms can also raise fund directly by issuing equity, corporate bonds and commercial papers (Gertler and Hubbrad, 1988).

Hence, small firms have less access to capital markets and are more likely to face credit constraints. When credit conditions worsen, large firms can rely on direct financing and dampen the effect of shock while small firms can only respond by cutting their spending and economic operations. Thus, small firms decline more when credit tightens.

In this chapter, I stress the role played by leverage in the firms' response to financial market shocks. One source of heterogeneity among firms is their access to credit markets. In fact, larger firms are less risky, as they have access to a more diversified credit portfolio than do small firms (Gertler and Gilchrist 1994), which allows them to rely excessively on external financing. This view is articulated in more depth in this chapter. To analyze the role of leverage, I develop a model representing an economy with two financial sectors (banking sector and the corporate bond market). The stochastic elements of the model are the interest rates (in two financial markets) and productivity. So I discuss how firms optimize their debt (leverage) and consequently, how this optimal leverage determines their fragility to different credit shocks.

The first element of the model is leverage. On the one hand, high leverage is costly because it makes the firms more fragile to credit shocks - because leveraged firms suffer more from insufficient cash flow in occurrences of financial distress. On the other hand, external financing is cheap and firms prefer to issue debt rather than using shareholders' funds. Having access to multiple financiers incentives firms to get more leveraged by decreasing the probability of distress or the cost of leverage. Definitely, the probability of facing distress is decreasing as the number of creditors increases. So access to credit markets is one determinant of firms' optimal leverage.

In this context, the main argument of the model is that when the economy is hit by a credit shock to one particular financial sector, e.g. banks, large firms damp it by borrowing from other credit markets (e.g. substitute bank loans with corporate bond). So, firms without access to other markets are severely affected by the shock. On the other hand, when the shock is extensive in the sense that all markets (in my case, both banking sector and bond market) weaken, even large firms face harsh credit constraint as they cannot borrow from the other creditors. Meanwhile, highly leveraged firms are fragile as they excessively rely on external financing. Therefore, since large firms are generally more leveraged, when the shock is big enough to affect all credit markets, they suffer more from the credit shock. In all, this mechanism explains how firms optimize their capital structure with a high exposure to financial distress. In this paper I formalize this argument and test it empirically.

1.1.1 Literature Review

This chapter relates to two strands of literature in macroeconomics and corporate finance. The first strand intends to explore the response of small v.s. large firms to macroeconomic and credit shocks where size is a proxy of access to credit markets. Since measuring the degree of credit constraint requires information which is not always available particularly for non-listed and private firms, many economics and finance studies use relevant firm characteristics and mainly size as a proxy for access to credit market. Size is considered as a relevant proxy since it is highly correlated firms' unobservable characteristics determining their degree of credit constraint. In this context, smaller firms suffers more from information asymmetry in credit markets where itself limits firms' size by constraining their investment.

In this line of research, the pioneering work directly addressing this issue is Gertler and Gilchrist (1994) that explores the response of small and large manufacturing firms to monetary policy shocks. They use the semi-aggregate data from Quarterly Financial Report for Manufacturing Corporations (QFR) from 1958 to 1992. The authors measure the response of firms by changes in the value of sales, inventories and short-term debt and show that small firms have been impacted harder by the exogenous monetary policy shocks. Gertler and Gilchrist interpret periods of monetary contraction as episodes of credit tightening and argue that differences in the cyclical behavior of firms is explained by their relative access to credit markets.

Another recent work is Chari, et. al. (2013) who examine the findings of Gertler and Gilchrist using the updated QFR data. They construct the same measure of the sales and explore how small and large firms respond to a contractionary monetary policy shock. Their findings mirror those of the previous study by Gertler and Gilchrist (1994). Indeed, they answer to the related question that what happens to the sales, inventories and short-term debt of large versus small firms in recessions. This study concludes that unlike the monetary policy shocks, no significant difference is observed in the response of large and small firms to real business cycle shocks . In a related work, Kudlyak et. al. (2010) produce results which corroborate the findings of a great deal of the previous works. Moreover, they look at the responses of firms to tight credit Shocks of 2008 through the lens of Gertler and Gilchrist. Using the same data set and the same methodology, they find that unlike the previous episodes of credit tightening, the sales and the short-term debt of large firms have decreased relatively more than that of small firms in the recent financial downturn.

Also, numerous studies have investigated the impact of financial distresses on non-financial firms in the literature of corporate finance (e.g. Townsend, 1979; Scharfstein, 1990; Sannikov, 2012 and Scheinkman and Weiss, 1986). One of the seminal papers in this field is that by Holmstrom and Tirole (1998) which offers a theoretical explanation for the findings of Gertler and Gilchrist (1994). In this model the distribution of wealth among firms plays the key role in the access to credit market. Since small firms can afford a small portion of the credit required for the projects, they can only use a monitored fund, which is more expensive. However, large firms have access to a direct fund without monitoring cost because their high provision of internal fund alleviates the moral hazer concerns. Hence, small firms are more sensitive to all kinds of credit shocks. In this analysis, the key role is played by leverage. However, in the model of Holmstrom and Tirol, since the size of the investment is the same between small and large firms, the distribution of the wealth is the main determinant of the leverage. However, one might criticize this view and argue that since firms in different sizes invest differently, it is not necessarily true that large firms are less leveraged. Since large firms usually invest more than that of the small firms, they are more leveraged even though they have more initial wealth.

In this paper I focus on another key factor which is cash reserves. Studies show that cash to asset ratio has been increasing in US during the last decades (e.g. Pinkowitz et. al. (2013) show that the average cash to asset ratio of US public firms was at 16.17% in 1998 and 21.48% in 2010). Since firms can accumulate cash to secure themselves against credit shocks, firms with weaker access to credit markets are expected to have higher cash to asset ratio and stay less leveraged. In this chapter, I explain theoretically and also support it empirically that how extensive reliance on external financing and low precautionary reserves might make firms more fragile to special credit market distresses.

Another strand of the literature puts the interplay between cash holding and debt at the center of analysis. The main issue in this literature is explaining the coexistence of debt and cash holding. The question is mainly why firms don't use their cash to reduce debt. Gamba and Triantis (2008) answer this question by considering fixed cost of debt issuance. The coexistence of debt and cash holdings minimizes the future cost of debt issuance even by financially unconstrained firms. Acharya et. al. (2007) stress the role of financial constraints to show that cash is different from negative debt. They point out the importance of hedging motive and argue that while saving cash allows financially constrained firms to hedge against future income shortfalls, reducing debt - saving borrowing capacity - is a more effective way of securing future investment in high cash flow states. Chaderina (2013) rationalizes this phenomenon by introducing costly default. To hedge the risk of default, firms issue long-term debt as proceeds in cash for precautionary motives. A similar setup is suggested by Sun (2014) as well. In this chapter, I emphasize on the stochastic nature of the interest rate to explain why firms hold cash instead of repaying their debt. This structure is explained more formally in the following section.

1.2 Model

In this part, the main idea of the paper is presented with a partial equilibrium model. The next two subsections describe the model in details.

1.2.1 The economic environment

The economic environment consists of firms maximizing the net present value of their dividend distribution in a two period horizon. In each period firms issue debt, invest, and decide how much cash to hold and how much dividend to distribute. These decisions are respectively denoted by $b_t,\ k_t,\ c_t$ and d_t. There exists a single multi-purpose good which is produced, used as capital and distributed as dividend. There are two periods and the economy closes when second period investment yields are achieved. All these yields are distributed as dividend. There are two sources of uncertainty in this economy. In the first period, there is uncertainty about productivity and in the second period there is interest rate uncertainty.

Each firm uses the following technology to invest:

$$f(z,k) = zk^{\alpha}$$

I assume that all firms share the same α. At $t\ = 2$, z is deterministic and $z_2 = \overline{z}$. But there is a productivity shock at $t\ = 1$ denoted by $z_1 \in \{\underline{z}, \overline{z}\}$ where $z_1 = \underline{z}$ with probability p and $z_1 = \overline{z}$ otherwise ($\underline{z} < \overline{z}$). p is same for all firms. In what follows, I argue how high accessibility to financial markets makes firms fragile without any discrimination regarding productivity or wealth distribution.

All firms start with no initial wealth, but can borrow from financial markets. There are two financial sectors in this economy: a bank and a bond market. The interest rates of the bank and the bond market are respectively r_{bt} and r_{mt} at time t. Some firms have access to both markets while the others' accessibility is restricted to the bank. Formally, this accessibility is denoted by dummy variable x_i, where $x_i\ = 1$ denotes access to both credit markets and $x_i\ = 0$ denotes restricted access to the bank. This variable is time invariant and i is the firm's index. However, to keep the notation simple, I drop i in the rest of the paper. So, the cost of issuing one unit of debt is r_{bt} if $x = 0$ and $\min\{r_{mt}, r_{bt}\}$ if $x\ = 1$. This is the only exante source of heterogeneity in this model which is exogenously predetermined for every individual firm. For the sake of simplicity, I mute this source of heterogeneity at period 1 by setting $r_{m1} = r_{b1} \equiv r_1$. Hence, firms are indifferent between financial markets in period 1 and accessibility to bond market matters only in the second period. In the real world, this heterogeneity might arise because of fixed cost of bond issuance, agency problems etc.

Firms can also keep precautionary reserves by buying short-term financial securities in the market. The yield of this security is $(1-\upsilon)r_{m1}$ where υ represents the premium in borrowing over lending. Let β denotes the discount rate. I assume (i) $\beta r_{mt} < 1$, (ii) $\beta r_{bt} < 1$ and (iii) $(1-\upsilon)r_{mt} < r_{bt}$ where (iii) rules out any arbitrage opportunity from borrowing and lending[1].

[1] I assume $\overline{z}$ is larger enough than $\underline{z}$, and also υ is small enough to capture interesting results for my

In each period, the chain of events proceeds as follows. First financial markets open and firms can borrow (sub-period 1). Next, financial markets close and firms invest. This is the point when the productivity shock is realized at $t = 1$. After investing, if firms do not deploy all their resources, they can decide whether to hold cash reserves or to distribute dividend (sub-period 2). This chain of events is depicted in figure 1.1.

The vector of state variables for each firm is $(w_t, r_{m,t}, r_{b,t}, x)$ where w_t is the firm's cashflow. In the first period I assume that firms start with no initial cash flow and hence $w_1 = 0$. In the second period the cash flow is:

$$w_2 = f(z_1, k_1) + (1 - \upsilon)r_1 c_1 - r_1 b_1$$

This includes the return from investment and also from cash reserves (which is held by purchasing short term securities) net of debt liabilities. Here k_1 is the firm's investment, b_1 is the firm's total debt and c_1 is the accumulated cash reserves; all in the first period. r_2 is also the interest rate at which each firm can borrow which is $\min\{r_{m2}, r_{b2}\}$ if $x = 1$ and r_{b2} if $x = 0$.

1.2.2 A two-period model

Firms face the technology shock at period 1. Meanwhile as assumed above, both financial markets offer loans with the same rate ($r_{1m} = r_{1b}$) at this period and there is no discrimination regarding credit market accessibility. Firms start with no initial cash flow and they only raise fund by issuing debt. But since the uncertainty about the productivity is resolved after closing the credit market, firms decide how much debt to raise based on their expectations about the second sub-period. In the second sub-period, after resolving the productivity shock and making investment, if firms end up with some cash they can decide to either hold precautionary reserves or distribute dividend (as explained above, firms hold cash by short-term lending which yields $(1 - \upsilon)r_1$). Formally, firms solve a two-stage stochastic programming scheme as follows. In the first sub-priod:

$$V_1(0, r_1, r_1, x) = \max_{b_1} E_{z_1} U(b_1, z_1)$$

where the second sub-period problem is:

$$\begin{aligned} U(b_1, z_1) &= \max_{k_1, d_1, c_1} d_1 + \beta E_{r_{2m}, r_{2b}} V_2(w_2, r_{m2}, r_{b2}, x) \\ & \quad s.t \\ k_1 &\leq b_1 - c_1 - d_1 \\ w_2 &= f(z_1, k_1) - r_1 b_1 + (1 - \upsilon) r_1 c_1 \end{aligned}$$

analytical purpose.

In period 2, there is only uncertainty about the interest rates r_{2m} and r_{2b}, and all firms use the investment technology $f(\overline{z}, k) = \overline{z}k^{\alpha}$ (where $z_2 = \overline{z}$ is predetermined). Both interest rates are realized at the beginning of the period and there is no uncertainty about the second sub-period. Since there is no uncertainty to be resolved in the second sub-period, firms never borrow more than their need for investment and they never hold cash or issue dividend at the end of the second period. Hence, optimal decision making of the firm simply has the following structure:

$$\begin{aligned} V_2(w_2, r_{m2}, r_{b2}, x) &= \max_{k_2, b_2} \beta d_2 \\ & s.t. \\ k_2 &\leq w_2 + b_2 \\ d_2 &\leq f(\overline{z}, k_2) - r_2 b_2 \end{aligned}$$

where r_2 is equal to $\min\{r_{2m}, r_{2b}\}$ for unconstrained firms ($x = 1$) and r_{2b} for the constrained firms ($x =$). It is easy to verify that:

$$k_2 = \left(\frac{\alpha\beta z_2}{r_2}\right)^{\frac{1}{1-\alpha}} \tag{1.1}$$

and

$$b_2 = (\frac{\alpha\beta z_2}{r_2})^{\frac{1}{1-\alpha}} - w_2 \tag{1.2}$$

I discuss the properties of the optimal solution in period 1 below:

Lemma 1.2.1 *There exists a firm specific probability threshold*

$$\widehat{p} = \frac{\gamma(r_{m2}, r_{b2}, x)\ \overline{z} - r_1 \underline{z}}{\gamma(r_{m2}, r_{b2}, x)(\overline{z} - \underline{z})}$$

such that optimal borrowing is:

$$\underline{b} \equiv b_1 = \left(\frac{\alpha E(z)}{r_1}\right)^{\frac{1}{1-\alpha}} \qquad \text{if} \quad p \geq \widehat{p}$$

and

$$\overline{b} \equiv b_1 = \left(\frac{\alpha(1-p)\overline{z}}{r_1 - p\gamma(r_{m2}, r_{b2}, x)}\right)^{\frac{1}{1-\alpha}} \qquad \text{if} \quad p < \widehat{p}$$

where

$$\gamma(r_{m2}, r_{b2}, x) = \max\left\{(1-\upsilon)r_1, \frac{1}{\beta E(\lambda_2(r_{m2}, r_{b2}, x))}\right\}$$

and $\lambda_2(r_{m2}, r_{b2}, x)$ *is the shadow price of cash in period 2.*

This lemma states that firm's borrowing depends on p. The intuition of this lemma is that when state $\overline{z}$ is very likely, firms issue more debt $(\overline{b})$ to have enough liquidity for high investment. On the other hand, when state $\underline{z}$ is probable, it is optimal to be more conservative in borrowing (and borrow $\underline{b}$) since ending up with cash is costly. This cost emerges because of the higher cost of debt rather than returns of holding cash or yields of dividend.

Remark 1 *Constrained firms borrow less than unconstrained firms.*

It is easy to verify that $\widehat{p}(r_{m2}, r_{b2}, x)$ is increasing in $E\left(\lambda_2(r_{m2}, r_{b2}, x\right)$ which is the expected shadow price of cash, or the expected interest rate in the second period. More formally:

$$E\left(\lambda_2(r_{m2}, r_{b2}, x)\right) = E\left(\min\left\{r_{2m}, r_{2b}\right\}\right)x + E(r_{2b})(1-x)$$

which is $E\left(\min\left\{r_{2m}, r_{2b}\right\}\right)$ if $x = 1$ (unconstrained firms) and $E(r_{2b})$ if $x = 0$ (constrained firms). Hence $\widehat{p}(r_{m2}, r_{b2}, 0) \geq \widehat{p}(r_{m2}, r_{b2}, 1)$ and $\overline{b}(r_{m2}, r_{b2}, 0) \geq \overline{b}(r_{m2}, r_{b2}, 1)$.

This means that $\widehat{p}$ is larger and $\overline{b}$ is smaller for constrained firms. This result is intuitive since large amounts of debt leads to lower cash flow in the next period, constrained firms are more conservative about issuing debt in this period.

Proposition 1.2.2 *The optimal investment, cash holding and dividend policy of firms after realization of technology shock is characterized as follows:*

(i) *if* $\overline{z}$ *is realized and the firm had borrowed* b_1*, then:*

$$k_1 = b_1 \quad \text{and} \quad c_1 = d_1 = 0$$

(ii) *otherwise, if* $\underline{z}$ is realized *:*

$$k_1 = \min\left\{b_1, \left(\frac{\alpha\underline{z}}{\gamma(r_{m2}, r_{b2}, x)}\right)^{\frac{1}{1-\alpha}}\right\}$$

$$c_1 d_1 = 0$$

where $c_1 > 0$ *iff* $\beta E(\lambda_2)(1-\upsilon)r_1 > 1$.

Proof. See Appendix ■

The intuition is straightforward. If $\overline{z}$ is realized, the whole liquidity is pledged in production function. If $\underline{z}$ is realized and the firm has borrowed $\underline{b}$, it is also optimal to invest all available liquidity. But if firm has borrowed $\overline{b}$ and productivity is low, some part is invested and the rest is either held as cash (in case the return of holding cash exceeds the discount rate which happens if $\gamma = (1-\upsilon)r_1$) or distributed as dividend (otherwise if $\gamma = \frac{1}{\beta E(\lambda_2)}$).

Remark 2 *Constrained firms have higher expected investment than unconstrained firms. Moreover, constrained firms have higher tendency towards holding cash rather than unconstrained firms which have a relative tendency towards issuing dividend.*

The specific notion here is the role of shadow price of cash constraint in period 2 which plays a crucial role in the optimality of holding cash and the level of investment in period 1. Since constrained firms have a higher expected shadow price of cash in period 2, they increase their cash flow by investing more and holding cash rather than issuing dividend. Higher cash flow implies lower reliance on external financing. Next proposition discusses it more formally:

Proposition 1.2.3 *Unconstrained firms have higher debt to asset ratio (leverage).*

The proof is trivial. Borrowing is decreasing in λ_2 (Remark 1), while both investment and cash holding (total asset) are increasing in λ_2 (Remark 2). Therefore, unconstrained firms, which have lower λ_2, will have a higher debt to asset ratio.

Proposition 1.2.4 *At the beginning of the second period, the sensitivity of firms' value to interest rate has the following characteristics:*

(i) $r_{m2} < r_{b2}$*: any increase in the bank interest rate affects only constrained firms.*
(ii) $r_{b2} < r_{m2}$*: any increase in the bond interest rate does not affect the firms.*
(iii) $r_{b2} < r_{m2}$*: any increase in the bank interest rate affects both types of firms, but herder the unconstrained firms.*

Proof. See Appendix ■

Corollary 1.2.5 *For each combination of interest rates, the same increase in both rates impact unconstrained firms harder.*

This is the main proposition of this paper. This proposition states that sensitivity of firms value to interest rate is state dependent. This is a more comprehensive view comparing to the common view that small constrained firms are always more sensitive to credit shocks.

Discussion

Some testable implications are generated from the theoretical section. According to this analysis, we expect constrained firms to rely less on the external debt and consequently, to be less leveraged than unconstrained firms. Moreover, constrained firms are expected to hold more cash relative to their asset regarding their fragile access to external resources. Hence, when there is any increase in the bank loan interest rate, the response of constrained firms should be harder (assuming a cheaper access to bond market). The main argument is that the economic activities of an unconstrained firm should not be impacted by small shocks to credit supply when there are other sources of credit provision. In the other words, firms with high credit scores can simply substitute towards other channels when one source of credit becomes scarce or expensive. On the other hand, when the rates in both financial markets increase, not only unconstrained firms are impacted, but the impact on them is even harder. This is mainly because they rely highly on external financing, without keeping enough precautionary reserves. and hence they cannot finance when all financial markets tighten. In the next section these implications are tested.

1.2.3 Empirical Analysis

I consider the sample from *Wharton Research Data Services* (*WRDS*) merged *Compustat* and *S&P Ratings Database* for US firms from 1968 to 2011. S&P Rating Dataset provides short and long-term debt credit rating in addition to stock market quality rating for listed firms in US. I restrict my analysis to industrial firms and exclude all other firms as their balance sheet might be impacted by other factors (e.g. regulatory forces), rather than by the economic reasons studied here. These firms might have very different responses to credit shocks, which are not the interest of this study. I also drop firms with negative asset, negative cash and short-term investment, negative investment and also firms with leverage ratio above 1. For testing the model, I need to define constrained and unconstrained firms. Hence, I define different categories of firms using the credit score data of the firms. For this purpose, I use *Compustat* variable *splticrm* which is S&P long-term issuer credit rating. This item ranges from AAA to D (default), in 22 classes. First, I follow the specification of Harford and Uysal (2014) and assume that firms with no reported credit score are constrained firms since typically they have no access to the public debt market. I label such firms as "Non-Rated" firms. I accumulate all other firms and label them "All Rated". Second, I identify "Junk Bond Issuers" which are firms with low S&P rating scores, and treat them as constrained firms. These firms have limited or costly access to the bond market and rely more on intermediaries such as banks. Moreover, a high rating is a signal for information asymmetries between the firm and investors, which implies that they are more opaque and are thus more likely to be rationed by lenders (Farre-Mensa and Ljungqvist, 2013). For such a setting, I classify public firms with ratings below BBB^{-} as junk bond issuers.

Collectively, I define four categories of firms which are "High Credit Score" firms, "All Rated" firms, "Junk Bond Issures & Non-Rated" firms and "Non-Rated" firms. I assume that from the former to the later category, the average degree of credit constraint increases. In the following section, I compare the response of firms in these credit rating classes to financial shocks.

Variable Definition

To construct firm level variables, I use data items provided by *Compustat* and S&P Rating Dataset. For credit rating, I use *Compustat* variable *splticrm* which is S&P long-term issuer credit rating to define four categories of firms mentioned above. Other key variables in this study are market values of the firms, investment, leverage, cash holding and Tobin's Q ratio. Equity market value is calculated as the price close at the end of the quarter (*prccq*) times common shares outstanding (*chsoq*). However, this item is directly reported in *Compustat* since 1999 (*mkvltq*). Also investment is calculated by summing capital expenditures (*capxy*) and acquisitions (*aqcy*). Size is measured as the natural logarithm of total book value of assets (*atq*). Cash holding is the total amount of cash and short-term investment (*cheq*). Leverage is defined as the sum of long-term debt (*dlttq*) and debt in current liabilities (*dlcq*) over total asset (*atq*). I define Tobin's Q ratio as the summation of market value of equities and market value of liabilities (*ltq*) over summation of book value of equities and market value of liabilities $\left(\frac{mkvltq+ltq}{mkvltq+ltq}\right)$.

Table 1.1 presents summary statistics for the sample which provides a general overview of firms' characteristics in different credit rating categories. This sample includes 114829 firm-quarter observations corresponding to 2154 unique firms. All firms belong to manufacturing industries (SIC code from 2000 till 3999) represented in our sample.

The mean leverage of the firms decreases as the access to credit market declines. Also a negative relation between size proxies (book value and market value of the firm) and cash to asset ratio is shown. This suggests that firms with higher S&P credit score typically rely more on external financing and hold relatively less cash.

The correlation matrix in Table 1.2 represents the correlation among the main variables of interest in this study. This matrix clearly depicts the correlation among the variables is not very high, which shows no multicollinearity problem. However, all coefficients of correlation are significantly different from zero at 5% level. Some more insight are provided in figures 1.2 and 1.3. From the data in these figures, it is apparent that during the last decades, firms with better access to credit market were relatively more indebted.

1.2.4 Results

In the previous section, I explained how I construct the categories of constrained and unconstrained firms. In this section, I test the implications of the model for these different categories of firms. The first implication is higher sensitivity of credit constrained firms to changes in the bank loan interest rate. I test this prediction of the model by adopting two empirical strategies. The first strategy is based on the interest rate changes at US federal level and the second strategy uses state level changes in interest rate. I explain each strategy in more details below.

The first strategy follows Gertler and Gilchrist (1994) (GG) to check how firms respond to changes in US bank prime loan rate. The prime rate is commonly used as the reference rate for business loans which are offered by banks. However, this rate is closely tied to federal fund rate which is the rate US banks charge on overnight interbank loans. The interest rate of business loans offered by banks is closely tied to the federal fund rate and hence, any exogenous change of the federal rate would automatically considered an exogenous shock to the prime loan rate as well. This assumptions has been made in many previous studies (see e.g. Gertler and Gilchrist,1994 and Chari et. al., 2013). Specifically, I consider five specific shocks on 1968 Q4, 1974Q2, 1978Q3, 1979Q4 and 1988Q4. The following dynamic panel regression is then used to test how the market value of firms respond to changes in bank prime loan rate by comparing the market value from 4 quarters before the shock up to 8 quarters after it.

$$mkvlt_{it} = \beta_0 + \beta_1 mkvlt_{it-1} + \beta mkvlt_{it-2} + \beta_3 DTmon_{t-1} + \beta X_{it} + \alpha_i + \varepsilon_{it}$$

where the dependent variable $mkvlt$ is the natural logarithm of the firm i's market value at time t. The change in the prime rate is denoted by $DTmon_t$ which is a dummy takes 1 if at time t one of the above-mentioned shocks occurs. I am mainly interested to see how changes in the interest rate at the preceding period affects the market values of the firms. Other controls include size which is measured by the natural logarithm of total asset, Tobin's Q ratio, leverage, cash and short-term investment and firm fixed effect. I also control for two lags of the market value. This is the first strategy that I follow.

As the second strategy, I follow the empirical strategy of Farre-Mensa and Ljungqvist (2013) (FL) to examine the impact of state-level changes in loan interest rates. For this purpose, I focus on changes in banks' marginal tax rates between 1989 and 2011 from their study, which are presented in Table 1.9. As they argue, changes in state taxes on banks impact the after-tax profitability of lending. This directly affects the supply of bank loans and consequently the interest rate to firms located in the state. As a result, we expect banks to expand lending in states with falling tax rate and reduce the lending activities in states with rising tax rate. Moreover, states apportion banks' income from lending based on the location of the borrower, rather than of the lender. Hence, firms cannot cancel the effect of increase bank tax rates by substituting their creditors with banks in other locations (look at Farre-Mensa and Ljungqvist, 2013 for a detailed discussion about the nature of this shock and its effect on firms). Therefore, as state level tax rate on banks changes, we expect the economic activities of the constrained firms to be affected significantly. On the other hand, we expect insignificant or very small precautionary reactions of unconstrained firms to such tax changes. Here, a difference in difference dynamic panel is run including state level variables.

$$mkvlt_{it} = \beta_0 + \beta_1 mkvlt_{it-1} + \beta mkvlt_{it-2} + \beta_3 BankTax_{st-1} + \beta X_{ist} + \alpha_i + \varepsilon_{it}$$

where $BankTax_{st}$ denote the tax change on banks in state s at time t. Tables 1.3 and 1.4 report the results of these regressions. Table 1.3 shows the effect of the federal monetary interventions (GG shocks) on firms in different rating categories. Table 1.4 reports the corresponding results for state level tax changes on banks (FL shocks). According to this table, changes in interest rate affect only firms with low credit rating and non-rated firms which have the weakest access to credit market. These are typically smaller firms in our sample.

As the next test of model implication, I estimate the effect of the interest rate shocks on firms' investment behavior. Since interest rate is the marginal cost of investment, the model predicts corporations to reduce their investing activities in response to increase in interest rate. Hence, when firms become more credit constrained, their investments decline more. The next exercise is to run corresponding regressions to test how the investment of firms in different credit rating categories respond to the GG and FL shocks. Again we include firm fixed effects in the regressions to control for heterogeneities across firms. As discussed by Gertler and Zaktajsek (2008), such heterogeneity may exist because the cost of investing differs across firms in some systematic way not captured by this specification.

Tables 1.5 and 1.6 describe the results for these tests. As reported in these tables, changes in interest rates motivate firms to reduce their investment. However, the effect of two shocks are not alike. In all the specifications in table 1.4, interest rate changes exert a significant negative effect on constrained firms. The relation is robust for all alternative credit rating classifications of firms with weak access to credit market. Moreover, the effect of prime rate is always negative and significant. This holds even for firms with high credit scores which represent unconstrained firms. This finding is not surprising as changes in prime rates are consequents of tight monetary policy at federal level which significantly affect the whole economy. However, as discussed before, this change does not significantly impacts the market valuation of the unconstrained firms. Overall, these results are in-line with the previous findings of the literature that small and constrained firms are the ones hit the hardest by the credit market shocks.

The results of the previous section suggest that while constrained corporations face challenges caused by increase in bank loan interest rates, unconstrained firms dampen such shocks due to their access to substitute creditors. In this section, I try to wash out the channel that helps unconstrained firms to dampen the effect of shock. To do this, I control for changes in the bond market interest rate as well. I consider cases in which both bank and bond markets face an increase in interest rates. Therefore, the supply of credit via both source is affected. Accordingly I do not expect the unconstrained firms to be able to dampen the effect of shocks in the condition. To test this argument, I run new difference in difference regressions to assess how firms respond to simultaneous changes of interest rate in both markets. For this purpose, a new dummy variable is constructed which accounts for the occurrence of changes in both interest rates. I employ the specification of the previous section to identify shocks on bank loan interest rate (FL shocks). For variation in corporate bond interest rates, I use the time series spread of corporate bond market in US. I use the spread between the federal fund rate and Aaa corporate rate to find the episodes of increase in the spread[2]. Hence, the targeted dummy variable is constructed by interacting such increases in the bond market spread and increases in state taxation on banks. This dummy allows me to measure the required shocks. In the following results, this dummy variable is represented by $ExtShock$.

The results are presented in Table 1.7. According to the results, $ExtShock$ has a significant and negative effect on the market value of the firms. This is not surprising because as discussed above, this dummy represents period of contraction in both financial markets. Hence, all firms in different credit rating categories are expected to respond. The interesting results appear in table 1.8 when I exert the banking sector shocks as well. When I control for both shocks, it reveals that the coefficient of $ExtShock$ is not statistically significant for constrained firms anymore. The main significant explanatory variable for constrained firms' valuation is $BankTax$ in all specifications. This implies that constrained firms with costly or limited access to corporate bond market are not affected by changes in the cost of borrowing from bond market. On the other side, the results remain the same for unconstrained firms and the coefficient of the new variable $BankTax$ is insignificant. This implies that what matters for unconstrained firms is not the increase in the bank loan rate. However, any overall increase in the marginal cost of capital in both markets has a negative impact on such firms.

[2]All time series are from Federal Reserve of Sant Louis.

1.3 Conclusion

This chapter challenges the common view in the literature that small firms -with limited access to credit markets- are always more fragile to credit shocks. In this paper I develop a model, proposing that fragility, while depending on firm size will also depend on the state of the credit markets. To test the arguments, I check how firms, based on their size, respond differently to various credit shocks. First, I assess firms' response when states increase the tax on bank loans. As expected, constrained firms which rely more on intermediaries' fund are impacted while unconstrained show no impact. Then I interact this shock with the periods when the bond market is also affected. The results suggest that when both intermediary and market rates increase, even unconstrained (typically large) firms are impacted significantly. The results suggest the state of credit markets an important determinant of the firms' fragility with respect to their size.

1.4 References

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1.5 Tables and Figures

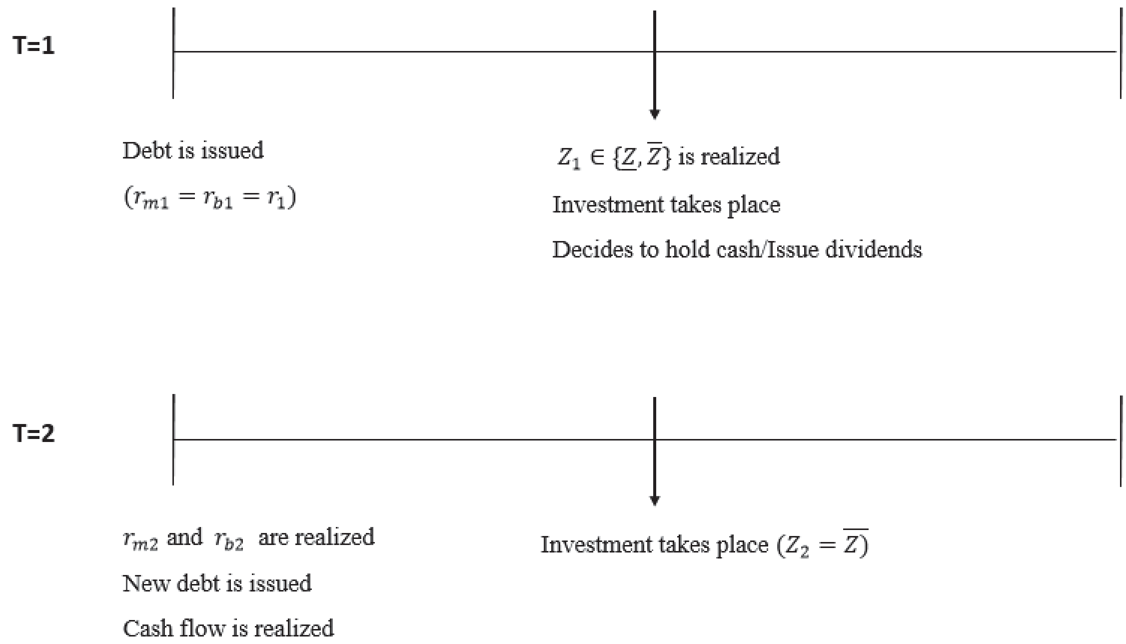

Figure 1.1: Timeline

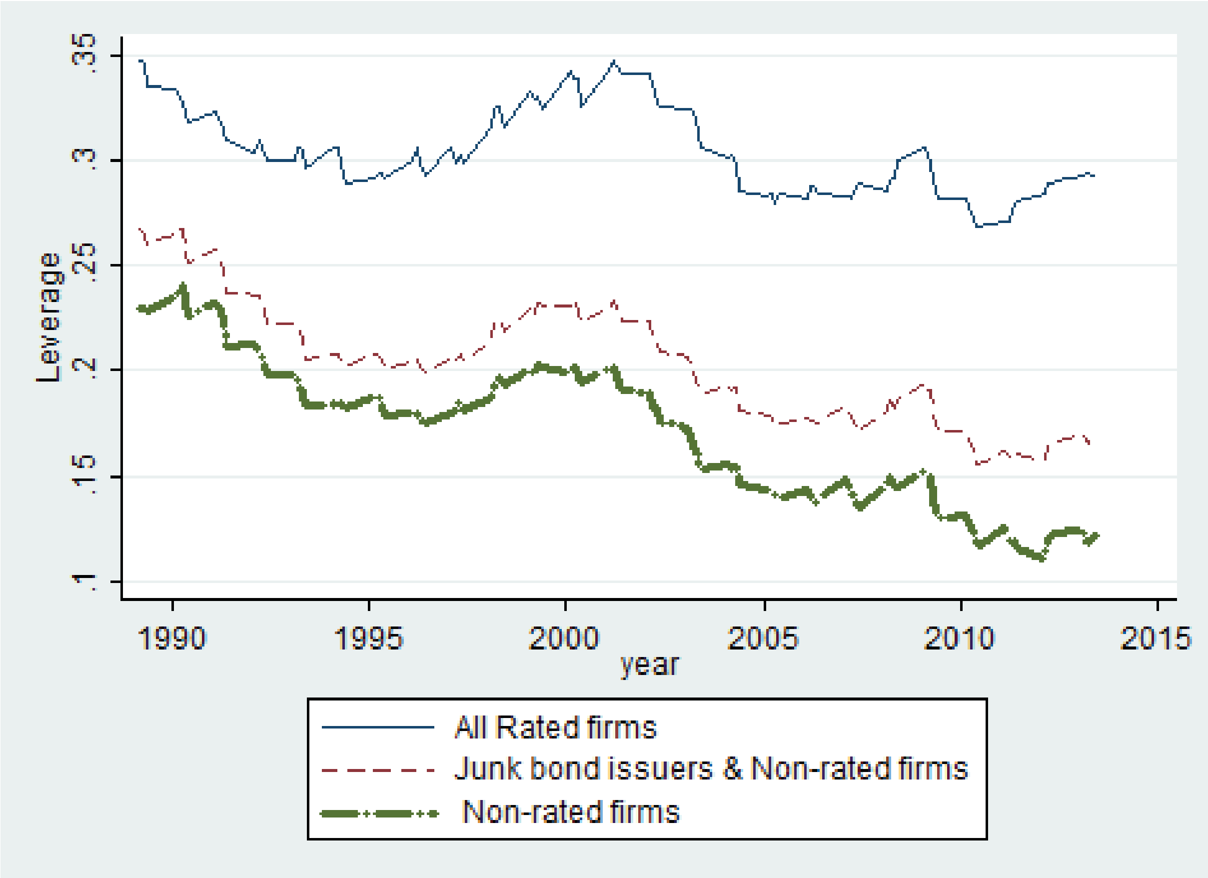

Figure 1.2: Leverage ratio of firms in different credit rating classes

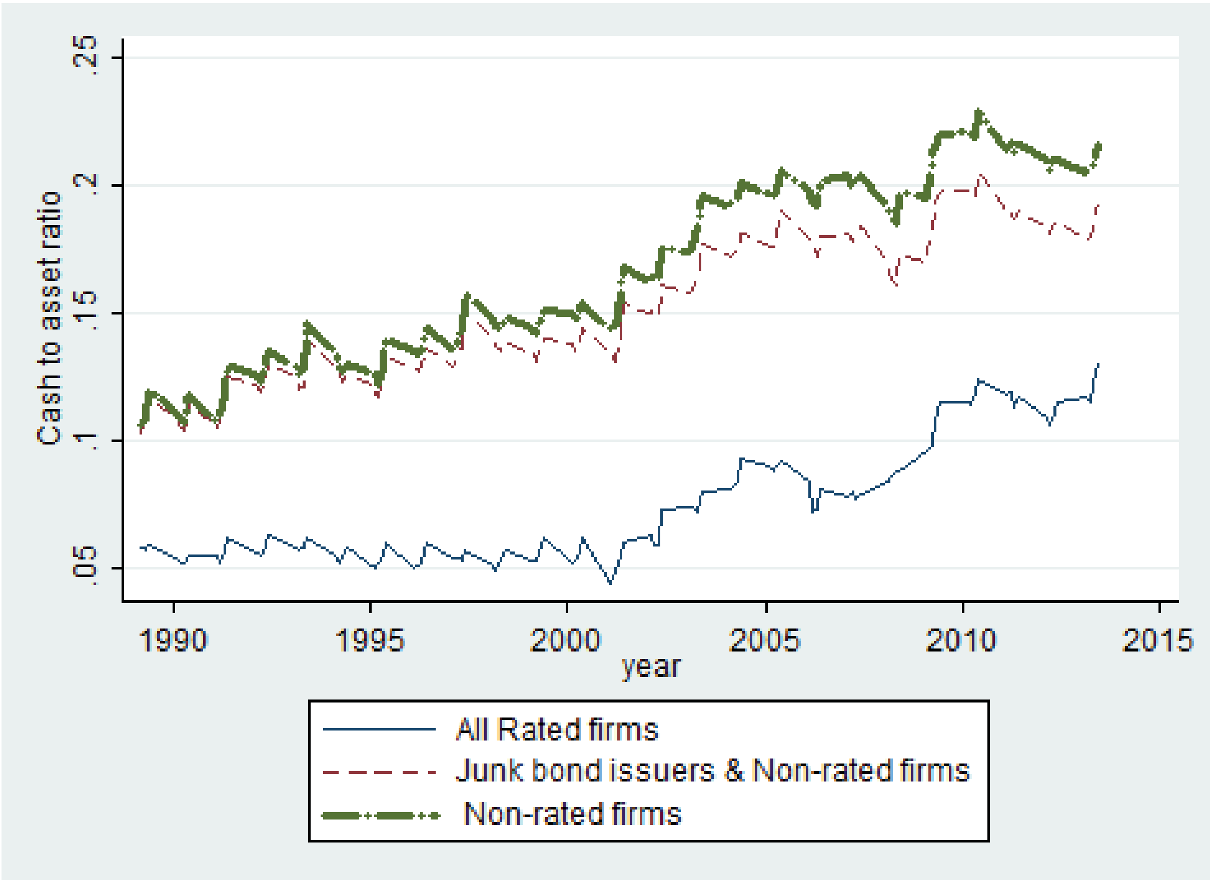

Figure 1.3: Cash to asset ratio of firms in different credit rating classes

	High score			All rated			Low score & Non-rated			Non-rated		
Variable	Obs	Mean	Std. Dev	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
market value	17960	15080.15	34296.77	13001	1713.44	3775.48	81697	541.37	5437.94	81697	541.37	5437.94
size	18308	11372.09	24769.72	14165	3431.05	13499.68	82240	513.98	2728.85	82240	513.98	2728.85
invstment	16379	518.31	1642.5	13265	135.56	601.29	74583	19.42	178.3	74583	19.42	178.3
cash and short investment	18289	939.57	2671.56	14164	326.07	2086.01	82171	58.56	532.24	82171	58.56	532.24
leverage	18308	0.25	0.12	14165	0.38	0.19	82240	0.19	0.17	82240	0.19	0.17

Table 1.1: Summary Statistics:
This table provides summary statistics for our sample over the period 1968-2014. Firms are classified into four categories based on their S&P long-run credit rating (which proxies their access to credit markt). Rated firms are the firms with S&P long-term credit rating. A all firms with rating BBB- or above are labeled as high rating firms. Junk bond issuers are firms with rating below BBBâ . Non-rated firms are the firms without any reported rating. In this table, equity market value is calculated as the price close at the end of the quarter (Compustat item prccq) times common shares outstanding (Compustat item chsoq). Investment is calculated by summing capital expenditures (Compustat item capxy) and acquisitions (Compustat item aqcy). Size is measured as the natural logarithm of total book value of assets (Compustat item atq). Cash holding is the total amount of cash and short-term investment (Compustat item cheq). Leverage is defined as the sum of long-term debt (Compustat item dlttq) and debt in current liabilities (Compustat item dlcq) over total asset (Compustat item atq).

	Market value	Size	Credit score	leverage	Cash to Asset ratio
Market value	1				
Size	0.3748	1			
Credit score	0.3195	0.6741	1		
leverage	-0.0175	0.1658	0.2125	1	
Cash to Asset ratio	-0.0091	-0.2155	-0.1694	-0.4142	1

Table 1.2: Correlation Matrix: This table provides correlation between main variables on interest in this paper. In this table, equity market value is calculated as the price close at the end of the quarter (Compustat item prccq) times common shares outstanding (Compustat item chsoq). Size is measured as the natural logarithm of total book value of assets (Compustat item atq). Cash holding is the total amount of cash and short-term investment (Compustat item cheq). Leverage is defined as the sum of long-term debt (Compustat item dlttq) and debt in current liabilities (Compustat item dlcq) over total asset (Compustat item atq).

	(1)	(2)	(3)
Dep Var: Market value	All Rated	Low Score & Non-Rated	Non-Rated
L.DTmon	-0.015	-0.023***	-0.019***
	(0.022)	(0.007)	(0.007)
L.Market value	0.245***	0.365***	0.335***
	(0.079)	(0.021)	(0.021)
L2.Market value	0.091	0.183***	0.189***
	(0.077)	(0.019)	(0.019)
Size	0.281***	0.446***	0.485***
	(0.099)	(0.024)	(0.025)
Cash/Asset	0.009	0.301***	0.408***
	(0.262)	(0.077)	(0.076)
Tobin's Q	0.935***	0.391***	0.373***
	(0.077)	(0.015)	(0.013)
Leverage	-1.165***	-0.865***	-0.807***
	(0.209)	(0.065)	(0.070)
Constant	1.445**	-0.516***	-0.592***
	(0.679)	(0.079)	(0.084)
Observations	1,261	4,722	4,148
R-squared	0.278	0.684	0.710
Number of firms	356	1,246	1,115

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.3: This table reports the effect of changes in prime loan rates of the firms' value. DTmon represents shocks to prime loan interest rates. These shocks are identified by exogenous monetary policy shocks, Romer and Romer dates, from 1970 onwards. In this table, equity market value is calculated as the price close at the end of the quarter (Compustat item prccq) times common shares outstanding (Compustat item chsoq).. Size is measured as the natural logarithm of total book value of assets (Compustat item atq). Cash holding is the total amount of cash and short-term investment (Compustat item cheq). Leverage is defined as the sum of long-term debt (Compustat item dlttq) and debt in current liabilities (Compustat item dlcq) over total asset (Compustat item atq). Tobin's Q ratio is calculated as the summation of equity market value and liabilities market value (ltq) over the summation of equity book value of asset and liabilities market value. Standard errors are reported in parenthesis. *, ** and *** represent statistical significance at 10%, 5% and 1% level, respectively.

Dep Var: Market value	(1) Rated	(2) Low Score & Non-Rated	(3) Non-Rated
L.BankTax	-0.007	-0.019***	-0.021***
	(0.009)	(0.007)	(0.007)
L.Market value	0.843***	0.825***	0.793***
	(0.011)	(0.005)	(0.005)
L2.Market value	-0.012	0.008	0.019***
	(0.010)	(0.005)	(0.005)
Size	0.158***	0.160***	0.187***
	(0.007)	(0.004)	(0.004)
Cash/Asset	0.217***	0.094***	0.093***
	(0.035)	(0.014)	(0.014)
Tobin's Q	0.119***	0.073***	0.075***
	(0.004)	(0.001)	(0.001)
Leverage	-0.266***	-0.380***	-0.409***
	(0.024)	(0.013)	(0.014)
Constant	-0.104***	-0.073***	-0.098***
	(0.032)	(0.011)	(0.012)
Observations	14,610	44,901	38,839
R-squared	0.884	0.892	0.892
Number of Corporations	661	2,064	2,005

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.4: This table reports the effect of changes in state level bank taxes on the firms'value. BankTax represents changes in state bank taxes. The values of this variable is borrowed from Farre-Mensa & Ljungqvist (2013). In this table, investment is calculated by summing capital expenditures (Compustat item capxy) and acquisitions (Compustat item aqcy). Size is measured as the natural logarithm of total book value of assets (Compustat item atq). Cash holding is the total amount of cash and short-term investment (Compustat item cheq). Leverage is defined as the sum of long-term debt (Compustat item dlttq) and debt in current liabilities (Compustat item dlcq) over total asset (Compustat item atq). Sales is the total value of sales (Compustat item saleq). Tobin's Q ratio is calculated as the summation of equity market value and liabilities market value (ltq) over the summation of equity book value of asset and liabilities market value. Standard errors are reported in parenthesis. *, ** and *** represent statistical significance at 10%, 5% and 1% level, respectively.

Dep Var: Investment/Asset	(1) High Score	(2) All Rated	(3) Low Score & Non-Rated	(4) Non-Rated
L.Investment/Asset	0.984***	0.797***	0.771***	0.803***
	(0.026)	(0.028)	(0.014)	(0.014)
L.DTmon	-0.005***	-0.007***	-0.002**	-0.002**
	(0.002)	(0.002)	(0.001)	(0.001)
Size	0.016	0.061***	0.029***	0.021***
	(0.010)	(0.010)	(0.004)	(0.004)
Cash/Asset	-0.120***	-0.107***	-0.093***	-0.090***
	(0.026)	(0.030)	(0.013)	(0.012)
L.Cash/Asset	0.109***	0.160***	0.103***	0.088***
	(0.027)	(0.030)	(0.012)	(0.012)
Sale/Asset	-0.038	-0.042	-0.001	0.004
	(0.027)	(0.030)	(0.009)	(0.008)
L. Sale/Asset	0.065**	0.077**	0.021**	0.018**
	(0.029)	(0.031)	(0.009)	(0.008)
L.Tobin's Q	0.002	0.011	0.007***	0.007***
	(0.005)	(0.007)	(0.001)	(0.001)
Leverage	-0.006	0.135***	0.076***	0.055***
	(0.017)	(0.019)	(0.010)	(0.010)
Constant	-0.109	-0.463***	-0.138***	-0.093***
	(0.085)	(0.075)	(0.021)	(0.018)
Observations	937	1,769	5,286	4,454
R-squared	0.695	0.456	0.465	0.513
Number of Corporations	189	368	1,128	959

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.5: This table reports the response of firms' investment to changes in prime loan rates. DTmon represents shocks to prime loan interest rates. These shocks are identified by exogenous monetary policy shocks, Romer and Romer dates, from 1970 onwards. In this table, investment is calculated by summing capital expenditures (Compustat item capxy) and acquisitions (Compustat item aqcy). Size is measured as the natural logarithm of total book value of assets (Compustat item atq). Cash holding is the total amount of cash and short-term investment (Compustat item cheq). Leverage is defined as the sum of long-term debt (Compustat item dlttq) and debt in current liabilities (Compustat item dlcq) over total asset (Compustat item atq). Sales is the total value of sales (Compustat item saleq). Tobin's Q ratio is calculated as the summation of equity market value and liabilities market value (ltq) over the summation of equity book value of asset and liabilities market value. Standard errors are reported in parenthesis. *, ** and *** represent statistical significance at 10%, 5% and 1% level, respectively.

Dep Var: Investment/Asset	(1) High Score	(2) All Rated	(3) Low Score & Non-Rated	(4) Non-Rated
L. Investment/Asset	1.026***	1.022***	1.019***	1.016***
	(0.006)	(0.005)	(0.003)	(0.003)
L.BankTax	-0.001	-0.002**	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Size	-0.003***	-0.001***	0.001***	0.002***
	(0.001)	(0.000)	(0.000)	(0.000)
Cash/Asset	-0.230***	-0.204***	-0.144***	-0.138***
	(0.008)	(0.006)	(0.003)	(0.003)
L.Cash/Asset	0.234***	0.213***	0.146***	0.138***
	(0.009)	(0.006)	(0.003)	(0.003)
Sale/Asset	-0.106***	-0.101***	-0.038***	-0.032***
	(0.007)	(0.005)	(0.002)	(0.002)
L. Sale/Asset	0.132***	0.113***	0.051***	0.046***
	(0.007)	(0.005)	(0.002)	(0.002)
L.Tobin'S Q	0.001***	0.002***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	0.028***	0.017***	0.013***	0.014***
	(0.003)	(0.002)	(0.001)	(0.001)
Constant	0.031***	0.019***	0.003**	-0.001
	(0.005)	(0.004)	(0.001)	(0.001)
Observations	11,337	19,883	61,493	52,947
R-squared	0.757	0.722	0.696	0.691
Number of Corporations	349	668	2,062	2,002

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.6: This table reports the response of firms' investment to changes in state level bank taxes. BankTax represents changes in state bank taxes. The values of this variable is borrowed from Farre-Mensa & Ljungqvist (2013). ExtShock is a dummy variable for represents the simultaneous increase in BankTax and increase of the spread of Aaa corporate bond. In this table, equity market value is calculated as the price close at the end of the quarter (Compustat item prccq) times common shares outstanding (Compustat item chsoq). Investment is calculated by summing capital expenditures (Compustat item capxy) and acquisitions (Compustat item aqcy). Size is measured as the natural logarithm of total book value of assets (Compustat item atq). Cash holding is the total amount of cash and short-term investment (Compustat item cheq). Leverage is defined as the sum of long-term debt (Compustat item dlttq) and debt in current liabilities (Compustat item dlcq) over total asset (Compustat item atq). Tobin's Q ratio is calculated as the summation of equity market value and liabilities market value (ltq) over the summation of equity book value of asset and liabilities market value. Standard errors are reported in parenthesis. *, ** and *** represent statistical significance at 10%, 5% and 1% level, respectively.

Dep Var: Market value	(1) High Score	(2) All Rated	(3) Low Score& Non-Rated	(4) Non-Rated
L.Market value	0.650***	0.843***	0.825***	0.793***
	(0.014)	(0.011)	(0.005)	(0.005)
L2.Market value	0.056***	-0.012	0.008	0.018***
	(0.013)	(0.010)	(0.005)	(0.005)
L.ExtShock	-0.062**	-0.098***	-0.049**	-0.031
	(0.024)	(0.028)	(0.021)	(0.023)
Size	0.289***	0.158***	0.159***	0.186***
	(0.009)	(0.007)	(0.004)	(0.004)
Cash/Asset	0.181***	0.216***	0.094***	0.092***
	(0.038)	(0.035)	(0.014)	(0.014)
Tobin's Q	0.132***	0.119***	0.073***	0.075***
	(0.004)	(0.004)	(0.001)	(0.001)
Leverage	-0.355***	-0.267***	-0.380***	-0.409***
	(0.027)	(0.024)	(0.013)	(0.014)
Constant	-0.117***	-0.105***	-0.073***	-0.098***
	(0.031)	(0.032)	(0.011)	(0.012)
Observations	8,548	14,610	44,901	38,839
R-squared	0.923	0.884	0.892	0.892
Number of Corporations	350	661	2,064	2,005

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 1.7: This table reports the response of firms' value to interest rate changes in both credit markets. BankTax represents changes in state bank taxes. The values of this variable is borrowed from Farre-Mensa & Ljungqvist (2013). ExtShock is a dummy variable for represents the simultaneous increase in BankTax and increase of the spread of Aaa corporate bond. In this table, investment is calculated by summing capital expenditures (Compustat item capxy) and acquisitions (Compustat item aqcy). Size is measured as the natural logarithm of total book value of assets (Compustat item atq). Cash holding is the total amount of cash and short-term investment (Compustat item cheq). Leverage is defined as the sum of long-term debt (Compustat item dlttq) and debt in current liabilities (Compustat item dlcq) over total asset (Compustat item atq). Sales is the total value of sales (Compustat item saleq). Tobin's Q ratio is calculated as the summation of equity market value and liabilities market value (ltq) over the summation of equity book value of asset and liabilities market value. Standard errors are reported in parenthesis. *, ** and *** represent statistical significance at 10%, 5% and 1% level, respectively.

Dep Var: Market value	(1) High Score	(2) All Rated	(3) Low Score & Non-Rated	(4) Non-Rated
L.Market value	0.650***	0.843***	0.825***	0.793***
	(0.014)	(0.011)	(0.005)	(0.005)
L2.Market value	0.056***	-0.012	0.008	0.019***
	(0.013)	(0.010)	(0.005)	(0.005)
L.ExtShock	-0.058**	-0.100***	-0.036	-0.017
	(0.025)	(0.029)	(0.022)	(0.023)
L.BankTax	-0.005	0.002	-0.017**	-0.020***
	(0.008)	(0.010)	(0.007)	(0.007)
Size	0.289***	0.158***	0.160***	0.187***
	(0.009)	(0.007)	(0.004)	(0.004)
Cash/Asset	0.182***	0.216***	0.094***	0.093***
	(0.039)	(0.035)	(0.014)	(0.014)
Tobin's Q	0.132***	0.119***	0.073***	0.075***
	(0.004)	(0.004)	(0.001)	(0.001)
Leverage	-0.356***	-0.267***	-0.380***	-0.409***
	(0.027)	(0.024)	(0.013)	(0.014)
Constant	-0.117***	-0.105***	-0.073***	-0.098***
	(0.031)	(0.032)	(0.011)	(0.012)
Observations	8,548	14,610	44,901	38,839
R-squared	0.923	0.884	0.892	0.892
Number of Corporation	350	661	2,064	2,005

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.8: This table reports the response of firms' value to interest rate changes in both credit markets. BankTax represents changes in state bank taxes. The values of this variable is borrowed from Farre-Mensa & Ljungqvist (2013). ExtShock is a dummy variable for represents the simultaneous increase in BankTax and increase of the spread of Aaa corporate bond. In this table, equity market value is calculated as the price close at the end of the quarter (Compustat item prccq) times common shares outstanding (Compustat item chsoq). Investment is calculated by summing capital expenditures (Compustat item capxy) and acquisitions (Compustat item aqcy). Size is measured as the natural logarithm of total book value of assets (Compustat item atq). Cash holding is the total amount of cash and short-term investment (Compustat item cheq). Leverage is defined as the sum of long-term debt (Compustat item dlttq) and debt in current liabilities (Compustat item dlcq) over total asset (Compustat item atq). Tobin's Q ratio is calculated as the summation of equity market value and liabilities market value (ltq) over the summation of equity book value of asset and liabilities market value. Standard errors are reported in parenthesis. *, ** and *** represent statistical significance at 10%, 5% and 1% level, respectively.

Table 1.9: List of Changes in State Bank Taxes:This table includes the lists all changes in state income tax rates affecting banks and other financial institutions (1989-2011). In states with more than one tax bracket, the change in the top bracket is reported. Source: Farre-Mensa and Ljungqvist (2013).

State	Year	Description
CO	1989	Cut in top rate from 5.5% to 5.4%
IL	1989	Increase in top rate from 4% to 4.8%
NJ	1989	Introduction of a 0.375% tax rate surcharge
WV	1989	Cut in top rate from 9.75% to 9.6%
AZ	1990	Cut in top rate from 10.5% to 9.3%
CO	1990	Cut in top rate from 5.4% to 5.3%
CT	1990	Introduction of a 20% tax surcharge
MN	1990	Increase in top rate from 9.5% to 9.8%
MT	1990	Introduction of a 5% surcharge
NE	1990	Increase in top rate from 3.25% to 3.53%
NY	1990	Introduction of a 15% surcharge
OK	1990	Increase in top rate from 5% to 6%
WV	1990	Cut in top rate from 9.45% to 9.3%
AR	1991	Increase in top rate from 6% to 6.5%
CO	1991	Cut in top rate from 5.3% to 5.2%
MT	1991	Repeal of 5% surcharge
NE	1991	Increase in top rate from 3.53% to 3.81%
WV	1991	Cut in top rate from 9.3% to 9.15%
CO	1992	Cut in top rate from 5.2% to 5.1%
CT	1992	Cut in tax surcharge from 20% to 10%
DC	1992	Introduction of a 2.5% surcharge on tax liability
MT	1992	Re-introduction of tax surcharge on tax liability at 2.3% rate
NY	1992	Cut in tax surcharge from 15% 10%
WV	1992	Cut in top rate from 9.15% to 9%
CO	1993	Cut in top rate from 5.1% to 5.0%
CT	1993	Repeal of 10% tax surcharge
MT	1993	Increase in tax surcharge on tax liability from 2.3% to 4.7%
NH	1993	Cut in top rate from 8% to 7.5%
NY	1993	Repeal of 10% tax surcharge
AZ	1994	Cut in top rate from 9.3% to 9%
DC	1994	Introduction of additional 2.5% tax surcharge on tax liability
HI	1994	Cut in top rate from 11.7% to 7.92%
MT	1994	Repeal of 4.7% tax surcharge

NH	1994	Cut in top rate from 7.5% to 7%
NJ	1994	Repeal of 0.375% tax surcharge
CA	1995	Cut in top rate from 11.47% to 11.3%
CT	1995	Cut in top rate from 11.5% to 11.25%
DC	1995	Cut in top rate from 10% to 9.5% (+2 tax surcharges at 2.5% each)
MA	1995	Cut in top rate from 12.54% to 12.13%
CT	1996	Cut in top rate from 11.25% to 10.75%
MA	1996	Cut in top rate from 12.13% to 11.72%
RI	1996	Increase in top rate from 8% to 9%
CA	1997	Cut in top rate from 11.3% to 10.84%
CT	1997	Cut in top rate from 10.75% to 10.5%
MA	1997	Cut in top rate from 11.72% to 11.32%
NC	1997	Cut in top rate from 7.75% to 7.5%
AZ	1998	Cut in top rate from 9% to 8%
CT	1998	Cut in top rate from 10.5% to 9.5%
MA	1998	Cut in top rate from 11.32% to 10.91%
NC	1998	Cut in top rate from 7.5% to 7.25%
CO	1999	Cut in top rate from 5% to 4.75%
CT	1999	Cut in top rate from 9.5% to 8.5%
KS	1999	Cut in top rate from 4.25% to 2.25%
MA	1999	Cut in top rate from 10.91% to 10.5%
NC	1999	Cut in top rate from 7.25% to 7%
NH	1999	Increase in top rate from 7% to 8%
AZ	2000	Cut in top rate from 8% to 7.968%
CO	2000	Cut in top rate from 4.75% to 4.63%
CT	2000	Cut in top rate from 8.5% to 7.5%
NC	2000	Cut in top rate from 7% to 6.9%
AL	2001	Increase in top rate from 6% to 6.5%
AZ	2001	Cut in top rate from 7.968% to 6.968%
ID	2001	Cut in top rate from 8% to 7.6%
NH	2001	Increase in top rate from 8% to 8.5%
NY	2001	Cut in top rate from 9% to 8.5%
NY	2002	Cut in top rate from 8.5% to 8%
TN	2002	Increase in top rate from 6% to 6.5%
AR	2003	Introduction of 3% tax surcharge on tax liability
CT	2003	Introduction of 20% tax surcharge on tax liability
NY	2003	Cut in top rate from 8% to 7.5%
CT	2004	Increase in surcharge to 25%

AR	2005	Repeal of 3% tax surcharge on tax liability
CT	2006	Cut in tax surcharge from 25% to 20%
NJ	2006	Introduction of 4% tax surcharge on tax liability
NY	2007	Cut in top rate from 7.5% to 7.1%
WV	2007	Cut in top rate from 9% to 8.75%
CT	2008	Repeal of 20% tax surcharge
MD	2008	Increase in top rate from 7% to 8.25%
NC	2009	Introduction of 3% tax surcharge on tax liability
OR	2009	Increase in top rate from 6.6% to 7.9%
WV	2009	Cut in top rate from 8.75% to 8.5%
MA	2010	Cut in top rate from 10.5% to 10%
NJ	2010	Repeal of 4% tax surcharge
IL	2011	Increase in top rate from 7.3% to 9.5%
MA	2011	Cut in top rate from 10% to 9.5%
NC	2011	Repeal of 3% tax surcharge
ND	2011	Cut in top rate from 7% to 6.5%
OR	2011	Cut in top rate from 7.9% to 7.6%

1.6 Appendix

This section provide the proof for propositions of this chapter. To provide more insight, I start from proposition 1.2.2.

Proof of proposition 1.2.2:

In the first period, if z_1 was deterministic and equal to $\overline{z}$, the optimal investment of the firm would be $b^{\max}$ equal to:

$$b^{\max} = \left(\frac{\alpha\overline{z}}{r_1}\right)^{\frac{1}{1-\alpha}}$$

and the firm would never hold cash or issue dividend.

Similarly, the firm would follow a corresponding scheme and invests $b^{\min}$ in case $z_1 = \underline{z}$ where:

$$b^{\min} = \left(\frac{\alpha\underline{z}}{r_1}\right)^{\frac{1}{1-\alpha}}$$

Hence, when the firm faces with uncertainty of z_1, it will borrow some amount between these extreme values. Borrowing neither more than $b^{\max}$ nor less than $b^{\min}$ is never optimal for firms. Hence I restrict my attention to different optimal borrowings in this range. Lets think about two different case:

(i): If the firm borrows any amount b_1 and $\overline{z}$ is realized, it is optimal to invest it all ($k_1 = b_1$) since marginal benefit of investment is larger than marginal benefit of holding cash or issuing dividend (look at assumptions (i) to (iii)).

(ii): If the firm borrows b_1 and $\underline{z}$ is realized, it is not necessarily optimal to invest all b_1 since marginal return of investment is less than r_1, and it might be optimal to hold some part of this amount in cash or distribute it as dividend.

In case (ii), the maximum investment is determined by comparing marginal benefit of all competing alternatives. The marginal benefit of issuing dividend is simply equal to 1. The marginal benefit of transferring one unit of cash to period 2 is:

$$\beta E(\lambda_2(r_{m2}, r_{b2}, x_2))(1-\upsilon)r_1$$

where $\lambda_2(r_{m2}, r_{b2}, x_2)$ is the shadow price of cash constraint in period 2. However, considering the uncertainties of interest rates, this term is considered in expectation (I remind that cash is transferred to next period by short-term lending with rate $(1-\upsilon)r_1$). Moreover, the marginal return of investing b_1 which yields in the second period is:

$$\alpha\beta E(\lambda_2(r_{m2}, r_{b2}, x_2))\underline{z}b_1^{\alpha-1}$$

Comparing marginal profits of these alternatives, the firm never invests more than $\widehat{b}_1$ where

$$\widehat{b}_1 = \left(\frac{\alpha \underline{z}}{\gamma(r_{m2}, r_{b2}, x_2)}\right)^{\frac{1}{1-\alpha}}$$

and

$$\gamma(r_{m2}, r_{b2}, x_2) = \max\left\{(1-\upsilon)r_1, \frac{1}{\beta E(\lambda_2(r_{m2}, r_{b2}, x_2))}\right\}$$

Collectively, if the firm initially had borrowed less or equal than $\widehat{b}_1$, it invests it all. If the amount of initial borrowing is more, the firm only invests $\widehat{b}_1$ and the extra resources are held as cash (if the benefits of cash holding exceeds the benefit of dividend) or distribute it as dividend. Alternatively, the firm keep it as cash iff:

$$\beta E(\lambda_2(r_{m2}, r_{b2}, x_2))(1-\upsilon)r_1 \geq 1$$

where the right hand side of inequality is the generated benefit for shareholders from holding one unit of cash.

Proof of lemma 1.2.1:

If the firm borrows b_1 and there is no alternative other than investment, the firm would invest it all ($k_1 = b_1$) and the expected profit for the firms is:

$$p\underline{z}b_1^{\alpha} + (1-p)b_1^{\alpha} - r_1 b$$

The optimal amount of debt in this case is:

$$b_1^* = \left(\frac{\alpha E(z)}{r_1}\right)^{\frac{1}{1-\alpha}}$$

However, referring to the previous proof, this holds only if b_1^* does not exceed $\widehat{b}_1$, or equivalently (look at the proof of proposition 1.2.2):

$$\frac{E(z)}{\underline{z}} \leq \frac{r_1}{\gamma(r_{m2}, r_{b2}, x_2)}$$

If this inequality holds, the firms always borrows b_1 and invests it for any realization of z. It is easy to show that this inequality holds iff

$$p \geq \frac{\gamma(r_{m2}, r_{b2}, x_2)\overline{z} - r_1\underline{z}}{\gamma(r_{m2}, r_{b2}, x_2)(\overline{z} - \underline{z})}$$

If p does not satisfy this inequality, the firm will consider other alternatives as well. Formally, considering the following return function the firms decides how much debt to issue:

$$p\underline{z}\widehat{b}_1^{\alpha} + p\gamma(r_{m2}, r_{b2}, x_2)\left(b_1 - \widehat{b}_1\right) + (1-p)\overline{z}b_1^{\alpha} - r_1 b_1$$

With some algebra we can show that firm's optimal borrowing is:

$$b_1^* = \left(\frac{\alpha(1-p)\overline{z}}{r_1 - p\gamma(r_{m2}, r_{b2}, x_2)}\right)^{\frac{1}{1-\alpha}}$$

Proof of proposition 1.2.4:

Case (i) is intuitive. Since unconstrained firms do not use bank loans, their optimization problems are independent of r_{b2}. Hence any increase in r_{b2} does not impact unconstrained firms. Obviously, it has a negative effect of constrained firms which use bank loans.

Case (ii) is also intuitive. All decision variables of firms are independent from r_{b2}. Hence any change in r_{b2} has no effect on firms.

Case (iii) is the main point of this proposition. In this case, both firms are impacted by the shock because of their reliance of bank loan. Moreover, both firms have the same investment regarding similar productivity factor in the second period, $z = \overline{z}$. Therefore, according to optimality equations (1.1) and (1.2), the firms with lower internal cash flow (w_2) will be impacted harder by interest rate changes. This is clear from equations (1.1) and (1.2) since unconstrained firms need to borrow more. This higher reliance on external financing causes then to be impacted more for a similar increase in the interest rate.

Chapter 2

How Small and Large Firms Respond to Tax Changes: Evidence from US Manufacturing Data

This chapter provides evidence on the different effects of corporate taxation across small and large firms. We use a local projection model to estimate the dynamic effects of tax policy changes on firms real and financial variables. We distinguish between changes in personal and corporate income taxes by narratively identified tax policy changes in the United States over the post-WWII period. Our estimates show that small firms account for a major share of aggregate changes of investment and sales following a corporate tax cut. Results are shown to be robust even controlling for personal tax changes. In addition, we find that while both firms increase their use of external financing, small firms rely much more heavily on debt to finance investment. Cash reserves of large firms appear to be a strong substitute for debt in response to a corporate tax cut[1].

2.1 Introduction

Corporate taxation has been one of the most widely discussed issues in the area of macroeconomics and corporate finance. Measuring the effect of tax changes on corporate investment is crucial for both tax policy evaluation and business cycle analysis.

The common view in the literature of fiscal policy is that the effect of tax changes on aggregate business investment is significant and many preexisting studies in this line of literature revealed that investment responds so strongly to tax changes (e.g. Blanchard and Perotti, 2002 and Romer and Romer, 2010). Moreover, Eskandari (2014) shows that such a strong investment response to tax changes is the main transmission mechanism

[1] This chapter is a joint research with Ruhollah Eskandari, PhD student in Economics - DEFAP at Università degli Studi di Milano - Bicocca.

of tax policy on output, and also suggests that the important part of the output state-dependent responses appears to be due to the non-linear behavior of business investment. However, investigating this effect has been limited to aggregate level analysis. There have been no controlled studies in fiscal policy comparing the responses of small v.s. large firms to corporate tax changes.

In addition, extensive research in corporate and public finance has been carried out on the impact of corporate tax policies on firms' investment. They found that taxation has a significant effect on investment (Hassert and Hubbard, 2002 for a review). However, as mentioned in Bond and Reenen (2007), it is perhaps a little too early to agree with Hassett and Hubbard (2002) that there is a new consensus on the size and robustness of this effect. Nonetheless, these studies mostly rely on datasets which restrict attention to publicly traded firms, such as *Compustat*. Although many of these studies control for size in estimating the effect of taxes on corporate investments, but since small firms are mostly private, they are excluded from such datasets and findings of many of these studies are thus biased towards large- and medium-sized firms.

While fiscal policy scholars mainly use aggregate data and then miss the marginal incentives, corporate finance scholars mainly rely on micro-data and then miss the overall economic conditions and also do not consider small firms behavior to investigate the response of investment to tax changes. However, over the past few years, a growing number of empirical studies have provided evidence that tax policy effects are different depending on the size of firms. The focus of these studies is on the differential effect of bonus depreciation policy on firms in different sizes (e.g. Zwick and Mahon, 2015 and Winberry, 2015). A serious concern about these studies, however, is that US bonus depreciation laws targeted specifically at small businesses (House and Shapiro, 2008) or at least the limits on its use tend to confine its benefits to small firms (Guenther, 2014). Hence, the results are biased and not very informative about the role of size.

This paper attempts to contribute to the empirical literature by investigating the effects of tax changes on both real and financial variables of the firms in different sizes. Understanding the discriminate effect of tax changes on firms in different size classes might be very insightful for realizing the channels through which taxation impacts the real economy. For this purpose, we use the *Quarterly Financial Report* (QFR), which is an inclusive estimate of all US manufacturing firms. This dataset reports real and financial variables of manufacturing corporations in all sizes which makes it ideal for our research purposes. This dataset contains a wide range of historical data, ranging from 1954 to the present. This allows us to explore different episodes of tax changes. It is particularly important because exogenous variations in the tax rates are not very frequent in the United States. Another advantage of using QFR is the quarterly frequency of the reported data. Hence, we can include a large set of macroeconomic variables in our econometric framework. Many macroeconomic variables such as GDP and inflation as well as many other data series are originally being observed and reported in quarterly frequencies (Schorfheide and Song, 2013). QFR permits us to use the informational content of such macroeconomic time series[2].

Also, identifying exogenous sources of tax shocks is another concern in measuring the effects of tax policy on investment. As we will discuss, papers in corporate and public finance typically do not exclude tax changes that are endogenous to macroeconomic conditions. This strand of literature do not separate tax changes to endogenous and exogenous shocks with respect to the macroeconomic conditions, which is paid lots of attention in fiscal policy. In this study we follow the narrative approach pioneered by Romer and Romer (2010) to identify exogenous corporate and personal income tax rates. In particular, we employ Mertens and Ravn (2013) approach to identify exogenous tax policy changes as proxies for structural tax shocks. Alesina, Favero and Giavazzi (2015) point out some of the main advantages of using narrative approach, such as the shocks identified via a narrative method are model independent and therefore are not affected by the possible omitted variables. Moreover, the narrative approach we can distinguish between anticipated and unanticipated components of fiscal policy shocks, and finally using narratively identified tax changes permits us to distinguish between corporate and personal tax changes which is very important when considering their impact on firms.

However, the role of firm size in macroeconomic volatilities has been taken into consideration in other strands of macroeconomics. Gertler and Gilchrist (1994) (GG) explore the response of small and large manufacturing firms to monetary policy shocks. They employ QFR data from 1958 to 1992 to compare how the sales, inventory and short-term debt of firms in different sizes respond to credit contractions. To control for credit contractions, they take the exogenous monetary policy dates of Romer and Romer (1994). They find that small firms account for the majority of decline in aggregate volatilities. GG explain this differential response of the firms by their relative access to credit markets. Since size is a proxy for access to capital market, small firms are impacted harder when the credit market tightens. Another recent work is that of Chari et. al. (2013), which examines the findings of GG using QFR data by constructing the same measures of firms' reactions to contractionary monetary shocks. Their findings mirror those of the GG study. In addition, they propose an answer to the related question of the behavior of small v.s.

[2]There are two semi-aggregate datasets reporting real and financial variables of US corporations in size classes; *Quarterly Financial Report* (QFR) and IRS's *Statistics of Income* (SOI). SOI reports taxable income sheet and balance sheet data of all US corporations, broken down by firm size. Nonetheless, SOI has some absolute advantages over QFR data. While QFR is only based upon a sample survey, SOI is constructed from tax return reports of all corporations in the US (around 150,000 firms in 2011). SOI is also richer in terms of data items and sectors which are included. However, the main advantage of QFR which makes it more proper for our research purposes is its quarterly frequency while SOI is conducted annually. In most business cycle applications, time series regressions are conducted based on quarterly observations to capture the aggregate volatilities with more precision.

large firms in recessions. They conclude that unlike in the case of monetary shocks, no significant differential response to real business cycle shocks is observed between these firms. In a related work, Kudlyak et. al. (2010) produce results which corroborate the findings of the previous works. Moreover, they look at the firms' performance aftermath of the 2008 credit crunch through the lens of GG. Using the same dataset and the same methodology, they find that unlike previous episodes of credit tightening, large firms were relatively more sensitive in the recent financial downturn. In another study, Moscarini and Posetl-Vinay (2012) document a stronger counter-cyclicality of large rather than small employers to unemployment cycles. They define employer size in terms of employee numbers and compare the net job creation rate of firms in different size brackets. They draw their data from the new Census Bureau's *Business Dynamic Statistics* (BDS), covering the period between 1978 and 2009, as well as matched employer-employee datasets from Denmark and France. They present evidence of higher volatility of large firms in response to unemployment dynamics.

Moreover, there are few related papers in tax literature which use comprehensive data of both small and large firms. Gordon and Lee (2001) use US *Statistics of Income* (SOI) *Corporate Income Tax Returns* data (1950-1995) to estimate the effect of corporate tax changes on corporate debt policies. Their results suggest that the effect of taxes on a firm's debt is significant such that cutting corporate tax rate by ten percentage points (e.g. from 46% to 36%), reduces the debt to asset ratio by around 3.5%. Moreover, they run a difference in difference regression to see how size matters in the corporate use of debt. They find evidence of a large effect of taxes on debt to asset ratios for the smallest and the largest size classes, but much less of an effect for intermediate sized firms. They also use aggregate data to estimate the separate effects of corporate and personal tax rates on debt to asset ratio. The results show significant and robust results for both types of taxes, but with opposite signs. Contos (2011) extends the study of Gordon and Lee (2001) by estimating their model with the same data from 1993 to 2000. His results qualitatively agree with the findings of Gordon and Lee. However, using micro-level data and constructing marginal tax rates from taxable income before the interest deduction. They evidence the positive relation between tax and debt usage in all three categories of small, medium and large firms. Another recent study conducted by Longstaff and Strebulaev (2014) which examines the interaction of leverage and corporate tax rates using micro-level data of SOI. Their results are consistent with those of other studies and suggest a positive relationship between corporate tax rates and corporate leverage. However, by controlling for size they find that this relationship is significant for all asset size classes with the exception of small firms. They also find that the adjustment process of leverage in response to tax changes is faster for large firms. Large firms respond over a short period, while intermediate-size firms react with a lag.

All these papers emphasize the notion of tax shields. According to this concept, corporate taxation provides an opportunity for firms to benefit from allowable deduction by using debt. Hence they have an incentive to finance with debt rather than equity. According to this argument, firms with higher access to credit markets are expected to raise their leverage after any increase in the corporate tax rates. The other part of this literature addresses the effect of personal taxation on corporate bond spread. As Elton et. al. (2001) argue, corporate taxation has a significant effect on the spread between rates on corporate and government bonds. They suggest that state tax on corporations accounts for a substantial portion of the premium in corporate rates over treasuries. This premium exists since interest income from corporate bonds is taxed whereas the interest income from treasury and municipal bonds are not. This tax exemption motivates investors to demand a higher spread on corporate bonds which amplify the degree of firms' credit constraint. According to this story, any increase in income taxation put a higher pressure on the firms which rely more of public debt market. Finally, some papers study the interaction of corporate and personal taxes (Graham, 2006). Miller (1977) stresses the opposite effects of corporate and personal taxes on the firms debt policy and suggests that personal taxation completely offset the corporate tax advantage of debt. All these empirical studies restrict their attention to the debt policy of corporations of different sizes. Moreover, there is no known study that measures the effect of taxation on firms' investment including small private firms.

In summary, the findings about how the interaction of tax and corporate real and financial variables is associated with size is still weak and inconclusive. This lack of relevant research indicates a need for more focus on various aspects of the issue.

This paper contributes to this literature by exploring the relationship between tax and both real and financial variables of firms. Meanwhile, we take into consideration endogeneity concerns which are neglected in some of the related papers. A number of major findings emerged in our study are as follows. We find that large firms account for a major share of aggregate changes of investment and sales following a corporate tax cut. Results are robust to many alternative specifications and also after controlling for personal income taxation. Our estimates show that all firms respond to corporate tax cuts by increasing their investment, sales and inventories. In all three variables, the response of large firms is larger. However, the differential response is mainly significant for investment and inventory, but less for sales. About financial variables, the result suggest that both small and large firms significantly increase their debt, but large firms more. Moreover, the results suggest that large firms significantly decrease their cash reserves. We did not find evidences of any significant change in cash reserves of small firms. This suggest that large firms mainly have financed their investment with issuing debt and cash reserves, while small firms relied only on external financing.

2.2 Data Description

The data used in this paper is compiled from the *Quarterly Financial Report* (QFR) of US manufacturing firms. The QFR program has collected and released statistics of US manufacturing firms at quarterly frequencies since 1950[3]. Currently, the program also covers mining, wholesale trade, retail trade and some selected service industries as well. Based upon a sample survey, the QFR reports income statements, balance sheets and related financial and operating ratios for US firms broken down by asset size and industry.

The main advantages of QFR for our research purposes are (i) providing data at business cycle frequencies, (ii) covering both small and large firms and (iii) a long period coverage of data. The latter is crucial as the exogenous variations in corporate taxation tend to be infrequent. This long coverage allows us to control for enough tax changes in order to complete our empirical analysis.

Currently, the QFR semi-aggregate statistics are released in 8 asset size brackets (all in million dollars); [< 5, 5-10, 10-25, 25-50, 50-100, 100-250, 250-1000, and >1000]. Moreover, there are some changes in size brackets and reported data items in 1974, 1980 and 1988. All these data we integrated in unified forms and transformed into electronic versions for the purpose of this study. However, prior to 1988, the data was only available in hard copies. We extended the data back to 1956Q1 by collecting data from various issues of the QFR books. We collected all balance sheet and income statement's items. The data are constructed using a simple version of the procedure applied in GG. However, these measures of size are all in nominal terms. This might lead to some measurement bias since inflation and growth trends cause firms to shift to larger size groups over time. In the next part we will introduce our categorization procedure to adjust for this bias.

2.3 Definition of Small and Large Firms and Econometric Framework

In this section, we first introduce net sales as our indicator of firm size. We then employ a linear local projection technique to estimate the effects of tax changes on firms, separately for small and large firms.

[3]The QFR program is conducted under the authority of Title 13 of the United States Code, Section 91, which requires that financial statistics of business operations be collected and published quarterly. The law imposes a joint obligation on corporations to respond and on the U.S. Census Bureau to maintain the confidentiality of information reported (http://www.census.gov/econ/qfr/historic.html).

2.3.1 Definition of Small and Large Firms

Figure 2.1 shows the dynamics of total assets in each class size from 1950 onwards. Figure 2.2 depicts the same dynamics for inflation adjusted assets. As one can see from this figure, the total asset is decreasing in the smallest class. However, this trend is strictly increasing in the largest class, while there are some volatilities in intermediate-sized classes. This might be primarily due to the effect of inflation and growth dynamics. The same trends are depicted in figures 2.3 and 2.4 for sales. To adjust for this bias, we follow the procedure of GG to aggregate all size classes into small and large groups based on their sales. We sort the size classes and accumulate their sales beginning from the smallest class until we reach the thirtieth percentile of the total sales at each period.

More formally, let S_{it} denotes total sales of firms in category i, in period t. We define $\overline{S}_{it}$ as the accumulated sales for categories less or equal to category i, normalized by total sales in that period (N is the number of categories):

$$\overline{S}_{it} = \frac{\sum_{j=1}^{i} S_{jt}}{\sum_{j=1}^{N} S_{jt}}$$

Then we compute the threshold value i_t and weights ω_t and ω_{t-1} such that categories i_t and i_{t-1} average 30 percent of sales at time t:

$$i_t = \min_{i \leq N_t} \left\{ \overline{S}_{it} > 0.3 \right\}$$

$$\omega_t \overline{S}_{i_t - 1, t} + (1 - \omega_t) \overline{S}_{i_t, t} = 0.3$$

Figure 2.5 depicts the cut-offs that straddle this thirtieth percentile over the period of analysis. When the cut-off falls inside the largest category, we simply set ω_t equal to one for calculating the growth rate of small firms.

Now we can define the growth rate of any variable of interest for both small and large groups as follows:

We define G as any variable of interest and g_t^S and g_t^L denote small and large firms.

$$g_t^S = \omega_{t-1} \frac{\sum_{j=1}^{i_{t-1}-1} G_{j,t}}{\sum_{j=1}^{i_{t-1}-1} G_{j,t-1}} + (1 - \omega_{t-1}) \frac{\sum_{j=1}^{i_{t-1}} G_{j,t}}{\sum_{j=1}^{i_{t-1}} G_{j,t-1}}$$

and

$$g_t^L = \omega_{t-1} \frac{\sum_{j=i_{t-1}}^{N_t} S_{j,t}}{\sum_{j=i_{t-1}}^{N_t} S_{j,t-1}} + (1 - \omega_{t-1}) \frac{\sum_{j=i_{t-1}+1}^{N_t} S_{j,t}}{\sum_{j=i_{t-1}+1}^{N_t} S_{j,t-1}}$$

Notice that the weight are the ones derived for period $t-1$. As discussed by GG, this procedure reasonably adjusts for biases arising from shifting firms across categories. The obtained growth rates of small and large firms are not seasonally adjusted. We perform this adjustment by using a moving average over four quarters and detrent the series by Hodrick-Prescott (HP) filter.

We then employ a linear local projection technique to estimate the effects of tax changes on firms' real and financial decisions, separately for small and large firms.

2.3.2 Local Projection Method

Following the methodology developed by Auerbach and Gorodnichenko (2013) and Ramey and Zubairy (2014), we use Jorda's (2005) local projection model to estimate impulse responses of the real and financial variables of firms in different sizes to exogenous tax changes. The Jorda model is based on sequential regressions that can be estimated by simple regression techniques for each horizon h and for each variable and then constructing the impulse response function[4]. We apply this model separately for small and large firms. The linear model looks as follows:

$$\Delta Y_{t+h} = \alpha_h + A_h(L)X_{t-1} + B_h shock_t + \epsilon_{t+h} \quad for \;\; h = 0, 1, 2, ... \tag{2.1}$$

where the *shock* is our exogenously identified corporate tax shocks, $\Delta Y_{t+h} \equiv Y_{t+h} - Y_{t-1}$ is the variable of interest[5], $A_h(L)$ is a polynomial in the lag operator. We estimate the series of regressions using quarterly data, where X is the control variables and $A_h(L)$ is a polynomial of order 4. Indeed, the coefficient B_h gives the accumulated response of ΔY at time $t+h$ to the shock at time t. In fact, each step in the accumulated IRFs is obtained from a single equation. The Newey-West corrected standard errors is employed to control the serial correlation in the error terms induced by the successive leading of the dependent variable.

Local projection technique computes impulse responses without specification and estimation of the underlying multivariate dynamic system. Thus, in contrast to the vector autoregression (VAR) model, where the impulse response coefficients are high-dimensional nonlinear functions of estimated parameters. Local projection method directly estimates impulse response coefficients as a sequence of the B_h's estimated in a series of single regressions for each horizon. This means that the coefficients $A_h(L)$ only control dynamic

[4]This technique has been used by Stock and Watson (2007) for forecasting the US rate of price inflation.

[5]This definition of dependent variables allows us to compare the behavior of firms before and after shocks.

effects of the baseline control variables and are not used directly to build IRFs[6]. Thereupon, Jorda model is less sensitive to misspecification of the SVAR models because it does not constrain the shape of the impulse response function. Thus, Jorda's method is a preferable alternative to VARs when calculating impulse responses is the object of interest.

Despite the above-mentioned advantages of Jorda's method, most of the estimated impulse responses using this method suffer from some weaknesses, such as erratic estimates because of the loss of efficiency and oscillations at longer horizons[7]. However, as also mentioned by Ramey and Zubairy (2014), for our analysis the short-run responses are concerned, and we are not interested in the long-run results. For this reason and also following Gertler and Gilchrist (1994), we estimate our impulse response functions over 16 horizons, i.e., $h = 0, 1, 2, ..., 16$.

2.4 Empirical Results

We begin by presenting the baseline results of our analysis using a minimalist specification of the local projection method and quarterly data for the US over the sample from 1956 through 2006. Then, we perform extensive robustness checks with respect to the inclusion of a variety of control variables, to the identification method, and to our econometric methodology.

2.4.1 Baseline Results

Following Romer and Romer (2010), we first present the baseline results by considering a minimalist specification of the model to estimate the effects of corporate tax changes on the investment and leverage policies of small and large firms. The model can be written as follows:

$$\Delta Y_{t+h} = \alpha_h + B_h shock_t + \epsilon_{t+h} \quad for\ \ h = 0, 1, 2, ... \tag{2.2}$$

where ΔY is the growth rates of investment and leverage of small and large firms and *shock* is an exogenous corporate tax cut based on our exogenously identified corporate tax rates. We estimate this model for each of the interested variable and separately for small and large firms. Since our corporate tax series are assumed to be truly exogenous, they

[6] Discussed in details in the next section

[7] See Ramey (2012b) for a detailed discussion, where she compares impulse responses estimated using Jorda's method with a standard VAR and dynamic simulation.

are unlikely to be systematically correlated with other factors affecting output in the short or medium run. Then there should be no need to control for other shocks[8]. However, many other factors besides corporate tax changes affect real and financial decisions of firms. Cost of capital, cash flows, personal tax shocks and macroeconomic conditions, as well as dynamics of leverage and investment are all likely components of ϵ_{t+h}. In the next section and in order to rule out the possibility of such correlations, we experiment with augmenting model with a variety of control variables.

We now present the results of our baseline analysis using equation 2.2. Figure 2.8 shows the estimated responses of investment and leverage to an exogenous corporate tax cut across small and large firms. First row of Figure 2.8, shows the responses of investment of firms in different sizes to a corporate tax cuts. As one would expect, corporate tax cut raises investment of both small and large firms. In particular, in the first two quarters after the tax change, investment response of small firms are not statistically significant, but then steadily and rapidly rise for the next two years. Interestingly, the investment response of large firms to tax changes is bigger than small firms and significant at every horizon. This implies that, the impact of an exogenous corporate tax policy on investment are different across firms. Perhaps surprisingly, as shown in the second row of figure 2.1, the estimated response of leverage look very different from the investment behavior that is quite different across firms. These findings imply that, small firms mostly increase debt to finance new investment but large firms use both debt and cash reserves. The light and dark shaded areas represent, respectively, 90% and 68% confidence bands for the linear model and are based on Newey-West corrected standard errors.

2.4.2 Robustness

In this section we conduct various robustness checks with respect to the inclusion of a variety of control variables, to the identification method, and to our econometric methodology.

Controlling for Other Variables

We now verify the sensitivity of our benchmark results with respect to the numerous control variables. To this end, we estimate our model by augmenting many other factors that affect real and financial decisions of firms. We include four lags of the US bank prime loan-middle rate- and US *Baa* corporate bond yield as two measures of cost of capital, net income before tax as an indicator of cash flows, and growth rates of GDP and inflation

[8]Romer and Romer (2010) tax changes motivated by factors unrelated to the current or prospective state of the economy.

rate to control macroeconomic conditions[9]. In each regression we also include four lags of investment and leverage to control for potential persistence in investment and leverage changes.

As Figure 2.9 shows, controlling for a variety of control variables has little impact on the estimated effects of exogenous corporate tax cuts on real and financial decisions of small and large firms. This implies that our baseline results are robust to many other control factors. The estimated investment response of small firms is not significantly different from zero over the first year after shock.

Identifying Personal Tax Shocks

Personal income tax policy is perhaps the most omitted variable to consider. Ideally, we would like to estimate the effect of corporate tax changes across firms, but there are a potential contemporaneous changes in corporate and personal tax rates. In our sample, the correlation between personal and corporate income narrative tax changes are 0.28 and 0.31 for small and large firms, respectively[10]. We introduce two solutions to deal with this possible measurement error. We first include the narratively identified personal tax shocks along with our exogenous corporate tax shocks in equation 2.2. We then use an alternative solution to exploit information contained in personal tax shocks. We propose four lags of the average personal income tax rate[11] instead of the narratively identified personal tax shocks in equation 2.2.

Figure 2.3 shows the estimated responses based on the first identification strategy. The figure shows that controlling for personal tax shocks has almost no effect on the results. This indicates that potential measurement error due to correlation between two taxes is not a serious concern in our analysis.

A comparison of the three identification strategies has shown in Figure 4. As this figure makes clear, different identification of the model with respect to two different tax policies do not affect our baseline results across firms. In fact, including personal income tax shocks in the model strengthens the estimated investment response of both small and large firms. Although, leverage response is different across firms for different specification.

[9]Our results are robust to using unemployment rate and also detrended log level of GDP instead of GDP growth.

[10]See Mertens and Ravn (2013) for a detailed discussion, where they show the importance of distinguishing between personal and corporate income tax policies when estimating their effects on aggregate macroeconomic variables.

[11]We use Mertens and Ravn (2013) constructed proxies for the average personal income tax rate and narratively identified personal tax shocks.

Other Real and Financial Variables

Based on our baseline estimation, we find that the effects of exogenous corporate tax cut on investment and leverage are different depending on firm size. We need to study responses of other variables to understand the workings of exogenous corporate tax shocks and shed light on how or why tax changes have such different effects across firms. To that end, we examine the responses of the corporate real and financial policies, such as nest sales and inventories from the real policies, as well as cash holding and total debt policies for the financial side. Ideally, one would like to examine the effects of changes in short-term loan from bank which contains valuable information about, specially, small firms external debt policies, but there are practical limits to the firms' short-term loan in data availability.

Figure 2.12 shows the nest sales and inventories responses to a corporate tax cut. The results for both real decisions look quite similar to the investment policy that large firms respond larger than small firms for a corporate tax cut. Finally figure 2.13 presents the effect of corporate tax changes on the cash holding and total debt policies of firms in different sizes. Perhaps somewhat surprising is that the behavior of large firms cash holding policy. While the response is not significantly different from zero for small firms, cash holding of large firms falls strongly in response to a tax cut, and suggests that large firms not only increase debt but also, more likely, use their cash to finance investment in response to tax policy changes.

2.5 Conclusion

This chapter contributes to this literature by exploring the relationship between tax and both real and financial variables of firms. Meanwhile, we take into consideration endogeneity concerns which are neglected in some of the related papers. A number of major findings emerged in our study are as follows. Our estimates show that large firms account for a major share of aggregate changes of investment and sales following a corporate tax cut. Results are shown to be robust to many alternative specifications and also after controlling for personal tax changes. We find that all firms respond to corporate tax cuts by increasing their investment, sales and inventories. In all three variables, the response of large firms are larger. However, the differential response is mainly significant for investment and inventory, but less for sales. In addition, we find that while both firms increase their use of external financing, small firms rely much more heavily on debt to finance investment. Cash reserves of large firms appear to be a strong substitute for debt in response to a corporate tax cut.

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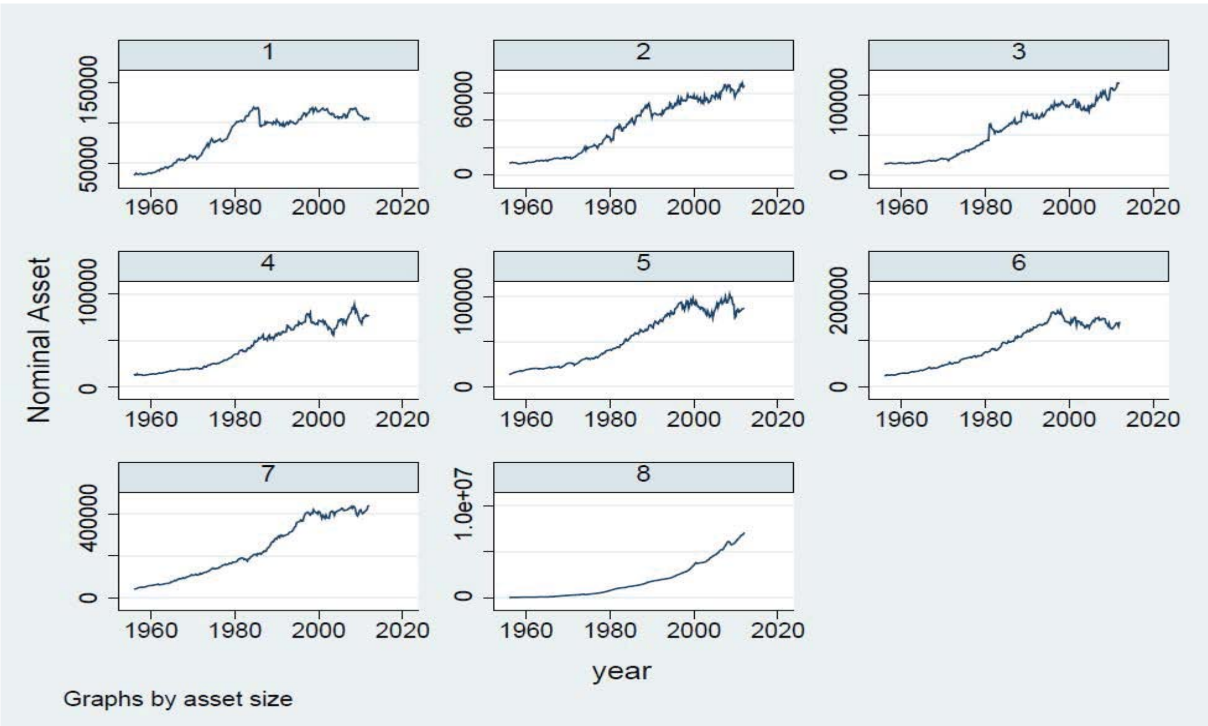
2.7 Figures

Figure 2.1: Nominal Asset in each Size Group

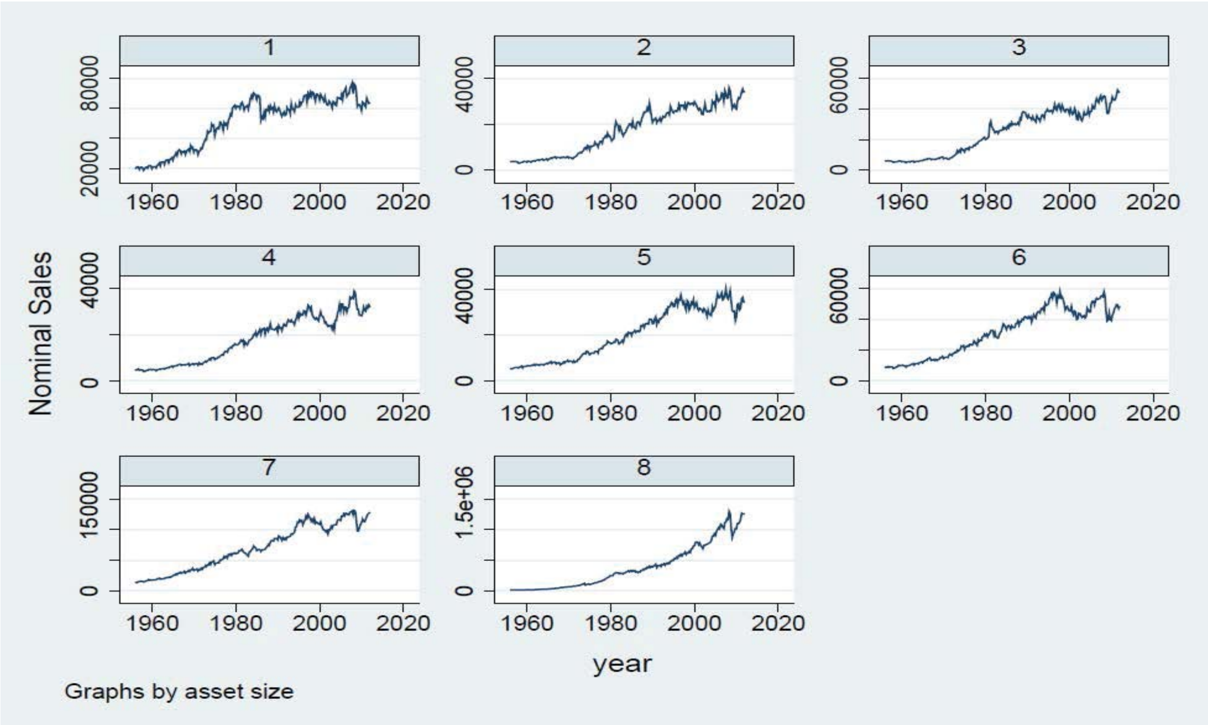


Source: QFR and Authors Calculation

Figure 2.2: Real Asset in each Size Group

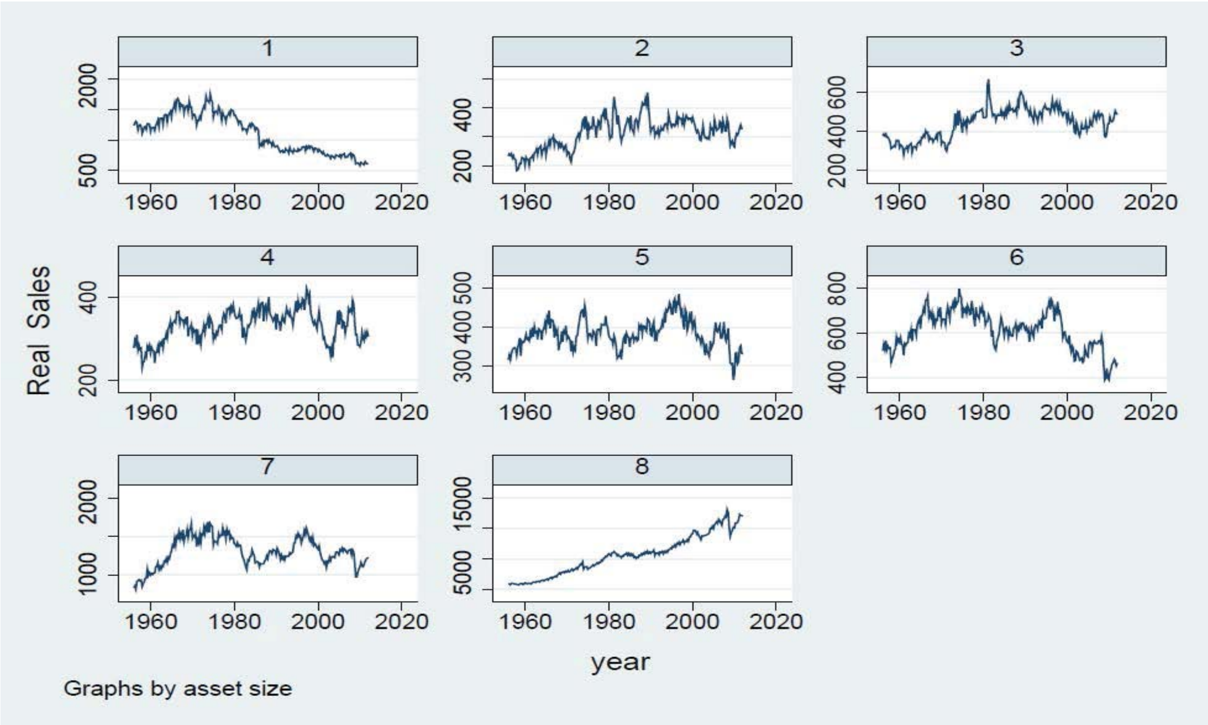
Source: QFR and Authors Calculation

Figure 2.3: Nominal Sales in each Size Group



Source: QFR and Authors Calculation

Figure 2.4: Real Sales in each Size Group



Source: QFR and Authors Calculation

Figure 2.5: Percent of Manufacturing Sales by Cumulative Asset Size

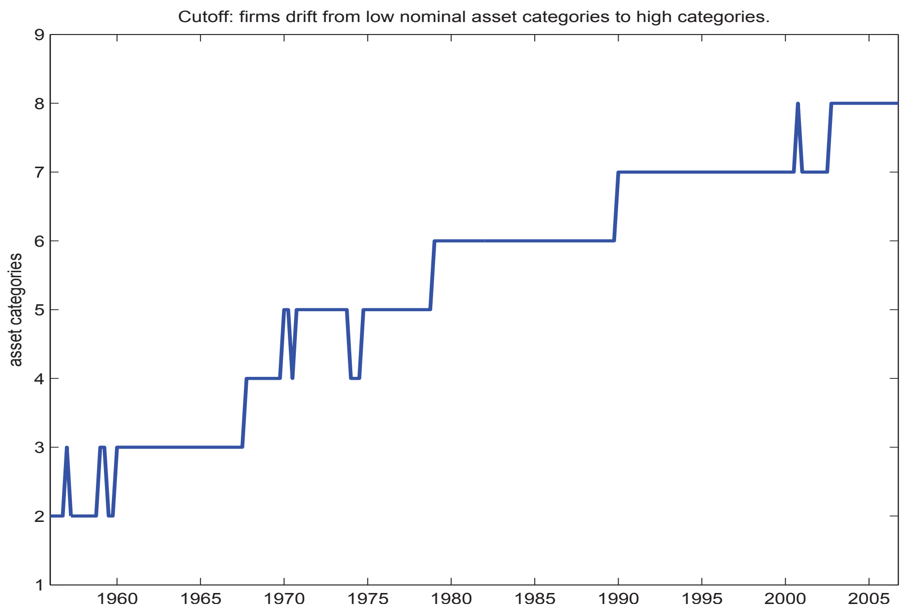
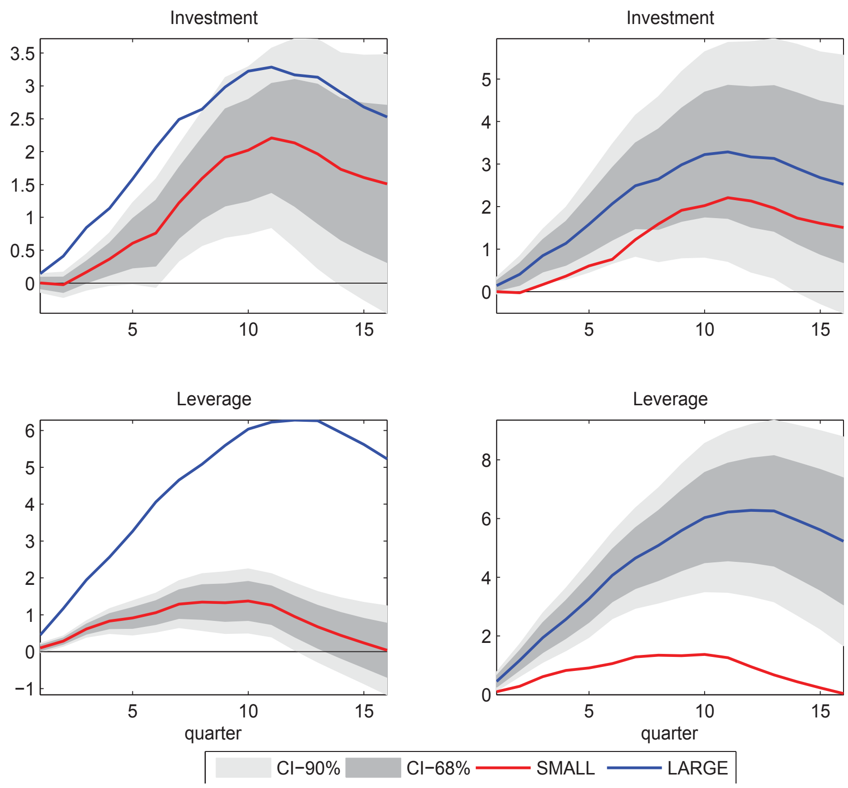
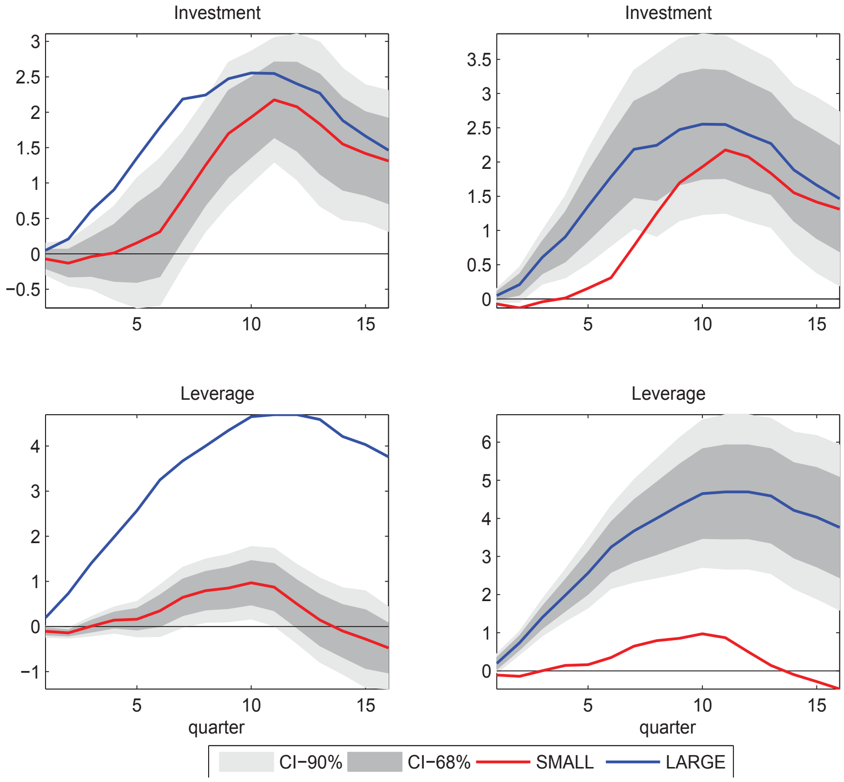


Figure 2.6: The Impact of an Exogenous Corporate Tax Cut on Investment and Leverage across Small and Large firms



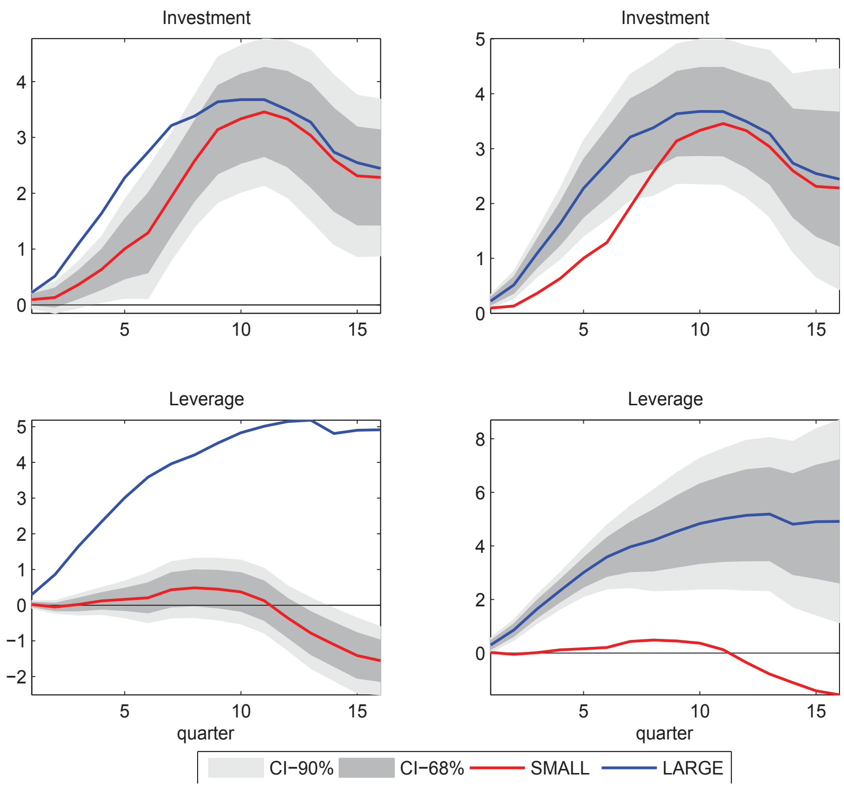
Notes: Red lines indicate responses of small firms and blue lines indicate responses of large firms. First row shows the IRFs of investment and second row shows for leverage. Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 2.7: The Impact of an Exogenous Corporate Tax Cut on Investment and Leverage across Small and Large firms



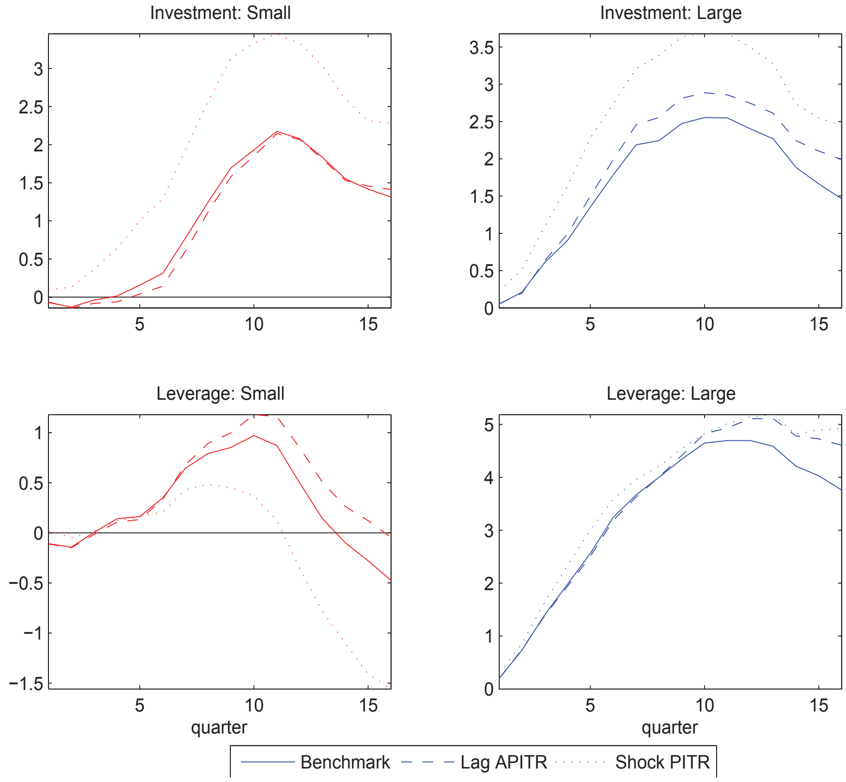
Notes: Red lines indicate responses of small firms and blue lines indicate responses of large firms. First row shows the IRFs of investment and second row shows for leverage. Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 2.8: The Impact of an Exogenous Corporate Tax Cut on Investment and Leverage across Small and Large firms



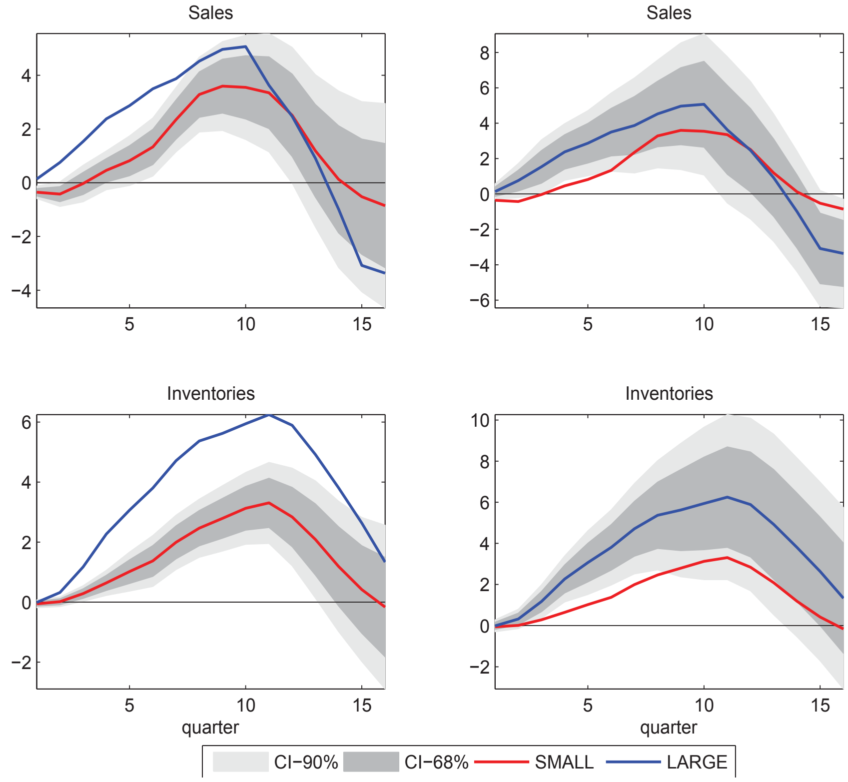
Notes: Red lines indicate responses of small firms and blue lines indicate responses of large firms. First row shows the IRFs of investment and second row shows for leverage. Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 2.9: Comparing Responses of different Specification



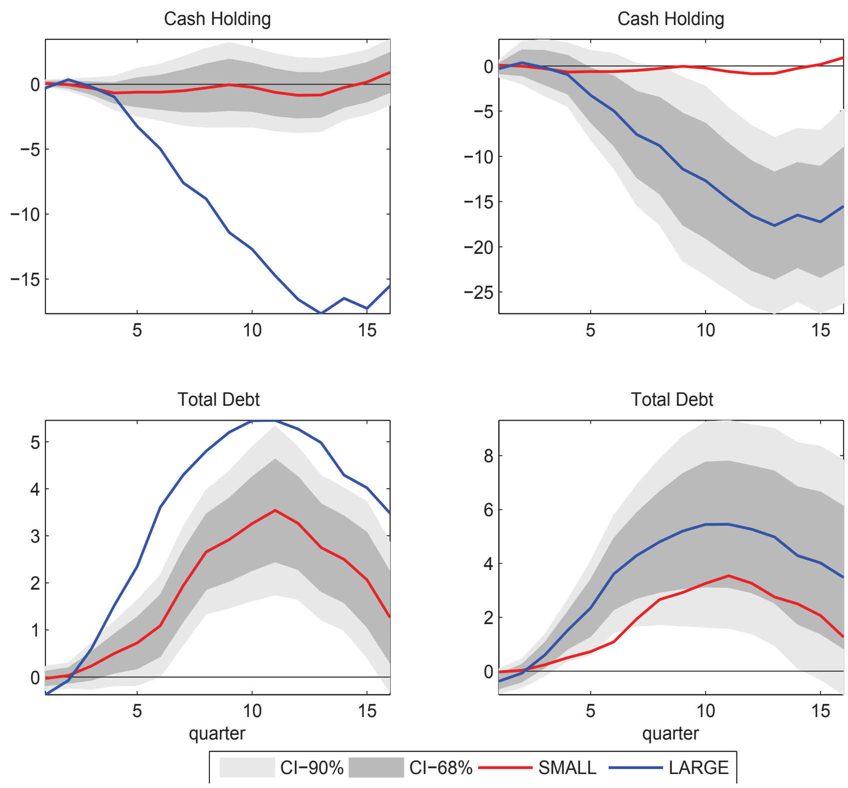
Notes: Solid red and blue lines indicate, respectively, responses of small and large in the baseline model. Dotted lines show estimated responses of corporate tax shocks along the personal tax shocks. Dashed lines present results when average personal income tax rates are controlled by lagged value.

Figure 2.10: The Impact of an Exogenous Corporate Tax Cut on Net Sales and Inventories across Small and Large firms



Notes: Red lines indicate responses of small firms and blue lines indicate responses of large firms. First row shows the IRFs of net sales and second row shows for inventories. Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Figure 2.11: The Impact of an Exogenous Corporate Tax Cut on Cash Holding and Total Debt across Small and Large firms



Notes: Red lines indicate responses of small firms and blue lines indicate responses of large firms. First row shows the IRFs of cash holding and second row shows for total debt. Light and dark shaded areas represent 90% and 68% confidence intervals, respectively.

Chapter 3

Firms' Composition, Investment Efficiency and Aggregate Output

This chapter is a theoretical investigation of how any shock causing volatility in the asset prices might affect the aggregate economy. In this regards, two assets are differentiated, capital asset and tradable which is also collateralizable. It is shown that any change in the price of this asset impacts production through three possible mechanisms. The first one is channeling capital to the more productive investors via trading. This is the reallocation effect mentioned by Martin and Ventura (2012). Secondly, it could contract or relax the collateral constraint of the producer investors. This effect was also pointed out by Kiyotaki and Moore (1997). Finally, grouping all investors into producers and non-producers, I show how any change in the composition of the producers and non-producers affects the average investment efficiency and consequently the aggregate output. I also show that financial intermediaries could hinder aggregate output by making the tradable asset illiquid. When the tradable asset is pledged as collateral, the reallocation mechanism becomes less effective in the economy.

3.1 Introduction

Investigating business cycles has always been a key question in Macroeconomics. Although this classic topic has been studied thoroughly by economists, however, there are still open debates and issues regarding it among scholars. The recent crisis has gained even more attention around this issue and has triggered many open questions. While many traditional models put emphasize on rigidities and labor market frictions, there is a strand in the literature that highlights the role of financial frictions. Among them, there are studies trying to put the financial frictions at the center of their analysis and explain how "financial accelerator" mechanisms could amplify the effect of traditional shocks to create a big recession like the recent one. This part of the literature is based on some influential papers which Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) are among the most seminal ones. The key intuition of these papers is simple: when the net worth of the firms increases (decreases), their ability in borrowing increases (decreases) which impacts the operation of the economy[1].

The main difficulty of the traditional financial accelerator models, like Kiyotaki and Moore (1997) and Bernanke and Gertler (1989) is the phenomena which I call the "depth of crisis puzzle". The puzzle denotes the incapacity of the traditional mechanisms in explaining the depth and pervasiveness of crisis such as the case of recent one. There has been new studies trying to solve the puzzle, like Martin and Ventura (2011).

Martin and Ventura (2011) argue that there are two potential ways of using the existing models to explain the recent crisis. The first one is that as a result of some changes in the global financial system, the existing financial accelerator mechanisms became more powerful in amplifying the traditional shocks and consequently small shocks caused such a great recession. But to articulate this view, we need formal models explaining the source of empowering traditional mechanisms of financial acceleration. Secondly, instead of amplifying a small shock drastically, one might think about a great shock that harshly affected the aggregate economy. This view also requires identifying the specific shock which led to such a deep and vast crisis. In all, both of these alternatives suffer from insufficient theoretical confirmations and empirical evidences in explaining the recent great collapse. In this paper I try to provide some insight about how some other forces might accelerate this phenomenon. This mechanism puts a more realistic assumption on the initial states of economy, most importantly the initial wealth distribution, and allows endogenous price determination. Moreover, we try to characterize a new mechanism of how the aggregate output is affected by the volatilities in the asset prices. In this regards, we examine how the composition of firms, grouping them to producers and non-producers, and the capital flow among them are influenced by any shock to asset prices. Then, we explore how the aggregate economy is impacted through this channel. To best of our knowledge, this mechanism has not been investigated before and characterizing it provides new insights about the volatilities in the aggregate economy.

To investigate this issue, we consider one specific type of assets which can be traded or collateralized. This asset is different from productive asset or *capital* but affects production because when it is traded or collateralized, capital is flowed towards more productive agents. Any changes in the asset prices can affect aggregate output via this channel. In this structure, we have a continuum of investors, only differing in their productivity in using capital. In the absence of frictions, the ideal allocation for this economy would be transferring all the resources to the most productive investors to gain the maximum production level (first best). However, such equilibrium will not be achievable due to the

[1]Gertler and Kiotaki (2010) is a recent paper trying to explain this crisis based on these models.

market frictions. To model financial frictions, we simply assume that the unproductive investors cannot lend to the productive ones. What is interesting for us, is investigating different channels that push the economy towards the first best.

Since the literature on the interaction between financial frictions and investment is vast, it would not be very fruitful to cover it all here. I just focus on two influential papers and explain how my idea relates to them.

In an influential study, Kiyotaki and Moore (1997) discuss how the flow of capital to high productive investors is securitized by collateralizable capital assets. On this basis, they explain how small shocks to the economy might be amplified and restrain the investment for highly productive investors. In Kiyotaki and Moore's framework, any shock causing a fall in the income of capital affects its price to a decrease and consequently makes it less valuable. This drop in the value of capital will restrict investors' capacity to use it as collateral. As a result, capital owners will be more restricted in borrowing and accordingly investment declines[2].

In another theoretical study, Martin and Ventura (2012) explore a mechanism through which asset prices affect aggregate output. They characterized the concept of *reallocation effect*: that productive investors sell their assets to unproductive agents and consequently, productive investments replace unproductive ones. This raises average investment efficiency. Martin and Ventura focused on the specific case of bubbly assets and argued that trading the bubble not only reduces inefficient investment, but also increases efficient ones. During the bubbly episodes, unproductive investors demand bubbly assets while productive ones supply them. This transfer improves the efficiency of resource allocation[3].

In this paper, I try to explore the investors' composition and how it affects aggregate output. To capture this idea, I group all economic agents into producers and non-producers. Producers are characterized as highly productive investors who end up with production in the equilibrium. Non-producers are less productive ones who decide not to produce. From a technical point of view, what is new here is endogenizing the investors' type (producer v.s. non-producer) regardless of usual strong assumptions over the primary situation of the economy. While in many previous studies, the investors' type of being producer or non-producer is imposed exogenously, here it is determined endogenously in the market equilibrium. As a result, variations in the initial condition of the economy cause this composition to change. This technical improvement has an interesting implication because the average efficiency of the economy depends on the specific group of the investors who will produce in the equilibrium. In this context, I argue how price of

[2]Also, Kiyotaki and Moore (2008) based on their previous paper pointed out that when collateral assets become bubbly, the credit constraint over productive investors is relaxed and more resources are transferred towards them which stimulates the aggregate output.

[3]There are other papers arguing how bubbles might hinder the economic growth, Saint-Paul (1992), King and Ferguson (1993) and Grossman and Yanagawa (1993).

the asset impacts agents' composition, and consequently the aggregate output. To best of my knowledge, this causality has not been investigated before. I also show that financial intermediaries could hinder aggregate output by making the asset illiquid. When the tradable asset is pledged as collateral, the reallocation mechanism becomes less effective in the economy.

3.2 Model

We consider a simple static model of an economy with two types of assets and a continuum of heterogenous agents. The economy starts at time zero and the outcome is realized at time one.

Assumptions:

- There are two types of assets in the economy:
  - A risky asset with a stochastic monetary dividend which is realized at the end of the period. The dividend is equal to D with probability δ and 0 with probability $1-\delta$. We assume that $\delta D > 1$.
  - Money. One unit of money is exchangeable with one unit of productive asset or capital
- There are a continuum of risk neutral agents named investors:
  - Investors whom are characterized by their linear deterministic production function $y = \theta k,$ where $\theta \in \left[0, \overline{\theta}\right]$ is the productivity of these heterogenous agents. To capture the interesting analytical cases, it is assumed that $\overline{\theta} > 1$. We consider monetary values of k and y. The total number of investors is normalized to one and we assume $F(\theta)$ to be the cumulative distribution of their productivity. Every investor is endowed with one unit of risky asset at time zero which can be traded among them.

Based on this framework, in the following section two different regimes are modeled. In the first regime, the baseline model, all investors are endowed with 1 unit of money and 1 unit of risky asset. There is not any bank or any financial intermediary in the economy. We formalize financial friction simply by removing the possibility of borrowing among investors. But they can trade the risky asset and this is the channel of transferring money from less productive investors to more productive ones who expect more return from production than dividend.

In the second regime, we introduce the bank as a new agent such that all investors deposit their money endowments in the bank. They can borrow from the bank and the only collateralizable asset is the risky asset. Any investor who decides to produce should decide to finance production by selling its asset or collateralizing it for borrowing from the bank.

Depending on the investors' decision in each model, they are labeled as "producers" and "non-producers". Producers are the ones who end up producing and the rest are non-producers. As mentioned above, producers can finance the required capital from their money endowment or by selling their endowment to the non-producers in the first regime. In the second regime they do it by borrowing from bank which needs their asset endowments to be collateralized or by selling their endowment.

In each regime, we calculate the social welfare in the economy. Since the utility function of the agents is considered as linear, the social welfare is simply calculated as the aggregate wealth at which the economy ends up. Then, it is analyzed how the composition of producer/non-producers and capital transfer mechanisms might affect the aggregate welfare.

3.2.1 The First Regime - The Baseline Model

In this model each investor starts with 1 unit of money and 1 unit of risky asset and should decide whether to trade the risky asset or not, and also whether to produce or not. The profit maximization problem for an investor with productivity θ_i is:

$$\max_{x_i^C,\ x_i^A,\ x_i^M} \theta_i\ x_i^C + \delta D\ \frac{x_i^A}{p} + x_i^M \tag{3.1}$$

$$s.t.$$

$$x_i^C + x_i^A + x_i^M \leq 1 + p \tag{3.2}$$

$$x_i^C, x_i^A, x_i^M \geq 0 \tag{3.3}$$

where $x_i^C,\ x_i^A$ and x_i^M are respectively the amounts of wealth devoted to production, risky asset and saving as cash. Also p is the risky asset price in the market. Inequality (2) is the budget constraint and the total value of each investor's asset at the beginning is $1 + p$.

Proposition 3.2.1 *In the equilibrium the risky asset is traded and it is characterized as follows:*

- *Case (i): if $\overline{\theta} \leq 1 + \frac{1}{\delta D}$ then all investors with $\theta_i \geq 1$ produce - these investors are producers and the rest are non-producers. They also sell their asset endowments to non-producers and the market clearing price is $p = \delta D$.*

- *Case (ii): if* $\overline{\theta} > 1 + \frac{1}{\delta D}$ *then all investors with* $\theta_i \geq \widehat{\theta}_1$ *produce where* $\widehat{\theta}_1 = \frac{-\delta D + \sqrt{\delta D(\delta D + 4\overline{\theta})}}{2}$. *They sell their assets to non-producers and the market clearing price is* $p = \frac{\overline{\theta}}{\overline{\theta} - \widehat{\theta}_1}$.

Proof. See Appendix ■

Referring to this proof, from now we use $\widehat{\theta}$ as a threshold which all investors with $\theta_i \geq \widehat{\theta}$ produce and others do not. Hence, $\widehat{\theta}$ characterizes the composition of producer v.s. non-producers in the economy. Bigger values of $\widehat{\theta}$ means that a tighter group of investors - always the ones with the highest productivity - produce and consequently the average productivity and the investment efficiency is higher.

According to this proposition, each producer starts producing with $1+p$ unit of capital and hence, the aggregate production and the expected social welfare are:

- In case (i) where $\overline{\theta} \leq 1 + \frac{1}{\delta D}$:

$$Y^1_{(i)} =_1^{\overline{\theta}} (1+p) \times \theta \; dF(\theta) = (1+\delta D)_1^{\overline{\theta}} \theta \frac{1}{\overline{\theta}} d\theta = \frac{(1+\delta D)(\overline{\theta}^2 - 1)}{2\overline{\theta}} \tag{3.4}$$

where $Y^1_{(i)}$ denote the total production of the economy. Considering the linearity of investors' utility function, the social welfare is measured by the aggregate level of wealth in the economy at the end of the period. Equivalently, it is equal to aggregate production plus what remains from the initial endowments in the economy - some of the initial capital is depreciated in the production process.

$$W^1_{(i)} = \frac{(1+\delta D)(\overline{\theta}^2 - 1)}{2\overline{\theta}} + \delta D + (1 - \frac{(1+\delta D)(\overline{\theta} - 1)}{\overline{\theta}})$$

where the first, second and the third terms are respectively the aggregate production, the expected dividend and the undepreciated capital remained at the end of the period. After some calculations we have:

$$W^1_{(i)} = \frac{(1+\delta D)(\overline{\theta} - 1)^2}{2\overline{\theta}} + \delta D + 1 \tag{3.5}$$

- In case (ii) where $\overline{\theta} > 1 + \frac{1}{\delta D}$

$$Y^1_{(ii)} =_{\widehat{\theta}^1}^{\overline{\theta}} (1+p) \times \theta \; dF(\theta) = \frac{\widehat{\theta}_1}{\overline{\theta} - \widehat{\theta}_1}{}_{\widehat{\theta}_1}^{\overline{\theta}} \theta \frac{1}{\overline{\theta}} d\theta = \frac{1}{2}(\overline{\theta} + \widehat{\theta}_1) \tag{3.6}$$

$$W^1_{(ii)} = \frac{1}{2}(\overline{\theta} + \widehat{\theta}_1) + \delta D \tag{3.7}$$

Here, all the capital endowment is depreciated.

3.2.2 The Second Regime - The Model with Bank

In this part a new agent, the bank, is introduced to the model. All investors can borrow from the bank and use the loan to finance production or to buy some risky assets. To borrow, they need collateral and the only collateralizable asset is the risky asset. The investors are all protected by limited liability and don't repay the loan in the case that no dividend is realized. This is based on this assumption that loan repayment is only enforceable from collateral dividend and not from the total wealth of the borrower. To keep the initial condition of this model similar to the baseline model, we assume that the money in the bank has been deposited equally by all the investors and at the end of the period, the whole money in the bank will be redistributed uniformly among them.

I remove any impact from the bank's strategic actions by assuming zero profit condition for it. This condition holds when the loans are offered with the interest rate $\frac{1}{\delta}$, since the loan is repaid with probability δ.

In this economy, each investor has two strategies w.r.t his asset endowment; to collateralize (C) it or not (NC). The ones who do not collateralize their assets, can sell if the market forms. If producers prefer to collateralize their assets rather than selling them, there won't be any market for the asset. Thus, the optimal behavior of some investors is contingent upon the formation of the market which itself depends on the others' decision to prefer selling their asset rather than collateralizing it.

Considering this complexity, we use a simple static game theoretical model to analyze this economy. Depending on how non-producers and producers take their actions, four cases are possible: C-C (collateralize-collateralize), C-NC, NC-C and NC-NC [4]. In following sections each case is investigated in details.

The C-C case

When all investors play C, all assets are collateralized and there isn't anything for trade. Hence the market doesn't form and each investor should decide to either produce or keep the loan.

Under this assumption, the profit maximization problem for the agent with productivity θ_i is:

$$\max_{z_i \in \{0,1\}} z_i(l_i\theta_i + \delta(D - \frac{l_i}{\delta})) + (1 - z_i)[l_i + (\delta(D - \frac{l_i}{\delta}))] + 1 \tag{3.8}$$

where $z_i = 1$ if the investor produces and $z_i = 0$ otherwise. If an investor borrows l_i and produces, he ends up with $l_i\theta_i$. Otherwise, he can keep the loan until the end. In any case, the expected return from the collateral asset after repaying the loan is $\delta(D - \frac{l_i}{\delta})$.

[4]The first action is the one taken by non-producers

Also 1 unit of money is the expected amount that all investors are being paid by the bank at the end of the period when the bank's assets are redistributed among them. Since all investors borrow, the amount of loan for each borrower is equal to 1, ($l_i = 1$).

Rearranging the objective function we have:

$$\max_{z_i \in \{0,1\}} z_i \,(\theta_i \; - 1) + \delta D + 1 \tag{3.9}$$

Obviously all investors with $\theta_i \geq 1$ produce and the others do nothing.

The aggregate production and the aggregate welfare in this case are as follows:

$$Y^{C-C} =_{1}^{\overline{\theta}} \theta \frac{1}{\overline{\theta}} d\theta = \frac{\overline{\theta}^2 - 1}{2\overline{\theta}} \tag{3.10}$$

$$W^{C-C} = \frac{\overline{\theta}^2 - 1}{2\overline{\theta}} + \delta D + \frac{1}{\overline{\theta}} = \frac{\delta D(\overline{\theta} - 1)^2}{2\overline{\theta}} + \delta D \tag{3.11}$$

where $\frac{1}{\overline{\theta}}$ is the undepreciated capital.

The C-NC case

In this case, the money is lent to non-producers and they decide to keep it or to buy some risky assets from producers.

Proposition 3.2.2 *The optimal behavior of the investors in this case is:*

- *Case (i): if $\overline{\theta} \leq \frac{\delta D}{\delta D - 1}$, then all investors with $\theta_i \geq 1$ produce and sell their endowments to non-producers at price $p = \delta D$.*
- *Case (ii): if $\overline{\theta} > \frac{\delta D}{\delta D - 1}$, then all investors with $\theta_i \geq \widehat{\theta}_2^{C-NC}$ produce where $\widehat{\theta}_2^{C-NC} = \frac{-(\delta D - 1) + \sqrt{(\delta D - 1)((\delta D - 1) + 4\overline{\theta})}}{2}$. Producers sell their endowments to non-producers at price $p = \frac{\overline{\theta}}{\overline{\theta} - \widehat{\theta}_2^{C-NC}}$. Thus the asset is underpriced.*

Proof. See Appendix ■

Consequently, the aggregate production and the social welfare are as follows:

- In case (i) where $\overline{\theta} \leq \frac{\delta D}{\delta D - 1}$

$$Y_{(i)}^{C-NC} =_{1}^{\overline{\theta}} (\delta D \times \theta) \frac{1}{\overline{\theta}} d\theta = \frac{\delta D\,(\overline{\theta}^2 - 1)}{2\overline{\theta}} \tag{3.12}$$

$$W_{(i)}^{C-NC} = \frac{\delta D\,(\overline{\theta}^2 - 1)}{2\overline{\theta}} + \delta D + (1 - \frac{\delta D\,(\overline{\theta} - 1)}{\overline{\theta}})$$

where the last term is the undepreciated capital. Equivalently:

$$W_{(i)}^{C-NC} = \frac{\delta D\,(\overline{\theta} - 1)^2}{2\overline{\theta}} + \delta D + 1 \tag{3.13}$$

- In case (ii) where $\overline{\theta} > \frac{\delta D}{\delta D-1}$

$$Y_{(ii)}^{C-NC} = \int_{\widehat{\theta}}^{\overline{\theta}} \left(\frac{\overline{\theta}}{\overline{\theta} - \widehat{\theta}_2^{C:NC}} \times \theta\right)\frac{1}{\overline{\theta}}d\theta = \frac{1}{2}(\overline{\theta} + \widehat{\theta}_2^{C-NC}) \tag{3.14}$$

$$W_{(ii)}^{C-NC} = \frac{1}{2}(\overline{\theta} + \widehat{\theta}_2^{C-NC}) + \delta D \tag{3.15}$$

The NC-C case

In this case all the money is lent to producers. Since highly productive investors don't have any incentive to buy the assets, since they prefer to raise capital, the market does not form.

It is easily verifiable that only the investors with $\theta_i > 1$ collateralize and produce and the others (NP) just keep their asset endowments.

Since all the money in the bank is lent to one fraction of the investors with $\theta_i > 1$, normally the amount of individual loan is greater than one and equal to:

$$l_i = \frac{\overline{\theta}}{\overline{\theta} - 1} \tag{3.16}$$

As the amount of loan is constrained by the value of the collateral[5], when $\overline{\theta} \leq \frac{\delta D}{\delta D-1}$ the individual endowments won't be enough for collateralizing $l_i = \frac{\overline{\theta}}{\overline{\theta}-1}$ and hence, the maximum amount of individual loans will be δD. If $\overline{\theta} > \frac{\delta D}{\delta D-1}$, there is no constraint for lending $\frac{\overline{\theta}}{\overline{\theta}-1}$.[6]

Thus,

- Case (i): if $\overline{\theta} \leq \frac{\delta D}{\delta D-1}$, then every investors with $\theta_i \geq 1$ borrows δD and produces $\delta D \times \theta_i$. The aggregate production and the social welfare are:

$$Y_{(i)}^{NC-C} = \int_{1}^{\overline{\theta}} (\theta \times \delta D)\frac{1}{\overline{\theta}}d\theta = \frac{\delta D(\overline{\theta} - 1)^2}{2\overline{\theta}} \tag{3.17}$$

$$W_{(i)}^{NC-C} = \frac{\delta D(\overline{\theta} - 1)^2}{2\overline{\theta}} + \delta D + 1 \tag{3.18}$$

- Case (ii): if $\overline{\theta} > \frac{\delta D}{\delta D-1}$, then every investors with $\theta_i \geq 1$ borrows $\frac{\overline{\theta}}{\overline{\theta}-1}$ and produces $\frac{\overline{\theta}}{\overline{\theta}-1} \times \theta_i$. The aggregate production and the social welfare are:

[5] Zero profit condition requires the repayment of l_i to be $\frac{l_i}{\delta}$ in good states - when D is realized. As every investor has exactly 1 unit of collateralizable asset, $D \geq \frac{l_i}{\delta}$ must hold to guarantee the full repayment in the good state. This implies $l_i \leq \delta D$.

[6] If $\overline{\theta} = \frac{\delta D}{\delta D-1}$, then $l_i = \frac{\overline{\theta}}{\overline{\theta}-1} = \delta D$

$$Y_{(ii)}^{NC-C} =_{1}^{\overline{\theta}} (\theta \times \frac{\overline{\theta}}{\overline{\theta}-1})\frac{1}{\overline{\theta}}d\theta = \frac{1}{2}(\overline{\theta}+1) \tag{3.19}$$

$$W_{(ii)}^{NC-C} = \frac{1}{2}(\overline{\theta}+1) + \delta D \tag{3.20}$$

The NC-NC case

In this case, there is no borrowing and thus there is no production in the economy. All investors end up with the expected payoff $\delta D + 1$ where δD is the expected dividend of the asset and 1 unit is the return from the bank at the end of the period.

$$W^{NC-NC} = \delta D + 1 \tag{3.21}$$

The Equilibrium

Comparing the expected payoffs for producers and non-producers in each case, the equilibrium is characterized as follows:

Proposition 3.2.3 *The equilibrium is C-NC or NC-C if* $\overline{\theta} \leq \frac{\delta D}{\delta D - 1}$*, and C-NC otherwise.*

Proof. See Appendix. ■

3.3 Welfare Analysis

In Sections 3.2.1 and 3.2.2, we found the equilibria and the social welfare under two different regimes. Under the first regime, we assumed that there is no bank in the economy and the only mechanism of capital reallocation is trading the endowments. In that model, trade increases the aggregate production and aggregate welfare by channeling resources from less productive to more productive agents. About the asset price, there is no possibility for emergence of bubble because nobody pays for the asset more than what he expects to receive as dividend. But the asset might be underpriced because for the highly productive investors, the opportunity cost of capital is so high that they liquidate the asset even less than its fundamental price. In the second regime discussed in section 3.2.2, a bank was introduced and it was endowed with all the money in the economy. In this regime, the loanable fund is available for the investors only by collateralizing the risky asset. Thus, the money might be circulated among the investors by trading the asset conditional on market formation. Similarly in this regime, the asset might be underpriced, but not bubbly. In this section we analyze how these two regimes are different in the sense of aggregate welfare. Before comparing two regimes, we focus on the welfare characteristics of the second regime in the following proposition.

Proposition 3.3.1 *Comparing the aggregate welfare of four cases in the second regime, we have:*

- *If* $\overline{\theta} \leq \frac{\delta D}{\delta D - 1}$:
$$W^{C:NC} = W^{NC:C} > W^{C:C} > W^{NC:NC} \tag{3.22}$$
- *If* $\overline{\theta} > \frac{\delta D}{\delta D - 1}$:

$$W^{C-NC} > W^{NC-C} > W^{C-C} > W^{NC-NC} \tag{3.23}$$

Proof. See Appendix. ■

What is the intuition of this proposition? All the pair inequalities can be explained by two factors; how efficient the resources are transferred from non-producer to producer investors, and how much the average productivity of the producers is. In the ideal case only the most productive investor with $\theta_i = \overline{\theta}$ produces and all the resources are allocated to this investor. Of course, this ideal case is not achievable in practice. But any mechanism that improves one of these two factors is welfare increasing.

In both (3.22) and (3.23), NC-NC has the lowest welfare because there is no production. C-C is the second worst because (i) the allocation of capital to producers is weak. Since non-producers get some part of the loan and there is no possibility of trade, only one fraction of the capital is allocated to producers and the rest remains in the pocket of non-producers without any contribution to production. (ii) the composition of producers is not proper because $\widehat{\theta} = 1$. With the same level of resource allocation to producers, bigger $\widehat{\theta}$ means higher efficiency of investment and more production. Moreover, going from C-C to NC-C is welfare increasing because although the composition remains the same, $\widehat{\theta} = 1$, more resources are allocated to producers in NC-C rather than that of C-C. When $\overline{\theta} < \frac{\delta D}{\delta D - 1}$, NC-C achieves higher welfare thanks to the possibility of trade which doesn't exist in C-C. Trade acts as a capital reallocation mechanism to producers. When $\overline{\theta} \geq \frac{\delta D}{\delta D - 1}$, although there is no trade, but since only producers borrow from the bank, the amount of loan is larger than C-C case in which both producers and non-producers borrow. Finally, when $\overline{\theta} < \frac{\delta D}{\delta D - 1}$, $W^{C-NC} = W^{NC-C}$ because in both cases we have $\widehat{\theta} = 1$ and the amount of money allocated to producers is the same. The only difference is that in NC-C this money is allocated directly from loan, while in C-NC it is transferred by trading the asset. When $\overline{\theta} \geq \frac{\delta D}{\delta D - 1}$, $W^{C-NC} > W^{NC-C}$. While in both cases the allocation of the capital to producers is ideal - all the money in the economy is transferred to producers via borrowing or trading, in the C-NC case the investment is more efficient as $\widehat{\theta}$ is greater.

Now we compare the social welfare of the two regimes.

Proposition 3.3.2 *The social welfare is higher in the first regime*

Proof. Referring to Propositions (3.2.3) and (3.2.4), the equilibrium welfare in the second regime is equal to $W^{C:NC}$ for any $\overline{\theta}$. It is true because if $\overline{\theta} \leq \frac{\delta D}{\delta D - 1}$, then both C-NC and NC-C are equilibria while both generate the same welfare - see (3.22) in Proposition (3.2.4). If $\overline{\theta} > \frac{\delta D}{\delta D-1}$, then C-NC is the unique equilibrium. Thus we can assume that always $W^{C:NC}$ is the equilibrium welfare in the second regime.

Comparing the aggregate welfare of the baseline model in the first regime, (3.5) and (3.7), with the corresponding welfare of the second regime, (3.22) and (3.23), it is easy to verify that the welfare is higher in the first regime. ■

What is the intuition behind this welfare gap? The same argument brought for proposition (3.2.4) holds here as well.

When $\overline{\theta}$ is low ($\overline{\theta} \leq 1 + \frac{1}{\delta D}$), both regimes have the same composition of producer and non-producers, as $\widehat{\theta} = 1$ in both cases. Also in both regimes we have weak allocation of resources and the whole money in the economy is not transferred towards producers[7]. But since more resources are allocated to producers in the first regime, a higher level of welfare is achieved.

On the other hand, when $\overline{\theta}$ is high ($\overline{\theta} > \frac{\delta D}{\delta D-1}$), all resources are allocated to producers. But the investment is more efficient in the first regime because $\widehat{\theta}_1 > \widehat{\theta}_2$ and the average productivity of producers is higher [8].

For $1 + \frac{1}{\delta D} < \overline{\theta} \leq 1 + \frac{1}{\delta D}$, the first regime enjoys both better resource allocation and higher average productivity.

Proposition 3.3.3 *In both regimes, aggregate production and social welfare are increasing w.r.t the expected return of the risky asset, δD.*

Proof. See Appendix. ■

This proposition has an important implication. As it was discussed above, there are two factors determining the aggregate welfare. The average productivity of the producers, and the efficiency of resource allocation to them. Now I discuss three mechanisms explaining how the expected return of risky asset might be effective via these factors. When $\widehat{\theta} = 1$,[9] a small increase in δD can not affect $\widehat{\theta}$ and thus the composition of the

[7]In the first regime, it is due to few number of producers - producers fall between $\widehat{\theta} = 1$ and $\overline{\theta}$ and $\overline{\theta}$ is low. Thus, the supply of the risky asset relative to its demand is low. Since the asset is never traded bubbly - no one buys the bubble, the whole money can not be transferred from non-producers to producers and this is a source of welfare loss. This argument holds for the C-NC equilibrium in the second regime.

If the NC-C equilibrium of the secons regime occurs, what prevents the whole resources to be allocated to producers is collateral constraint, see footnote 1.

[8]Here $\widehat{\theta}_1 = \frac{-\delta D + \sqrt{\delta D(\delta D + 4\overline{\theta})}}{2}$ and $\widehat{\theta}_2 = \frac{-(\delta D-1) + \sqrt{(\delta D-1)((\delta D-1)+4\overline{\theta})}}{2}$. Since $\widehat{\theta}_1 > \widehat{\theta}_2$, investors in the first regime are more productive and the efficiency of investment is higher.

[9]It occurs when $\overline{\theta} > 1 + \frac{1}{\delta D}$ in the first regime and $\overline{\theta} > \frac{\delta D}{\delta D-1}$ in the second regime.

investors and the average productivity doesn't change. But since the asset price increases, more resources are allocated to producers and the production increases - in the second regime it occurs in the C-NC equilibrium. This is the first mechanism pointed out by Martin and Ventura (2012). When we are in the NC-C equilibrium, in the second regime and there is no trade, increasing the asset value relaxes the collateral constraint and the producers can borrow more from the bank which improves the aggregate output. This is the second mechanism argued by Kiyotaki and Moore (1997).

When $\widehat{\theta} > 1$,[10] aggregate production is increasing *w.r.t.* δD. It means that as the expected dividend, and consequently the asset price increases, some of the less productive producers stop producing and become non-producer. Accordingly, average productivity increases and investment becomes more efficient. This is the third mechanism and the central argument of this paper. This change in the composition of the investors increases the output because the resources of these investors is channeled to the ones who continue producing. This occurs since a more valuable asset can transfer more resources when it is traded or collateralized. Thus, the aggregate output and the social welfare increase. This effect can be restated as follows. When the expected return of the asset increases, more investors are tempted to keep the asset rather than liquidating it to produce. Hence the investment is performed by more efficient producers.

One interesting implication of this analysis is the negative effect of collateralizing tradable assets. When one asset is collateralized, it gets illiquid because it can not be traded anymore. Hence, the price of the asset and the composition of the agents is impacted.

Based on this analysis, one might think about the effect of housing price volatility on the production sectors. Houses, and more generally real estates, are a traditional class of collateralizable assets. Assuming each investor to represents one productive sector in the economy, any change in the composition of producer and non-producers might cause a subsequent change in the portfolio of the aggregate output. Furthermore, any transfer of capital among investors could be interpreted as flowing resources among different sectors. In all, this paper provides an analytical framework for analyzing the mechanisms that non-productive assets, like houses, might impact the amount and the composition of the aggregate production via trading or collateralizing. This might be investigated more in empirical researches.

3.4 Concluding remarks and Further Extensions

This chapter is a theoretical analysis of how tradable asset/collateral prices might affect the aggregate output and its composition. A model with two assets is introduced, capital

[10]It occurs when $\overline{\theta} < 1 + \frac{1}{\delta D}$ in the first regime and $\overline{\theta} < \frac{\delta D}{\delta D - 1}$ in the second regime.

asset and tradable asset/collateral. Any changes in the price of the tradable/collateral asset might impact the production through three possible mechanisms. The first one is channeling capital to the more productive investors via trading. This is the reallocation effect mentioned by Martin and Ventura (2012). Secondly, it could contract or relax the collateral constraint of the producer investors. This affects was also pointed out by Kiyotaki and Moore (1997). Thirdly, any shift in the composition of producer v.s. non-producers impacts the average efficiency of investment in the economy.

In sum, what is new in this chapter is endogenizing the decision of investors with different productivity either to produce or not. This determines what is called the composition of investors, or accordingly the efficiency of the investment in this paper. Then, it was investigated how the asset price is a determinant of the composition and the aggregate output. This is captured in the third mechanism mentioned above. Also by integrating all three mentioned mechanisms, this study provides a deeper understanding of the interaction between asset prices and aggregate economy. This study also shows that financial intermediaries could hinder aggregate output by making the tradable asset illiquid. When the tradable asset is pledged as collateral, the reallocation mechanism becomes less effective in the economy.

While this is only a theoretical research, an empirical analysis of how volatility in the price of the assets like houses, or other tradable v.s. collateral assets, affects the composition of the aggregate output could be insightful.

Another extension might be exploring how the initial distribution of resources among investors affects the aggregate welfare. In this model, I have simply assumed a uniform distribution of both types of endowments.

3.5 References

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3.6 Appendix

Proof. [Proof of Proposition 3.2.1] From the objective function, the return of production is increasing in θ. Considering the linearity of the objective function in θ, there exist a $\widehat{\theta}$ such that an investor with productivity $\widehat{\theta}$ is indifferent to be producer or non-producer and agents with $\theta \geq \widehat{\theta}$ prefer to be producers. Accordingly, all the other investors prefer not to produce.

Let's assume that the asset is bubbly in the equilibrium, $p > \delta D$, thus all investors with $\theta \geq 1$ choose $(x_i^C,\ x_i^A,\ x_i^M) = (1,\ p,\ 0)$. Respectively, the other investors choose $(x_i^C,\ x_i^A,\ x_i^M) = (0,\ p,\ 1)$. Since $x_i^A = p$ for all investors, no one trades the risky asset in this price range. In the other words, the market does not form for trading the bubbly asset.

Now, we focus on the bubbleless equilibrium. When $p \leq \delta D$, non-producer investors prefer to buy more assets (they are indifferent in the special case of $p = \delta D$) and producers prefer to sell their assets to produce . Then a market forms for the risky asset. It is easily verifiable that in such equilibrium investors with $\theta < \widehat{\theta}_1$ choose $(x_i^C,\ x_i^A,\ x_i^M) = (0,\ 1+p,\ 0)$ and the other investors with $\theta \geq \widehat{\theta}_1$ choose $(x_i^C,\ x_i^A,\ x_i^M) = (1+p,\ 0,\ 0)$.

Here $\widehat{\theta}$ is characterized as the productivity of an investor who is indifferent between producing or not:

$$\widehat{\theta}_1(1+p) = \frac{\delta D}{p} + \delta D \Rightarrow \widehat{\theta}_1 = \frac{\delta D}{p} \tag{3.24}$$

Finally, the equilibrium price clears the market. The aggregate money endowment of buyers is $\frac{\widehat{\theta}_1}{\overline{\theta}}$ that is paid for $\frac{\overline{\theta}-\widehat{\theta}_1}{\overline{\theta}}$ units of risky asset owned by the sellers. So the price that equalizes these supply and demand is:

$$p = \frac{\widehat{\theta}_1}{\overline{\theta} - \widehat{\theta}_1} \tag{3.25}$$

(24) and (25) give:

$$\widehat{\theta}_1 = \frac{-\delta D + \sqrt{\delta D(\delta D + 4\overline{\theta})}}{2} \tag{3.26}$$

and

$$p = \frac{\overline{\theta}}{\overline{\theta} + \frac{1}{2}(\delta D - \sqrt{\delta D(\delta D + 4\overline{\theta})})} \tag{3.27}$$

The necessary and sufficient condition for realizing this equilibrium is satisfying $p \leq \delta D$, equivalently:

$$\overline{\theta} \geq 1 + \frac{1}{\delta D} \tag{3.28}$$

■

Proof. [Proof of Proposition 3.2.2] In this case, the money is lent to non-producers. The producers can sell their assets to non-producers and finance production - we will rule out the equilibrium without trade. If each non-producer borrows l_i, then the profit maximization problem is as follows:

$$\max_{z_i \in \{0,1\}} z_i(p \times \theta_i) + (1 - z_i)(\frac{l_i}{p}\delta D + \delta(D - \frac{l_i}{\delta})) + 1 \tag{3.29}$$

where $z_i = 1$ if the investor produces and $z_i = 0$ otherwise. If an investor gets producer, he chooses NC and sells his asset to finance production. Thus he ends up with $p\theta_i$. A non-producer collateralizes and borrows l_i. With this amount, he can buy $\frac{l_i}{p}$ units of the risky asset with the expected return $\frac{l_i}{p}\delta D$. Also the expected return of his own endowment after repaying the loan is $\delta(D - \frac{l_i}{\delta})$. As before, 1 unit of money is the expected amount that all investors are being paid by bank at the end of the period. Since only non-producers borrow (the ones with $\theta < \widehat{\theta}_2^{C:NC}$), the amount of loan for each borrower is equal to $\frac{\overline{\theta}}{\widehat{\theta}_2^{C:NC}}$, ($l_i = \frac{\overline{\theta}}{\widehat{\theta}_2^{C:NC}}$).

Some calculations like proposition 1 yield the following results:

- if $\overline{\theta} > \frac{\delta D}{\delta D - 1}$

$$\widehat{\theta}_2^{C:NC} = \frac{-(\delta D - 1) + \sqrt{(\delta D - 1)((\delta D - 1) + 4\overline{\theta})}}{2} \tag{3.30}$$

and

$$p = \frac{\overline{\theta}}{\overline{\theta} + \frac{1}{2}((\delta D - 1) - \sqrt{(\delta D - 1)((\delta D - 1) + 4\overline{\theta})})} \tag{3.31}$$

- if $\overline{\theta} \leq \frac{\delta D}{\delta D - 1}$, then $\widehat{\theta} = 1$ is the threshold of being producer or non-producer - the ones with $\theta \geq 1$ produce and the others not. Thus,

$$p = \delta D \tag{3.32}$$

In both cases the asset is not bubbly. In the first case the asset is traded underpriced and in the latter case the market is cleared in the fundamental price. Hence, we can rule out the equilibrium without any trade. If the risky asset was bubbly, non-producers wouldn't have any incentive to buy it. When it is underpriced (or it is in fundamental price), they prefer (or at least indifferent) to buy the asset. Worthy to mention that in both cases highly productive agents have incentive to sell their assets because of their high TFP. ■

Proof. [Proof of Proposition 3.2.3] According to Table 1:

- if $\overline{\theta} \leq \frac{\delta D}{\delta D-1}$, then non-producers are indifferent between C and NC (the payoff is always $\delta D+1$). But any action taken by them, producers take the opposite. To show this, if non-producers take C, then (π_C^P denotes the expected payoff for a producer taking C):

$$\pi_C^P - \pi_{NC}^P = \theta\delta D + 1 - \theta - \delta D = \delta D(\theta - 1) - (\theta - 1) = (\delta D - 1)(\theta - 1) > 0$$

If non-producers take NC, then $\pi_{NC}^P - \pi_C^P = \delta D(\theta - 1) > 0$. Ruling out any mixed strategy by the investors, **C-NC and NC-C are equilibria in this case**.

- If $\overline{\theta} > \frac{\delta D}{\delta D-1}$:

If producers take C, then non-producers are indifferent (the payoff is $\delta D + 1$). If producers take NC, then non-producers take C ($\pi_C^{NP} - \pi_{NC}^{NP} = \frac{\overline{\theta}}{\widehat{\theta}}(\frac{\delta D}{p} - 1) > 0$). Thus, non-producers prefer C.

Again, whatever non-producers do, producers take the opposite action. To verify this, if non-producers take C, then:

$$\pi_{NC}^P - \pi_C^P = \frac{\overline{\theta}}{\overline{\theta} - \widehat{\theta}}\theta + 1 - (\theta + \delta D) = \theta\frac{\widehat{\theta}}{\overline{\theta} - \widehat{\theta}} - (\delta D - 1)$$

This is an increasing function of θ and if we show that it is non-negative for the least productive producer, with $\theta = \widehat{\theta}$, then it will be positive for all other producers too. In the other words, all producers prefer NC:

$$\widehat{\theta}\frac{\widehat{\theta}}{\overline{\theta} - \widehat{\theta}} - (\delta D - 1) = \frac{[-(\delta D - 1) + \sqrt{(\delta D - 1)((\delta D - 1) + 4\overline{\theta})}]^2}{2\overline{\theta} + (\delta D - 1) - \sqrt{(\delta D - 1)((\delta D - 1) + 4\overline{\theta})}} - (\delta D - 1) =$$

$$\frac{[-(\delta D - 1) + \sqrt{(\delta D - 1)((\delta D - 1) + 4\overline{\theta})}]^2}{4\overline{\theta} + 2(\delta D - 1) - 2\sqrt{(\delta D - 1)((\delta D - 1) + 4\overline{\theta})}} - (\delta D - 1) = (\delta D - 1) - (\delta D - 1) = 0$$

Thus, $\pi_{NC}^P - \pi_C^P \geq 0$ and all producers prefer NC.

On the other hand, if non-producers take NC, then $\pi_C^P - \pi_{NC}^P = \frac{\overline{\theta}}{\overline{\theta}-1}(\theta - 1) > 0$.

In sum, non-producers take C and producers take NC and hence **C-NC is the equilibrium in this case.** ■

Proof. [Proof of Proposition 3.2.4] Referring to Propositions (3) and (4), the equilibrium welfare in the second regime is equal to $W^{C:NC}$ for any $\overline{\theta}$. It is true because if $\overline{\theta} \leq \frac{\delta D}{\delta D-1}$ then both C-NC and NC-C are the equilibria while both create the same welfare - see (22) in Proposition (4). If $\overline{\theta} > \frac{\delta D}{\delta D-1}$, then C-NC is the unique equilibrium. Thus we assume that $W^{C:NC}$ is always the equilibrium welfare in the second regime.

Now, we compare the social welfare of the two regimes in different cases:

- If $\overline{\theta} \leq 1 + \frac{1}{\delta D}$, comparing (5) and (13) we have: $W^1_{(i)} - W^{C:NC}_{(i)} = \frac{(\overline{\theta}-1)^2}{2\overline{\theta}} > 0$
- If $\overline{\theta} > \frac{\delta D}{\delta D-1}$, comparing (7) and (15) we have: $W^1_{(ii)} - W^{C:NC}_{(ii)} = \frac{1}{2}(\widehat{\theta}_1 - \widehat{\theta}_2^{C:NC})$

  Tho show that this difference is positive, we start from a trivial inequality:

$$(2\overline{\theta})^2 > 0 \Leftrightarrow$$

$$(2\overline{\theta})^2 + 2 \times (2\overline{\theta})(\delta D - 1) + (\delta D - 1)^2 > (4\overline{\theta})(\delta D - 1) + (\delta D - 1)^2 \Leftrightarrow$$

$$(2\overline{\theta} + \delta D - 1)^2 > (\delta D - 1)(\delta D - 1 + 4\overline{\theta}) \Leftrightarrow$$

Taking sqrt and then multiplying both sides by 2 yields:

$$4\overline{\theta} + (2\delta D - 1) - 1 > 2 \times \sqrt{(\delta D - 1)(\delta D - 1 + 4\overline{\theta})}$$

Substituting $(2\delta D - 1)$ by $\delta D^2 - (\delta D - 1)^2$ and adding $4\delta D\overline{\theta}$ to both sides, with some simplifications, lead to:

$$\delta D(\delta D + 4\overline{\theta}) > (1 + \sqrt{(\delta D - 1)(\delta D - 1 + 4\overline{\theta})})^2 \Leftrightarrow$$

Again by taking sqrt and subtracting δD from both sides, with some simplifications, we have:

$$-\delta D + \sqrt{\delta D(\delta D + 4\overline{\theta})} > -(\delta D - 1) + \sqrt{(\delta D - 1)(\delta D - 1 + 4\overline{\theta})}$$

Referring to Propositions 1 and 2, this inequality implies that $\widehat{\theta}_1 > \widehat{\theta}_2^{C:NC}$ or equivalently $W^1_{(i)} - W^{C:NC}_{(ii)} > 0$.

- If $1+\frac{1}{\delta D} < \overline{\theta} \leq \frac{\delta D}{\delta D-1}$, comparing (7) and (13) we should show that $W_{(ii)} >^1> W^{C:NC}_{(i)}$. We proved that $W^1_{(ii)} > W^{C:NC}_{(ii)}$. Also it is easily verified that $W^{C:NC}_{(ii)} > W^{C:NC}_{(i)}$, and thus it is concluded that $W^1_{(ii)} > W^{C:NC}_{(i)}$.

■

Proof. [Proof of Proposition 3.3.3] To prove this proposition, we only show that the aggregate production is increasing w.r.t δD. The proof then for the social welfare is straighforward. Now:

- When $\overline{\theta} \leq 1 + \frac{1}{\delta D}$, it is trivial.

- When $\overline{\theta} > 1 + \frac{1}{\delta D}$, we should show that $\frac{\partial \widehat{\theta}_1}{\partial \delta D} = \frac{\delta D + 4\overline{\theta}}{\sqrt{\delta D(\delta D + 4\overline{\theta})}} > 1$. We start from the following inequality:

$$(2\overline{\theta})^2 > 0 \Leftrightarrow (2\overline{\theta})^2 + 2 \times (2\overline{\theta}) \times \delta D + \delta D^2 > (4\overline{\theta})\delta D + \delta D^2 \Leftrightarrow$$

$$((2\overline{\theta} + \delta D)^2 > \delta D(\delta D + 4\overline{\theta}) \Leftrightarrow 2\overline{\theta} + \delta D > \sqrt{\delta D(\delta D + 4\overline{\theta})} \Leftrightarrow$$

$$\frac{2\overline{\theta} + \delta D}{\sqrt{\delta D(\delta D + 4\overline{\theta})}} > 1$$

  About the second regime, for both $\overline{\theta} \leq \frac{\delta D}{\delta D - 1}$ and $\overline{\theta} > \frac{\delta D}{\delta D - 1}$ cases the same argument holds.

■