Financing Constraints and Risk Aversion: A Tax-based Theory of Rising Industrial Concentration

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Abstract

I propose a theory that shows for financially constrained firms, lower tax rate on cash returns can cause firms to hoard more cash and increase their investment in risky projects. As a result, industry sales becomes increasingly concentrated in top firms. The model has three central ingredients: (1) Risk-neutral firms behave as if they were risk-averse because of financial constraints (2) The tax rate of the return on cash is negatively related to firms’ effective risk-aversion. (3) Investments in risky projects, after the resolution of uncertainty, become ex-post dispersion in firms’ sales, which give rise to an increase in the level of market concentration. So when the foreign tax rate were lowered in the late 90s, the theory suggests that multinational firms’ effective risk-aversion was reduced and they had the incentive to increase investments in risky projects. This, in turn, leads to an increasingly concentrated economy. Empirical evidence is consistent with the proposed risk-taking channel.

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1 Introduction

The last 20 years have witnessed a substantial increase in sales concentration across a wide range of industries in the US. The rising concentration has received much attention from academic economists and policy makers since it likely has important linkages to observed structural change in the economy, including lower capital investment, a declining labor share, slow productivity growth and declining dynamism. Although its importance is well recognized, the potential cause of it is still unclear. At the same time, the aggregate cash balance soared in the US corporate sector: the cash balance increased from $1.5 trillion in mid 1990s to $4 trillion by the end of 2017, and that the burgeoning cash balance is mostly concentrated in the foreign subsidiaries of multinational firms Faulkender, Hankins, and Petersen (2019).

In this paper, I propose a theory that relates these two trends by showing that they share one common cause – the decreased foreign corporate tax rate. To develop this argument, I first present a model that shows how lower tax rate on the return of firms’ foreign cash leads firms to hoard more cash and increase their investments in risky projects, and how the increased risk-taking in turn contribute to the rising market concentration. I then provide empirical evidence that is consistent with the proposed risk-taking channel.

The model builds on the theoretical frameworks by Bolton, Chen, and Wang (2011), which focuses on dynamic investment and risk management decisions for a financially constrained firm. The model considers an industry consisting of a number of such financially constrained firms. In terms of model setup, I mainly add the following: (1) firms can invest in risky projects, (2) firms’ return on their cash is taxable and (3) firms are subject to an industry-level displacement rate. First, firms in the model can either invest in risk-less investments, which deterministically increase their capital stock, or in risky projects, which comes in a Poisson process and only increases their capital stock in case of success. The risky projects are abstracted from investments such as merges and acquisitions and R&D, whose outcomes, unlike physical investments, are inherently uncertain. Second, firms’ return on their cash reserve, which includes interest income, is assumed to be taxable. So the return on cash is decreasing in the tax rate. Third, firms are subject to a displacement shock that they take as given. Once a firm receives such a shock, it exits the economy and a new firm enters. The displacement rate is meant to
reflect the force of creative-destruction and within industry competition: the former is driven by R&D investments, and the latter is mostly attributable to merges and acquisitions. Therefore, the displacement rate is assumed to be determined by the aggregate risky investments in the industry. In the model, firms maximize its value by optimally managing its cash reserves, investment and payout decisions.

There are two main results in my analysis. First, when the tax rate on cash becomes lower, firms increase their investment in risky projects and accumulate more cash as a response. This result goes against the traditional thinking that when tax rate on risk-less assets (cash) becomes lower, all else equal, firms should shift their resources from risky investments to risk-less assets. The key to this result is that risk-neutral firms behave as if they were risk-averse because they internalize the possibility of financial constraints. So when the tax rate decreases, it reduces a firm's risk-aversion in two ways. The first is a static effect: the lower tax rates increases the carrying return of cash, and consequently reduces the probability of being constrained and hence the firm's risk-aversion. The second effect is dynamic: when the return on cash increases, firms accumulate more cash as a response. As firms accumulate their cash balance, they are increasingly distant from constrained areas and thus become less risk-averse. Together, the decreased tax rates reduce firms' risk-aversion, which in turn increases their risky investments.

Second, a lower tax rate leads to an increasingly concentrated economy. This is because higher firms' risk-taking can lead to a more dispersed distribution of firms' sales, which gives rise to an increase in market concentration. With investment in risky projects, a firm should expect a dispersed outcome: it could expand its sales rapidly because of a series of successful projects, or its market share could shrink following a number of failed projects. From an ex-post perspective, a firm can be viewed as having experienced a period of high or low productivity, depending on the realization of the risks they take. In the model, whether a project succeeds or not is due to pure luck as there is no fundamental productivity difference among firms.

So when the tax rate becomes lower, firms are effectively less risk-averse and they invest more in risky projects. After the resolution of uncertainty, firms that have succeeded in their risky investments expand their sales and become "winners", whereas those who failed risky projects lose their market share and become "losers", and over time the industry is increasingly characterized by “winner takes most”. As a result, the market share is gradually concentrated in
those winners.

To assess the impact of the decrease in foreign tax rate, I consider the check-the-box regulation that was introduced in 1997 as an unexpected deterministic negative shock that lowers the tax rate on return of cash for multinational firms, by an amount implied by the difference between average foreign tax rate and US corporate tax rate. This treatment is based on two observations. First, the check-the-box (CTB) regulation unexpectedly improved the ability of multinational firms to defer the taxation of passive income including return on foreign cash reserve \(^1\). Second, foreign tax rates have been falling since 1990 \(^2\). I then study the transition dynamics of the economy from the initial stationary equilibrium to the new one.

In the model, the amount of risky-taking in the economy is crucial in determining the ensued rise in market concentration. To discipline the quantitative impact of the risk-taking channel, I calibrate the model’s parameters for risky investments to match the level of R&D-assets ratio for multinationals and non-multinationals. In the simulation, the model shows that the falling foreign tax rate can generate an sizable increase in market concentration during the initial 20 years (1997-2017) of the transition dynamics.

The model also predicts that after the shock of the tax rate, (i) multinational firms (MNCs) accumulate more cash than non-multinational firms (non-MNCs), (ii) multinational firms invest more in risky projects than non-multinational firms, and (iii) Within multinationals, industry sales should be increasingly concentrated in a small number of firms.

I then establish the following facts that are consistent with the model’s predictions. First, there has been a rise in aggregate cash balance since late 1990s and the rise is mostly accounted for by the multinational firms. Second, compared with non-multinational firms, multinational

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\(^1\)Before the tax regulation in 2017, U.S. multinationals are permitted to defer tax liabilities on certain foreign profits until they are repatriated. However, under the Sub-part F provision of U.S. law, “passive income” that includes interest income and dividends received from investment in securities are immediately taxable by the U.S. even if it is not repatriated (Fritz Foley et al. (2007)). Nevertheless, with the introduction of CTB, firms can find a way to treat such payments as internal transfers and not subject to U.S. taxation (Faulkender et al. (2019), Albertus (2018), Zucman (2014), Beer et al. (2018)). In particular, Blouin and Krull (2014) document a growth of subsidiaries in tax haven countries and a growth of intercompany transfers following the introduction of CTB.

\(^2\)Faulkender et al. (2019) calculate the average top corporate tax rate across the fifteen countries with the most cash in 1998 dropped from 38.7% to 29.0% between 1998 and 2008, while the U.S. corporate tax rate did not change. Blouin and Krull (2014) find that on average U.S. multinational firms’ worldwide tax rates declined by 4.3% in the post-1996 period. Zucman (2014) reports that over the last 15 years, the effective corporate tax rate of US companies has declined from 30 to 20 percent.
firms increase their risky investments such as R&D expenditure. Third, if more risks can lead to a higher level of dispersion, as our model predicts, one should expect that within multinationals, industry sales should be increasingly concentrated in a small number of firms. I show that this is indeed the case. Specifically, each year I calculate the sales share accounted for by the top 10% firms within multinational firms. I find that the top sale share for multinational firms has been stable before 1997, and has risen rapidly after the introduction of CTB in 1997, while that of non-multinational firms has been flat.

Finally, one alternative explanation is that existing top firms are more productive than the rest of the economy, so over time the rising concentration just reflects the increasing importance of the existing top firms. To distinguish the role of risks and productivity, following Gomes (2018), we quantify their respective contribution by decomposing the growth of top sale share into two components: a within term and a displacement term. The within term quantifies the contribution of the sales growth of top firms if the composition of top firms was fixed, and the displacement term measures the sales of firms entering the top percentile minus the sale of firms that exit the top. If rising concentration is because top firms grow faster than the average, then the composition of top firms should remain stable over time and the displacement term should be small. Alternatively, if the rising concentration is due to risk-taking in the economy, one should observe a small within term and a large displacement term.

There are two main findings. First, over the last two decades, the displacement is positive while the within term is negative, suggesting that on average, top firms grow slower than the rest of economy. The large displacement term indicates that risks play an important role in explaining the upward trend in market concentration.

Second, over time the within term has been rising and displacement term has been falling, suggesting that it has been increasingly difficult for firms from the rest of the economy to replace the existing top firms. This is consistent with the slowdown of industry dynamism (De Loecker and Eeckhout (2018)) and the emergence of “superstar firms” Autor, Dorn, Katz, Patterson, and Van Reenen (2017).

Taken together, our evidence complements the “superstar firms” view in suggesting that these ex-post “superstar firms” are not those who have already in the top percentile. Instead, they might have gained their positions by taking risks and having succeeded in their risk-taking.
Put differently, the “superstar firms” are just ex-ante normal firms who have legitimately competed with other firms on the merits of their innovations and other risky investments, and later the winners among those firms become the ex-post “superstars”.

**Related Literature** Our paper relates to the theoretical literature studying the dynamic impacts of financial constraints. In this line of work, firms’ financial constraints can be exogenously introduced, as in Bolton, Chen, and Wang (2011, 2013), or endogenously generated from moral hazard problem, as in Demarzo and Sannikov (2006); Biais, Mariotti, Plantin, and Rochet (2007); DeMarzo and Fishman (2006, 2007); Demarzo, Fishman, He, and Wang (2012); Hartman-Glaser, Mayer, and Milbradt (2019). While existing work mostly focuses on how the level of physical investment is affected by the financial frictions, our model emphasizes the role of finance-induced risk aversion and its economic consequences. Importantly, since I show that more risks can later lead to an increase in market concentration, our work suggests a novel mechanism through which financial frictions affect the macroeconomic environment in which firms operate and creates room for a broader series of potential policy considerations. Specifically, financial policies that ameliorates financing constraints and industrial policies are often considered separately. By identifying firms’ financing-induced risk aversion as a potential cause of industrial concentration, it lends support to the consideration for a joint analysis for financial development and industrial regulation. In terms of modeling risky investment, our model builds on Krieger, Li, and Papanikolaou (2019), who show that firms risk aversion lead firms to underinvest in novel innovation. The main distinction is that they focus on the novelty of the investment, whereas I show additionally that policies that affect financial constraints could have an unintended consequence on the level of market concentration.

The paper also contributes to the recent but growing body of research that studies the rise of concentration in US industries. The rising concentration could be an inefficient outcome: it can lead to an under-investment (Philippon and Gutierrez (2019)), an increase of market power as suggested by the measured markups (De Loecker and Eeckhout (2018)), a decrease in competition (Gruillon et al. (2019)); and a rise in profit share of non-financial sector (Barkai (2018)). Alternatively, Autor, Dorn, Katz, Patterson, and Van Reenen (2017) argue that there are a few leading firms with high productivity in each industry, and rising concentration could be effi-
cient as it reflects the increasing importance of ‘superstar’ firms. Therefore, understanding the source of rising concentration is crucial in gauging its overall welfare implications (Crouzet and Eberly (2018)).

Our model suggests that the rise of concentration might be caused by a higher level of ex-ante risk taking, which is induced by the falling foreign corporate tax rate. The evidence following decomposition in is also consistent with the proposed story of the emergence of “superstar firms”: these firms are not highly productive to begin with, rather, they have gained their positions by first taking risks and latter having succeeded in their risky projects.

Another related literature is the work on tax avoidance Albertus (2018); Xu and Zwick (2018); Zwick and Mahon (2017). Most of the existing literature focuses on the impact of transfer pricing and the strategic location of intellectual property. My paper instead focuses on the role of debt shifting and intra-company loans that affect the return of passive income. I find that the presence of debt shifting reduces firms’ risk aversion and incentivizes them to take more risks, which later can lead to a more dispersed economy, a mechanism absent from the current literature.

Finally, this paper is also linked to the literature on corporate cash holdings Bates, Kahle, and Stulz (2009); Pinkowitz, Stulz, and Williamson (2015). US multinational firms have accumulated large stocks of can and financial securities in their foreign subsidiaries (Fritz Foley, C. Hartzell, Titman, and Twite (2007); Faulkender, Hankins, and Petersen (2019); Graham and Leary (2018)). My findings are consistent with the existing literature that falling foreign tax rates, coupled with relaxed restrictions on tax avoidance, play an important role in firms’ cash reserve abroad.

2 Model

The model builds on Bolton, Chen, and Wang (2011), which developed a tractable framework for a firm's dynamic investment and liquidity management decisions in continuous time. I consider an industry that consists a large number of such firms, and study how the industry changes as one changes the carry cost of cash. I first describe the firm's physical production and investment technology. Next, I introduce the firm's external financing costs and its carry cost of holding cash. Finally, I state firm optimality.
2.1 Production

A firm’s operating revenue is proportional to its capital stock $K_t$ and is given by $K_t dA_t$, where $dA_t$ is the firm’s productivity shock over $dt$. The productivity shock of firm $i$ is assumed to follow an arithmetic Brownian motion

$$dA_t = \mu dt + \sigma dB^i_t$$

Where $dB^i_t$ is a standard Brownian motion. $\mu$ and $\sigma$ denote the drift and volatility of the firm. Different firms in the industry have the same $\mu$ and $\sigma$ but have independent productivity shock $dB^i_t$, that is $\text{corr}(dB^i_t, dB^j_t) = 0$.

2.2 Investment and Risk

There are two types of investments that firms can do to increase their capital stock $K_t$

The first is the standard risk-less investment whose opportunities are always available. By investing $I_t$, the capital stock increases but it also incurs a quadratic adjustment cost $G(I, K) = \frac{\theta}{2} i^2 K$ where $i = \frac{I}{K}$. This functional form is standard in the literature and the parameter $\theta$ measures the degree of the adjustment cost.

The second is the risky investment, whose opportunity comes as a Poisson process with intensity $\lambda$. The firm can only invest in risky project when the opportunity arrives. When it arrives, the firm decides whether to invest in it. If the firm does invest, the firm needs to pay the cost $fK$ which is proportional to the existing capital stock. Otherwise, the opportunity is forgone. The investment project is risky: with probability $\pi$ the project succeeds, in which case the capital stock increases by $\xi$, with probability $1 - \pi$ the project fails and the capital stock remain unchanged. The uncertainty resolves instantaneously.

The setup of risky investment is very similar to Krieger, Li, and Papanikolaou (2019), where the firm has a spectrum of risky projects to choose from. To highlight the mechanism, there is only one type of risky project in our model, but it can be easily extended to multiple projects. In our model, the risky project can either be interpreted as acquiring a new customer base, as in Krieger, Li, and Papanikolaou (2019), or be thought of as gaining market share from other
companies within the same industries, such as merge & acquisition activities. In the former interpretation, the risky project develops a new market and it does not affect other firms in the same industry. In the later interpretation, it facilitates creative destruction within the industry. I assume that firms are subject to random death in the industry, corresponding to the creative destruction within an industry. The death rate of an individual firm, which firms take as exogenously given, is proportional to the aggregate proportion risky investment projects in the economy. When a firm dies, it will be replaced by a new firm to ensure a stationary equilibrium. I will specify the relationship between death rate and aggregate risky investment later.

Therefore, the firm's capital stock evolves according to

\[
dK_t = (I_t - \delta K_t) dt + \xi K_t dN_t 1_{\text{invest&success}} - K_{t-} d\tilde{N}_t
\]

where \(dN_t\) is the Poisson process that governs the opportunity of risky investment. As I will show later, firms may not always invest in risky projects. The last term is the indicator function that equal to one when the firm has the opportunity to invest and the project turns out to be successful. In case of the project failure or the firm decides to forego this opportunity, the indicator function equals to zero. The last term represents the random death of the firms. The death process is a Poisson process \(d\tilde{N}_t\) with intensity \(\gamma\). When it occurs, the firm's entire capital stock is wiped out. Here, \(K_{t-} = \lim_{s\uparrow t} K_t\) denotes the left limit of capital stock \(K_t\). Intuitively, \(K_t\) represents capital stock just before the catastrophic event \(d\tilde{N}_t \in \{0, 1\}\) realizes.

The firm's operating profit \(dY_t\) over time increment \(dt\) is then given by

\[
dY_t = K_t dA_t (1 - \tau_D) - I_t dt - G(I, K) dt - fK dN_t 1_{\text{invest}}
\]

Where \(K_t dA_t\) is the firm's operating revenue, \(\tau_D\) is the U.S. corporate tax rate, \(I_t dt\) is the investment cost over time \(dt\), \(G(I, K) dt\) is the adjustment cost associated with risk-less investment, and \(fK\) is the investment cost of risky investment.
2.3 Liquidity Management

Let $W_t$ denote the liquidity or the cash balance of the firm. If the firm has both domestic cash and foreign cash, as most of multinational firms do, I use to $W_t$ denote the cash balance if all the cash were repatriated back to the US. This way, I am able to compare cash balance between multinational firms and non-multinational firms.

If the firm runs out of cash, in which case $W_t = 0$, it needs to raise funds to continue operating, otherwise its assets will be liquidated. To simplify the notation and highlights the central mechanism between carry cost of cash and risk preference, I assume that the firm has no access to capital market. Therefore, the firm has to liquidate its asset when the cash holding $W_t$ reaches zero. In addition, the firm can liquidate its asset at any time. In liquidation, the firm recovers $l_t$ per unit of capital where $0 < l_t < 1$. As I will show later on, firms’ operations are productive so they will not voluntarily liquidate when $W > 0$.

The assumption that the firm has no access to finance is not consequential. In fact, even if the firm has access to the financial market, as long as the external finance is costly, the risk neutral firm will operate as if it was risk-averse. Admittedly, having no access to the financial market is an extreme form of costly external finance, and the degree of risk-aversion is positively related to severity of frictions in the financial market.

The firm can invest its cash holding in the market and earns interest rate $r$. The firm has to pay tax on its interest earnings, and it is characterized by a tax rate $\tau$. So the dynamics for the firm’s cash $W$ as follows:

$$dW_t = dY_t + r(1 - \tau)W_t dt - dU_t$$  \hspace{1cm} (3)

Where $dY_t$ is the firm's operating cash flow, $r(1 - \tau)W_t dt$ is the passive earning from investing cash holdings, and $dU_t$ is the payout to investors.

2.4 Tax and Multinational firms

Background on US Tax Code  The U.S. tax code affects not only the incentives of firms to hold foreign earnings abroad or to repatriate them back, but also the decisions of whether invest-
ments in risky projects should be made. This section describes the tax rules and how I map those rules into our theoretical analysis.

Almost all countries tax the income of corporations that operate within their borders. Besides, the U.S. and other countries tax the foreign income of their residents. To avoid double taxation, U.S. tax code grants tax credits for foreign income taxes paid abroad. U.S. multinational firms are allowed to defer their tax liabilities on certain foreign profits until they are repatriated. And when they do get repatriated, the taxes due are equal to the difference between foreign income taxes paid and tax payments that would be due if they were taxed at the U.S. rate.\footnote{This is the typical way of avoiding double taxation for countries under worldwide tax system: the residence country grant a tax credit against its own tax so that the tax is limited to the excess of the residence country’s effective tax rate over that in the country in which the income is generated \cite{Beer2018}}.

The extent to which multinational firms can defer tax liabilities is limited. Under the Subpart F provisions of U.S. tax code, the income classified as “passive income” are immediately taxable by the U.S. even if it is not repatriated. Passive income includes interest income and passive earnings and dividend received from investment in securities.\footnote{Multinational firms (MNCs) generate income in two ways: selling products or services, which is known as active income, or investing their cash on hand, which is passive. The taxing rights of MNC income is based on the source of the income and the residence of the corporate taxpayer.} Therefore, multinational firms have to pay U.S. corporate tax rate on passive earnings even though the cash is invested abroad. The main purpose of Subpart F is to prevent U.S. citizens, resident individuals, and corporations from deferring the recognition of otherwise taxable income through the use of foreign entities, thereby creating a fair environment for economic entities to operate. Thus under the Subpart F, the net return on firm’s cash holding should be \( r (1 - \tau_D) \), where \( r \) is the earning of investments, and \( \tau_D \) is the U.S. tax rate.

**Tax Regulation and its Impact** However, in 1997, the U.S. treasury enacted “check-the-box” (CTB) regulations, also known as Treasury Decision 8697, to allow firms to self-identify subsidiaries for tax purposes \cite{Albertus2018}. Originally, CTB was introduced to reduce the burden for small firms to apply to unincorporated business entities. The name “Check-the-box” means that small firms can elect their tax designation by simply checking a box on IRS form 8832.

One unintended consequence of the enactment of CTB is that multinational firms are also
allowed to elect their organization designation for their foreign subsidiaries, for U.S. federal purposes. For example, a subsidiary in a foreign country can elect to be taxed as disregarded entity (DE) for U.S. federal tax purposes, and a DE reports on a consolidated basis with its parent under U.S. tax code Albertus (2018). Therefore, financial payments such as interest payments between a parent firm and a DE are not separately reported to U.S. tax authorities.

In effect, CTB allowed U.S. multinationals to defer passive incomes by treating those as internal transfers and not subject to U.S. taxation\(^5\), thereby reducing the tax rate on the passive income. Specifically, multinational firms may use internal loan to strip its foreign earnings. There are various empirical studies that confirm the presence of such behavior, by showing that international tax differentials have a positive and significant effect on internal debt of German MNCs (Weichenrieder (1996); Buettner and Wamser (2013); Mintz and Weichenrieder (2010)), on intra-firm interest and debt ratio of U.S. MNCs (Grubert (1998), Altshuler and Grubert (2003)), and on internal leverage of MNCs in Europe (Barrios et al. (2012)).

Although the aforementioned debt-related tax avoidance comes in various form, the essence of it involves a foreign subsidiary borrowing from a DE and paying interests to DE, which locates in low-tax countries, and deducting interest payments from tax liabilities in high-tax countries. Assuming that the operating subsidiary's income is subject to a positive foreign tax rate, the interest payment will generally be effective in reducing the tax burden on that entity's operations because the disregarded entity will bear little or no foreign tax on its interest income.

**Model's Tax Assumption** In our model, the firms’ active earnings \(Y_t\) are taxed at the U.S. tax rate \(\tau_D\). This tax rate applies to both multinational firms and non-multinational firms. That is, the model does not take into account the economic impact of deferring firms’ active earnings, and that the cash balance \(W_t\) keeps track of the amount of cash if all the foreign cash were repatriated back to the U.S.. Instead, the model highlights the difference on their passive earnings between Multinational firms (MNC) and Non-multinational firms.

For Non-multinational firms, the tax rate on their passive income is the U.S. domestic tax rate \(\tau_D\). However, due to the reasons we layed out above, the effective tax rate for multinational

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\(^5\)After 1997, there was a proliferation of Hybrids that was disregarded by the U.S. tax laws (DE) but were treated as a corporation in foreign jurisdiction Faulkender et al. (2019). Albertus (2018) discusses how the passive incomes such as patent loyalties can meet the requirements for deferral.
firms is assumed to be lower: $\tau_{MNC} < \tau_D$. Indeed, if the firm has $D < 1$ fraction of domestic cash, over the next year its cash holding becomes:

$$W(1 + r(1 - \tau_{MNC})) = (DW)(1 + r(1 - \tau_D)) + ((1 - D)W)(1 + r(1 - \tau_F))$$

Where $\tau_F$ is the foreign tax rate at the place the cash resides. Thus, the effective tax rate for multinational firms can be written as a weighted average of domestic tax rate and foreign tax rate:

$$\tau_{MNC} = D\tau_D + (1 - D)\tau_F < \tau_D$$

(4)

There are two observations worth noting on the effective tax rate. First, if $\tau_F < \tau_D$, then over time the cash abroad is growing faster and the fraction of domestic cash $D$ is coming down. As a result, the effective tax rate $\tau_{MNC}$ will decrease. Second, over time the average foreign tax rate $\tau_F$ has been declining Faulkender, Hankins, and Petersen (2019). These two observations mean that the effective tax rate $\tau_{MNC}$ has been declining over the past decades. The theoretical analysis will be focusing on its impact on risk-taking, cash holdings, and on the aggregate level, industrial concentration.

### 2.5 Entry and Exit: Creative Destruction

Firms are subject to an exogenous shock that wipes out the value of its entire capital $K$ and trigger immediate liquidation. This shock arrives according to a Poisson process with intensity $\gamma$. The Poisson process conceptually captures the endogenously creative destruction within an industry. When a firm succeeds in doing risky projects, it may acquire market share from other firms within the same industry. Thus, the intensity of this shock $\gamma$, is assumed to positively related with the fraction of successful risky projects in the economy. Similar assumptions were
made in endogenous growth literature (e.g. Jones and Kim (2018)). Specifically, we assume that

\[
\gamma = \gamma_0 \frac{\int_{W,K \in \mathbb{R}^2} K dN_t 1_{\text{invest & success}} g(W,K) dWdK}{\int_{W,K \in \mathbb{R}^2} Kg(W,K) dWdK}
\]

(5)

\[
1 = \int g(W,K) dWdK
\]

(6)

Where \(g(W,K)\) is the probability density function of the cross-sectional distribution over \(W\) and \(K\). The parameter \(\gamma_0\) measures the extent of creative destruction in the exogenous death. When \(\gamma = 1\), it means that all the gains from risky projects are coming from the obsolete capital from firms in the same industry. When a firm receives such shock, it exits the market. At the same time, it is replaced with a new firm with capital stock \(K_0\) and cash holding \(W_0\). This assumption is needed to guarantee a stationary equilibrium and ensures the model is well-behaved.

### 2.6 Industry Equilibrium

In equilibrium, firms decisions depend on individual state variable specific to a particular firm, and aggregate state variable that are common to all firms in the industry. The individual state variables are capital stock \(K_t\) and cash holdings \(W_t\). The aggregate state variable is the exogenous replacement rate \(\gamma\), which is affected by the cross-sectional distribution of firms over their individual state variables \(g(W,K)\).

In such industry, each individual firm takes the aggregate variable – the exogenous replacement rate \(\gamma\) – as given. A firm chooses its risk-less investment \(I_t\), whether to take risky investment \(R_t\), cumulative payout policy \(U_t\), and liquidation time to maximize the firm value.

\[
P(W_t, K_t) = \max_{I_t, R_t, U_t, \tau} \mathbb{E}_t \left( \int_t^\tau e^{-r(s-t)} dU_t + e^{-r\tau} (L_t + W_t) \right)
\]

The first term is the discounted value of net payouts to shareholders, and the second term is the discounted value upon liquidation. When the liquidation value \(l\) is low, firm never voluntarily liquidate when cash holdings is positive \(W_t = 0\). That is, firm only liquidates when the cash is zero. The liquidation value \(L_t = lK_t\) when the firm is run out of cash, and \(L_t = 0\) when the firm receives a shock that depletes all its capital.

On the aggregate level, the exogenous replacement rate is a function of individual firm's
choice and the cross-sectional distribution of firms, as given by 5. The cross-sectional distribution evolves according to the following equation (see appendix for derivation):

\[
\frac{dg_t(W,K)}{dt} = -\frac{\partial}{\partial K} [\mu_K(W,K)g(W,K)] - \frac{\partial}{\partial W} [\mu_{W,t}(W,K)g(W,K)] + \frac{1}{2} \frac{\partial^2}{\partial W^2} [\sigma^2 K^2 (1 - \tau_D)^2 g(W,K)] \\
+ \lambda 1_{\text{Invest}}(W - f K, \frac{K}{1 + \xi}) \pi P(W - f K, \frac{K}{1 + \xi}) - \lambda 1_{\text{Invest}}(W, K) P(W, K) \\
+ 1_{\text{Invest}}(W + f K, K) (1 - \pi) P(W + f K, K) - \gamma g_t(W, K) + \gamma g_0(W_0, K_0)
\]  

(7)

where \(1_{\text{Invest}}(W, K)\) is the indicator function of whether to invest in the risky project for a firm with \(W\) and \(K\), and

\[
\mu_K(W,K) = I(W,K) - \delta K
\]  

(8)

\[
\mu_W(W,K) = (r - \lambda) W + \mu K (1 - \tau_D) - I(W,K) - G(I,K)
\]  

(9)

are the drifts of capital stock and cash holdings, respectively. The equation (7) is known as Kolmogorov Forward Equation. The first term on the right hand side of (7) captures the evolution of distribution \(g\) due to the dynamics of capital stock. The second and third terms captures the effect of drift, diffusion of cash holdings. The fourth, fifth, and sixth terms captures the change of distribution due to the risky investments: the fourth term captures the density inflow from state \((W - f K, \frac{K}{1 + \xi})\) if risky investments are made and succeeded at that state. The fifth term captures the density outflow if firms invest in \((W, K)\). The sixth terms captures the density inflow from state \((W + f K, K)\) if investments are made and failed at that state. The last two terms captures the entry and exit.

3 Model Solution

This section characterizes the solution of the firm’s problem. Since a firm has to cease operation when the cash becomes zero, the firm’s value depends on both its capital stock and its cash holding \(W_t\). Due to tax friction the internal earning rate is lower than \(r\), one would expect that the firm pays out some of its cash when the stock is beyond certain levels \(\bar{W}_t\). The firm
will find itself in one of the following regions (i) liquidation region \((W_t = 0)\) (ii) interior region \((0 < W_t < \bar{W}_t)\) and (iii) the payout region \((W_t \geq \bar{W}_t)\).

When the firm’s cash holdings \(W_t\) is in the interior region \((0, \bar{W}_t)\), the firm value \(P_t(K, W)\) at time \(t\) satisfies the following Hamilton-Jacobi-Bellman (HJB) equations:

\[
r P_t(W, K) = \max_i (I - \delta K)P_{K,t} + [(r - c)W + \mu K - I - G(I, K)]P_{W,t} + \frac{\sigma^2 K^2}{2}P_{WW,t}
+ \lambda 1_{Invest}(\pi P_t(W - RK, (1 + \xi)K) + (1 - \pi)P_t(W - RK, K) - P(W, K)]
+ \gamma_t(W - P(W, K)) + \frac{1}{dt}E[dP_t(W, K)]
\]

(10)

The first term represents the marginal value of net investments on firm value. The second and the third term captures the effects of the expected change in the firm’s cash holdings and volatility of cash holdings on firm value, respectively. The third term represents the effects of risky investments on firm values. The last term represents the change associated with exogenous death.

The aggregate variable depends on the cross-sectional distribution of \(W, K\) :

\[
\gamma_t = \gamma_0 \frac{\int_{W,K \in \mathbb{R}^2} KdN_t 1_{\text{Invest & success}}(W, K)dwdk}{\int_{W,K \in \mathbb{R}^2} Kg_t(W, K)dwdk}
\]

(11)

and the distribution \(g(W, K)\) evolves according to the Kolmogorov Forward Equation (KFE):

\[
\frac{dg_t(W, K)}{dt} = -\frac{\partial}{\partial K} [\mu_K(W, K)g(W, K)] - \frac{\partial}{\partial W} [\mu_{W,t}(W, K)g(W, K)] + \frac{1}{2} \frac{\partial^2}{\partial W^2} [\sigma^2 K^2(1 - \tau_D)^2 g(W, K)]
+ \lambda 1_{Invest}(W - fK, \frac{K}{1 + \xi}P(W - fK, \frac{K}{1 + \xi}) - \lambda 1_{Invest}(W, K)P(W, K)
+ 1_{Invest}(W + fK, K)(1 - \pi)P(W + fK, K) - \gamma g_t(W, K)
\]

(12)

We define **Steady State** as an equilibrium with constant aggregate replacement rate \(\gamma\) and time-invariant distribution \(g(W, K)\).
In steady state, the dynamic system is given by

**HJB:** \( r P(W, K) = \max_I \left( I - \delta K \right) P_K + \left( (r - c) W + \mu K - I - G(I, K) \right) P_W + \frac{\sigma^2 K^2}{2} P_{WW} \)

\[ + \lambda 1_{\text{Invest}} \left( \pi P(W - RK, (1 + \xi) K) + (1 - \pi) P(W - RK, K) - P(W, K) \right) \]

\[ + \gamma (W - P(W, K)) \]  

**KFE:** \( 0 = -\frac{\partial}{\partial K} \left[ \mu_K(W, K) g(W, K) \right] - \frac{\partial}{\partial W} \left[ \mu_{W,t}(W, K) g(W, K) \right] + \frac{1}{2} \frac{\partial^2}{\partial W^2} \left[ \sigma^2 K_t (1 - \tau_D)^2 g(W, K) \right] \)

\[ + \lambda 1_{\text{Invest}}(W - f K, K) \frac{K}{1 + \xi} P(W - f K, K) - \lambda 1_{\text{Invest}}(W, K) P(W, K) \]

\[ + 1_{\text{Invest}}(W + f K, K) (1 - \pi) P(W + f K, K) - \gamma g_t(W, K) \]  

We solve for the steady state equilibrium using the iterative approach in the literature, which consists of the following steps:

**Step 1.** Make an educated guess of the displacement rate in the equilibrium \( \gamma_0 \).

**Step 2.** Solve the HJB equation for a single firm using \( \gamma_0 \) as given.

**Step 3.** Simulate the model so that we obtain a stationary distribution, and calculate the displacement rate \( \gamma_1 \).

**Step 4.** Replacing the \( \gamma_0 \) in step 2 with the \( \gamma_1 \) calculated from step 3, and repeat step 2 - step 3 until \( \gamma_0 \) and \( \gamma_1 \) are sufficiently close.

Among these steps, step 3 is straightforward, so we focus on our discussion on step 2, which is similar to the problem in the dynamic finance literature.

The production technology in our model is essentially the same as the one used in \textit{Bolton, Chen, and Wang (2011), Demarzo, Fishman, He, and Wang (2012)}. In these papers, the homogeneity in the production technology, adjustment costs and risky investment costs allow us to study the impact of corporate tax code on corporate investment, liquidity hoarding, risk-taking in an analytically tractable framework.

Because firm value is homogeneous of degree one in \( W \) and \( K \) in each state, we can write \( P(K, W) = p(w) K \), where \( w = \frac{W}{K} \) is the cash-capital ratio. Substituting this expression into the previous equation and simplifying, we obtain the following ordinary differential equation for
The first order condition for the investment capital ratio $i(w)$ is

$$i(w) = \frac{1}{\theta} \left( \frac{p(w)}{p'(w)} - w - 1 \right)$$

Where $p'(w) = P_W(K, W)$ is the marginal value of cash.

**Payout Boundary $\bar{w}$**: The firm starts paying out dividend when the marginal value of cash inside the firm is less than the marginal value of dividend. Therefore, the payout boundary $\bar{w} = \bar{W}/K$ thus satisfies the following value matching condition

$$p'(\bar{w}) = 1$$

In other words, the marginal value of cash when the firm decides to payout is one, which is equal to the risk neutral valuation of dividend. Otherwise, the firm can do better by holding more cash. In addition, the payout boundary is optimally chosen, so that the boundary also satisfies the super-contact condition

$$p''(\bar{w}) = 0$$

When the marginal value of cash is less than 1, the firm is better off paying out a lump-sum dividend and reducing its cash holding to $\bar{w}$. Therefore, when $w \geq \bar{w}$, we have

$$p(w) = p(\bar{w}) + (w - \bar{w})$$

**Liquidation**: Recall that the firm always has the option to liquidate the firm and recover $l$ per unit of capital. Under our assumptions, the firm’s capital is productive so the firm never voluntarily liquidates itself before it runs out of cash. The firm has to liquidate when it exhausts its
cash holdings, then:

\[ p(w) = 1 \text{ for } w \leq 0 \]

when the firm receives the exogenous shock with intensity \( \gamma \), the remaining capital is completely obsolete and therefore has no market value. In this case, we have \( p(w) = 0 \).

### 3.1 Risk-taking Policy

There are two sub-regions in the interior region, and they differ in whether the firm invests in risky project. We show that when the cash balance is low, the firm optimally forego risky investment opportunities. The firm only chooses to invest in risky investment when they have sufficient liquidity buffer \( W \).

For a firm with cash holdings \( W \) and capital stock \( K \), the net present value of a risky investment is

\[
NPV(W, K) = \pi P(W - RK, (1 + \xi)K) + (1 - \pi)P(W - RK, K) - P(W, R)
\]

The first term is the value of the firm when the risky project becomes successful, which is with probability \( \pi \). If the risky project fails, which comes with probability \( 1 - \pi \), the firm’s cash balance is reduced, which is represented by the second term. The third term is the firm’s original value. Since the firm value and production is homogeneous of degree one in \( K \), we can write down the Net Present Value (NPV) of the risky investment project per unit of capital:

\[
NPV(w) = \pi (1 + \xi) p\left(\frac{w - R}{1 + \xi}\right) + (1 - \pi) p(w - R) - p(w)
\]

the firm only invests in the risky project when its NPV is positive.

The NPV of the project is increasing in the firm’s cash holding. This result is intuitive. The risky investment project trades off the upside expansion \( \xi K \), which the firm gets in case of success, with the liquidity loss \( RK \), which the firm suffers in case of project’s failure. Because the firm has to costly liquidate when the cash holdings become zero, it accumulates cash to reduce
the cost of potential liquidation in the future. The higher the cash holding, the lower the probability of future liquidation. Therefore, marginal value of cash $p'(w)$ is decreasing in $w$. When the cash balance is low, the project failure gets firm closer to the liquidation region, which is very costly to the firm and makes the risky project unappealing. On the contrary, when the cash balance is high, the benefit of success outweighs the liquidity loss associated with the failure, so the NPV becomes positive.

Figure 9 illustrates this tradeoff. With the cutoff strategy, we can write down the dynamics in these two sub-regions: (1) The cash accumulation region where the firm optimally foregoes the risky investment. (2) The risk-taking region where the firm chooses to invest in risky projects.

**Cash accumulation region**: $w_t \in (0, \bar{w})$. In this region, a firm forego all the risky investment opportunities, so that its HJB is:

$$(r + \gamma)p(w) = \gamma w + (i(w) - \delta)(p(w) - wp'(w)) + \left((r - c) w + \mu - i(w) - g(i(w))\right)p'(w) + \frac{\sigma^2}{2} p''(w)$$

where the dynamics of cash holdings and capital stock are given by:

$$dK_t = (I_t - \delta K_t)\,dt$$

$$dW_t = K_t\,dA_t(1 - \tau_D) - I_t\,dt - G(I, K)\,dt + (r - \lambda)W_t$$

**Risk-taking region**: $w_t \in (\bar{w}, \tilde{w})$. In this region, a firm invests in all the available risky projects, so that its HJB is:

$$(r + \gamma)(w) = \gamma w + (i(w) - \delta)(p(w) - wp'(w)) + \left((r - c) w + \mu - i(w) - g(i(w))\right)p'(w) + \frac{\sigma^2}{2} p''(w)$$

$$+ \lambda \left(\pi(1 + \xi)p\left(\frac{w - R}{1 + \xi}\right) + (1 - \pi)p(w - R) - p(w)\right)$$

---

6From figure 9 one can observe that firms also invest in risky projects when the cash ratio is very close to zero. This risk-shifting behavior is caused by the fact that the downside of failure is limited when cash ratio is sufficiently small. But its impact in our model is very limited. See some citations for its relevance.
The dynamics of cash holdings and capital stock are given by:

\[ dK_t = (I_t - \delta K_t) dt + \xi dN_t 1_{\text{success}} \]

\[ dW_t = K_t dA_t (1 - \tau_D) - I_t dt - G(I, K) dt - RK dN_t + (r - \lambda) W_t \]

And the switching threshold is characterized by the condition that the NPV of the risky project is zero. This condition determines the value of \( \tilde{w} \).

\[ \pi (1+\xi) p(\frac{\tilde{w} - R}{1+\xi}) + (1-\pi) p(\tilde{w} - R) - p(\tilde{w}) = 0 \]

When the cash holdings is low, the firm does not invest in risky projects and retains profits to accumulate cash. When the firm has sufficient cash, the liquidation concern is low so it invests in risky projects. When the cash balance is so high that the marginal value of cash is equal to the marginal value of dividend payout, the firm starts paying out dividend.

### 3.2 Ex-ante Risks and Ex-post Dispersion

Firms take more risks by investing in risky projects when they have sufficient liquidity. We show that ex-ante risks, after realization, manifest themselves as ex-post dispersion in firms’ sizes. First, we characterize this result in a simplified theoretical framework to illustrate the logic between risks and dispersion. In the next section, we show that the numerical results are consistent with the theoretical analysis.

The dynamics for firm’s size can be written as

\[ dK_t = (I_t(w_t) - \delta K_t) dt + \xi \pi dN_t 1_{\text{risky}} \]  

The indicator functions \( 1_{\text{risky}} \) is one in the risk taking region and zero in the cash accumulation region.

Firms in the model exit the market for two reason: first, firms may exhaust their cash holdings due to operations; second, firms may exit due to exogenous shocks that change their cash holdings to zero. If one firm exits the industry, we assume another firm enter the industry with
capital stock $K_0$ and capital-cash ratio $w_0$. Under our assumptions, capital are productive – the drift of productivity is sufficiently high – so that most of the exits are due to exogenous shocks rather than cash decreasing to zero because of operational expenses. Thus, we can approximate the dynamics of capital stock in our model by assuming that it is only subject to a random reset with Poisson density $\gamma$.

The following proposition provides the theoretical link between risks and dispersion in a simplified framework.

**Proposition**: Suppose that $K$ have the following dynamics

$$dK = (I - \delta K)dt + \xi \pi K dN_t 1_{\text{risky}}$$  \hspace{1cm} (16)

$$d\log(k) = (i - \delta)dt + \pi \log(1 + \xi) dN_t$$  \hspace{1cm} (17)

and that the process subject to Poisson reset with positive rate $\gamma$. The resulting stationary distribution of $K$ is a Pareto distribution. The Pareto parameter $a$ \(^7\) is smaller for the case with risky investment than the case without risky investment, meaning that the former distribution is more dispersed than the latter.

To see this, note that the Kolmogorov Forward Equation (KFE) of $K$ is (see Appendix for derivation)

$$\frac{\partial p(k, t)}{\partial t} = -(i - \delta) \frac{\partial p(k, t)}{\partial k} + \lambda \pi \frac{p(k, t)}{1 + \xi} - p(k, t) - \gamma p(k, t)$$

It is known in the literature that one candidate solution to this problem is Pareto Distribution. If we insert the Pareto distribution density $p(k, t) = Ck^{-a-1}$.

$$\gamma = (i - \delta)a + \lambda \pi ((1 + \xi)^a - 1) 1_{\text{risky}}$$  \hspace{1cm} (18)

The Pareto coefficient $a$ is determined by 18. Since $(1 + \xi)^a - 1$ is positive, the $a$ that solves

\(^7\)The parameter $a$ is also known as Pareto Index. A Pareto Index of 1.16 means top 20% of the population has about 80% of the sales, corresponding to the 80-20 rule. See Gabaix (2009) for its use in modeling income and wealth inequality.
the equation with risky investments should be lower than the one without risky investments. Therefore, the resulting distribution has a fatter tail (i.e., more dispersed) in the presence of risky investments.

4 Quantitative Results

We first calibrate the model, then provide a quantitative analysis of the effects of the reduced tax rates on investment, cash and on the aggregate level, the industrial concentration.

4.1 Parameter Choices

In the choice of parameters, we select plausible numbers based on existing literature to the extent that is available. For those parameters on which there is no empirical evidence we make a guess to reflect the situation we are seeking to capture in the model.

We adopt the parameters values that are in line with the estimates in Eberly, Rebelo, and Vincent (2008), who provide empirical evidence in support of Hayashi (1982). In particular, we set the mean and volatility of the productivity shock to $\mu = 0.18$ and $\sigma = 0.09$, respectively. The risk free rate is 0.07 and the depreciation rate is 10%. The liquidation value $l$ is 0.9, as suggested in Hennessy and Whited (2007).

We set the U.S. domestic tax rate as 35%, and the effective foreign tax rate as 20%. These numbers are consistent with Zucman (2014). The tax rates imply that the carry cost of cash are $0.07 \times 0.35 = 2.4\%$ and $0.07 \times 0.2 = 1.4\%$ for Non-MNCs and MNCs, respectively.

No empirical study exists on which we can rely for the estimates of the return distribution of risky investments. The choice for the risky projects parameter reflects the fact that risky investments are inherently uncertain. The success probability $\pi$ is set at 0.10, which means that 1 out of 10 projects will be a success. The jump size $\xi$ is set at 0.20, meaning that the firm's capital base increases by 20% if the projects succeeds.

We calibrate the frequency of risky projects $\lambda$, and the cost of the risky projects $R$ to match the median R&D-assets ratio for US multinationals and non-multinationals. For the median firm, the R&D-assets ratio is 0.4 for MNCs and 0.29 for non-MNCs. The details of data construction are given in Appendix. We then obtain $\lambda = 2.7$ and $R = 0.02$. This implies that a firm
on average invests two to three projects per year, and that each project requires an amount of investment that equal to 2% of the total assets. Table 1 summarizes the parameters in the model.

### Table 1: Summary of Key Variables and Parameters

<table>
<thead>
<tr>
<th>Parameter List</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk-free rate</td>
<td>$r$</td>
<td>0.07</td>
</tr>
<tr>
<td>Rate of depreciation</td>
<td>$\delta$</td>
<td>0.10</td>
</tr>
<tr>
<td>Mean of productivity</td>
<td>$\mu$</td>
<td>0.18</td>
</tr>
<tr>
<td>Volatility of productivity</td>
<td>$\sigma$</td>
<td>0.09</td>
</tr>
<tr>
<td>Adjustment cost</td>
<td>$\theta$</td>
<td>1.50</td>
</tr>
<tr>
<td>Capital liquidation value</td>
<td>$l$</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Tax</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax rate for multinationss</td>
<td>$\tau_{MNC}$</td>
<td>0.20</td>
</tr>
<tr>
<td>Tax rate for non-multinationss</td>
<td>$\tau_{nonMNC}$</td>
<td>0.35</td>
</tr>
<tr>
<td>Carry cost for multinationss</td>
<td>$c_{MNC}$</td>
<td>0.14</td>
</tr>
<tr>
<td>Carry cost for non-multinationss</td>
<td>$c_{nonMNC}$</td>
<td>0.24</td>
</tr>
<tr>
<td><strong>Risky Projects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of risky projects</td>
<td>$\lambda$</td>
<td>2.70</td>
</tr>
<tr>
<td>Success Probability</td>
<td>$\pi$</td>
<td>0.10</td>
</tr>
<tr>
<td>Jump size (if success)</td>
<td>$\xi$</td>
<td>0.20</td>
</tr>
<tr>
<td>Cost</td>
<td>$R$</td>
<td>0.02</td>
</tr>
</tbody>
</table>

### 4.2 The Numerical Solution

The goal of the model is to assess the impact of foreign tax rate on (1) risky investments and (2) market concentration. In this subsection, we study its effect on risky investment by solving
for the policy functions for MNCs and non-MNCs, with the only difference between these two groups being their tax rates.

Based on our baseline parameter values, the payout boundaries are () for MNCs and () for Non-MNCs. Moreover, as we discussed in the previous section, MNCs generally find risky investments more attractive: MNCs start investing in risky projects as long as the cash ratio is higher (). Non-MNCs, on the contrary, are more conservative, and their risky investment boundary is (). The value function is above the liquidation value for all \( w > 0 \), which validates the assumption that firms won't liquidate unless they have to.

Figure 8 plots the value of MNCs and Non-MNCs \( p(w) \) and their investments and payout boundaries \( w_{\text{risky mnc}}, \bar{w}_{\text{mnc}} \), respectively. For MNCs, when the cash ratio reaches the upper bound \( \bar{w}_{\text{mnc}} \), it is optimal for the firm to pay out any cash in excess of \( \bar{w}_{\text{mnc}} \). The value function becomes linear beyond the payout threshold. At the boundary, the marginal value of liquidity inside the firm is equal to the marginal value of payout. When the cash is between the risky investment region \( w \in (w_{\text{risky mnc}}, \bar{w}_{\text{mnc}}) \), the firm invests in risky projects once it has the opportunity. When the cash ratio is lower than the risky investment region, the firm accumulates cash and forego all the risky investments. Indeed, in the cash accumulation region, the firm finds the downside of risky project too costly relatively to its upside.

It is important to note that higher return on cash holdings effectively lowers MNCs' risk-aversion, even with the same level of cash. To understand why, first note that risk neutral firms behave as if they are risk averse because the presence of costly liquidation when the cash balance is zero. In the dynamic environment, even firms that are away from the liquidation region are taking into account the future possibility of the costly liquidation. The probability of the potential liquidation is decreasing in firms' cash holdings, so that firms are less risk-averse when they have sufficient liquidity holding. Because of this, the dynamics of cash holdings also affect the possibility of liquidation in the future: the higher the drift of cash dynamics, the less likely the firms will run out of cash and liquidate in the near future. Therefore, even with the same cash holdings, MNCs are less risk averse than Non-MNCs.

On the other hand, the lower tax rate on cash incentives firms to accumulate more cash as its returns increase. And over time, with higher level of cash, the firm's risk-aversion is also diminished.
The difference in their effective risk aversion cause them to have difference preference over risky projects. In the model, the NPV of a risky project involves a trade-off between a size growth (success) and a higher probability of liquidation (failure). One would expect that MNCs firms, with relatively lower risk aversion, find risky projects more attractive than non-MNCs.

Figure 10 plots the Net Present Value of risky projects for MNCs and Non-MNCs. The NPV of the risky project increases as the firm becomes less constrained and liquidation becomes less likely. The curvature of the curve confirms that firms behave as if they were risk averse. Intuitively, the marginal value of a dollar is lower when the cash ratio is higher $p''(w) < 0$. MNCs have a lower accepting threshold for risky projects $w_{\text{risky mnc}} < w_{\text{risky nonmnc}}$. Also, the higher carry return of cash lowers the gap between the marginal value of inside liquidity and outside dividend, and increases the payout boundary for MNCs.

Figure ?? plots the investment-capital ratio $i(w)$. Similar to the previous models, the investment-capital ratio $i(w)$ is increasing in $w$ and reaches the peak at the payout boundary $\bar{w}$. The investment-capital ratio drops rapidly when cash-capital ratio is close to the liquidation. Relative to MNCs, lower carry return on cash increases the severity of financing constraints for Non-MNCs, therefore leading to more underinvestment.

To summarize, because of the difference in tax rates, relative to Non-MNCs, MNCs have

- Higher carry return on their cash
- Lower threshold for risky investments
- Higher payout boundary

4.3 The Impact of Tax on Market Concentration

In this subsection, I analyze the impact of foreign tax rate on market concentration. To this end, I simulate the steady state when there is no tax rate difference between MNCs and Non-MNCs, so all the firms are identical in their fundamentals. Next, we implement the CTB policy change in the model by lowering the tax rates on cash for MNCs and calculate the level of market concentration for MNCs and non-MNCs, respectively.

We next investigate the stationary distributions for the key variables tied to the optimal firm policies. Before the introduction of CTB in January 1997, all the firms’ passive earnings are taxed
at the U.S. rates. That is, we assume away the distortion of tax policy, if any, before 1997. Two observations lend support to this assumption. First, CTB was known to facilitate the practice of tax avoidance. Second, the foreign tax rates on average had been higher than U.S. tax rates until late 1990s. (Faulkender et al. (2019)).

We simulate 20000 Non-MNCs and MNCs with the same initial condition: $K_0 = 100$ and cash $W_0 = 10$. The time interval $dt$ is 0.1 year in our model, so each year consists of 10 periods. Once a firm exits, it is replaced with a new firm with $(K_0, W_0)$. In this case, both types of firms have the same tax rates and are therefore identical. Nevertheless, the stochastic realization in their diffusion process and risky investments can generate sizable cross-section heterogeneity. To get the stationary distribution, we simulate the model for 100 years and use the last 10 years data as the stationary distribution.

Figure 11 plots the stationary distribution of cash-capital ratio. The cash holding of a firm are close to the boundary for the most of the time, meaning that the firm's policy is effective at maintaining sufficient liquidity and keeping itself away from the liquidation. Figure 12 shows the distribution of capital stock in the steady state. Most firms in the economy are relatively small. In fact, the majority of firms don't grow beyond their injection point $k_0 = 100$ due to depreciation and underinvestment. However, a few firms are quite large and lies on the right tail of the distribution. In our model, firms grow larger because of both positive realization in diffusion process and risky projects. Initially, firms grow because of positive realization of the diffusion process. After a positive realization of productivity shock, the firm generates revenue and invests in its capital stock. Once the firm's cash holdings is sufficiently high, it start taking risky projects. The risky project has low probability of success, but once it succeeds, it produces substantial returns in term of firm's size. In the aggregate level, the realization of the uncertainty associated with risky projects generate a sizable dispersion in the size distribution.

Figure 13 plots the time series of the fraction of capital accounted for by the top 10% of the firms. The initial condition sets the starting point to be 10%. The number grows rapidly in the beginning and it gradually slows down as the convergence at the tail is considerably slower than the mass of the distribution(Gabaix, Lasry, Lions, and Moll (2016)). Over time, the top 10% firms account for increasingly large share of the economy. The number converges to 45% when all firms are taxed at the U.S. domestic rate.
4.4 The Impulse Response of Check-The-Box

The enactment of CTB in Jan 1997, effectively allowed U.S. multinationals to defer passive incomes by treating those as internal transfers and not subject to U.S. taxation. We map the introduction of CTB in the model by changing the tax rate of passive income for MNCs firms from U.S. domestic rate $\tau_{Non-MNCs} = 35\%$ to a lower tax rate $\tau_{MNCs} = 20\%$, in the year of 1997. These number bring the carry return of cash to 5.6% for MNCs and 4.6% for Non-MNCs. Previous sections show that the small difference in tax rates leads to a meaningful distinction on firm’s liquidity decisions and investment policies. In this section, we ask if these differences can generate substantial implication on market concentration.

To answer this question, we start from the stationary distribution obtained in the last section and change the passive tax rate for MNCs to 20%. We then simulate the path to the new steady state. The detail for calculating the path is in appendix, and it basically involves the following steps: (1) Guess and verify the new steady state, as in the previous section (2) Using the average of the displacement rate as the displacement rate on the path, and then calculate the path. The time interval $dt$ is 0.1 year in our model, so each year consists of 10 periods.

Figure 8 shows that once the passive tax rate is lower, a multinational firm increases its payout boundary and is more willing to invest in risky projects. After the tax policy change, one would expect that (1) cash ratio to rise and (2) higher ratio of risky investment. Figure 14 shows the cash ratios of MNCs rise rapidly after the tax policy change. This is not surprising given that most firms are close to the payout boundary. Once the tax rate comes down, the payout boundary becomes higher and firms accumulate cash to reach the new boundary. At the same time, the risky investment threshold also decreases. MNCs under the lower tax rate are willing to take risky projects that they would not have taken had the rate not decrease. As a result, the fraction of risky investment within the MNCs rises. Figure 15 plots the average ratio of risky investment over capital stock and it show that it is increasing for MNCs. The initial distance between their risky investment ratios due to the fact that the threshold for risky investment comes down so a number of firms can start investing in risky projects immediately. To summarize, MNCs hoard more cash and invest more in risky projects relative to Non-MNCs.

More importantly, we argue that ex-ante risk, after realization, manifest themselves as ex-
post dispersion. In a simplified theoretical framework, we have shown that the presence of risky projects increases the dispersion in the stationary distribution. On the other hand, the higher fraction of risky investment may facilitate creative destruction in the aggregate level, raising the displacement rate, and thus reduces the dispersion. Under our parameter values, the sensitivity of creative destruction with the total amount of risky projects is relatively low, so that the rise in death rate is far from offsetting the increased dispersion from risky projects. This observation in the model is also consistent with the literature documenting a recent decline in business dynamism.

Figure 16 plots the within group concentration for MNCs and Non-MNCs. It calculates the fraction of capital stock accounted for by the top 10% of firms in each period, and then take average for each year. The blue line corresponds to the ratio for MNCs. The capital accounted for by the top 10% for MNCs has increased significantly: from 40% in 1997 to 47% in 2017, an approximately 20% increase. This pattern is consistent with Autor, Dorn, Katz, Patterson, and Van Reenen (2017). It is worth noting that the new steady state is not reached after 20 years of convergence, in fact, it takes a very long time to converge, and we are indeed showing the initial transition path.

4.5 Summary of Model’s Predictions

The model stresses the important of tax differential on firm’s policies, and therefore it can be tested by comparing MNCs and non-MNCs in the data. To summarize, the model has the following predictions:

- Multinationals accumulate more cash than non-multinationals.
- Multinationals, relative to non-multinationals, increase their investment in risky projects.
- Multinationals become increasingly concentrated over time, meaning that the top firms in multinationals take increasingly amount of market share.

In the next section, we provide empirical evidence on these predictions.
5 Empirical Evidence on the Risk-Taking Channel

In this section, we present evidence that is consistent with model’s predictions. Specifically, we show that

- Cash ratio has been rising since late 1990s, and the rise is mostly accounted for by the MNCs.
- In the late 1990s, MNCs increase their R&D investment, which is a form of risky projects (Hall and Lerner (2014); Brown et al. (2009)).
- The sales among multinational firms are becoming increasingly concentrated than that of non-multinational firms: the share accounted for by the top 10% in multinational firms has been increasing, while that of non-multinational has remained flat.

The Definition of Multinational Firms  The accounting data is from Compustat-CRSP Merged database. Compustat contains information about the geographical segments where firms operate. The segments information allows us to classify whether the firm is a multinational. Financial accounting standards (FAS) No.131 requires firms to report foreign operations if foreign assets, income or revenue exceed 10% of total activities. The SEC also stipulates that firms to report foreign income taxes if these exceed 5% of total income before taxes. We follow Fillat and Garetto (2015) and Fritz Foley et al. (2007) in defining multinationals: firms that (1) report the existence of a foreign geographical segment associated with positive sales and (2) not missing both Pretax income (Data item 273) and Income tax –Foreign account (Data Item 64) are classified as multinationals. All other firms are classified as domestic.

Rising Sale Concentration  Figure 1 plots the fraction of sales accounted for by the largest 5 firms in each NAICS 3-digits industries. The blue line first calculate the sum of sales for all the top 5 firms in each year, and then divide it by the total sales in the given year. It initially decreased from 75% in early 1980s to 55% in 1997. After 1997, it starts to rise and reaches 62% in 2015. In the dashed line, we first calculate the fraction of sales accounted for by Top 5 firms in each NAICS 3-digits industries, and the take the average. Both lines exhibit the same pattern and the turning point 1997 is the same time when CTB was introduced and foreign tax rate...
starts to become lower than the U.S. domestic tax rate. This is consistent with the finding from Grullon et al. (2019).

**Cash Ratio** The large increase in corporate cash balances in recent years has received much attention from the academic literature. Figure 4 plots the mean, median and aggregate cash for U.S. public firms from Compustat. Although the rise of average of cash starts as early as 1990, the aggregate cash ratio has been flat until the late 1990s. While recent changes in characteristics of publicly traded firms can account for the rise in average cash ratios (Graham and Leary (2018)), the changes in aggregate cash since 2000 are mostly driven by macroeconomic variables and repatriation taxes (Faulkender et al. (2019)). If repatriation tax is responsible for the recent rise in aggregate cash, one should expect that the rise in cash is mostly coming from multinational firms. Figure 4 shows that this is the case: the cash ratio for MNCs increased from 7% in 1995 to 12% in early 2000s and finally reachd 14% in 2010s. Contrary to the MNCs, the cash ratio of non-multinational firms remain relatively stable over the last twenty years.

**Cause: Risky Investments** With the additional cash holdings and their higher carry returns, MNCs in our model are expected to take more risks. Figure 5 plots the aggregate R&D investment ratio over the last 30 years. The R&D ratio for non-MNCs has been relatively stable until 2000, where it starts to decline rapidly. Contrary to non-MNCs, MNCs have kept their R&D investment at a relatively higher level than that of Non MNCs. Overall, multinational firms account for increasingly share of R&D investment in the economy.

**Effect: Concentration within MNCs and Non-MNCs** One model prediction is that multinational firms should increase their investment in risky projects and as a result become more concentrated over time. I examine whether the concentration is increasing with in multinational firms.

To this end, each year I divide the firms into two groups: MNCs and Non-MNCs. I then calculate the sales share accounted for by the top 10% firms within each group for each industry. I find that the shares accounted for by the top 10% firms is increasing for MNCs, and this upward trending is not observed in Non-MNCs group, which is consistent with the model prediction.
6 The Emergence of Superstar Firms

One alternative explanation for the rising concentration is that top firms grow faster than the average economy, and thus over time the rising concentration is merely a reflection of an increasing importance of these highly productive firms (‘superstar’ firms).

To distinguish the role of risk-taking and high productivity, following Gomes (2018), I decompose the growth of top sale share into two components: within growth and displacement. I first discuss the methodology, then I present the results.

6.1 The Decomposition Framework

The growth of the top sale share $S_t$ between $t$ and $t + \tau$ can be decomposed into a term due to the average sale growth of firms at the top, and a term due to entry and exit:

$$
\frac{S_{t+\tau} - S_t}{S_t} = \frac{\sum_{A} x_i, t + \tau}{\sum_{A} x_i, t} - 1 + \frac{\sum_{E} x_i, t - \sum_{X} x_i, t}{\sum_{A} x_i, t}
$$

(19)

Where $x_i, t$ is the normalized sale for firm $i$ at time $t$, $A_t$ is the set of top firms in each industry, $E$ is the set of firms that enter the top distribution and $X$ is the set of firms that exit the top distribution.

The idea is that if rising concentration is because top firms grow faster than the average, then the composition of top firms should remain stable over time. As a result, we should expect the within term to be large and displacement term should be small. Alternatively, if the rising concentration is due to increasing risk-taking in the economy, we expect a large displacement term.

Next, we first derive the model's predictions about the displacement term. Then, we examine whether the predictions are consistent with the data.
6.2 Displacement rate in the Model

In the model, the dynamics of capital stock in our setting is

\[ dK_t = (I - \delta K_t)dt + \xi K_t dN_t \]  
(20)

According to Gomes (2019), if the distribution can be approximated by a Pareto distribution with coefficient \( a \), then the change in top shares can be written as

\[ \frac{dS_t}{S_t} = \mu dt + \lambda \frac{Ef[e^{\lambda a} - 1]}{a} \]

In our setting \( e^\lambda = (1 + \xi)^8 \). Therefore, the change in shares for a distribution with tail parameter \( a \) is

\[ \frac{dS_t}{S_t} = \mu dt + \lambda \pi \frac{(1 + \xi)^a - 1}{a} \]  
(21)

The RHS is increasing in \( a \), meaning the displacement decreases as the economy becomes more concentrated. This is confirmed in the simulation. Figure ?? plots the displacement rate in the simulation, which is measured by the fraction of firms that exit the top 5 percentile. In the simulation, the displacement goes up after the 1997 tax policy shock, after that the displacement rate gradually declines over time. In our theoretical framework, the decrease in displacement can be fully attributable to the decline of the tail parameter \( a \), as other parameters are fixed as constants. Intuitively, sale concentration increased so much that firms with positive shocks now have a harder time entering the top.

6.3 Displacement rate in the Data

In this section, I decompose the growth of the sale share of Top 5 firms in each NAICS 3-Digits industry. The data is COMPSTAT-CRSP Merged Database. There are two main findings:

\(^8\)Here, we ignore the effect of the dynamics of the distribution of cash ratio \( w \). It can be shown numerically that as the economy converges to new distribution, its impacts on capital distribution is limited.
Fact 1: **Displacement is positive and within term is negative**  
Table 2 reports the result of the accounting decomposition. The first line reports each term geometrically averaged over the entire time period. From 1990 to 2015, the displacement term is positive and within term is negative: the within term is on average 3.9% yearly decline and the displacement term is on average 3.7% yearly growth. The first columns of the table is consistent with the time trend in figure 1: the U.S. public sector experienced a decline in sale concentration between 1990 and 1996, followed by a rapid rise between 1997 and 2007 and a mild increase after 2007.

The entire sample period is subdivided into three periods: 1990-1996, 1997-2007 and 2008-2015. I choose these three periods because under the theoretical framework, we expect the displacement to rise after the tax policy change in 1997, and to decline as the economy becomes more concentrated. This is confirmed in the data: the displacement term increases from 4.0% in 1990-1996, to 4.7% in 1997-2007, and finally drops to 2.1% in the final sample period 2007-2015. The decrease in the last period is due to the fact the sale distribution is getting increasingly fat-tailed as the economy converges to the new steady state. To further understand the dynamics of displacement term from the empirical perspective, I calculate the higher order cumulants of top sale distribution. The volatility and kurtosis increased after 1997 and decreased after 2007, suggesting that top firms take more risk after the tax policy change.

Fact 2: **Within term has steadily increased (less negative) over time**  
Unlike the displacement term, I find that the within term has been rising over time. More precisely, it goes from -5.6% in 1990-1997, to -4.1% in 1998-2007, and finally to -1.9% in 2008-2015. This means even though the displacement term has declined after 1997, the with in term drops faster so that the economy end up with a net rise in concentration. In other words, if the with in term had been constant over the entire period, the economy would have been less concentrated.

Discussion  
Taken together, the findings suggest that top firms grow slower than the average economy, so the argument that existing top firms take increasingly amount of share can not fully explain the rising concentration, especially in the earlier period of the last two decades. The large displacement term indicates that a number of ex-post “superstar” firms have emerged to the top distribution during the past two decades. It also raise the question of how these
“superstar” firms emerge? Were they born to be highly productive or they have taken risks can then succeeded in their risk-taking?

From an ex-post perspective, being productive and having had good luck in risky investments are almost observational equivalent, if one does not turn to the data that can reflect risk-taking behaviors. Put differently, if the concentration level rises without an increase in firms’ risk-taking, then it is likely that the potential “superstars” are highly productive without taking risks. On the contrary, if the rise in concentration is accompanied by an increase in risk-taking, then the risk-taking is more likely to play a role. The evidence in the previous section suggests that risk-taking channel has contributed to the rise in concentration.

7 Conclusion

This paper proposes a theoretical framework to evaluate the causes of two macro trends observed in the last two decades: increasing market concentration and rising corporate cash holdings. In the model, firms have finance-induced risk-aversion because they internalize the probability of being financially constrained. And when the tax rate on their liquidity holding is lower, their risk-aversion is reduced. As a result, firms increase their risk-taking by investing more in risky projects. After the resolution of uncertainty, ex-ante risk-taking manifest as ex-post dispersion in firms’ size, which gives rise to market concentration.

So when the foreign tax rate were lowered in late 1990s, the theory suggests that multinational firms’ effective risk-aversion was reduced and they had incentive to increase risky investment. This, in turn, leads to an increasingly concentrated economy. Empirical evidence is consistent with model’s predictions: multinationals, relative to non-multinationals increase their cash balance and risky investments such as R&D and M&A. Additionally, the multinational firms become increasingly concentrated over time: the top firms within multinationals account for an increasing amount of shares.

The theoretical analysis sheds light on the interaction between tax, firm’s risk-taking and market concentration. It shows that when the possibility of financial constraints are incorporated, increasing tax on risk-less assets might reduce the incentive for risky investments. Moreover, it reveals that firm’s risk-taking and market concentration, which might seem to be unre-
lated issues, are closely linked, thereby suggesting a novel mechanism through which financial frictions affect macroeconomic environment in which firms operate. This way, it also creates room for a broader series of potential policy considerations, and we plan to investigate those issues in future research.
References


Xu, Qiping and Eric Zwick (2018), “Kinky tax policy and abnormal investment behavior.”

Table 2: Decomposing the Growth of Top Sale Share

<table>
<thead>
<tr>
<th>Period</th>
<th>Total</th>
<th>Within</th>
<th>Displacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-15</td>
<td>-0.2</td>
<td>-3.9</td>
<td>3.7</td>
</tr>
<tr>
<td>90-96</td>
<td>-1.6</td>
<td>-5.6</td>
<td>4.0</td>
</tr>
<tr>
<td>97-07</td>
<td>0.6</td>
<td>-4.1</td>
<td>4.7</td>
</tr>
<tr>
<td>07-15</td>
<td>0.2</td>
<td>-1.9</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Notes: The table reports the geometric average of the growth rate of the sale share of top 5 firms in each NAICS-3 digits industry, as well as the geometric average of the within term, the displacement term. All terms in percentage.

Table 3: Moments of Sale Growth

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean</th>
<th>Volatility</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-16</td>
<td>0.09</td>
<td>0.26</td>
<td>3.51</td>
<td>56.98</td>
</tr>
<tr>
<td>90-96</td>
<td>0.11</td>
<td>0.26</td>
<td>3.29</td>
<td>31.48</td>
</tr>
<tr>
<td>97-07</td>
<td>0.11</td>
<td>0.28</td>
<td>2.13</td>
<td>41.07</td>
</tr>
<tr>
<td>08-16</td>
<td>0.05</td>
<td>0.23</td>
<td>7.47</td>
<td>146.79</td>
</tr>
</tbody>
</table>

Notes: The table reports summary statistics of the sale distribution and higher-order moments of log sale growth. Data from Compustat/CRSP merged database.
Figure 1: Trends in industrial concentration

Notes: This figure shows two time series of industrial concentration. The blue line plots the ratio of the total sales of top 5 firms in each NAICS Three Digits industry over the total sales of all firms: $\frac{\sum_{\text{Top 5 sales}_i}}{\sum_{\text{all firms}} \text{sales}_i}$. The orange line first calculates the fraction of sales accounted for by the top 5 firms in each NAICS three digits industry, then take an average across all industries. That is, $\frac{1}{\text{# of industry}} \sum_{\text{industry}} \frac{\sum_{\text{Top 5 sales}_{i,j}}}{\sum_{\text{industry}} \text{sales}_{i,j}}$, where $\text{sales}_{i,j}$ is the firm $i$’s sale and firm $i$ belongs to industry $j$. 
Figure 2: Decomposition of the Growth of Top firms' Sale Share

Notes: The figure plots the growth of the sale share of the top 5 firms in each NAICS three-digits industry, as well as its decomposition into within term and displacement term. The within term, which is the orange line, keeps track of the difference between average growth rate of top 5 firms and that of the economy. The blue line plots the displacement term, which measures the sale share of new top 5 firms minus that of exited top 5 firms. Data is from COMPUSTAT.
Figure 3: Corporate Tax Rates: US and Foreign Rates Source: Faulkender et al. (2019)
Figure 4: Trends in aggregate corporate cash holding

Notes: The figure shows the time-series trend in aggregate cash holdings measured by the ratio of total cash over total assets. The blue dotted line plots the ratio for all firms; the orange line tracks the ratio of multinational firms and the green line for non multinational firms.
Figure 5: Trends in aggregate R&D intensity

Notes: The figure shows the time-series trend in aggregate R&D intensity measured by the ratio of total R&D over total assets. The blue dotted line plots the ratio for all firms; the orange line tracks the ratio of multinational firms and the green line for non multinational firms.
Figure 6: Trends in Mergers and Acquisitions

Notes: The figure shows the time-series trend in aggregate M&A intensity measured by the ratio of total mergers and acquisitions over total assets. The blue dotted line plots the ratio for all firms; the orange line tracks the ratio of multinational firms and the green line for non multinational firms.
Figure 7: Sales concentration: multinationals vs non multinationals

Notes: This figure plots the sales shares accounted for by the top 10% firms in multinational firms and non-multinational firms, respectively. The blue line plots the sales shares of top 10% for multinational firms, and the orange line tracks that ratio for non-multinational firms.
**Figure 8: Value Functions for Multinationals and Non-Multinationals**

Notes: This figure plots the solution for the multinationals and non-multinationals, as well as their risky investment and payout policies. The blue line is the solution for non-multinationals and the red line, multinationals.
Figure 9: Net Present Value (NPV) of Risky Projects

Notes: This figure plots net present value of risky projects. A firm only invests in risky projects if its net present value is positive.
Figure 10: Net Present Value (NPV) of Risky Projects: multinationals vs non-multinationals

Notes: This figure plots net present value of risky projects for multinationals and non-multinationals. The multinationals (MNCs) and non-multinationals (non-MNCs) are identical other than the tax rate on their return on cash. A firm only invests in risky projects if its net present value is positive.
Figure 11: Stationary Distributions before Tax Regulation

Notes: This figure plots stationary distribution of cash-to-capital ratio $w$ when multinationals and non-multinationals have the same tax rate.
Figure 12: Stationary Distributions of Firm Size

Notes: This figure plots stationary distribution of firm's capital stock $k$ when multinationals and non-multinationals have the same tax rate.
Figure 13: Path of Concentration

Notes: This figure plots the path of sales share accounted for by the top 10% in the economy, when multinationals and non-multinationals have the same tax rate. The $x$-axis is the time period, and the $y$-axis is the top sale share. In period 0, every firm has the same amount of capital.
Figure 14: Cash-to-Capital Ratio after the Tax Regulation

Notes: This figure plots the path of simulated cash-to-capital ratio after the tax regulation in 1997. The orange line tracks the non-multinationals and the blue line, multinationals. In the simulation, the tax rate is reduced for multinationals in 1997.
Figure 15: Risky Investment

Notes: This figure plots the path of simulated risky investment-to-capital ratio after the tax regulation in 1997. The orange line tracks the non-multinationals and the blue line, multinationals. In the simulation, the tax rate is reduced for multinationals in 1997.
Figure 16: Within Group Concentration Level: Multinationals and Non-multinationals

Notes: This figure plots the path of sales share accounted for by the top 10% firms in multinationals and non-multinationals, respectively. The blue line first calculate the total sales for top 10% in multinationals, and then divide it by the total sales for all multinationals. The orange line keep tracks of that ratio for non-multinationals.
A Appendices

A.1 First appendix

A.2 Second appendix