

Economic Reforms and the Evolution of China's TFP in the State and the Private Sectors

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Abstract

Over the past 20 years, China has experienced one of the most remarkable growth episodes in modern economic history which has been largely fueled by growth in total factor productivity (TFP). This rise followed major economic reforms that reduced barriers to entry on private businesses. China has since transitioned from a predominantly state-run to a mixed economy of both private and state sectors. In this paper, I develop a model to investigate the extent to which economic reforms can quantitatively explain China's TFP growth. I model two sectors whose main difference is access to financial markets: the private sector faces financial frictions while the state sector does not. The model endogenously generates persistently higher TFP in the private sector than in the state sector via a selection mechanism. In the private sector, only the most productive businesses can overcome the financial frictions. In the state sector, businesses at both low and high productivity levels are able to obtain the necessary financing to operate. As a result, differences in the composition of sector-level productivities arise: the private sector has a higher fraction of productive businesses relative to the state sector. Reforms initiate aggregate TFP growth through the reallocation of factor inputs towards the productive private businesses. The quantitative analysis accounts for 25 percent of China's TFP growth since the 1992 economic reforms.

Keywords: China, Total Factor Productivity, Economic Reforms, Financial Frictions.

JEL Classification Numbers: O11, O16, O43, O53, P23.

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1 Introduction

Over the past 20 years, China has experienced one of the most remarkable growth episodes in modern economic history. Total factor productivity (TFP) has been a main engine of China's growth, accounting for 50 percent of its 7.6 percent annual rise in output per worker in the non-agricultural economy from 1992-2007. This rise followed major economic reform that reduced barriers to entry on private businesses. China has since transitioned from a predominantly state-run to a mixed economy of both private and state sectors. At the time of economic reform in 1992, the private sector accounted for only 12 percent of non-agricultural employment. By 2007, this figure climbed to 52 percent. Additionally, TFP in the private sector has been 80 percent higher, on average, than the state sector throughout this time.

The goal of this paper is to investigate the extent that the reallocation of resources towards the private sector following economic reforms in the non-agricultural sectors can quantitatively account for China's aggregate TFP growth. To this end, I build a two-sector model – the private and the state sectors – whose main difference is access to credit markets: the private sector faces financial frictions while the state sector does not. This captures the widely documented differences in access to credit markets between the two sectors that has characterized China's economy. The model captures China's economic transition by the removal of barriers to production on private businesses (reforms). In the “pre-reform” environment, state owned businesses carry out all production as barriers to entry on private firms are severe enough that none can operate at a profitable scale. At reforms, the barriers to entry on private firms are removed, leading to entry by private business. In the model, the only exogenous change is the removal of barriers to entry on the private sector: the magnitude of financial frictions remains constant throughout. TFP growth arises solely from the reallocation of factor inputs following economic reforms. The quantitative analysis can account for 25 percent of China's observed TFP growth in the non-agricultural economy from 1992-2007.

The model also generates persistently higher TFP in the private sector than in the state sector via a selection mechanism. In the private sector, only the most productive businesses can overcome the financial frictions. In the state sector, businesses at both low and high productivity levels are able to obtain the necessary financing to operate. As a result, differences in the composition of sector-level productivities arise: the private sector has a higher fraction of productive businesses relative to the state sector.

The model draws upon the Lucas (1978) span-of-control framework and all agents belong to either the state or the private sectors. Individuals in both sectors choose the most profitable option between operating an establishment (entrepreneurship) and supplying their labor for a wage. Agents are heterogeneous in wealth and entrepreneurial talent. Individual talent evolves stochastically while wealth is determined by forward-looking saving decisions. Financial frictions on individuals in the private sector are given as collateral constraints arising from poorly developed financial markets. The occupational choice for agents in the private sector therefore depends on both their entrepreneurial talent and assets. Are they talented enough to viably operate a business? If so, do they have enough collateral to finance their business?

The occupational choice plays a quantitatively important role in accounting for both TFP differences and the reallocation of productive resources between sectors. TFP differences between ownership arise endogenously through a novel channel: a world with uniformly low initial wealth levels leads to only the most productive entrepreneurs entering the private sector. Intuitively, financial constraints force entrepreneurs to rely on self-financing to expand their capital to operate at a profitable scale. Entrepreneurs with high talent are able to profitably run their businesses with a relatively smaller capital stock than less talented individuals. As a result, only the most talented private entrepreneurs are able to overcome the constraints and start a business. This is not the case for state firms who enjoy favorable access to credit markets. Financial frictions essentially “prop-up” TFP in the private sector by limiting entry to only the most talented entrepreneurs. This selection mechanism leads to differences in the composition of sector-level productivities whereby the state sector, although they do have productive enterprises, has disproportionately more low-productive firms than the private sector.

In the main exercise, the model starts from an economy where all production is carried out by the state sector. Barriers to entry on private entrepreneurs are given as an output “tax” on production, capturing all barriers to private entrepreneurship prior to reforms in 1992. The tax is so high that all individuals in the private sector choose to supply their labor for a wage by working for a state owned business. I simulate the model from an initial steady state and analyze the transitional dynamics following a permanent and unexpected elimination of the “tax” on private production (reforms) to a new mixed-economy steady state with both sectors active in production. Following the reforms, entrepreneurs with sufficiently high talent and assets to overcome the collateral constraints enter into production. A critical assumption is that individuals in the private sector start with initial low

wealth levels. Collateral constraints slow the expansion of private establishments as the owners have to save to expand their capital use to a profit-maximizing scale. Reallocation of productive resources is a gradual affair, consistent with China's growth experience.

TFP growth is fueled from three sources. First, the reforms introduce a wave of private entrepreneurs into the market. Selection due to financial frictions results in entry exclusively of the most productive entrepreneurs. Second, following entry, financial frictions cause private entrepreneurs to operate at an inefficiently small scale. As they accumulate collateral and expand, resources are directed toward more efficient use in productive private establishments, increasing aggregate productivity and real wages. Third, on the extensive margin, productivity growth is not only due to entry but also exit of the marginally productive establishments. Rising wages induces the exit of less talented entrepreneurs on two fronts: they reduce business level profits and the outside option of becoming a worker becomes more attractive. In sum, the endogenous TFP dynamics evolve gradually through the ongoing expansion of the private sector and exit of marginally productive establishments.

The analysis also allows me to quantify the impact of financial frictions on long-run TFP and aggregate output. I isolate this channel by varying the magnitude of financial frictions and find that aggregate TFP gains from the complete removal of financial frictions are small but can increase aggregate GDP by a significant amount. The removal of financial frictions only raises aggregate TFP by 1.5 percent. On the one hand, TFP increases in the private sector as previously financially constrained private sector entrepreneurs can now operate at their profit-maximizing scale. Additionally, as the private sector accumulates more capital and increases the scale of their operations, wages increase. This forces the least productive state businesses to close as they can no longer profitably operate, raising total state sector TFP. On the other hand, the removal of financial frictions allows relatively less productive private sector entrepreneurs to enter, lowering the total private sector TFP. Together, these opposing forces negate any substantial aggregate TFP gains.

However, the impact of financial frictions has a significant long-run impact on aggregate output through its impact on capital deepening. In the model simulations, GDP can increase as much as 28 percent by the removal of collateral constraints. Although TFP is largely unaffected, the absence of financial frictions allows for the entry of more private firms and they can operate with more capital intensity.

The overall theme of this paper is related to Song, Storesletten, and Zilibotti (2011)

who consider a small-open economy, transitional growth model to explain China’s growth acceleration and acquisition of foreign assets. In their model, the private sector does not influence the equilibrium wage during the transition. In contrast, I contend that changing factor prices play a pivotal role in explaining China’s TFP dynamics. Specifically, rising wages from private sector expansion induces ongoing exit of the least productive establishments. Resource reallocation away from these establishments toward more productive ones raises TFP over time. In addition, I neither assume exogenous productivity growth nor exogenous differences between sectors. This allows me to both identify the direct impacts of reforms on productivity growth and the underlying elements leading to differences in TFP between sectors.

This paper is part of a growing research line that explores reasons for productivity differences between China’s state and private sectors. Hale and Long (2011) also explore the link between financial frictions and productivity differences between China’s state and private sector. The authors argue that private firms defy financial constraints by managing working capital more efficiently. In my model, TFP differences arise via selection into entry of only the most efficient firms. Other studies focus on alternative explanations for productivity differences between sectors: Bai, Yang, Xu, and Jin (2010) focus on lower productivity of state owned enterprises through excess employment and agency cost of management; Lin, Cai, and Li (1998) focus on poor performance of state owned enterprises arising from policy burdens imposed by the central government; and Brandt and Zhu (2001) create a model showing that state firms, on average, are less productive because the government will keep providing loans even if they make poor investment decisions.

Recent work that connects aggregate TFP and micro-level distortions include Restuccia and Rogerson (2008), Buera, Kaboski, and Shin (2011), Guner, Ventura, and Xu (2008), Hsieh and Klenow (2009), and Sandri (2010). This study is closer to Buera and Shin (2010) who also study transitional economies facing imperfect financial markets. I extend Buera and Shin’s model by including a financially unconstrained (state) alongside a financially constrained sector (private) to capture China’s unique institutional setup. Jeong and Townsend (2006) model Thailand’s growth experience through gradual development of financial markets. In my model agents save collateral to relax the financial constraints, while credit markets remain undeveloped.

The remainder of the paper is as follows. I next presents the empirical facts. In Section 3, I present the model. I describe the model parameterization and analyze the simulation

results in Section 4, and Section 5 concludes.

2 Data

This section presents the relevant empirical facts. I begin by detailing the sources and construction of the main data before discussing the events of China’s economic reforms. I then explore three main features of China’s transitional economy. First, I show that TFP growth followed the reallocation of resources towards the private sector after economic reforms in 1992. Second, I document two key dimensions by which the private and state sectors differ; access to credit markets and TFP. The state sector enjoys easier access to credit than the private sector but has lower productivity as measured by TFP. Third, I emphasize the relationship between these differences using provincial-level data; when the private sector has more difficulty accessing credit markets than the state sector, TFP differences between the two are more pronounced.

2.1 Sources and Definitions

The data comes from various issues of the China Statistical Yearbook (CSY). Young (2003) contends that using the implicit price deflators provided in the CSY overstates real GDP and investment (gross capital formation). Following his suggestions, I reconstruct and extend his series of the alternative deflators for GDP and investment.¹ I use all other data series provided in the CSY without modification. Appendix A.1 describes the complete methodology on construction of the aggregate data.

I decompose output, investment, and labor in the non-agricultural sector into government and private ownership. Following Dekle and Vandenbroucke (2010, 2011), I define government ownership as the entirety of state-owned enterprises (SOEs), urban collectively owned units, and township and village enterprises (TVEs). The private sector consists of private enterprises, self-employed workers, foreign owned firms, and other types of ownership. See Appendix A for a further discussion on the classification of ownership.

Compared to the U.S., China’s government owned enterprises are active in most facets of the economy. SOEs alone are involved in a diverse range of businesses from energy,

¹Due to revisions of output and prices in the service sector following the Chinese Economic Census in 2004, I use the implicit deflator for this sector reported by the CSY.

steel, and pharmaceuticals to architecture and design and film production². Throughout the paper, I refer to the government owned sector, which includes TVEs and collectively owned units, as the “state sector” to emphasize the clear differences in the size and economic role government owned enterprises play in China compared to places like the U.S. In short, the terminology is not technically accurate but it serves to distinguish the differences in ownership.

To construct China’s TFP series, I assume non-agricultural output depends on TFP, capital, and labor. Due to lack of time series data on labor hours, I calculate total labor L , as the number of employed people. I build the aggregate capital stock K using the perpetual inventory method with annual depreciation rate 0.075.³ The initial capital stock is taken from Chow (1993) for 1978. Taking data on capital, labor, and output, China’s TFP series is constructed based on the Cobb-Douglas production

$$Y_t = A_t K_t^\alpha L_t^{1-\alpha}$$

where Y is output at time t , A is the Solow residual (total factor productivity), and α and $(1 - \alpha)$ are the exponents on input factors. I let $\alpha = 0.50$, consistent with the average labor share of output (Brandt and Zhu 2010), and I assume that the factor shares are identical in the state and the private sectors.

2.2 China’s Economic Reforms and TFP Growth

Although there were earlier attempts at reforms, China’s major steps toward initiating a vibrant private sector within a mixed economy took place in 1992. This section provides a brief history and summarizes the economic impacts of the 1992 reforms.

Prior to 1978, China’s economy was centrally planned. The government controlled prices, agricultural production decisions, and owned nearly all industrial production. The first wave of economic reforms beginning in 1978 broke up communal agricultural units and gradually relaxed price controls on selected products. Local governments were granted more autonomy leading to the expansion of TVEs – firms owned by local governments – in rural areas.

Across China, a small private sector developed but faced political discrimination.

²http://www.gov.cn/misc/2005-10/21/content_80894.htm the official web portal of the Central People’s Government of the People’s Republic of China

³I choose the depreciation rate at 0.075, between the 6 percent in Young (2003) and the 9.8 percent in Perkins and Rawski (2008).

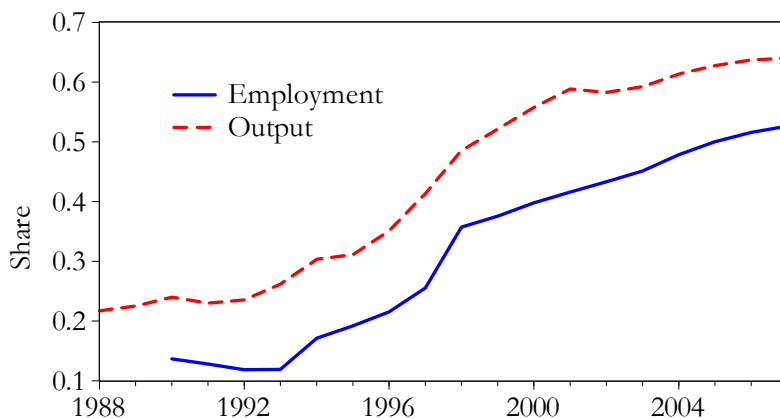


Figure 1: Private Sector Output and Employment Shares

Various movements such as the campaigns against spiritual pollution in 1983 and 1984, the campaign against bourgeois liberation in 1987, and other movements demanding an “attack on speculation” challenged the legitimacy of private enterprises (Li, Meng, Wang, and Zhou 2008). However, the central government created several special economic zones (SEZs); select areas with a market-oriented economic system. The SEZs developed economic practices that fell outside central government economic policy which reigned throughout the rest of China.

In 1989, the Tiananmen Square Incident prompted turnover in Communist Party leadership which put further reforms on hold. In response to the stagnation of reforms, former Communist Party leader Deng Xiaoping made his famous Southern Economic Tour in early 1992. He traveled to Shenzhen SEZ and, upon witnessing its development under a market-oriented economy, he called on the country to emulate its example. Following his remarks, in late 1992 the Communist Party officially endorsed the “socialist market economy.” This marked a turning point in reforms and since then China has transitioned from a planned, state dominated economy to a mixed economy with both state and private enterprises in production.

The ignition of private sector expansion following the reforms in 1992 is highlighted in Figure 1, which shows the share of private employment and output in China’s non-agricultural economy. In unison with the economic reforms, the share of private sector employment accelerated from under 15 percent in 1992 to over half of the employment in 2007 and its output share nearly tripled over the same time frame.

The rising importance of the private sector has coincided with China’s aggregate TFP

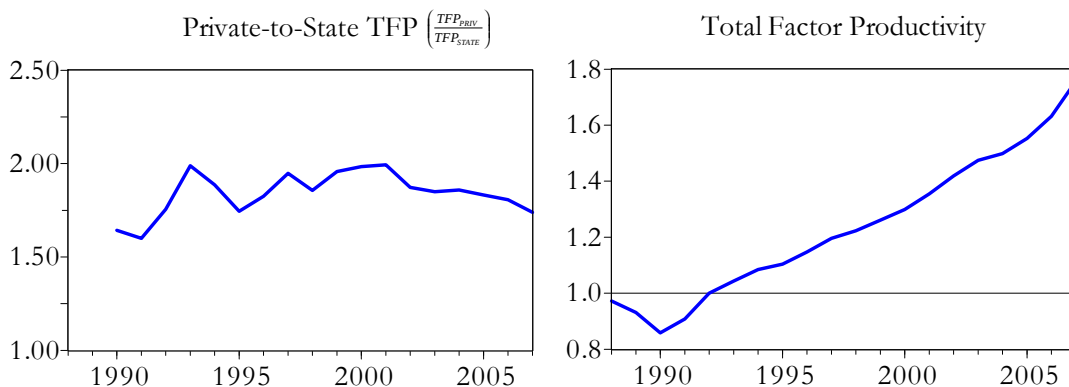


Figure 2: Private-to-State TFP and Total Factor Productivity

growth. In the left panel of Figure 2, I show the ratio of private sector TFP to state sector TFP (private-to-state TFP) which has averaged 1.82 since 1992. Aggregate productivity gains are, in part, a result of resource reallocation from the state to the more productive private sector. The right panel depicts the extent of China's TFP gains which rose over 70 percent from 1992-2007. In a related study, Brandt and Zhu (2010) find that over a quarter of the increase in labor productivity is strictly due to the reallocation of labor from the state to private sector. Using a slightly different classification of ownership from this study, they estimate an average private-to-state TFP above 2 over this time frame.

My estimate of annual TFP growth, 3.4 percent, is close to 3.9 percent in Bosworth and Collins (2008), 3.4 percent in Perkins and Rawski (2008), and 3.9 percent in Brandt and Zhu (2010), all from 1993-2004⁴. To place China's experience in an international context, Young (1995) reports annual TFP growth rates of 3 percent in Taiwan and between 2.4 and 2.6 percent in South Korea during their growth episodes from 1979-1989.

2.3 Differential Access to Credit in the State and the Private Sectors

In China, the state sector has easier access to financial markets than the private sector. Huang (2004) argues that China's domestic credit markets have a "political pecking order" which gives preferential access to SOEs and collectively owned units. Using firm-level data, Guariglia, Liu, and Song (2011) find evidence of discrimination in access to credit for private sector firms and Poncet, Steingress, and Vandebussche (2010) document

⁴The estimates of these authors are inclusive of agriculture.

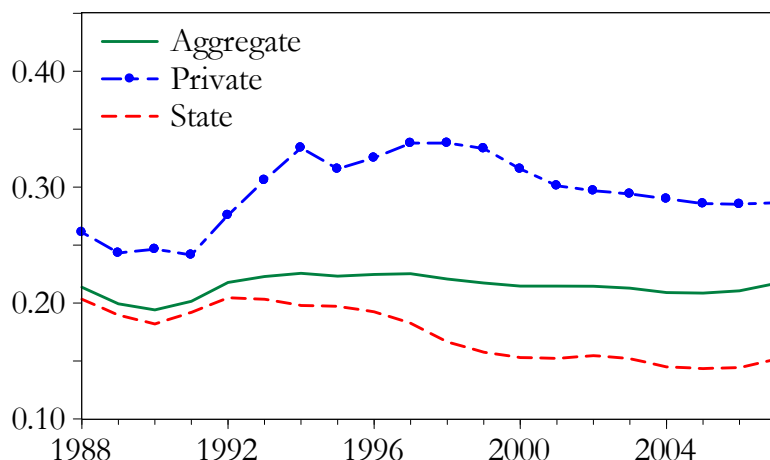


Figure 3: Marginal Product of Capital: $\alpha \frac{Y}{K}$

that private firms face severe financial constraints while SOEs tend to be unconstrained. Brandt and Li (2003) find evidence of discrimination by the Agricultural Bank of China on private sector firms. Naughton (2007) contends that the backing of TVE loans by local governments provides them with favorable access to external credit markets. As a result of difficulty obtaining formal credit, private firms have relied more on retained earnings and other types of financing such as informal loans and FDI (Allen, Qian, and Qian 2007; Hèricourt and Poncet 2008).

As a signal of the differences in access to external financing, the return to capital has been substantially higher in the private sector than in the state sector. This can be seen in Figure 3 which traces the marginal product of capital by ownership. The difference in capital intensity between ownership is clearly reflected by the wide discrepancy in capital returns. Since 1992, the marginal return to capital has been 15 percentage points higher in the private sector than in the state sector.

2.4 Access to Credit and Private-to-State TFP

I have presented evidence of differences in TFP levels and access to external finance between the state and the private sectors. But is there a cross sectional relationship between these facts? I investigate this question using TFP and a measure of relative access to finance for 21 Chinese provinces.

First, I construct a measure of relative access to formal finance between sectors. I define private-to-state external financing as the ratio of the share of investment financed by

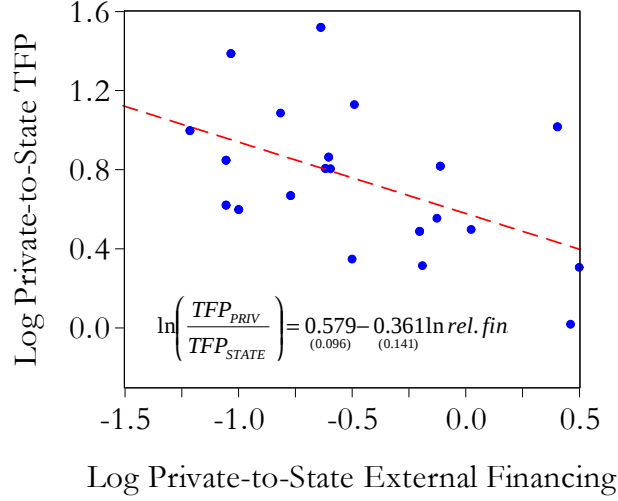


Figure 4: Relative TFP Against Relative External Financing

the central government and domestic bank loans in the private sector to the corresponding share in the state sector⁵. A log value below zero indicates that the private sector relies less on formal credit than the state sector, which is the case for 18 of the 21 observations. In Figure 4, I plot the log of private-to-state TFP against private-to-state external financing in 2002^{6,7}. The negative relationship of relative external financing on private-to-state TFP suggests that when private firms have the same access to credit as state firms, TFP differences go away. This does not suggest a casual relationship for there may be other, regional factors behind this correlation. The main takeaway is that the relationship is negative and statistically significant at the 5 percent level.

Ideally, informal financing and other lines of credit would be included in the relative external financing measure, but data on these are scarce at this level of aggregation. Dollar and Wei (2007) report that privately owned firms rely on family and friends for 8 percent of investment financing. Thus, the previous relationship may be biased downward. On the other hand, the external financing measure does not capture loans from local governments which may be an important source of financing for the state sector in particular. This may, in fact, bias the relationship upward. Unfortunately, the data does not allow me to separate these other external financing sources from internal sources like retained earnings

⁵Specifically $\frac{Loans_{PRIV}}{Investment_{PRIV}} / \frac{Loans_{STATE}}{Investment_{STATE}}$.

⁶2002 is the most recent year that I can estimate TFP by ownership in the provincial data consistent with the method used in the aggregate data. See Appendix A.2 for details on the data sources.

⁷I drop 2 outliers: Guizhou and Ningxia Provinces. Guizhou is China's poorest province in terms of per-capita GDP and Ningxia accounts for less than 1 percent of aggregate GDP.

and self-funded investment.

To summarize, the expansion of the private sector followed the reforms in 1992. Following these reforms, China's impressive TFP growth coincided with the reallocation of productive resources towards the private sector. Throughout the 1992-2007 period, the state sector had better access to external credit markets yet had lower TFP than the private sector. Using provincial data, I presented an interesting relationship between the relative use of external financing in investment and relative TFP; in provinces where the private sector's share of investment financed through formal channels is relatively lower than the state sector, TFP differences are more pronounced. Given these empirical facts, I next build a model to explain these features of China's transitional economy.

3 Model

I model an economy with two types of agents; those who are exogenously financially constrained and those who are not. Mapping the model to the data, the former corresponds to the private sector and the latter to the state sector.

All agents are heterogeneous in their entrepreneurial talent z and wealth. Entrepreneurial talent is drawn from a time-invariant discrete distribution $\mu(z)$. Individual wealth is accumulated via saving.

In each period, all agents face an occupational choice: whether to work for a wage or to operate a business. Each agent is endowed with one unit of labor that can only be supplied to one activity. If he decides to operate a business, I refer to him as an entrepreneur. Although one may not consider operation of state firms as entrepreneurship, for clarity I define entrepreneurs in the state and the private sectors as state entrepreneurs and private entrepreneurs, respectively. Individuals are exogenously assigned to belonging to a sector. Entrepreneurs cannot move from one sector to the other, however, workers can supply their labor to any business regardless of its sectoral classification.

3.1 The Private Sector

The private sector consists of a measure N of infinitely lived agents. Agents are heterogeneous in entrepreneurial talent z and wealth, the latter is determined by the individual's

assets a . I define $G(a, z)$ as the joint distribution function of private sector wealth and entrepreneurial talent. Each individual's entrepreneurial talent follows a stochastic process where he retains his ability from one period to the next with a probability γ and loses his ability with a probability $1 - \gamma$, in which case he redraws a new ability from the distribution. The persistence of ability can be interpreted as the rate of change in the market structure that renders an individual's current talent unprofitable. I characterize the private sector based off Buera and Shin (2010).

Preferences Individual preferences are characterized by the CRRA utility over consumption c of a single good

$$\mathbf{E} \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma} - 1}{1-\sigma} \quad (1)$$

where $\beta \in (0, 1)$ is the subjective discount factor and σ is the coefficient of relative risk aversion.

Production The unit of production is the establishment operated by a private entrepreneur. Production of the final good y requires a combination of capital k and labor l with an entrepreneurial talent z and is described by the production function $f(z, k, l)$. The function f is increasing in z , k , and l and exhibits decreasing returns to scale in k and l . In the quantitative analysis, I draw from the Lucas (1978) span-of-control model with production technology

$$y = zk^\alpha l^\theta \quad (2)$$

where $\alpha, \theta \in (0, 1)$ and $\alpha + \theta < 1$. Decreasing returns to scale implies that $(\alpha + \theta)y$ is the input factor share and profits are $(1 - \alpha - \theta)y$.

Next, I discuss the markets for factor inputs and the private entrepreneur's problem. Each individual has access to a competitive financial intermediary who receives deposits and rents capital to entrepreneurs. I consider only the case where agents cannot borrow for consumption purposes, $a \geq 0$. The interest rate on deposited assets a is r . The assumption of the perfectly competitive intermediary dictates that the capital rental rate is $r + \delta$, where δ is the depreciation rate.

Each private entrepreneur faces a limitation on his capital rental given by the collateral constraint $k \leq \lambda a$ where the parameter λ dictates the magnitude of financial frictions. For

example, when $\lambda = 1$ all capital has to be self-financed ($k = a$). On the other hand when $\lambda = \infty$, access to credit is unlimited. This constraint can be motivated from a limited commitment problem and is commonly employed in the literature on financial frictions (see Appendix B for an example).

Each establishment hires labor at wage w . Labor is mobile between sectors; an individual worker in the private sector can work for an establishment in the state sector and vice versa. In equilibrium, the wages in the two sectors are equal.

Conditional on operating an establishment, a private entrepreneur maximizes profit taking the rental rate and wage as given. Formally, the profit function is defined as

$$\pi = \max_{l,k} \{zk^\alpha l^\theta - wl - (r + \delta)k\} \quad (3)$$

subject to

$$k \leq \lambda a. \quad (4)$$

The indirect profit function is therefore $\pi(z, w, r)$.

The Private Agent's Problem An individual chooses sequences of consumption c and saving in a non-state of nature risk free asset a , along with the decision to become a worker or an entrepreneur. He will decide to become an entrepreneur if his profit exceeds the market wage. This decision jointly depends on his entrepreneurial talent and whether his wealth is sufficient to overcome the collateral constraint. I follow Buera and Shin (2010) and characterize the occupational choice by a single policy function. An individual with entrepreneurial talent z will operate an establishment if his current assets are greater than or equal to a threshold asset level $\underline{a}(z)$ that solves $\pi(\underline{a}(z); z, w, r) = w$.

The private individual's problem is to maximize (1) subject to

$$c_t + a_{t+1} \leq \max\{\pi(\underline{a}(z), w_t, r_t), w_t\} + (1 + r_t)a_t, \quad (5)$$

where the *max* operator captures the occupational choice.

3.2 The State Sector

In the state sector, there is a single representative household comprised of S members. Similar to the private sector, every period individuals face an occupational choice between

working for a wage or operating an establishment. However, the state sector differs from the private sector in two ways. First, although entrepreneurial talent is drawn from the same distribution as in the private sector, persistence of talent in the state sector is permanent, i.e., $\gamma = 1$. This reflects the fact that Chinese state firms in major industries such as utilities, energy, financial services, etc., have a monopoly on the “low hanging fruit” which allows them to survive over time. Second, as explained in the previous section, the state sector has easier access to credit than the private sector. In the model, I assume that the state sector has complete access to capital rental markets.

Preferences Utility in the state sector follows the same functional form and preference parameters as the private sector. The household maximizes utility over total household consumption C given as

$$\sum_{t=0}^{\infty} \beta^t S \frac{(C_t/S)^{1-\sigma} - 1}{1-\sigma} \quad (6)$$

where each household member consumes an equal share of the household’s aggregate consumption. Since the persistence of talent γ is permanent and there are no aggregate shocks in the economy, the household faces a perfect foresight problem.

Production Production of the final good y at each state establishment requires combining capital k and labor l with an individual talent z with the same technology as in the private sector (2).

A state entrepreneur has access to the same competitive financial intermediary as one in the private sector. However, they have perfect access to capital rental. In the context of the collateral constraints, this is equivalent to $\lambda = \infty$. Like the private sector, I abstract from borrowing for consumption purposes ($a \geq 0$). State entrepreneurs also hire workers at a wage w in the same labor market as their private sector counterparts.

Contingent on operating an establishment, an individual with a talent z solves (3) and receives the indirect profit $\pi(z, w, r)$.

The Household’s Problem Each individual decides whether to operate an establishment or to work for a wage. Whether one is an employer or an employee, individuals within a household pool their collective income and the household chooses sequences of consumptions that maximize utility. If an agent chooses to be a worker, he contributes a wage w to the collective income of the household. If he operates an establishment, he

contributes $\pi(z, w, r)$ instead. His occupational choice is the most lucrative option. Since an individual in the state sector faces perfect capital rental markets, given factor prices, their occupational choice depends solely on individual talents. Formally, an agent chooses to operate an establishment if his individual talent is greater than or equal to a unique threshold $\underline{z}$ that solves $\pi(\underline{z}, w, r) = w$.

The household's problem is to maximize the lifetime utility (6) subject to the budget constraint

$$c_t + a_{t+1} \leq \sum_{z \geq \underline{z}} \mu(z) \pi(z; w_t, r_t) + \sum_{z < \underline{z}} \mu(z) w_t + (1 + r_t) a_t$$

where the lower case variables represent per-capita notation.

3.3 Equilibrium

In equilibrium, the market for capital and labor must clear. Let the demand for capital and labor for a private entrepreneur with assets a and talent z be $k(a; z, w_t, r_t)$ and $l(a; z, w_t, r_t)$. Next, let $k(z; w_t, r_t)$ and $l(z; w_t, r_t)$ be the capital and labor demands of a state entrepreneur with a talent z . Market clearing in the capital market requires

$$\begin{aligned} N \sum_{z \in \mathcal{Z}} \mu(z) \left[\int_{\underline{a}(z, w_t, r_t)}^{\infty} k(a; z, w_t, r_t) dG_t(a, z) - \int_0^{\infty} a dG_t(a, z) \right] \\ + S \left[\sum_{z \geq \underline{z}} \mu(z) k(z; w_t, r_t) - a_t(\cdot) \right] = 0 \end{aligned} \quad (7)$$

where the first term in each bracket is total capital demand by the private and the state sector, respectively, and the second term is capital supply (total assets).

Market clearing in the labor market requires

$$\begin{aligned} N \sum_{z \in \mathcal{Z}} \mu(z) \left[\int_{\underline{a}(z, w_t, r_t)}^{\infty} l(a; z, w_t, r_t) dG_t(a|z) - G_t(\underline{a}(z, w_t, r_t), z) \right] \\ + S \left[\sum_{z \geq \underline{z}} \mu(z) l(z; w_t, r_t) - \sum_{z < \underline{z}} \mu(z) \right] = 0 \end{aligned} \quad (8)$$

where the left term in each bracket is total labor demand by the private and the state sector, respectively, and the right term is labor supply (total workers).

I now define a competitive equilibrium where a variable with an asterisk indicates an equilibrium value.

Given a sequence of prices $\{w_t^, r_t^*\}_{t=0}^\infty$, for all $t \geq 0$, the following holds in a competitive equilibrium:*

- (i) *for the private sector, the sequences $\{c_t^*, a_{t+1}^*, l_t^*, k_t^*\}_{t=0}^\infty$ solves the individual's problem (1);*
- (ii) *for the state sector, the sequences $\{c_t^*, a_{t+1}^*, l_t^*, k_t^*\}_{t=0}^\infty$ solves the household's problem (6);*
- (iii) *the goods market clears;*
- (iv) *the markets for capital and labor clear (Equations (7) and (8) hold);*
- (v) *financial intermediaries make zero profits.*

4 Quantitative Analysis

In this section, I first parameterize the model to characterize China's economy. I then conduct the transition from production being carried out by state establishments to a mixed economy with active state and private entrepreneurs. I begin the exercise where individuals in the private sector face barriers to operating an establishment. I model these restrictions on private production as an output "distortion," defined as τ , representing all obstacles to production, $(1 - \tau)zk^\alpha l^\theta$. Prior to reforms, the production technology for all individuals in the private sector is subject to $\tau = 1$. This initial value of τ captures an economy where state entrepreneurs are the only producers.

Reforms are introduced by the unexpected, permanent change from $\tau = 1$ to $\tau = 0$, which is the only exogenous change I impose on the economy. Once the reform takes place, everyone realizes the change is permanent. Reforms essentially "open up" the economy to a second sector. Following the "opening up," labor flows freely between the two sectors but financial constraints limit the capital flows between the two. As discussed in Section 2.2, reforms may have been, in fact, more gradual, but this simplified characterization highlights the impact of major reforms in 1992. In any case, the data suggest that the reforms were drastic, exemplified by the immediate reallocation of labor and production following the 1992 reforms.

4.1 Parameterization

I discipline the quantitative analysis by choosing parameter values that match key moments in the data. In total, I specify values for 10 parameters.

- Three technology parameters α , θ , and δ .
- Two parameters describe the process for entrepreneurial talent γ and η . Specifically, I assume the distribution of z follows a truncated and discretized Pareto distribution with p.d.f. $\eta z^{-(\eta+1)}$ for $z \geq 1$ where η determines the dispersion of ability across individuals.⁸
- Two preference parameters β and σ .
- The size of the state and private sectors S and N .
- The magnitude of collateral constraints λ .

Some of the model parameters are chosen with values common in the literature. I let the subjective discount factor $\beta = 0.96$, a common value for annual models, and the coefficient of relative risk aversion is set to $\sigma = 1.5$. I use $\delta = 0.075$ for the one year depreciation rate.

The remaining seven parameters are set to match moments in the data specific to this study and are summarized in Table 1. To determine the dispersion of talent parameter η , I match the distribution of individual talent $\mu(z)$ to the US establishment size distribution measured by employment due to the lack of comprehensive Chinese establishment-level data. I choose η by simulating the steady state of the model without financial frictions and the state sector to match the US establishment size distribution because the US has relatively well developed financial markets and a large private sector. It has long been documented that US firm size can be well approximated by the Pareto distribution (Simon and Bonini 1958; Steindl 1965; Ijiri and Simon 1977). The matching of the US and China

⁸I truncate the Pareto distribution by finding $\bar{z}$ that solves $G(\bar{z}) = 1 - 0.00005$ where $G(\cdot)$ is the c.d.f of the Pareto distribution. This cutoff ensures that the mass above $\bar{z}$ is probabilistically very small.

Table 1: Parameter Values

Target Moments	Chinese Data	Model	Parameter
Labor income share	0.50	0.50	$\theta = 0.50$
1992 Gini coefficient	0.24	0.24	$\alpha + \theta = 0.82$
2007 share of private labor	0.52	0.51	$\frac{S}{N} = 0.04$
2007 external fin./GDP	1.46	1.46	$\lambda = 1.45$
Target Moments	US Data	Model	Parameter
Top 12 percentile employment share	0.72	0.72	$\eta = 4.44$
Establishment exit rate	0.10	0.10	$\gamma = 0.895$

talent distribution is under the assumption that the same technological blueprints available in the US are available in China. Given the technology and preference parameters, I set η of the talent Pareto distribution $\eta z^{-(\eta+1)}$ at 4.44. This matches the model employment share of the largest 12 percent of establishments with the US in 2007, 0.72.⁹ Appendix D compares the model’s establishment size distribution with the data.

I set the persistence of individual talent γ equal to 0.895, leading to an annual exit rate of establishments of 10 percent in the model. This is consistent with the exit rate of establishments in the US as reported in Buera and Shin (2010).

Next, I let $\theta = 0.50$ to match the 50 percent labor share of output in China. The profit share of output $1 - (\alpha + \theta)$ largely determines the income distribution. Therefore, I infer the value of θ by targeting China’s 1992 income Gini coefficient.

Since there is no data on the wealth distribution in 1992, I set the initial distribution of assets in the model to match the income Gini coefficient in the data. Specifically, agents within the same sector have the same asset level, however the level is higher in the state sector than in the private sector.

The remaining parameters N , S , and λ are set to match moments of China’s transitional economy. I simulate the transition by changing the output “distortion” on the private sector from $\tau = 1$ to $\tau = 0$. I fix the number of simulated private agents to $N = 150,000$ and adjust the size of the state sector S to match the private sector’s share of employment of 52 percent in 2007.

For the magnitude of the collateral constraint λ , I target China’s external finance to GDP ratio in 2007 of 159 percent. External finance is the sum of domestic and foreign

⁹The size distribution from the US Bureau of Labor Statistics is reported in bins. The 12 percent figure is the closest I can estimate to the top 10 percent of establishments.

bank credit, private bond market capitalization, and stock market capitalization.¹⁰ I let $\lambda = 1.45$ which gives an external finance to GPD ratio of 146 percent.

4.2 Baseline Model Results

In this section, I analyze the transition from an initial steady state where the only establishments belong to the state sector ($\tau = 1$) to a mixed economy with both private and state entrepreneurs ($\tau = 0$). I first show the growth in TFP as a result of the modeled reform along with the basic underlying intuition, and then examine the mechanisms in detail. To be consistent with the TFP calculations in the data, I aggregate capital and labor and use the Cobb-Douglas production function to back out TFP, assigning equal shares to both inputs.

Figure 5 presents the transition dynamics of TFP, private employment share, private-to-state TFP, and factor input prices. The solid line corresponds to the China data and the dashed lines to the model results. In Panel A, we see that TFP continues to evolve after the initial rise following reforms in 1992 even though there are no additional exogenous changes. By 2007, the model accounts for 25 percent of the observed TFP growth since reforms.

Three mechanisms contribute to the TFP growth. First, the reforms introduce a wave of entrepreneurs with above average talents. Talented private entrepreneurs with enough assets to overcome the collateral constraints and operate at a profitable level enter into production. Financial frictions, however, impede entry of the less talented. High-talent individuals profitably operate a business using less capital, so their occupational choice is dictated less by financial constraints compared to less talented individuals. In contrast, individuals in the state sector do not face this barrier to entry, so there are relatively more low-talent entrepreneurs active in this sector. This selection mechanism results in a relatively larger share of talented entrepreneurs in the private sector than in the public sector, generating a difference in the composition of entrepreneurial talent between these sectors. This ultimately leads to persistent differences in TFP (Panel C) with the private sector displaying higher TFP. Thus, aggregate TFP increases due to the exclusive entry

¹⁰I follow Buera, Kaboski, and Shin (2011) to calculate external finance. I use the data from the International Monetary Fund's *International Financial Statistics* (IFS) and Beck and Demirgüç-Kunt (2009). The market value of the stock market capitalization overstates the book value which is conceptually closer to financed capital in the model. I multiply the stock market capitalization by the average book-to-market ratio in the data, 0.35. This calculation does not account for private consumer credit, so the actual value of borrowing for investment is most likely smaller.

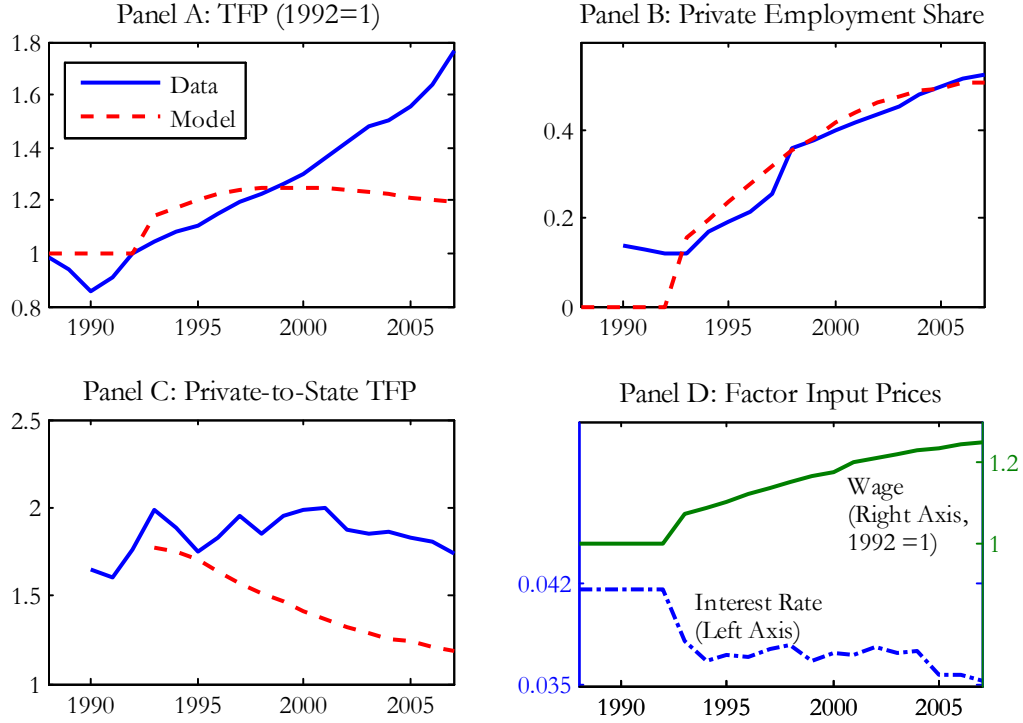


Figure 5: Transition in the Baseline Economy

of the most talented private entrepreneurs.

Second, aggregate TFP growth largely comes from the reallocation of resources from the state sector to the more productive private sector (Panel B). Following entry, financial frictions cause private entrepreneurs to operate at an inefficiently small scale. As private entrepreneurs accumulate wealth to increase collateral and approach the profit-maximizing scale, this sector expands and gradually attracts more labor. In the calibration I targeted the private sector employment share in 2007 only, but the simulated series mirrors the time-path of labor reallocation in the data.

Third, productivity growth is due not only to entry of but also exit of the marginally talented entrepreneurs. Ongoing productivity growth causes a rise in the equilibrium wage (Panel D), which induces the exit of less productive enterprises on two fronts. First, business level profits decline. Second, the outside option of being a worker becomes more attractive.

Now, I explore these mechanisms in more detail.

TFP Differences Between the Private and the State Sector

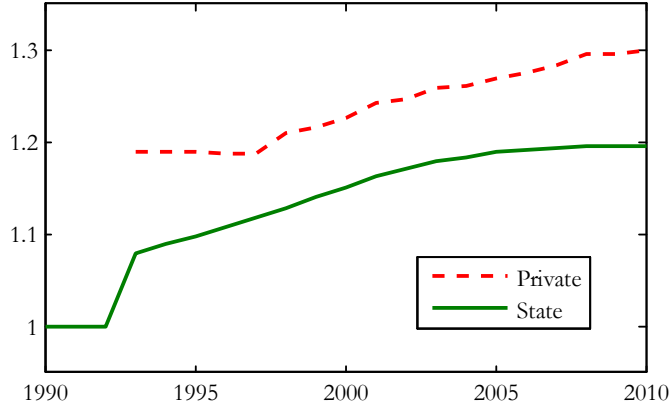


Figure 6: Average Entrepreneurial Talent

In this section, I explore the mechanisms that lead to the differences in TFP on the extensive margin. I focus on the micro-level occupational choice to capture the differences in entrepreneurial talent between sectors. Figure 6 shows that throughout the transition the average talent, normalized by the pre-reform level of the state sector, is higher in the private sector than in the state sector. The differences in talent composition arise from financial frictions that alter the occupational choice rules for the private sector.

To further investigate these differences, I consider the occupational decision rules for both sectors in Figure 7 which plots assets a against entrepreneurial talent z .¹¹ First, for an agent in the private sector, the decision to become an entrepreneur depends jointly on his talent and wealth. The threshold asset level a at a given entrepreneurial talent z is given by $\underline{a}(z)$. To the right of the cutoff, the agent operates an establishment and to the left he becomes a worker. The downward slope of the decision rule indicates that more talented individuals require fewer assets to enter entrepreneurship.

Second, for agents in the state sector, the occupational choice cutoff only depends on individual talent. The vertical line at $\underline{z}$ shows the cutoff for the state sector. It is worthwhile to point out that an individual in the private sector would never choose to be an entrepreneur if his talent was below $\underline{z}$ no matter how wealthy he may be.

The difference in the occupational decision rules illustrates a barrier to entrepreneurship due to financial constraints that particularly affects the less talented. For example, a private agent at point A would not choose to become an entrepreneur since he is unable to overcome the collateral constraint. In contrast, a state agent at point A would become an

¹¹This figure plots the model occupational choice in the final stationary steady state.

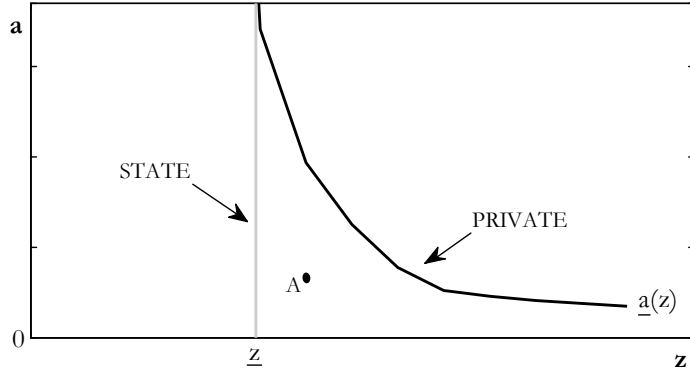


Figure 7: Occupational Decision Rules

entrepreneur. As a result, the share of low-talent entrepreneurs is smaller in the private sector than in the state sector. This mechanism generates a variation in the composition of talent between sectors.

In Figure 8, I show the steady state probability density functions (p.d.f.) of entrepreneurial talent in each sector to highlight the compositional differences of talent between the two. The point where the distribution starts corresponds to $\underline{z}$ from the previous figure. Observe that close to $\underline{z}$ on the right, the state sector has a large mass of active entrepreneurs while the private sector does not. Individuals in the private sector in this range of talent cannot save the necessary collateral to operate at a profitable scale. In the absence of collateral constraints, these distributions would be identical.

The overall difference in private-to-state TFP is a result of two opposing factors. On the one hand, collateral constraints cause private entrepreneurs to operate at an inefficiently small scale, suppressing TFP. On the other hand, the composition effect – selection of the most talented entrepreneurs – raises TFP. However, the latter effect dominates the former which keeps private sector TFP relatively high. I measure these individual effects in Section 4.4.

The magnitude of the compositional effect of talent between sectors is influenced by the persistence of ability γ . If γ equals 1, all private agents' talents remain indefinitely relevant. In this scenario, all potential private entrepreneurs with talent $z > \underline{z}$ eventually overcome the collateral constraints and the steady state composition of talent will be the same in both sectors. At a low persistence of talent, since asset accumulation takes time, saving to overcome the collateral constraints may be futile because an agent's current

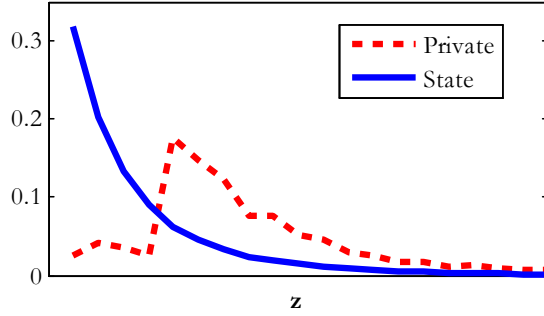


Figure 8: Probability Distribution Function of Individual Talent z

ability may become obsolete before he can profitably become an entrepreneur.¹² In section 4.3, I show that along the transition path this does not play a quantitatively large role on the main aggregates. It does, however, matter in the long run.

Interest rates also impact an individual's ability to overcome the financial constraints. Following reforms, the interest rate in the model moves from 4.15 percent in 1992 to 3.6 percent in 2007. With lower interest rates, private agents become more impatient ($(1 + r)\beta < 1$), rendering them less willing to save in order to overcome collateral constraints. This disproportionately affects the least talented as they already require more wealth to start a business.

Interest rates initially fall from the decline of capital demand in the state sector. State entrepreneurs exit and production shifts towards the less capital intensive private sector. Over time, interest rates continue to fall as private entrepreneurs increase savings to self-finance. Additionally, when the persistence of talent $\gamma < 1$, under the permanent income hypothesis, private entrepreneurs save to smooth consumption for future periods when they will most likely be workers. These forces work in tandem to decrease interest rates.

Expansion of the Private Sector

Following the entry of private entrepreneurs on the extensive margin, aggregate TFP growth also arises from the expansion of these firms on the intensive margin. Financial constraints cause private entrepreneurs to operate an inefficiently small scale, but as time progresses they save collateral to expand their capital use. Figure 9 illustrates the evolution of capital intensity, measured as the capital-output ratio, for both sectors in the left panel and for the entire economy to the right. The increase in capital intensity

¹²In the model, only the top 4 percent of private agents meet the talent requirement ($z > \underline{z}$) to become an entrepreneur. Thus, even though it is possible for a potential private entrepreneur to draw a higher talent if he loses his current talent, it is more likely that such an agent would become less talented.

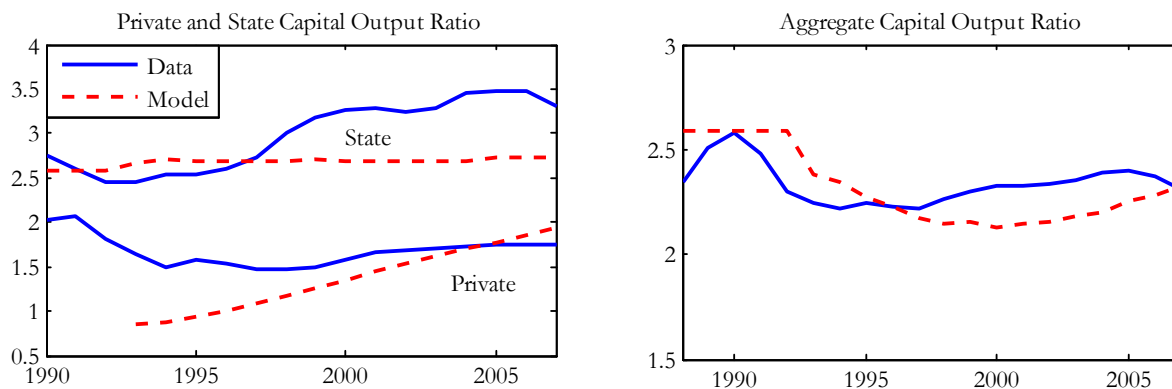


Figure 9: Capital-Output Ratios

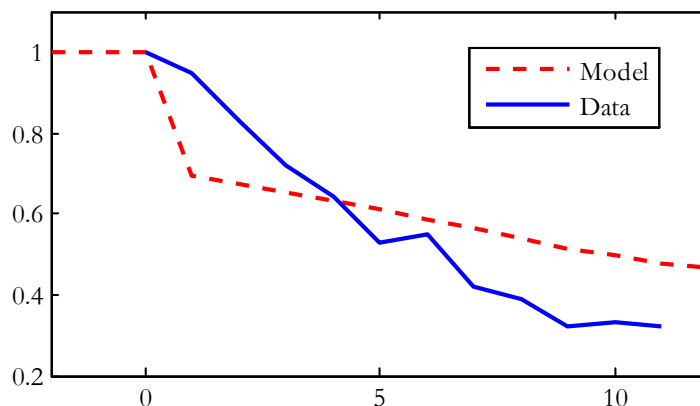


Figure 10: Number of State Firms

in the private sector reflects self-financing. The model predicts a faster rise in capital intensity in the private sector and a slower rise in the state sector compared to the data. However, the simulations clearly show differences in the capital-output ratios between sectors which is driven by variation in access to credit. Other factors not present in the model may account for the disparities in the model-data trends. For instance, many state firms benefit from subsidized inputs (Prasad 2009), a channel I do not explore.

The fall in the aggregate capital-output ratio is an indicator of more efficient resource use because TFP and output grow following the reforms. As the less capital intensive private sector expands, aggregate capital intensity falls yet GDP grows by 20 percent.

Exit of the Marginally Talented Entrepreneurs

On the extensive margin, productivity gains also come from the exit of the least tal-

ented, marginal entrepreneurs. As the private sector expands, the growth in productivity raises the equilibrium wage which induces exit, i.e., $\underline{z}$ shifts to the right. Exit is particularly pertinent for the state sector as this is the only mechanism that changes their composition of entrepreneurial talent. I next compare the exit of state enterprises in the model to the data.

The data used includes all state owned manufacturing and construction firms with sales over 5 million RMB from 1998-2009. Figure 10 traces the number of establishments in the model normalized by the pre-reform number and firms in the data normalized by 1998.¹³ Because of the shortened sample size, I overlap the two series with $time = 0$ as 1992 in the model and 1998 in the data. Despite the differences in classification (firms vs. establishments) and timeframe, both series point out the salient dismantling of inefficient state owned companies. The closure and declining profitability of state firms occurs because the rise of the private sector increases wages, and wages erode profits.

Discussion

In summary, TFP growth following the 1992 economic reforms arises from three sources. First, only the most talented entrepreneurs enter. Second, as the private sector expands, resources are reallocated to the more productive private sector. Third, as wages rise, the least talented entrepreneurs exit.

Two main features of the TFP dynamics stand out. For one, the model can account for 25 percent of total TFP growth in China from 1992-2007 without imposing any exogenous TFP growth. The increase in simulated TFP does not include growth in human capital, adoption of new technologies, or other sources of productivity growth. Instead, the model generates TFP growth entirely from both the structural changes that closely correspond to the 1992 economic reforms and from the financial constraints that characterize an important sectoral difference in the Chinese economy.

Also, TFP differences evolve endogenously without assuming any exogenous discrepancies in productivity between the state and the private sectors. In 2007, the model accounts for 22 percent of the average private-to-state TFP and the explanatory power increases to 26 percent in the steady state. This provides an alternative, unexplored channel that relies on selection into entrepreneurship based on empirically motivated differences in access to financial markets across sectors.

¹³I smooth the model series using the HP filter with $\lambda=100$ to capture the trend.

4.3 Sensitivity Analysis

I now conduct a sensitivity analysis by describing three alternative cases: (1) no financial constraints, (2) permanent persistence in talent, and (3) a small open economy with an exogenous world interest rate. In each experiment, I retain the baseline model parameterization except for the parameter in question. These alternative scenarios are plotted in Figure 11 against the baseline parameterization.

First, consider the case of perfect capital rental markets $\lambda = \infty$. In the baseline model, TFP dynamics continue to evolve after the initial reform as the private entrepreneurs accumulate the collateral to increase the scale of production. This is not the case in the perfect credit economy; given factor prices, all establishments immediately reach their profit-maximizing scale. In addition, the occupational decision rule is identical for both sectors. The distributions of entrepreneurial talent are the same, captured by the private-to-state TFP equaling 1 in all periods. Also, the private sector employment share immediately reaches its long-run value, in stark contrast to the baseline model. Interest rates, however, continually change. They first rise due to an increased demand for capital. As private entrepreneurs save to insure against future changes in their individual talent, interest rates begin to gradually fall below the initial rate.

Next, suppose there is permanent persistence in talent $\gamma = 1$. In this scenario, agents face a standard perfect foresight problem with financial constraints. The results are qualitatively similar to the baseline economy. As discussed in the previous section, in the long run all private entrepreneurs eventually overcome the collateral constraints and private-to-state TFP and the private sector employment share will be the same as in the perfect credit economy. In the short-run, however, selection into entry from the financial constraints still exists. Additionally, the interest rate returns to its initial level in the long run because agents have no precautionary savings motive.

Finally, consider the small open economy model with a constant interest rate $r = 0.04$. I lower the interest rate from the initial $r = 0.0416$ to invoke the impatience condition $(1+r)\beta < 1$ to avoid infinite asset accumulation which would otherwise occur in a setting with precautionary motives. In this experiment, capital rental markets need not clear domestically because excess saving or borrowing will be absorbed in international markets. Again, these results are similar to the baseline economy, however the private sector expands at a slightly faster rate. With higher interest rates, the impatience condition is less severe so entrepreneurs are more willing to acquire the necessary collateral to operate

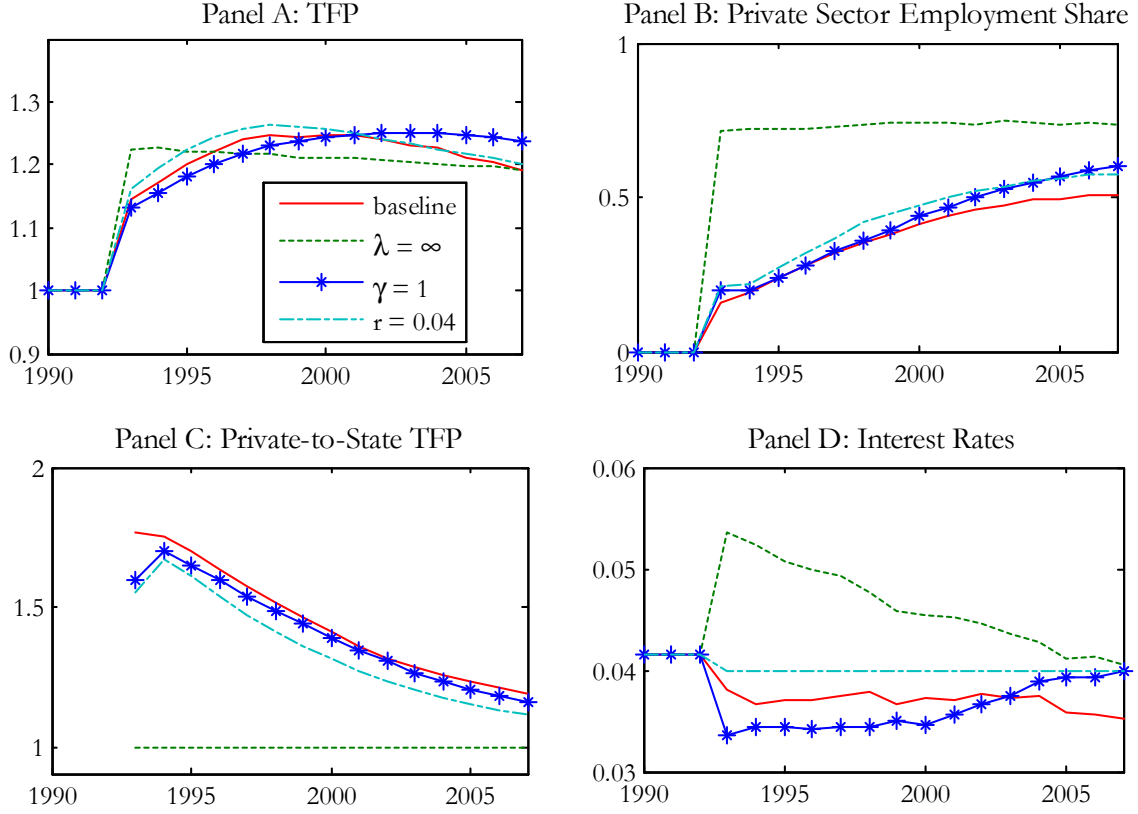


Figure 11: Sensitivity Analysis

an establishment, i.e., the occupational decision rule is less distorted by financial frictions. In reality, China is neither a small-open economy nor completely closed. If the model was expanded to characterize China as a large open economy, one may think that the model dynamics may lie between the small open economy and the baseline cases, which turn out to be similar.

4.4 Financial Frictions on China's Economy in the Long Run

I next quantify the long run impacts of financial frictions faced by private entrepreneurs on TFP and GDP. Consider first the impacts on TFP in the aggregate economy and at the sector level. The y-axis in Figure 12 shows the stationary steady state TFP for different values of λ , normalized by TFP in the perfect credit case ($\lambda = \infty$). The empirical counterpart of λ , private-to-state external financing, is shown on the x-axis and the carrot marks the baseline parameterization of λ . It is clear that TFP differences between sectors are increasing in financial frictions. At the baseline parameterization, removal of financial

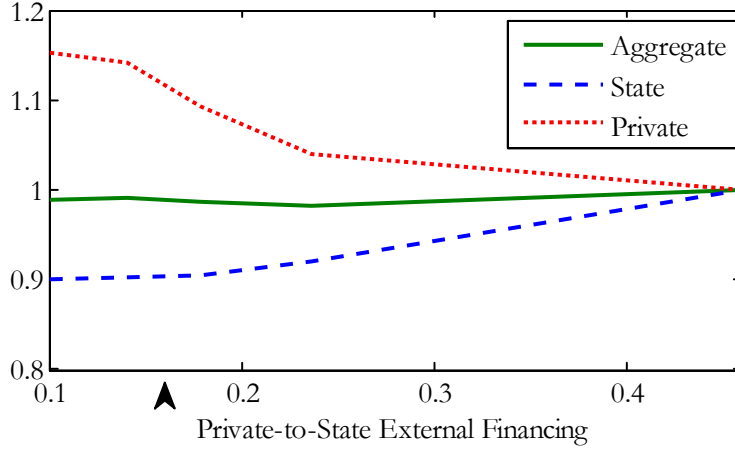


Figure 12: Long Run Impacts of Financial Frictions on China's TFP

frictions lowers TFP by 10 percent in the private sector and raises state sector TFP by 11 percent. The discrepancies in TFP between sectors largely cancel each other out as the aggregate TFP only increases by 1.5 percent.

Variations in sectoral TFP can be explained by distortions on the intensive and extensive margins. In the state sector, the monotonic rise in TFP is solely attributable to changes on the extensive margin. As financial constraints are removed, there is an influx of private entrepreneurs and the expansion of productive scale changes factor prices. In particular, wages rise 20 percent from the baseline parameterization which drives the marginal state entrepreneurs into becoming workers. In the absence of financial frictions, fewer entrepreneurs are active in the state sector but the overall talent composition is higher.

In the private sector, financial frictions distort both the extensive and intensive margins. On the intensive margin, private entrepreneurs who face binding credit constraints operate at inefficiently small scales. On the extensive margin, they distort the occupational decision rules. Figure 13 quantifies the impact of these margins on private sector TFP. The solid line shows the deviation, in percent, of private sector TFP for a given λ from TFP in the perfect credit economy. The dashed and dotted lines show the percentage point contribution of the extensive and intensive margin distortions, respectively, on the percent deviation of TFP. The sum of the two lines equals the deviation of TFP (the solid line).

I measure the intensive margin distortions by holding fixed the pool of private entrepreneurs and the total amount of labor and capital at each value of λ and I distribute

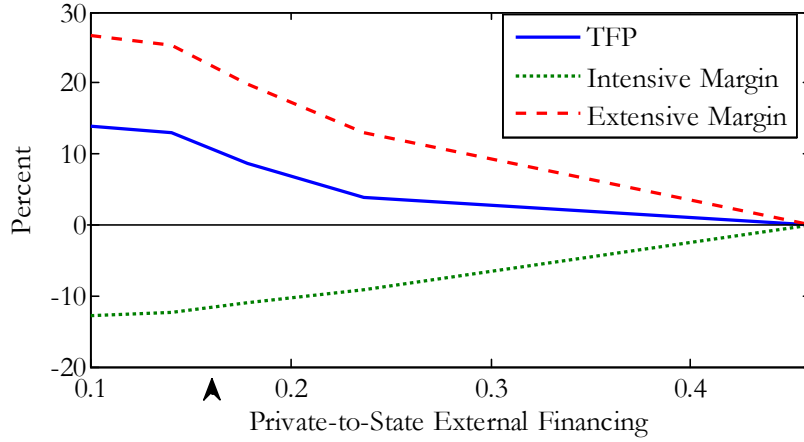


Figure 13: Impact of Intensive and Extensive Margin Distortions on Private Sector TFP

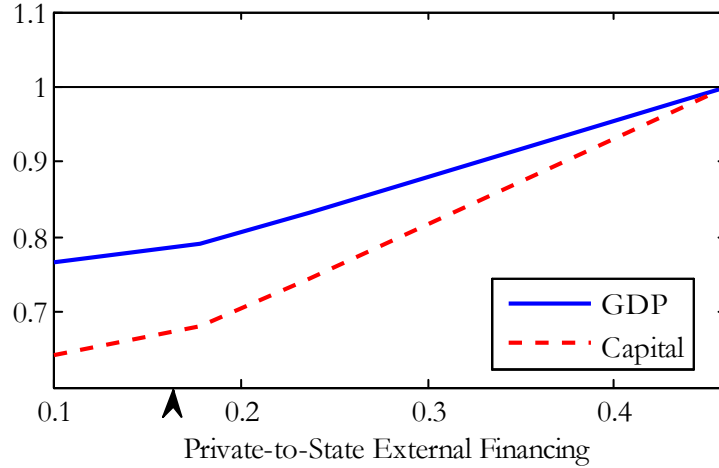


Figure 14: Impacts of Financial Frictions of China's GDP and Capital Use

capital among them to equalize their marginal products. The dotted line shows that the inefficient allocation of capital under financial lowers private sector TFP. In the baseline economy, the misallocation of capital lowers TFP by 10 percent. The remaining contribution, distortions on the extensive margin, raises TFP through the selection of entry of only the most talented private entrepreneurs. TFP is 20 percent higher through this mechanism in the baseline parameterization. Overall, extensive margin distortions are the dominant factor that keeps private sector TFP above the perfect credit case.

Although the aggregate efficiency gains in TFP from relaxing financial frictions are small, the output gains are substantial. Figure 14 shows GDP and capital use for different values of λ , again normalized by the perfect credit case. As financial frictions are relaxed,

more private entrepreneurs enter and they operate at larger scales. For example, the steady state capital-output ratio is 2.9 in the baseline parameterization and increases to 3.4 under perfect credit markets. The rise in GDP results from a combination of more establishments and increased capital intensity.

These results suggest the following long-run implications of relaxing financial constraints in China's economy. First, the model predicts that aggregate efficiency gains, measured by TFP, would change very little, but output would substantially increase through an influx of establishments and increased capital use. Second, we may expect TFP levels in the private and the state sectors to become more similar. At the aggregate level, this would appear as the state sector "catching up" to the private sector, but in fact it is a selection effect, not the increased productivity of existing state establishments. Third, relaxation of financial constraints may lead to slower growth in private sector TFP, but existing establishments would actually operate more efficiently.

5 Conclusion

China's growth acceleration has followed the emergence of the private sector after the major reforms in 1992. This paper developed a quantitative model explaining a main engine of China's growth, total factor productivity, following a removal of production barriers on private entrepreneurs. Without assuming exogenous productivity growth, the reallocation of factor inputs can account for 25 percent of the total change in TFP from 1992-2007.

A key component of the model is the differences in financial frictions faced by the private and the state sectors. I show that financial frictions faced by individuals in the private sector results in the selection of only the most talented entrepreneurs which leads to differences in the composition of entrepreneurial talent between the sectors. This endogenous selection mechanism accounts for 22 percent of TFP differences between the state and the private sectors. It follows from the analysis that aggregate TFP growth arises from the reallocation of productive resources from the state to the more productive private sector after reforms.

Projecting forward, the model suggests that China can benefit from large output gains with the development of financial institutions. Interestingly, there would only be small gains in TFP. Although existing establishments would operate more efficiently with financial development, the influx of less productive enterprises would keep TFP from

rising.

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Appendix

A Construction of the Data

In this appendix, I first begin by discussing the classification of ownership before explaining the construction of the aggregate and provincial data.

In the government (state) sector, I include state-owned enterprises (SOEs), urban collectively owned units, and township and village enterprises (TVEs). The private sector consists of private enterprises, self-employed workers, foreign enterprises, and other types of ownership.

There is often a blurred line between government and private ownership in China. In fact, shareholding and limited-liability corporations, which I include in the private sector, are commonly privatized SOEs. In many cases the government retains a stake in these corporations, although usually not to the extent of SOEs. Also, I include TVEs in the government sector which are owned by local governments. These firms face competitive pressure from other TVEs and operate similarly to private corporations. However, local governments back TVE loans which gives them easier access to external credit markets (Naughton 2007). Since I focus on differences in access to credit between government and private sectors, these are more appropriately categorized as belonging to the government sector.

A.1 Aggregate Data

GDP Deflators The CSY separates GDP by the primary, secondary, and tertiary sectors. The primary sector consists of agriculture, fisheries, forestry, and mining. I refer to this as the agricultural sector and I classify the non-agricultural sector as the sum of the secondary (industry and construction) and tertiary (service and transportation) sectors. Young (2003) claims real GDP is overstated because the implicit GDP deflators reported by China's National Bureau of Statistics (NBS) understates inflation. He instead proposes an alternative set of deflators based on final goods prices.

For the secondary sector, I follow Young and use the ex-factory price index. This deflator grows 6.1 percent annually from 1985-2009 compared to 4.8 percent from the implicit deflator. For the tertiary sector, Young suggest the consumer services price index as an alternative to the implicit deflator. However, following the 2005 economic census

the NBS revised data in the tertiary sector. The consumer services price index used by Young is based off the unrevised series, so I instead use the implicit deflator based on the revised data which is 22 percent higher than the unrevised series.

Investment I use gross fixed capital formation (GFCF) from the CSY. To net out primary sector investment, I use data from Hsueh and Li (1999) who report primary sector GFCF for 26 provinces. I next use fixed asset investment as my investment series, a slightly different series that GFCF based on enterprise surveys, which separates fixed investment by ownership. I assume that the ratio of primary sector GFCF to total GFCF is the same for the fixed asset investment series, and I subtract primary sector investment from the series. For 1996-2007, I use primary sector investment from the CSY and various issues of the *China Statistical Yearbook of Fixed Asset Investment*. Three years are absent from these reports, so I assume that the share of primary sector investment in these missing years is the average of the previous and next year.

Next, I calculate the investment deflator following Young (2003) and Brandt and Zhu (2010) based on separate deflators for equipment and structures. Having the real investment series, I construct the capital stock using the perpetual inventory method with 7.5 percent annual depreciation. I begin the series from Chow's (1993) capital stock in 1978.

Employment Employment by ownership and broad economic sector is reported in the CSY. I use data from the *China Labour Statistical Yearbook 2009* and subtract primary sector employment for each ownership classification. The NBS made an upward adjustment in the employment series in 1990 following new information from the population census in 2000. Data prior to 1990 is unrevised, so I report the employment series from 1990 onward.

GDP by Ownership The CSY does not report output by ownership in the non-agricultural economy for urban areas, however it does in rural areas. I divide output by ownership in urban areas using average wage data by ownership and the total number of employees by sector. Following Brandt and Zhu (2010), I assume that wages are proportional to their average value products and the labor shares are identical across ownership. I then infer the division of output based on this measure in urban areas. In rural areas, the NBS reports output by TVEs and other ownership types until 2005. For 2006 and 2007, such data is not available. Instead I construct an out-of-sample forecast of real

TVE output based on TVE output growth regressed on GDP growth, TVE employment growth, and a time trend. I then add the rural and urban data to obtain the division of output for the whole economy.

A.2 Provincial Data

For the provincial data, I focus only on 2002, the most recent year where the data allows me to separate output by ownership at the provincial level. TFP calculations only require GDP and employment in 2002, but a long investment series is needed to estimate the capital stocks. I calculate employment, investment, and GDP by ownership and province in the same way as the aggregate data. For the GDP deflators in the secondary and tertiary sectors, I use the province-specific implicit deflators reported in the CSY. Investment data are deflated using province level price indexes on investment goods from 1993-2007. Data prior to 1993 is unavailable as well as data for Tibet or Chongqing. I follow Brandt, Tomb, and Zhu (2011) and estimate an out-of-sample forecast of the provincial deflators based on regressing GDP deflators and year and province fixed effects on provincial investment deflators. With the real investment series at hand, I assume that an individual province's share of investment from 1978-1985 is proportional to that province's share of the aggregate capital stock in 1978.

I obtain total loans by ownership and province from the individual provincial statistical yearbooks and the *China Yearbook of Fixed Asset Investment 2003*. These sources do not include loans for TVEs, so I assume that they use the same proportion of loans for investment as the urban cousins – urban collectively owned units. Data for this series is only available for 23 of the 31 provinces.

B Limited Enforcement Constraint

I motivate the collateral constraint with a limited enforcement problem which has been widely utilized in the literature on financial frictions. Assume that a private entrepreneur with assets a who rents capital k can deny repayment to the intermediary the share $1/\lambda$ of the rented capital. If he denies repayment, he loses his deposited assets. The parameter λ measures the strength of enforcement where a lower value reflects a lower degree of enforcement. In this scenario, the intermediary would limit the amount of rented capital to ensure the entrepreneur has the incentive to repay in full. This requires that

an individual's assets are greater than denying repayment, $k/\lambda \leq a$.

C Numerical Solution Method

In this appendix, I describe the numerical solution method for the model transitional dynamics. I first find the initial steady state by solving the private individual's problem (1) and the state household's problem (6). In this economy agents face no uncertainty and I simply find the wage and interest rate that clears the labor and capital markets, respectively.

Next, I solve for the transitional dynamics and the final stationary steady state after the removal of the output distortion on private entrepreneurs ($\tau = 0$) at time $t = 0$. The aggregate problem is solved by finding wage and interest rate sequences such that labor and capital markets clear in all periods. I solve the equilibrium for each period following these steps:

1. Choose a number of transition periods T that is sufficiently long enough for the model to converge to a new stationary steady state.
2. Guess a wage sequence $\{w_t\}_{t=0}^T$ and an interest rate sequence $\{r_t\}_{t=0}^T$.
3. Compute the value functions for the state and the private sectors at time T . Iterate the value functions backwards from time T to 0. Simulate $N + S$ individuals for T periods using the optimal policy functions and the initial distribution of assets and talent as given. I choose $N + S = 156,000$. Examine if the labor market clears in each period. Update the wage transition sequence and repeat this step until the labor market clears in each period.
4. After the labor market clears, again compute the value functions for each sector at time T . Iterate backwards the value functions from time T to 0 and simulate $N + S$ individuals. Check if the capital market clears in each period, that is, capital demand equals aggregate assets. Update the interest rate transition sequence and repeat this step until the capital market clears in each period.
5. Repeat steps 3 and 4 until labor and capital markets both clear in each period.

For each model economy except for the small open economy model in Section 4.3, I choose $T = 150$. In the small open economy model, I choose $T = 400$ as the transition takes longer than in the other model economies.

D A Comparison of the Establishment Size Distribution in the Model with the Data

I compare the model establishment size distribution with the US data in Figure 15. It plots the log of establishments greater than a particular employment size against size for the actual size distribution. The dashed line is the size distribution from the model without credit constraints and the solid line is the US data. Establishment employment size is reported in discrete bins by the US Bureau of Labor Statistics Quarterly Census of Employment and Wages. Visual inspection reveals that it does not account for the concavity in establishment size distribution, but overall it fits relatively well.

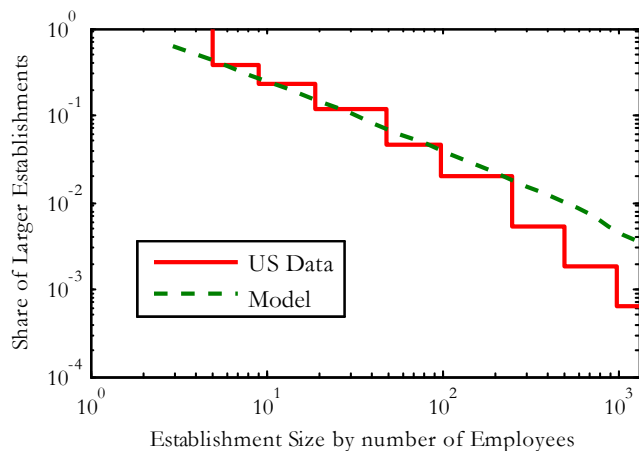


Figure 15: Establishment Size Distribution in the Model and Data