Essays on Development Policy: Resource Misallocation, Productivity and Inequality

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ABSTRACT

China has achieved phenomenal economic development over the last three decades and is now the world's second largest economy. However, as observed by many economists, the country is characterized by a large and inefficient state sector, rising income inequality and severe resource misallocation, all of which hinder productivity growth. In Chapter 1, I argue that much resource misallocation and income inequality especially that between state and private sector workers, is a consequence of China's development strategy. This strategy emphasizes state dominance in capital-intensive sectors and state leadership in accelerating industrial upgrading. The state-dominated financial system provides cheap capital to state-owned enterprises (SOEs), which allows them to produce goods that are more capital intensive than permitted by China's labor abundant factor endowments without such strategy. This distortionary development strategy in turn contributes to inefficiency and inequality. I also provide historical and political reasons why China pursues such a strategy.

In Chapter 2 I examine the hypothesis of capital-skill complementarity using Chinese manufacturing data. This hypothesis says that capital is more complementary with respect to skilled labor than unskilled labor, and as such has clear links to inequality. I consider three types of skilled labor definition and use a range of econometric techniques, including nonlinear least squares and generalized method of moments (GMM), yet find only weak evidence in favor of the hypothesis in a limited number of industries. The results are consistent with the idea that countries at different development stage may have different capital-skill relationships.

In Chapter 3 I examine heterogeneous effects of investment climate variables on productivity and employment growth, using firm-level data from China, Malaysia and Vietnam. I accommodate heterogeneity using a quantile regression approach. The results show that firms in different productivity quantiles are differentially affected by investment climate variables. Improving credit availability is very effective in enhancing aggregate industrial productivity since it confers greater benefits to firms in lower quantiles. Longer import custom clearance times hinder employment growth for firms in higher quantiles. The study complements and enriches investment climate research by calling for more targeted efforts for

firms at different quantiles (particularly the lower level) of the productivity distribution to enhance aggregate productivity and reduce resource misallocation.

To my parents and my love

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CONTENTS

1. CHAPTER 1: Resource Misallocation, Inefficiency, Inequality and China's Development Strategy

Abstract

China's economic growth is strongly influenced by the country's development strategy. This strategy asserts a dominant role for the state in capital-intensive, technologically sophisticated sectors and state leadership in upgrading the technological sophistication of the range of goods produced by domestic industry. A key instrument of this strategy is the over-allocation, through state dominated financial system, of capital to state-owned enterprises (SOEs). This study explores the trade-off between the benefits of this strategy and its negative features, including resource misallocation, output inefficiency and income inequality. This strategy enables SOEs to engage in technologically sophisticated activities that are otherwise inconsistent with the country's labor-abundant endowment structure. China's SOEs as a whole can act *as if* it were a wealthier economy, producing and exporting at a higher cutoff point on the international product sophistication ladder. The paper analyzes the historical and political reasons for pursuing such a strategy. It also examines the implications of the country's policy dyssynchrony that permits private firms to exist but is unsupportive of their capital financing. It shows that due to artificially high capital costs, expansion by private firms into capital-intensive sectors is inefficient.

1.1 Introduction

China's economy has experienced stellar growth since adopting the Reform and Opening-up Policy in the late 1970s. Burgeoning private firms (PFs), mostly concentrated in labor-intensive tradable sectors, have made much of the growth contribution (Bai et al., 2001). China's state-owned enterprises (SOEs), despite retreating from many aspects of economic life, continue to dominate the economy and are still the leading forces for accelerating industrial upgrading. However the country's phenomenal economic performance has been associated with severe resource misallocation (particularly of capital), growth inefficiency (Hsieh and Klenow, 2009; Song et al., 2011) and wage inequality between workers in SOEs and PFs (Zhao, 2002; Deng and Li, 2009).[1]

Two puzzles emerge from China's development pattern. First, in a globalized trading system, is a development strategy that promotes state dominance in capital-intensive (and hence technologically sophisticated) sectors and leadership in accelerating industrial upgrading (being able to produce sophisticated products beyond the frontier allowed by one's comparative advantage) a driver of economic growth, or an impediment to it? Second, although economic reforms since the late 1970s and the SOEs' retreat from liberalized labor-intensive sectors have legitimated and encouraged the expansion of PFs, the business environment is still unsupportive of their growth—particularly in capital financing, due to crowding-out by SOEs (Bai et al., 2001; Haggard and Huang, 2008). What is the implication of such policy dyssynchrony?

This paper presents an integrated perspective on these issues and extends the existing literature in two ways. First it confirms that China's development strategy ensures state dominance in capital-intensive sectors by supporting it with cheap capital resources. This strategy does create resource misallocation, inefficient production and income inequality, but the concentration of capital also enables SOEs to produce goods that are more sophisticated than would otherwise be consistent with the country's labor-abundant endowment structure. In addition, the strategy's over-allocation of capital to SOE induces wage inequality between SOE and PF workers. Second, the permissive but unsupportive environment for PFs makes their expansion into more capital-intensive sectors inefficient, due to high capital costs, even if SOEs retreat from those sectors.

The expansion of international trade is a prominent feature of China's economic development strategy in recent decades. Accordingly I base the analysis on a general equilibrium North-South trade model, extending this to accommodate elements of the distortionary development strategy aforementioned. The North represents an aggregate of advanced economies, and the South represents China. The South in

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[1] In this paper, I broadly categorize firms into on state-owned and domestic private firms. In reality, the ownership types are more diverse, which include foreign invested, joint-venture, collectively owned, foreign invested, and so on. See Haggard and Huang (2008).

turn consists of two subnational components, SOE and PF. The Southern development strategy emphasizes (1) state dominance in capital-intensive sectors, (2) state leadership in industrial upgrading. Implementation of (1) by providing cheap capital to SOEs generates resource misallocation that implies inefficient production compared to the distortion-free scenario and wage inequality between SOE and PF. But (1) provides the foundation for (2): *because of* this "state-mandated" over-allocation of capital to SOEs, they become sufficiently capital-rich to lead industrial upgrading by extending the upper end of their product specialization range (PSR) on the international product sophistication ladder (IPSL). As a result, the aggregate Southern PSR becomes compatible with a wealthier economy compared to the counterfactual without this strategy. Under this development strategy, the Southern PFs will specialize in producing relatively labor-intensive goods; the North in relatively capital-intensive goods; and the Southern SOEs will occupy a range in between. The distribution of the Southern labor and capital between PFs and SOEs, economy-wide factor prices, and cutoff point between SOEs and the North are endogenous. The development policy target cutoff point along the IPSL between PFs and SOEs within the South and the Southern capital market distortion variables are assumed to be exogenous. When the policy target cutoff point between SOEs and PFs is set at a higher level, i.e. PFs are allowed to participate in more capital-intensive sectors in a more liberalizing environment, due to high capital cost, their expansion induces inefficient Southern aggregate output.

My model builds on the seminal work of Zhu and Trefler (2005) (hereafter ZT), whose objective is to investigate how the Southern technology catch-up in a North-South trade setting contributes to wage inequality. I use ZT model as a distortion-free benchmark scenario and extend their framework by incorporating different firm types and the distortionary development policy. My work analyzes China's development in a political economy context in the sense that production inefficiency and inequality are two prices paid for fulfilling China's political ideology-driven development strategy. For historical and political reasons, Chinese SOEs' are tasked with high-end development missions which are inconsistent with the country's contemporaneous comparative advantage. An implication of this study is that even if without any common problems like corruption and cronyism which are prevalent in many emerging economies (*The* Economist, 2014), the pursuit of a distortionary development strategy driven by a political ideology can lead to inefficiency and inequality. Thus to some extent, criticism directed at Chinese SOEs' production inefficiency may be exaggerated.

The study contributes to several strands of literature. First, it enriches the fast growing resource misallocation literature by exploring the implications of national development strategy as a source of misallocation. Banerjee and Moll (2010) (and articles cited) identify many causes of resource misallocation, including land market frictions, poorly managed financial institutions, lack of hard infrastructure and poor contract enforceability. Influential studies from Hsieh and Klenow (2009) and Song et al. (2011) show that policies that undo capital misallocation may promote sustained growth. Particularly, Song et al. (2011) predict that China's SOEs will retreat to more and more capital-intensive sectors, and will be eventually replaced by efficient PFs as the latter can overcome capital constraints through self-financing. An implication from my work is that given the current political environment, it is unlikely that China's development strategy induced resource misallocation can be easily removed; SOEs will continue to play a dominant role for a very long time.

Second, this study enriches the international trade literature where both national and sub-national activities are important in influencing welfare, by explicitly accounting the effects from national development strategy and firm ownerships. Also building from ZT model, Li and Coxhead (2011) investigate how international trade can increase income inequality in China given the country's significant development disparity and a spatially fragmented labor market between coast and inland area. Bernard et al. (2007) examine how country, industry and firm level characteristics interact to determine a country's response to trade liberalization. In their general equilibrium framework these levels are characterized by factor endowment, factor intensity and productivity respectively. In a similar vein, Chor (2010) quantifies the influences of comparative advantage from each industrial organizational level by extending Eaton and Kortum (2002). My study focuses on the interaction between SOEs and PFs, a phenomenon that is observed in many developing country settings.

Third, it enriches the development literature of state intervention and industrial upgrading by exploring their trade-offs and implications for the private sector. Leamer (1987) and Leamer et al. (1999), Deardorff (1999) and Schott (2003) show how an economy engages in industrial upgrading along the IPSL at a “natural” rate by relying on capital accumulation in a neoclassical growth fashion. Industrialization can also occur at an “accelerated” rate if the state can concentrate sufficient resources into capital-intensive sectors with strong policy support (Rodrik, 1995; Lin and Li, 2009). Hirschman (1968) and many advocates of import-substituting industrial policy call for infant industry protection and prioritizing heavy industry development.[2] Murphy et al. (1989) formalize the Big-Push model and argue that an economy can industrialize rapidly when a sufficient number of firms overcome the fixed cost of adopting increasing-returns-to-scale technology. A similar idea from the unbalanced growth school was proposed by Krishna and Pérez (2005), who emphasize the linkage effect from key (usually capital-intensive) industrial sectors to the rest of the economy. State intervention, by coordinating investment and production structure, is able to affect a country’s growth potential. Hausmann et al. (2007) show that specializing in different export product mixes has different consequences for future growth rate. My study shows that China’s development strategy favoring SOEs can cause production inefficiency, inequality and inhibit private sector’s expansion at least in the short run.

Fourth, this study contributes to the literature of China’s transitional industrial policy. Bai et al. (2001) argue that although China has granted full legitimacy to its domestic private sector since the initiation of the Reform and Opening-up Policy, the playing field between SOEs and PFs is still uneven. The latter are still discriminated against, particularly in capital markets. They point out that capital scarcity was not a big problem when PFs were mainly concentrated in labor-intensive sectors such as restaurants and light manufacturing. The constraint begins to bind as they move up along the product sophistication ladder. Haggard and Huang (2008) summarize this dyssynchrony as permitting for existence but unsupportive for growth. My study proposes a formal theoretical framework to account for and help confirm this observation.

[2] The cost of Latin America’s inward looking development strategy is examined by Taylor (1998).

The rest of the paper is organized as follows. Section 1.2 presents empirical evidence on China's development strategy, market distortion, and wage inequality. Section 1.3 describes the benchmark distortion-free model and the version with the distortionary development strategy. Section 1.4 is a numerical exercise that compares model outputs under different scenarios. Section 1.5 is an empirical analysis that further examines the model's implications. Section 1.6 provides some further discussion on institutional governance and China's economic reform. Section 1.7 concludes with some thoughts on the relationship between the current framework and studies on dynamic comparative advantage.

1.2 Empirical Evidence

1.2.1 China's national development strategy and SOEs

China's socialist ideology regards SOEs' dominance in key economic sectors as an important manifestation of the socialist public ownership and the most pivotal force in leading China's modernization and industrialization. The country's Constitution (Article 7) says: "The state-owned economy, that is, the socialist economy under ownership by the whole people, is the leading force in the national economy. The state ensures the consolidation and growth of the state-owned economy." The dominant and leadership roles of SOEs, as two important components of the country's development strategy, have been the mainstay for China's economy since 1956, when the government had finished nationalization of means of production at the beginning of the planned economy era. The Communist Party of China (CPC) has fortified them over the decades even when the government has been advocating diverse firm ownerships to encourage the vibrancy of the economy after Deng Xiaoping's Southern Tour in 1992 (CPC, 1997 and 2002).

As claimed in the CPC report (1997), the form of dominance of SOEs has transitioned from full operation in almost all aspects of China's economic life during planned economy era to enhanced control power over the capital-intensive and strategic sectors: high-tech industries (e.g. aviation, aerospace), natural resource industries (e.g. minerals, petroleum), strategic competitive industries (e.g. high-end heavy equipment, chemical), national security (e.g. banking, weaponry) and strategic emerging industries (e.g. biological engineering, clean energy). Table 1.1, Column 2 shows a short list of well-known Chinese SOEs ranked by firm revenues in 2012. They all play dominant roles in key sectors in China's economy, with high product capital intensity and sophistication. Song et al. (2011) show that SOEs are more capital-abundant than PFs, and the latter are dominant in labor-intensive industries. In terms of size, Szamosszegi and Kyle (2011) find that SOEs and entities directly controlled by SOEs, account for more than 40% of China's non-agricultural GDP. This number will be greater (close to 50%) if indirectly controlled entities (e.g. some collectively-owned firms) are included. Figure 1.1 shows the proportion of aggregate assets from industrial SOEs among all Chinese industrial firms. It is clear that although the country has made much transitional effort from a state-dominated planned economy in the past to a market economy today, the SOEs still command more than 40% of production asset. Table 1.2 shows the distribution of assets of SOEs in 35 major Chinese industrial sectors ranked from high to low based on their averages. One can see that for capital-intensive and usually strategically sensitive sectors, the state maintained a substantial share of assets.

Besides being the dominating component of China's socialist economy, SOEs are also granted the leadership role in *accelerating* the country's industrial upgrading and are designed to be the major representatives of Chinese overall economic strength in the international arena (CPC, 1999). Chen (2012, p.45) argues that economic competition among major countries in the world is reflected in the rivalry among their major enterprises in strategic sectors. Table 1.1, Column 5 shows the foreign competitive counterparts of Chinese SOEs in corresponding key sectors. The enhanced influence of China's SOEs in the world can also be seen from the historical trend of Global 500 since 1996 (Figure 1.2).[3] The number of SOEs made into the list has jumped from single digit before 2000 to 80 in 2013.[4] Only since 2008 did Chinese PFs (mainland) make into the list (e.g. Lenovo and later Huawei). In terms of total Chinese firms,

[3] The ranking is provided from Fortune Magazine (Chinese edition). Result published in a current year is based on firms' financial performance from the previous year.

[4] This number is subject to change depending whether one restricts SOE to be ones directly administered by the state level authority or provincial/municipal level authorities. But regardless, this number should be close to 80.

China ranks the second (87 from mainland China), trailing only after the US (132). An interesting observation is that the existence of so many large-scale Chinese state-owned capital-intensive and sophisticated powerhouses at the world level is at odds with the country's comparative advantage in labor-intensive industries determined by its labor-abundant endowment structure. On the other hand, this scenario that defies one's comparative advantage does enhance the country's status and national security, which have been desperately needed throughout China's development.

1.2.2 A historical background: why SOEs are important for China?

This sub-section explains why SOEs are granted the dominant and leadership roles in China's economic development. Beside the socialist political ideology mentioned earlier, there are three reasons.

First, from a historical development perspective, state intervention helps solve the coordination problem and provides a necessary impetus in the early periods of a poor and institutionally weak developing country. As argued by Murphy et al. (1989) for the well-known Big-Push model, a country will be pushed up to a higher growth trajectory when many sectors of its economy industrialize simultaneously. This joint effort requires high capability in inter-sector coordination and should be better handled by the government at the initial stage.

The early stage of rapid industrialization of many western countries was led primarily by their SOEs.[5] Chen (2012, p.61) argues that in the history of western advanced economies, the distribution and degree of dominance of the state sector are closely related to countries' development stage. He points out that there is an inverse-U relationship between SOEs' output and national GDP over development stages. Initially, at the stage of primitive capital accumulation, private capital takes the leading role in industrialization. When it comes to the stage of economic take-off characterized by the rise of heavy industries, in order to accelerate this process, state capital becomes deployed extensively in energy, mineral, steel production, automobile, ship building and other pillar industries in national economy. In this period, one would observe the largest share of SOEs' output in GDP. SOEs begin to orderly withdraw

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[5] Historical account of evolution of western SOEs in the current and the following paragraph borrows heavily from Chen (2012, p.65-p.109).

from the Western economies during the post-industrial era when their internal market and regulatory environment have become more mature, and the state sector's inherent problems (e.g. soft budget constraint, too much intervention and corruption) have become more severe and outweighed SOEs' benefits.

Western economies have experienced two waves of significant expansion of their state sectors. One occurred from the late 19th to early 20th century, while the other was from the end of WWII to the late 1970s. The means of expansion include both direct establishment of SOEs and nationalization of private enterprises. The main purposes were to enhance military and economic security and accelerate industrialization through advanced industries.[6] The contraction of state sectors by privatization started in the 1980s and lasted for about two decades.[7] The then aim was to reduce government interference in market activities as the market itself has become more mature. Other considerations include reducing government deficit by selling state assets, introducing competition for enhancing economic efficiency and winning elections. The order of retreat usually began from more competitive industries to less competitive industries. In today's Western economies, manufacturing industries such as automobile, airplane, ship building, and electronics are prevalently private. State capital usually remains in infrastructure sector.[8] The point is that China as the largest developing economy is still in the process of industrialization and

[6] According to Chen (2012, p.65-p.70), in the first period (from late 19th to early 20th century), the British government nationalized telecommunication industry and British Petroleum Company, electric grid and airline industry in the 1910s and 1930s respectively. The French government invested heavily in road, railroad, canal and port facility constructions between 1879 and 1904; in the 1930s, railroad and military industries have been nationalized. The same pattern can also be observed in other major European countries like Italy and Germany. In the second period (post-WWII to 1980s), the British government nationalized more private components in telecommunication, aerospace, ship building, railroad, gas and steel industries. The French government nationalized the 5 largest private banks and combined them to establish Paris National Bank in 1946. In 1979, the proportions of state economy in different sectors were 100% in railroad, 80% steel production, 85% airplane manufacturing and 50% automobile. By 1982, 8 out of the 10 largest French industrial firms were state-owned.

[7] For example, beginning from the Thatcher's administration, the British government privatized many big corporations in strategic or pillar sectors such as British Petroleum Company, National Freight Corporation, Rolls-Royce (airplane parts manufacturer) and even British Energy in the nuclear industry. Starting in 1993 after the implementation of the privatization law, the French government has withdrawn substantially from financial, pharmaceutical, petroleum and gas, and automobile industries. In the late 1990s to early 2000s, the state reduced shareholding of many companies in competitive sectors.

[8] Different countries have degrees of state control in infrastructure, e.g. the United States and Britain are low while France and Germany are relatively high.

there is a long way to go before its market environment becomes mature. Based on historical experience of the Western advanced economies, Chen (2012, p.117) points out that China should also rely on its SOEs for advancing the process of industrialization.

Second, national security concern since the nation's early periods has also promoted this strategy. International blockades of goods and technology imposed mainly by the US right after the founding of China in 1949 as a way to thwart the communist regime forced the leadership to pursue self-sufficiency of strategic heavy industrial products; The Korean War in the early 1950s with the US and potential military conflicts with the former Soviet Union in the 1960s have also fortified this development strategy (Zhang, 2008). Even in today's US, there are still tremendous political oppositions against exporting high-tech products to China (Li and Yang, 2013).

The third reason is more pertinent to China's own existing social-economic backwardness: the country's long-term weak business environment makes China not conducive for cultivating private business giants fast enough to fulfill the country's urgent need for rapid industrialization. For example, in the financial sector, there is a vast literature documenting the underdevelopment of China's stock and bond markets.[9] Major symptoms include insufficient corporate transparency, weak property right protection, institutional investor and reliable credit rating agencies (Durnev, 2004; Boyreau-Debray and Wei, 2005; Allen et al. 2005; Hasan et al., 2009; Ayyagari, 2010).

Besides the weaknesses in the financial market, which are crucial causes of capital misallocation, there are many other impediments for doing business in China. Table 1.3 shows the World Bank's annual "Doing Business" ranking for China as well as some other countries for comparison purpose. A high ranking (smaller number) means it is easy to start and operate a business in the local economic environment.[10] This statistics is aggregated from many sub-rankings such as the ease of dealing with construction permits, contract enforcement and accessing to electricity. China has been at 91st position

[9] See Allen et al. (2008) for a comprehensive review of China's financial system.

[10] The ranking is based on information from the previous year. The earliest overall ranking available for China dates back to 2012. The earliest sub-rankings are from 2004 and they do not change much over the years.

for both years of 2012 and 2013 out of 185 economic entities in the world, at a level comparable to Uruguay (89th) and Guatemala (93rd). Particularly, in the sub-rankings that are beyond 100th position, the country performs miserably in "dealing with construction permits" (181st), "starting a business" (151st), "paying taxes" (122nd), "getting electricity" (114th), and "protecting investors" (100th). Improving business environment requires tremendous amount of efforts in bureaucratic reform, legal reform, and enhancement of the civilian spirit of contract. It can be imagined that without state support, especially in capital financing, it is almost impossible for a firm to rapidly develop into a large-scale, technologically sophisticated entity from scratch.

In sum, given the fact China has an objective not-so-business-friendly environment which cannot be fundamentally changed in short time period, it is difficult to rely on PFs for rapid industrialization. In this situation, an effective, fast and pragmatic approach would be to use the state power to concentrate resources in SOEs by an apparently "misallocative" fashion to accelerate this process.

1.2.3 Differential capital costs and SOE reform

Differential capital costs

It is well known that SOEs in China are more capital-abundant than PFs. A primary reason is that SOEs have access to cheap credits from state-dominated formal financial system (see Boyreau-Debray and Wei 2005);[11] PFs are usually discriminated against and have to rely on internal saving and informal financing mechanism (Ayyagari et al., 2010). Song et al. (2011) show that SOEs are able to finance more than 30% of their investment through bank credits compared to less than 10% for PFs. China's financial system has been dominated by state-led banking sectors (Cull, 2000 and 2003); in contrast, underdeveloped equity and bond markets do not play significant roles in PFs' capital financing (Ayyagari, 2010).

[11] Chinese banking sector is dominated by four big state-owned banks which were commercialized in 1995. They are: Industrial and Commercial Bank of China, China Agriculture Bank, China Construction Bank, and the Bank of China. Besides these, there are also a number of policy banks such as Export-Import Bank and China Development Bank. Other players include foreign banks (with limited service), regional banks and rural credit cooperatives. See Allen et al. (2008) for a comprehensive description of Chinese financial system.

Informal financial sector consists of pawnbrokers, private money lenders, and underground money houses (Allen et al., 2008). Loans with low interest rate are common only within close circles of friends and family (Tsai, 2004; Ayyagari et al., 2010). Professional private money lenders and money houses would typically charge exorbitant interest rates and may even resort to violence to enforce repayment (Allen et al., 2008). Due to high domestic inflationary pressure in recent years, Chinese government has tightened lending from official channels and that has pushed more small borrowers into the arms of underground financiers, who charge as high as 6% per month (*The* Economist, 2011).

State sector reform

State sector's high capital abundance also results from China's economic reform: SOEs retreat from competitive and typically labor intensive areas and concentrate capital resources towards large and strategically important SOEs (CPC, 2003). The methods usually include privatization, reduction of government share-holding, merger and so on. [12] Song et al. (2011) show that employment share in PFs has experienced rapid increase from less than 10% since early 1990s to about 60% by 2006. The years between 1998 and 2004 have witnessed large scale lay-off of SOE workers (China Labor Bulletin, 2007). On the other hand, the proportion of industrial SOEs aggregate asset fell only by about half from 1978 to 2010 (Figure 1.1).

The primary objectives of state sector reform include eliminating inefficiencies and reducing government intervention for fostering a mature market economy (CPC, 1997 and 1999). There is a large body of literature documenting the inefficiencies of Chinese SOEs. Song et al. (2011) use profitability (the ratio of total profits to fixed assets net of depreciation) as proxy for productivity, and find that SOEs are about 9% less productive than PFs per year. Total factor productivity (TFP) gap between SOEs and PFs is 1.8 during 1998-2004, according to Brandt et al. (2008a). Xu and Wang (1997) argue that among Chinese publicly listed corporations, labor productivity has a negative correlation with the state's shareholding. Similar results about SOE inefficiency are confirmed by Brandt and Zhu (2010) and Hsieh

[12] Brandt et al. (2008b) is a good source accounting the industrialization history of China.

and Klenow (2009). The measures of SOE contraction are similar to the Western countries' mentioned above, which include privatization, reduction of shareholding, merger and so on.

1.2.4 Capital misallocation and income inequality

Capital misallocation

How do people measure the degree of capital misallocation? Boyreau-Debray and Wei (2005) show that capital mobility is low in China's current financial system. Capital movement across regions can take the forms of firm investment, between-institutional lending, and external fund raising. In the extreme case where capital is perfectly immobile, local investment should correlate perfectly with local saving. In contrast, if capital is perfect mobile, it will seek places with the highest return; thus the correlation between local investment and saving should be very small. The authors find that the value for China ranges from 0.44 during 1978-1989 to 0.58 during 1990-2001, compared to almost zero for advanced economies like US and Japan.

A more direct approach is based on calculating the dispersion of firm-level revenue total factor productivity within a region: the greater the dispersion, the larger the capital misallocation. Hsieh and Klenow (2009) show that the ratios between the 90th and the 10th percentiles of the statistics' distributions of firms are 4.9 for China and 3.3 for the US, respectively. They conclude that if China can allocate its resource as efficiently as the US, its TFP will increase by 30% to 50%.

Income inequality[13]

Many studies have found income inequality between workers in SOEs and PFs in China. When considering wage and non-wage benefits (e.g. pension, housing and health care), Zhao (2002) using urban household survey, finds that SOE workers earn significantly more than PF workers. Deng and Li (2009, Table 1) show that workers from the central government administered SOEs earned 5%, 27% and 63% more than their PF counterparts in 1988, 1995 and 2002 respectively.[14] Local government administered

[13] Although there does exist marked inequality within state and private sectors, it is not the primary focus of the present study. Labor is homogeneous and the only difference in the distorted ZT model is the sector they work for.

[14] Earnings here presumably do not include non-wage benefit.

SOEs fare similarly but with less magnitude. Démurger et al. (2012) find that in terms of hourly wage, SOEs' workers earn 40% and 14% more than PF workers in 2002 and 2007 respectively.[15]

1.3 Theoretical Model

1.3.1 Trade model without distortions

Set-up

There are two regions, North (N) and South (S), representing advanced economies and China respectively. Two factors, capital (K) and labor (L) are involved in the production and cannot move across regions. The production function is constant returns to scale and takes the Cobb-Douglas form:

$$Q(K, L, z) = K^{x(z)} L^{1-x(z)},$$

where z is defined as an index for goods capital intensity, located between 0 and 1, and $x(z)$ is a function strictly increasing in z. As z goes up, greater share of capital must be used in production. Here, greater capital intensity is synonymous with greater production sophistication. Goods markets are assumed perfectly competitive with zero profits in equilibrium. Consumers have identical continuous Cobb-Douglas utility. Trade between the North and the South is balanced without any trade barriers involved.

Let w_i and r_i be the wage of labor and capital rental price in entity or region i (=N, S). Following ZT model, I assume the North is sufficiently abundant in capital while the South is sufficiently abundant in labor, such that $\frac{w_N}{r_N} > \frac{w_S}{r_S}$. Therefore, the North has a comparative advantage in capital-intensive good, which means that it has a lower unit cost when producing capital-intensive goods. This can be seen from the unit cost function:

$$\min_{K(z), L(z)} rK(z) + wL(z)$$

$$s.t.\ \ K(z)^{x(z)} L(z)^{1-x(z)} = 1,$$

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[15] Different studies may use different definitions for SOEs and PFs.

where $K(z)$ and $L(z)$ denote the capital and labor used in producing good z. The solution gives the following unit factor requirement:

$$a_K(r,w,z) = \left[\frac{1-x(z)}{x(z)}\frac{r}{w}\right]^{x(z)-1} \qquad a_L(r,w,z) = \left[\frac{1-x(z)}{x(z)}\frac{r}{w}\right]^{x(z)}$$

The general form of unit cost function for i=N,S:

$$C_i(z) = r_i\left[\frac{1-x(z)}{x(z)}\frac{r_i}{w_i}\right]^{x(z)-1} + w_i\left[\frac{1-x(z)}{x(z)}\frac{r_i}{w_i}\right]^{x(z)}$$

or,

$$C_i(z) = w_i[\frac{r_i}{w_i}]^{x(z)}[\frac{1-x(z)}{x(z)}]^{x(z)}\frac{1}{1-x(z)}.$$

Given the assumption of factor endowment, we can see that the cost ratio between N and S, $\frac{C_N(z)}{C_S(z)} = \frac{w_N}{w_S}[\frac{r_N}{r_S}\frac{w_S}{w_N}]^{x(z)}$, has a negative derivative with respective to z:

$$\frac{\partial[\frac{C_N(z)}{C_S(z)}]}{\partial z} = \frac{w_N}{w_S}[\frac{r_N}{r_S}\frac{w_S}{w_N}]^{x(z)} \cdot \ln\left(\frac{r_N}{r_S}\frac{w_S}{w_N}\right)\cdot\frac{\partial x}{\partial z} < 0,$$

which means that the North has a comparative advantage in capital-intensive goods, while the South has a comparative advantage in labor-intensive goods.[16]

In the next subsection I will show there exists a unique cutoff point z^* in the unit interval where $C_N(z^*) = C_S(z^*)$, for $z < z^*$, $C_S(z) < C_N(z)$, and for $z > z^*$, $C_S(z) > C_N(z)$ (Figure 1.3). It implies that the North produces all goods $z > z^*$ and the South produces all goods $z < z^*$. A region's specialization at

[16] One can see that without explicitly introducing differences in technology and relying only on technology as in ZT (2005), we are still able to discern regions' comparative advantage. This observation is consistent with their remark that even without Ricardian comparative advantage "under a plausible assumption, one can still expect a similar characterization of equilibrium."

different level of product sophistication thus depends on its comparative advantage which then hinges on its factor endowment.[17]

Equilibrium analysis

Consumers have identical Cobb-Douglas preferences:

$$U = \int_0^1 \beta(z) \ln Q(z)\, dz$$

where $\beta(z)$ is consumption share of good z, $Q(z)$ is the quantity consumed. Because of zero profit condition, incomes earned in the N and S, Y_N and Y_S, should equal to the sum of total wage and rental respectively:

$$Y_N = w_N L_N + r_N K_N \qquad Y_S = w_S L_S + r_S K_S$$

where L_i and K_i are aggregate labor and capital endowment in region i, $i = N, S$.

Consumer demand of good z would be:

$$Q(z) = \frac{\beta(z)}{P_i(z)}[w_N L_N + r_N K_N + w_S L_S + r_S K_S]$$

$$i = S\ (z < z^*), N\ (z > z^*)$$

$P_i(z)$ is the price of product z produced in region i. The market is assumed perfectly competitive following ZT (2005). For **producer**, the set of equations are:

Production: $$Q(K, L, z) = K_i(z)^{x(z)} L_i(z)^{1-x(z)},$$

where $K_i(z)$ and $L_i(z)$ mean capital and labor from region i used for product z.

Factor price: $$P_i(z)\, x(z) \left[\frac{K_i(z)}{L_i(z)}\right]^{x(z)-1} = r_i$$

[17] Difference in factor endowment structures alone is sufficient to construct the desired pattern of comparative advantage. Thus for simplicity purpose, I do not further include technology as a source of comparative advantage.

$$P_i(z)[1-\ x(z)]\left[\frac{K_i(z)}{L_i(z)}\right]^{x(z)} = w_i$$

Market clearing conditions for factors:

I used ZT's approach by having the excess demand for capital relative to labor equal to zero to represent market clearing conditions:

Define $S(z^*)$ as the excess demand for capital relative to labor in South:

$$S(z^*) \equiv \int_0^{z^*} K_s(z)/K_S dz - \int_0^{z^*} L_s(z)/L_S dz \qquad ,$$

where $h_i = K_i/L_i$, $h_i(z) = a_{K,i}(z)/a_{L,i}(z)$, $n_i = r_i/w_i$ where $i = N, S$

Following ZT's approach, for the South:

$$0 = S(z^*) = \frac{Y_N + Y_S}{w_S K_S}\int_0^{z^*} \beta\,(z)\frac{h_S(z) - h_S}{1 + n_S h_S(z)}dz$$

$$= \frac{w_N L_N + r_N K_N + w_S L_S + r_S K_S}{w_S K_S}\int_0^{z^*} \beta\,(z)\frac{h_S(z) - h_S}{1 + n_S h_S(z)}dz \qquad ,$$

Simplifying the remaining terms in the integral we have:

$$n_S = \frac{\int_0^{z^*} \beta\,(z) x(z) dz}{h_S \int_0^{z^*} \beta\,(z)[1 - x(z)]dz} \qquad (1)$$

Similarly, for the North:

$$n_N = \frac{\int_{z^*}^1 \beta\,(z) x(z) dz}{h_N \int_{z^*}^1 \beta\,(z)[1 - x(z)]dz} \qquad (2)$$

Trade balance between N and S is defined as:

$$B(z^*) \equiv \frac{(w_S L_S + r_S K_S)\int_{z^*}^{1} \beta\,(z)dz}{(w_N L_N + r_N K_N)\int_{0}^{z^*} \beta\,(z)dz}$$

Following ZT, this expression yields:

$$B(z^*) \equiv \frac{L_S}{L_N}\frac{L_N(z^*)}{L_S(z^*)}\frac{1+n_S h_S}{1+n_N h_N}\frac{1+n_N h_N(z^*)}{1+n_S h_S(z^*)}\frac{\int_{z^*}^{1} \beta\,(z)dz}{\int_{0}^{z^*} \beta\,(z)dz} = 1 \qquad (3)$$

Solving for the competitive equilibrium is then reduced to the search for a triplet (n_S, n_N, z^*) that jointly solves Eq. (1),(2),(3). Last but not least, given the comparative advantage pattern assumed in Section 4.1.1, we have $\frac{w_N}{r_N} > \frac{w_S}{r_S}$, which implies that the solution should satisfy $n_N < n_S$. This condition can be met as long as the Northern endowment is sufficiently capital abundant, which is also required in ZT and Dornbusch et al. (1980). The proof of the existence of solution for this undistorted model is in Appendix 1.A. Until here, the equilibrium characterization for the undistorted economy is complete. In sum, we reach an equilibrium where the North specializes in more capital-intensive good ($z > z^*$) and the South specializes in labor intensive good ($z < z^*$).

1.3.2 Trade model with distortions

Set up

In the distorted mode, the South will be comprised of PF and SOE. Use K_E and K_F, L_E and L_F to represent capital and labor employed in SOE and PF respectively (E for SOE and F for PF,). Similarly as in the benchmark model, I make the following assumption of factor price orders:

$$r_F > r_E > r_N$$

$$w_N > w_E > w_F \;\;,$$

The order of capital cost between SOE and PF is a manifestation of the Southern capital market distortion; while the wage order is its natural consequence (see Section 1.3.4). Again, based upon these orders, we must have: $\frac{\partial[\frac{C_E(z)}{C_F(z)}]}{\partial z} < 0$, and $\frac{\partial[\frac{C_N(z)}{C_E(z)}]}{\partial z} < 0$, which implies that PF, SOE and N will have comparative advantages in labor intensive good, mid-level capital-intensive good and high-level capital-intensive good respectively. This pattern is illustrated in Figure 1.4. The cutoff point between SOE and N is z'' which is also the cutoff point of the South as a whole versus the North. The cutoff point between PF and SOE in the South is z' ($z' < z''$); it is assumed to be exogenous which reflects the government policy target in restricting PFs' entry into greater capital intensive sectors due to various long-term political and practical barriers. Capital market distortion is reflected by the ratio of capital price faced by PF versus SOE, r_F/r_E or d_2 (great than 1). Greater d_2 means relatively less favorable financing condition for PF. Other variables, factor allocation of K_E and K_F, L_E and L_F, wage ratio w_F/w_E defined as d_1, factor price ratios n_F, n_E, n_N and South-North cutoff z'' will be endogenous.

Equilibrium analysis

The equilibrium is characterized by the following equations:

[1] Trade balance between N and S:

$$B(z', z'') \equiv \frac{Y_S' \int_{z''}^{1} \beta\,(z)dz}{Y_N' \int_{0}^{z''} \beta\,(z)dz} = 1, \qquad (4)$$

where $Y_S' = w_F L_F + r_F K_F + w_E L_E + r_E K_E$ and $Y_N' = w_N L_N + r_N K_N$. Note that there is no restriction of trade balance between PF and SOE since they belong to the same country.

[2] Factor market clearing conditions:

The condition and derivations are the same as in the benchmark model: excess demand for capital relative to labor is zero. For the North, this is:

$$n_N = \frac{\int_{z''}^{1} \beta(z)x(z)dz}{h_N \int_{z''}^{1} \beta(z)[1 - x(z)]dz} \qquad (5)$$

Southern factor market clearing condition for SOE and PF respectively:

$$n_E = \frac{\int_{z'}^{z''} \beta(z)x(z)dz}{h_E \int_{z'}^{z''} \beta(z)[1-x(z)]dz} \quad (6)$$

$$n_F = \frac{\int_{0}^{z'} \beta(z)x(z)dz}{h_F \int_{0}^{z'} \beta(z)[1-x(z)]dz} \quad (7)$$

Let $\lambda, \mu \in (0,1)$ be the fraction of Southern capital and labor employed in SOE, we have:

$$h_E = \frac{K_E}{L_E} = \frac{\lambda K_S}{\mu L_S} \qquad h_F = \frac{K_F}{L_F} = \frac{(1-\lambda)K_S}{(1-\mu)L_S}$$

[3] Since SOE and PF meet at the cutoff z', using $P_E(z') = P_F(z')$, we have:

$$d_1 = \frac{w_F}{w_E} = \frac{P_F(z')}{P_E(z')} \frac{[1-x(z')]}{[1-x(z')]} \frac{\left[\frac{K_F(z')}{L_F(z')}\right]^{x(z')}}{\left[\frac{K_E(z')}{L_E(z')}\right]^{x(z')}} = \left(\frac{n_E}{n_F}\right)^{x(z')}.[18] \qquad (8)$$

[4] Last but not least, solution vector $(\lambda, \mu, n_F, n_E, n_N, d_1, z'')$ should maximize the real output of the economy intervening South:[19]

$$\arg\max Y_S'/P' \qquad \text{s.t. all conditions from Eq. (4) to Eq. (8)} \qquad (9)$$

where P' is the price index in the distorted model (see next subsection for derivation). Expression of Y_S'/P' is derived as Eq. (11) in the next sub-section. The solution of the equilibrium in the distorted model is a vector of endogenous variable $(\lambda, \mu, n_F, n_E, n_N, d_1, z'')$ that maximizes Eq. (9) subject to Eq. (4) to (8). Since this system of equations is very complicated, existence of solution can only be found by computer. In Section 1.4, I will conduct a numerical exercise for the model. Until here, the equilibrium

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[18] $\frac{K_i(z)}{L_i(z)} = \frac{x(z)}{1-x(z)}\frac{1}{n_i}$ $(i = N, F, E)$. Similarly, the condition of $P_E(z'') = P_N(z'')$ is incorporated in the trade balanced equation to find the relationship between w_N and w_E.

[19] We could use Southern utility but maximizing real output is more convenient and the outcome is the same.

characterization for the distorted economy is complete. In sum, we reach an equilibrium where the North specializes in goods $z > z''$, SOE in $z' < z < z''$ and PF in $z < z'$.

1.3.3 Output efficiency comparison

This sub-section shows the comparison of the Southern output efficiency with and without distortion. The key measure is the ratio of real outputs:

$$\frac{Y_S'/P'}{Y_S/P}$$

Here, Y_S' and Y_S are nominal output of the South with and without distortion respectively. P and P' are price indexes for the distorted and undistorted case respectively.

The formula for P is:

$$P = \int_0^1 P(z)dz = \int_0^{z^*} P_S(z)dz + \int_{z^*}^1 P_N(z)dz = \int_0^{z^*} C_S(z)dz + \int_{z^*}^1 C_N(z)dz$$

where,

$$\int_0^{z^*} C_S(z)dz = \int_0^{z^*} w_S\left(\frac{r_S}{w_S}\right)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z}dz$$

$$\int_{z^*}^1 C_N(z)dz = \int_{z^*}^1 w_N\left(\frac{r_N}{w_N}\right)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z}dz$$

Normalize $w_S = 1$, and rely on the following relationships:

$$\frac{r_S}{w_S} = n_S, \qquad \frac{r_N}{w_N} = n_N,$$

$$\frac{w_N}{w_S} = \frac{P_N(z^*)[1 - x(z^*)]\left[\frac{x(z^*)}{1-x(z^*)}\frac{1}{n_N}\right]^{x(z^*)}}{P_S(z^*)[1 - x(z^*)]\left[\frac{x(z^*)}{1-x(z^*)}\frac{1}{n_S}\right]^{x(z^*)}} = \left(\frac{n_S}{n_N}\right)^{x(z^*)}$$

We have,

$$\int_0^{z^*} C_S(z)dz = \int_0^{z^*} (n_S)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z} dz = f(z^*)$$

$$\int_{z^*}^{1} C_N(z)dz = \int_{z^*}^{1} \left(\frac{n_S}{n_N}\right)^{x(z^*)} (n_N)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z} dz = g(z^*)$$

The real output in benchmark undistorted case is:

$$\frac{Y_S}{P} = \frac{L_S + n_S K_S}{f(z^*) + g(z^*)} \quad ,$$

The equilibrium solution vector (n_S, n_N, z^*) are used to compute the real output in the benchmark model.

Same principle applied to the distorted model. The real output of the intervening South is:

$$\frac{{Y_S}'}{P'} = \frac{w_F L_F + r_F K_F + w_E L_E + r_E K_E}{\int_0^{z'} C_F(z)dz + \int_{z'}^{z''} C_E(z)dz + \int_{z''}^{1} C_N(z)dz}$$

where,

$$\int_0^{z'} C_F(z)dz = \int_0^{z'} w_F \left(\frac{r_F}{w_F}\right)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z} dz$$

$$\int_{z'}^{z''} C_E(z)dz = \int_{z'}^{z''} w_E \left(\frac{r_E}{w_E}\right)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z} dz$$

$$\int_{z''}^{1} C_N(z)dz = \int_{z''}^{1} w_N \left(\frac{r_N}{w_N}\right)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z} dz$$

Normalize $w_F = 1$ in the distorted model and rely on the following relationships:

$$\frac{w_E}{w_F} = \frac{1}{d_1} \qquad \frac{r_E}{w_F} = \frac{r_E}{w_E}\frac{w_E}{w_F} = n_E \frac{1}{d_1} \qquad \frac{w_N}{w_F} = \frac{w_N}{w_E}\frac{w_E}{w_F} = \left(\frac{n_E}{n_N}\right)^{x(z'')} \frac{1}{d_1}$$

We have:

$$\int_0^{z'} C_F(z)dz = \int_0^{z'} (n_F)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z} dz = \alpha(z')$$

$$\int_{z'}^{z''} C_E(z)dz = \int_{z'}^{z''} \frac{1}{d_1} (n_E)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z} dz = \delta(z', z'')$$

$$\int_{z''}^{1} C_N(z)dz = \int_{z''}^{1} \left(\frac{n_E}{n_N}\right)^{x(z'')} \frac{1}{d_1} (n_N)^z \left[\frac{1-z}{z}\right]^z \frac{1}{1-z} dz = \gamma(z'')$$

The real output in the distorted model is:

$$\frac{Y_S{}'}{P'} = \frac{L_F + n_F K_F + \frac{1}{d_1} L_E + \frac{1}{d_1} n_E K_E}{\alpha(z') + \delta(z', z'') + \gamma(z'')} \qquad (10)$$

The equilibrium solution vector $(\lambda, \mu, n_F, n_E, n_N, d_1, z'')$ are used to compute the real output in the distorted model.

The ratio of real output between with and without distortion is:

$$\text{real output ratio} = \frac{Y_S'/P'}{Y_S/P}$$

1.3.4 Impact of capital distortion on wage inequality

Here I show the relationship between capital market distortion variable d_2, and wage inequality, d_1. Since $\frac{n_E}{n_F} = \frac{\frac{r_E}{w_E}}{\frac{r_F}{w_F}} = \left(\frac{w_F}{w_E}\right)\left(\frac{r_F}{r_E}\right)^{-1} = \frac{d_1}{d_2}$, we have:

$$d_1 = \left(\frac{d_1}{d_2}\right)^{x(z')},$$

Taking natural logarithm on both sides, we have:

$$\ln d_1 = x(z')[\ln d_1 - \ln d_2] \quad ,$$

Rearrange we have:

$$\ln d_1 = \frac{-x(z') \ln d_2}{1 - x(z')} < 0 \rightarrow d_1 = \frac{w_F}{w_E} < 1 \quad (11),$$

It follows that:

$$\frac{\partial \ln d_1}{\partial \ln d_2} = \frac{-x(z')}{1 - x(z')} < 0 \quad (12),$$

Eq. (11) shows that as long as there is capital market distortion ($d_2 > 1$), we will have wage inequality $d_1 < 1$. Eq. (12) shows that greater financial market distortion will lead to greater wage inequality (smaller d_1).

1.4 Numerical Exercise

In this section, I conduct a numerical exercise for the benchmark and distorted models under various cases.[20] Results are shown in Table 1.5.

In all cases, for demonstration purpose, capital and labor endowments in the labor-abundant South and the capital-abundant North are 1 and 4, 6 and 1 respectively. Column A shows the results for the benchmark distortion-free model. Column B to D show results under different combinations of exogenous policy variables z' (default at 0.65) and d_2 (default at 2.9). Model outcomes of interest include the cutoff point of the benchmark model z^*, cutoff point between the North and the South in the distorted model z'', real output and welfare comparison between the benchmark and the distorted model, and factor allocation in the distorted model. Cutoff points z' and z'' are expressed in multiple of z^*. All solutions satisfy the comparative advantage pattern inequalities. For simplicity purpose, the functional forms for product's capital intensity $x(z)$ and budget share (density) $b(z)$ are specified as: $x(z) = z, b(z) = 1$.

A summary of key results are as follows. First, in the benchmark model (Case A), the North and the South meet at the cutoff point z^* at 0.4679. Since in the distortion-free scenario there is no distinction

[20] Admittedly, this numerical exercise is quite qualitative. The main purpose is to see the direction of changes of endogenous variables of interest.

between *SOE* and *PF* in the South, I do not show endogenous values of factor allocation and wage inequality between *SOE* and *PF*.

Second, the two political economy goals of the South: have *SOE* dominate in capital intensive industries in the South *and* reaching a higher North-South cutoff point z'' greater than z^* (accelerate industrial upgrading) are achieved; while the associated negative consequences are inefficient output (real output ratio less than 1) and wage inequality (d_1<1). Examining the distorted Case B, SOE only pays a third of price faced by *PF* for a unit of capital: in equilibrium the former occupies PSR ranging from z' ($z' = 0.650 \times z^*$) to z'' ($z'' = 1.013 \times z^*$) while the latter specializes in the most labor-intensive regions: from 0 to z'. By channeling cheap capital to SOE, the Southern government enables SOE to function *as if* it were a more capital-abundant (albeit smaller) country, thus acquiring the ability to produce goods more sophisticated than the Southern contemporaneous comparative advantage allowed. As evident by the Southern factor allocation, SOE employs 71% and 13% of Southern capital and labor respectively, resulting in a capital-labor ratio of 1.37 ($= \frac{71\% \times 1}{13\% \times 4}$), which is higher than the average of the South (1:4) but still less than the North (6:1). In terms of efficiency, comparing the benchmark model (Case A) and distorted model (Case B), the relative real output and relative utility of the distorted model reach about 98.7% and 98.2% of the benchmark distortion-free model respectively. For inequality, wage of PF workers is 62.8% of SOE workers.

Third, ceteris paribus, greater capital market distortion causes greater efficiency loss and inequality. As seen by comparing Case B and C, if we increase the degree of distortion d_2 from 2.9 to 3 (a 3.4% increase), the relative real output falls from 98.7% to 97.2% and the relative wage of PF workers falls from 62.8% to 61.9%. The negative relationship between d_1 (wage inequality) and d_2 (relative capital price) is indicated by Eq. (11).

Fourth, ceteris paribus, an increase in z' results in lower relative real output and greater inequality.[21] The exogenous cutoff z' represents the restriction of industrial access imposed on PF. Suppose the Southern government decides to reform the *SOE* by making it retreat from relative labor intensive sectors and allow PF to advance into more capital intensive sectors. Compare Case B to Case D, z' is adjusted from 65% of z^* to 68% of z^*. Marching upward into more capital intensive sectors requires relatively more capital; however, without mitigating the capital market distortion (d_2 is held at 2.9), such advancement is too costly for PF which makes the entire relative real output of the South goes down from 98.7% to 97.8%. In order to pay for additional need of capital, PF workers' wage is suppressed which causes greater inequality: d_1 falls from 62.8% to 60.8%. This observation echoes well with the phenomenon of reform policy dyssynchrony as pointed out by Haggard and Huang (2008) where the Chinese government has legitimated PFs in many sectors over the decades but remained stagnant in capital market reform.

1.5 Empirical Analysis

This section empirically examines two key implications from the model to further support the theory. One is related to wage inequality and the other is on output inefficiency.

1.5.1 Estimation strategy

Hypothesis One

The wage ratio between PFs and SOEs' workers, d_1, should be inversely related to capital price ratio between PFs and SOEs, d_2. Greater capital market distortion leads to higher wage inequality. This relationship can be seen from Eq. (11). Given that China is a large country with vast regional development variations and market fragmentation, I exploit wage inequality variation at the city-level;

[21] From a rigorous general equilibrium perspective, z' should be endogenous: the cutoff point between PF and SOE should be affected by their relative financing cost, d_2. However, the primary reason it is set exogenously here is because historically, firm entry into capital intensive or advanced sectors is typically blocked by many legal barriers and bureaucratic hurdles. Thus from a reality perspective, z' is better modeled as exogenous.

this approach has a potential advantage of ameliorating firm-level wage outliers and reporting errors. The hypothesis can be tested by estimating[22]:

$$\ln(Wage\_ratio_i) = \beta_0 + \beta_1 \ln(Cap\_Distort_i) + \gamma X_i + e_i. \qquad (12)$$

Here, $Wage\_ratio_i$, is ratio of average wage between PFs and SOEs' workers in city i:

$$\ln(Wage\_ratio_i) = \ln \frac{\left(\sum_j PF\ wage_{ij}\right)/\left(\sum_j PF\ employment_{ij}\right)}{\left(\sum_k SOE\ wage_{ik}\right)/\left(\sum_k SOE\ employment_{ik}\right)},$$

where $PF\ wage_{ij}$ is the wage bill of PF j in city i, similarly for SOE.[23] Following the World Bank (2006) where firm ownership determination is more relied on its stock ownership structure rather than self-claimed registration status. Here, a firm is classified as PF if more than 50% of its stock is privately held; it is classified as SOE if more than 50% of stock is held collectively or by the state.

Since there is no city-wise interest rate information by firm types, capital market distortion, $Cap\_Distort_i$, is proxied by the share of small and medium enterprises (SMEs) without loans from financial institutions in city i.[24,25] Large state firms and foreign firms are usually without capital constraint, it is the SMEs (usually private) that are capital constrained. This proxy is also consistent with China's financial system which is dominated by the banking sector as opposed to many developed countries where equity and bond market play essential roles for firm financing. A potential problem is that a firm may rely on retained earnings to satisfy its capital needs thus reporting no bank loans does not necessarily mean being credit constrained. The problem is mitigated by a screening question asking the firm manager

[22] For Chinese capital and labor market fragmentation, see Boyreau-Debray and Wei (2005), Li and Coxhead (2011).

[23] Using available survey data, a firm's total wage is constructed as the sum of wage bills from its permanent and temporary workers. Wage bill of each worker type is its average wage times the number of workers of that type. To avoid extreme payment affecting the result, firms are excluded from its analysis if their average wages of a worker type exceed 95% quantile or below 5% quantile.

[24] The corresponding question in the firm survey I use is: "Does your company have loans from banks or other financial institutions?" 1- Yes, 2- No.

[25] Following Ayyagari et al. (2003), a firm is defined as SME if it has less or equal to 250 employees.

whether application for bank loan has become more or less difficult: SMEs which chose “not applicable” are excluded from the sample. The inverse relationship between $Cap\_Distort$ and $Wage\_ratio$ implies that $\beta_1 < 0$.

$Cap\_Distort_i$ can be potentially endogenous, for example due to heterogeneity in local saving preference and level of financial development. The instrumental variable I use is the share of state firms in city i, SOE_prop_i. It is computed as the number of SOEs divided by the total number of SOEs and PFs in city i. The idea is that a greater proportion of state firms tends to occupy a greater share of local saving which means less capital available for private firms. The establishment of SOEs has been substantially influenced by political or security reasons rather than profit maximization. Many SOEs’ history can be traced to the 1950s’ when cities’ development levels were rather homogenous. Other control variables for city i, such as the logarithm of city population, per capita GDP, share of foreign firms and effective tax rate are included in regressor X_i.[26]

Hypothesis Two

A city’s aggregate real output level should be inversely related to that its SOEs’ relative size**.** This is derived from a main theme of the paper that China’s development strategy which favors SOEs causes inefficient output. Comparing two otherwise identical regions with and without such strategy, the former which concentrates relatively more capital into SOEs should be associated with lower aggregate output than the latter. This hypothesis can be tested by estimating:

$$\ln Y_i = \alpha_0 + \alpha_1 \ln(SOE\_Size_i) + \gamma Z_i + e_i \ , \qquad (13)$$

where Y_i is city i’s aggregate output; SOEs’ relative size is proxied by the log share of SOEs’ net fixed asset among the sample firms from city i:

$$SOE\_Size_i = \frac{\sum_k SOE\ net\ fixed\ asset_{ki}}{\sum_k SOE\ net\ fixed\ asset_{ki} + \sum_j PF\ net\ fixed\ asset_{ji}} \ ,$$

[26] The percentage of foreign firms is constructed as the number of foreign firms divided by the sum of SOEs, PFs and foreign firms.

where $SOE\ net\ fixed\ asset_{ki}$ is net fixed asset of SOE k in city i, similarly for PF. Other control variables in Z_i include: log of city population, shipment cost to the port (transportation cost), average year of schooling of surveyed companies' CEOs (human capital), effective tax rate (tax burden) and road length index (transportation capacity), which are presumably important in affecting production. If the hypothesis is supported, we would expect $\alpha_1 < 0$. To avoid impact from extreme values, firms are excluded from the analysis if their net fixed asset is above or below 95% and 5% of respective quantiles.

The variable of interest, SOE_Size, can be endogenous due to supposedly causal relationship between aggregate output, Y and SOE_Size's denominator, aggregate net fixed asset of SOE and PF. This source of endogeneity will automatically make SOE_Size be inversely related to Y even if there is no supporting theory. The instrumental variable I use is $Old\_Industrial\_Base$, a dummy variable equals to 1 if a city was officially designated as a national industrial base during one of the three historical periods: First Five-Year Plan (1953~1957), Second Five-Year Plan (1958~1962) and the Third Front Construction (1964 to early 1970s) by China's National Development and Reform Commission (Chen, 2003).[27] For industrial base cities, the distortive development strategy has been presumably more thoroughly implemented than undesignated cities. This phenomenon translates into persistent greater share of capital (or net fixed asset here) under the control of SOEs. The location choice of industrial bases was driven primarily by political and national security purposes.

1.5.2 Data description

The data comes from two sources. City level information such as: $Wage\_ratio_i$, $Cap\_Distort_i$, SOE_prop_i, share of foreign firms and, SOE_Size_i, are constructed from firm-level data which comes from the World Bank's "Investment Climate Survey" in China. It contains cross-section information of 12400 Chinese enterprises that covers 30 two-digit manufacturing industries, located in 120 cities around the country in 2004. The variety of manufactured product is diverse, ranging from food and beverage production to electronic and telecommunication equipment. The survey contains firm-level variables such

[27] National Development and Reform Commission. 2013. "Quanguo laogongye jidi tiaozheng gaizao guihua 2013~2022." [The Plan for Adjustment and Reform of National Old Industrial Bases 2013~2022]

as wage, total employment, income, shareholding structure and location. Another source of city-level aggregate information such as per capita GDP, population and effective tax rate comes from the World Bank (2006) which is a report associated with this survey. Appendix 1.B presents the number of firms by ownership types and cities. Table 6 shows the descriptive statistics.

1.5.3 Results

Table 1.7 shows the first-stage OLS result for *Capital_Distort* as the dependent variable for Hypothesis One. The instrumental variable, *SOE_prop*, is statistically positive across different specifications. Table 1.8 shows the results for estimating Eq. (12). In Column 1, the coefficient of *Capital_Distort* in the single regression is statistically negative. It suggests that if there is a 1% increase of capital market distortion (share of SMEs without bank loans), the wage inequality between PFs and SOEs workers will increase by about 0.5%. This magnitude is pretty uniform across different specifications (Column 2-4). Share of foreign firms also generates interesting result: regions with relatively more foreign firms are associated with more equal labor wage. Although the theory does not explicitly take foreign firms who have access to external capital (e.g. parent companies, foreign stock markets) into account, the result suggests that inequality can be mitigated by collaborating with foreign enterprises. Other control variables, log of city average wage which represents general labor income level, effective tax and fee rate (a proxy for bureaucratic efficiency) and log of city population are not statistically significant.

Table 1.9 shows the first-stage OLS result for $\ln(SOE\_Size)$ as the dependent variable for Hypothesis Two. The instrumental variable, $Old\_Industrial\_Base,$ is positive and statistically significant. It suggests that if a city was designated as a national industrial base, the share of capital controlled by SOE in that city tends to be about 47.5% (= $(e^{0.3889} - 1) \times 100\%$) higher than an undesignated city. Table 1.10 shows the results for estimating Eq. (13). In Column 1, the coefficient of $\ln(SOE\_Size)$ is -1.02 and statistically significant at 5% level, suggesting that a 1% increase of share of capital controlled by SOEs will lead to about 1% decrease of aggregate city income. In Column 2, coefficients for log of city population, shipping cost to the port (transportation cost), and years of CEO schooling (human capital) all have expected sign and statistically significant.[28] There is a possibility that the observed inverse relationship between the log aggregate city GDP and the log share of capital controlled by SOEs is actually caused by SOEs' well-known bureaucratic inefficiency to use capital, rather than the nation's development strategy. In this case, the coefficient of SOE_Size should be overestimated. To account for the quality of general bureaucratic environment, effective tax and fee rate is introduced in Column 3. Indeed, the negative impact of SOE_Size is reduced from -1% to -0.89%, suggesting that bureaucratic inefficiency does undermine city's aggregate income.[29] Road length index which represents the transportation capacity of a city is not significant in this analysis.[30,31]

In sum, the empirical analysis supports my main hypotheses derived from the model: (1) greater capital market distortion tends to exacerbate wage inequality between PFs and SOEs' workers; (2) channeling greater share of capital to SOEs leads to lower regional aggregate output. There are some caveats of the regression result in order. First, since the working data is cross-section, unmodeled city fixed effects such as culture and local institution may bias the result. Second, instrumental variable "*Old_Industrial_Base*" could potentially have direct effect on city's GDP. Although assigning cities as industrial base has a lot to do with military considerations, we cannot completely rule out that it has also economic development concerns. The instrument would not be ideal if it violates the exclusion restriction.

[28] Shipping cost to port is "an estimate of the cost of trucking a 20-foot container to the seaport typically used by the manufacturers in a particular city" (World Bank, 2006).

[29] Many municipal officials have big influence in SOEs' decision-making in their jurisdictions. So a city-level effective tax and fee rate should be a good proxy for SOE bureaucratic efficiency.

[30] Road length index is constructed as the normalized length of graded road at the city level with unit standard deviation.

[31] A potential concern in the second hypothesis analysis is that the exclusion restriction of the instrumental variable, *Old_Industrial_Base* might be violated: choices of some industrial base cities in Five-Year Plans might be somewhat related to economic considerations. To mitigate this concern, I redo the regressions exclusively using cities involved in the Third-Front Construction era as old industrial base when SOEs' location choices were primarily based on military concerns. Cities in the following provinces in the dataset are included: Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Ningxia, Qinghai, Shanxi, Hebei, Henan, Hunan, Hubei and Guangxi (Chen, 2003, p2). The result is very similar as before.

1.6 Discussion

1.6.1 Institution and economic outcome

Acemoglu et al. (2005) argue that institutions, rather than geography or culture, are the fundamental causes of economic growth. They define institutions as "the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction". They show that the choice of institutions is endogenous to the distribution of political power among agents, and it is "the way that humans themselves decide whether or not they prosper." Given that China's political power has been concentrated in the ruling Communist Party, it is natural for the country to adopt its economic institution prone to implement the Party's political ideologies. The resulting institution emphasizing state dominance and leadership for rapid industrial upgrading leads to resource misallocation and inefficiency. However, a small extension of Acemoglu et al. (2005)'s notion reveals that institution cannot only decide whether people prosper but also *how* they prosper. China's economy is likely to be inefficient when the government incorporates many non-market based political ideology in its economic policies. But from a broader political economy vantage point, the fact that this deliberate sacrifice has enhanced national security and higher international status makes the contemporary economically inefficient outcome desirable. In terms of wage inequality, the mechanism illustrated in this study is only one of the causes. Other channels include bureaucratic corruption, better enforcement of employee benefit regulation in SOEs, and perhaps more importantly, the state monopoly in capital-intensive sectors.[32]

1.6.2 Economic reform and policy implications

After Deng Xiaoping initiated the Reform and Opening-up Policy in China in the late 1970s', private sector has received more political legitimacy. In the past three decades, the country has transformed from the planned economy where all aspects of economic life is controlled by the state to a new stage where the private sector occupies a large portion of the economy. However, there are still many problems.

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[32] Song et al. (2011) argue that as PF grows larger, there is a greater demand for capital-intensive goods which strengthens the power of the state monopolists.

First, as pointed out by Haggard and Huang (2008), there is a policy dyssynchrony where there are less legal and procedural barriers for PFs entering capital-intensive sectors but not much support for them in capital financing.

The second problem is closed related to the first one. As SOEs retreat from labor intensive sectors, PFs tend to move up the sophistication ladder. This study shows that the policy dyssychrony results in even greater efficiency loss in this process. This observation echoes well with Bai et al. (2001) who argue: "[…] as the non-state enterprises have gone beyond the start-up stage and are aspiring to grow larger. The negative impact of the tilted playing field [between SOEs and PFs], becomes ever more prominent, and the pain ever more acute". They point out that in early 1980s at the initial stage of private sector development, most start-ups concentrated in labor-intensive sectors (e.g. restaurants, light manufacturing and small hotels) where barriers due to high cost of capital were not acute; procedural obstacles of getting into capital-intensive industries were not binding. However, as private firms seek to grow bigger and venture into more capital-intensive activities, the high price of capital financing begins to bite.

The present study calls for improving PFs' financing environment by encouraging state-dominated banking sector to lend more PFs through policy mandates, and more fundamentally perfecting bond and equity markets. In 2013, China's central bank has made effort to liberalize the interest rate and let market play more "decisive" role in capital allocation. However, the pace and magnitude of such reform remain to be seen.

Besides the financial system reform, state sector reform should further allow greater participation from the PFs in capital-intensive areas, commercialization of SOEs' operation and head appointment. The process has accelerated after the Third Plenary Session of the 18th Central Committee of CPC (*The* Economist, 2013). It can be expected that the outcome largely depends on the willpower of the central government and collaboration from the local governments.

1.7 Conclusion

China has maintained rapid economic growth in the past thirty years. On one hand, its private sector has made much of the growth contribution; on the other hand, SOEs still dominate in capital-intensive sectors and are the leaders in industrial upgrading. The country's phenomenal economic performance has associated with much resource misallocation in capital, growth inefficiency and income inequality between workers in state and private sectors.

This paper answers two questions: Is China's development strategy emphasizing state dominance in capital intensive sectors and leadership in accelerating industrialization a force for growth or an impediment, or a mixture of both? What is the implication for the country's PFs of a strategy in which their legitimacy is recognized but their capital financing is constrained?

This study shows that such development strategy can be a source of resource misallocation, growth inefficiency and inequality in the setting of a labor-abundant economy. In addition, policy dyssynchrony permitting for existence but unsupportive the growth of PFs can make their expansion into capital-intensive sectors costly and inefficient. The key of the theory lies in understanding the general equilibrium consequences of state industrial promotion policies in a trade-dependent economy. Building on important prior contributions to the literature on trade and industrial upgrading with a continuum of goods (notably by Zhu and Trefler, 2005), I develop a model that captures, in stylized form, the salient features of China's economic structure and its trade with the rest of the world. The model shows that over-allocation of capital SOEs due to the distortionary development strategy enables SOEs to expand the PSR which is otherwise not allowed by the country's labor-abundant endowment structure.[33] However, such "acceleration" by state intervention in capital market leads to inefficient output and income inequality between SOEs in the PFs' workers in the labor market. The paper shows the trade-off between growth inefficiency and the acquisition of ability to produce more sophisticated products by defying one's contemporary comparative advantage. SOEs, unlike profit-driven PFs, are tasked with many political

[33] An important difference between this paper and those emphasizing building dynamic comparative advantage is that the former shows a country, at least in theory, is able to advance on IPSL almost instantly by deliberately implementing capital distortionary policy.

economy strategic missions. Thus attacking SOEs' production inefficiency from a pure economic standpoint seems unfair.

A limitation of this paper is that it only involves static comparative advantage without featuring dynamic comparative advantage (DCA) which is an important source of long-run gains. As pointed out by Redding (1999), the concept of DCA has two underlying contexts. In the first context, experiencing short-term welfare loss is justified by expected long-term benefit: an economy can achieve comparative advantage it currently does not have (usually in sophisticated, capital-intensive products) by gradually lowering its marginal cost through R&D and learning by doing in those sectors (e.g. Bruno, 1970; Redding, 1999). Klein (1973) finds that foreign subsidiary of US multinational firms located in developing countries with low technology gains comparative advantage as total output of the whole firm goes up. Amsden (1989, Table 12.2) reports that Korea's leading steel maker Pohang Iron and Steel Company Ltd. did not have comparative advantage in 1973 but became more efficient with unit cost as low as two third of the US in the mid-1980s after receiving initial stage support from the state including preferable government procurement (Rodrik, 1995). In the second context, countries exhibit DCA towards more advanced sectors in the process of capital accumulation. Schott (2003) finds that as a country's capital-labor ratio goes up, its focus will shift from traditionally low-tech products to more sophisticated products. For example, the author shows that for $1 increase of a developing country's capital per worker, its output per worker for labor-intensive products will decrease by $1.3, representing a shift for more advanced product.[34] Pham and Riedel (2013) also find similar result: as a country's becomes richer, its comparative advantage will shrink in labor-intensive goods and expand in capital-intensive goods. In the present study, the protected SOE if put in a dynamic setting would be expected to be more efficient through learning by doing and as the nation rapidly accumulates capital, and it should be easier for the nation to produce more advanced sectors without imposing distortionary policies. However, one should keep in mind that advanced countries also engage in R&D and learning by doing; thus the process of industrialization of a poor country does not only depend on its own domestic conditions but

[34] Schott (2003, Table 7).

also on performance of other countries (Yanagawa, 1996). So it is possible to see a catch-up period longer than expected.[35,36] Of course, political economy factors such as corruption and governance as observed in the Latin American experience of import-substitution industrialization should also be considered (e.g. Braga, 2006). Other limitations of the paper include adoption of the simple Cobb-Douglas production function with constant return to scale. Protected advanced sectors such as ship building and aviation usually require lots of fixed cost and thus exhibit increasing return to scale (Melitz, 2005). It can be anticipated that in a dynamic setting, greater fixed cost may make welfare loss in the initial period even greater. In addition, the study does not take human capital into account and assumes only one labor type, this is also a bit restrictive.

Future research can further study both the inter-industry and spatial spillover effects between capital-intensive SOEs and relatively labor intensive PFs, in areas such as product differentiation, technology evolution and institutional governance. In addition, it is also interesting to investigate the relative performance (e.g. productivity) and interactions between SOEs and also capital abundant foreign invested firms in a range of capital-intensive industries.

[35] The decision whether or not to support an infant industry for catch-up, according to studies like Redding (1999) and Melitz (2005) depends on whether or not the industry can be profitable in the long run without government support. However in China, when we take international politics into consideration, long-term loss can be potentially justified by utility gained of being self-reliant in producing sophisticated high-tech products.

[36] A presumably long panel data is needed to study the dynamic gains of efficiency of SOEs imposed on China's economy.

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Table 1.1 Select Chinese firms in Fortune 500 in 2013

Rank	Company name (Chinese/English)	Revenue (Million $)	Main sector	Foreign Counterparts
4	中国石油化工集团公司 （SINOPEC GROUP）	428167.4	Oil	Royal Dutch Shell, Exxon Mobil, Gazprom
5	中国石油天然气集团公司 （CHINA NATIONAL PETROLEUM）	408630	Oil	-
7	国家电网公司 （STATE GRID）	298448.8	Electricity	Tokyo Electric Power, Électricité De France, Korea
70	中国银行 （BANK OF CHINA）	98428.7	Banking	Hsbc Holdings, Bank Of America Corp., Citigroup
71	中国移动通信集团公司 （CHINA MOBILE COMMUNICATIONS）	96874.5	Telecom	At&T, Nippon Telegraph & Telephone
93	中国海洋石油总公司 （CHINA NATIONAL OFFSHORE OIL）	83458.9	Oil	Rosneft Oil, Conocophillips
100	中国铁道建筑总公司 （CHINA RAILWAY CONSTRUCTION）	77164.7	Railway	Deutsche Bahn, French Nationalrailroad Company
111	中国人寿保险（集团）公司 （CHINA LIFE INSURANCE）	73671.4	Insurance	Prudential, Assicurazioni Generali, Allianz, Nationwide
141	中国第一汽车集团公司 （CHINA FAW GROUP）	64886	Automobile	Ford Motor, Hyundai Motor
161	中国兵器工业集团公司 （CHINA NORTH INDUSTRIES GROUP CORPORATION）	58027.8	Weaponry	Boeing, United Technologies, Lockheed Martin
209	中国南方工业集团公司 （CHINA SOUTH INDUSTRIES GROUP）	47967.4	Weaponry	-
212	中国航空工业集团公司 （AVIATION INDUSTRY CORP. OF CHINA）	47351.2	Aviation	Boeing, Airbus
222	宝钢集团有限公司 （BAOSTEEL GROUP）	45682.7	Steel	Tata Steel, Nippon Steel & Sumitomo Metal
315	华为投资控股有限公司 （HUAWEI INVESTMENT & HOLDING）	34900.6	Telecom	At&T, Siemens, Panasonic
322	首钢集团 （SHOUGANG GROUP）	34329.7	Steel	Tata Steel, Nippon Steel & Sumitomo Metal
326	中国机械工业集团有限公司（SINOMACH）	33952.3	Machinery	Mitsubishi, Hyundai Heavy Industries
329	联想集团 （LENOVO GROUP）	33873.4	Computer	Microsoft, Google
336	北京汽车集团 （BEIJING AUTOMOTIVE GROUP）	33374.5	Automobile	Toyota Motor, Volkswagen
357	中粮集团有限公司 （COFCO）	31751.5	Food	Nestlé, Pepsico, Costco Wholesale
417	中国船舶重工集团公司 （CHINA SHIPBUILDING INDUSTRY）	27753	Ship building	Mitsubishi, Hyundai Heavy Industries

Source: Adapted from Fortune Magazine (Chinese edition) Global 500 database.

Table 1.2 Asset shares of state-owned enterprises (SOE) in major manufacturing sectors

	% asset from industrial SOE					
Insdustrial Sectors	2000	2003	2005	2007	2010	Mean
Petroleum and natural gas exploitation	99	97	95	97	97	97
Production and supply electric power and thermal power	89	89	87	89	89	89
Coal mining and selecting	93	91	83	79	73	84
Water production and supply	90	88	86	76	77	83
Gas production and supply	94	88	73	59	53	73
Petroleum processing and coking	90	80	70	66	60	73
Smelting and pressing of ferrous metals	86	73	61	60	57	67
Transportation equipment	78	70	60	57	54	64
Non-ferrous metals mining and selecting	74	63	54	44	44	56
Smelting and pressing of non-ferrous metals	72	62	50	46	43	55
Ferrous metals mining and selecting	78	59	45	39	48	54
Non-metal mining and selecting	77	69	41	32	31	50
Raw chemical materials and chemical products	69	55	43	39	31	47
Equipment for special purposes	63	55	43	35	34	46
Beverages production	59	48	37	30	27	40
General machinery	61	47	36	30	22	39
Medical and pharmaceutical products	61	47	35	28	21	38
Chemical fiber products	70	44	30	25	15	37
Printing and record medium reproduction	51	38	30	23	19	32
Nonmetal mineral products	49	35	25	20	19	30
Rubber products	51	34	25	17	17	29
Instruments, meters, cultural and office machinery	49	30	23	19	18	28
Electronic and telecommunications equipments	51	33	22	15	16	27
Papermaking and paper products	45	36	22	15	16	27
Food production	41	29	21	18	12	24
Agricultural and side-line food processing	51	26	15	10	9	22
electrical equipment and machinery	36	25	18	14	14	21
Timber processing, bamboo, cane, palm fiber and straw products	38	29	23	10	5	21
Textiles manufacturing	46	26	13	9	5	20
Metal products	24	17	12	10	9	14
Plastic products	23	15	10	6	5	12
Cultural, educational and sports goods	17	10	6	4	2	8
Furniture manufacturing	15	8	5	3	3	7
Garment, shoes, and caps manufacturing	12	6	4	3	2	5
Leather, furs, down, and related products	12	4	2	1	1	4

Source: Adapted from Chen (2012, p165, 168).

Table 1.3 Ranking of Doing Business index among select economies in 2012

Economy	Ease of Doing Business Rank	Starting a Business	Dealing with Construction Permits	Getting Electricity	Registering Property	Getting Credit	Protecting Investors	Paying Taxes	Trading Across Borders	Enforcing Contracts	Resolving Insolvency
Singapore	1	4	2	5	36	12	2	5	1	12	2
Hong Kong SAR, China	2	6	1	4	60	4	3	4	2	10	17
United States	4	13	17	19	25	4	6	69	22	6	16
United Kingdom	7	19	20	62	73	1	10	16	14	21	8
Taiwan, China	16	16	9	6	32	70	32	54	23	90	15
Canada	17	3	69	152	54	23	4	8	44	62	4
Germany	20	106	14	2	81	23	100	72	13	5	19
Japan	24	114	72	27	64	23	19	127	19	35	1
France	34	27	52	42	146	53	82	53	27	8	43
Italy	73	84	103	107	39	104	49	131	55	160	31
Serbia	86	42	179	76	41	40	82	149	94	103	103
China	**91**	**151**	**181**	**114**	**44**	**70**	**100**	**122**	**68**	**19**	**82**
Guatemala	93	172	94	34	20	12	158	124	117	96	109
Egypt, Arab Rep.	109	26	165	99	95	83	82	145	70	152	139
Russian Federation	112	101	178	184	46	104	117	64	162	11	53
Argentina	124	154	171	74	135	70	117	149	139	48	94
Brazil	130	121	131	60	109	104	82	156	123	116	143
Philippines	138	161	100	57	122	129	128	143	53	111	165
Mozambique	146	96	135	174	155	129	49	105	134	132	147
Malawi	157	141	175	179	97	129	82	58	168	144	134
Iraq	165	177	84	46	100	176	128	65	179	141	185
Haiti	174	183	136	71	130	159	169	123	149	97	160

Note: The first column has the aggregate indeces indicating the relative easiness of doing business in respective economies. It is constructed out of the other ten listed sub-rankings.

Source: World Bank Doing Business Ranking, http://www.doingbusiness.org/rankings

Table 1.4 Survey questions: please indicate to what extent the following factors affect your company's operation and growth

	None (%)	Low (%)	Moderate (%)	High (%)	Very high (%)	% above or equal to Moderate
Communication	70.3	24.2	3.7	1.5	0.2	5.4
Electricity	35.9	30.9	15.5	14.6	3.1	33.3
Transport	46.4	26.2	15.5	10.6	1.3	27.4
Tax administration	52.8	26.6	13.0	6.8	0.8	20.6
Customs	72.9	18.6	5.9	2.2	0.4	8.5
Worker's skills and education level	26.4	30.9	27.8	13.8	1.1	42.7
Access to finance (e.g. loan guarantee)	34.3	21.1	19.6	20.6	4.4	44.6
Financing cost (e.g. interest rate)	39.7	24.9	21.3	12.6	1.5	35.4
Local protectionism	56.8	26.6	11.2	4.6	0.8	16.6
Unstable economic and administration policies	45.7	28.1	15.2	9.5	1.5	26.2
Crime, theft	54.7	34.9	7.5	2.5	0.4	10.4
Anti-competition behaviors by other enterprises	37.7	28.1	19.7	12.9	1.7	34.3
Access to information on laws and regulations	48.4	34.9	13.7	2.7	0.3	16.7
Water services	59.5	27.4	8.5	3.7	0.9	13.0

Source: Computed from World Bank Investment Climate Survey on China, 2005.

Table 1.5 Comparison of South's major characteristics in distorted model and the benchmark model under various hypothetical cases

		Case			
		A	B	C	D
Exogenous variable	South's Capital	1	1	1	1
	South's Labor	4	4	4	4
	North's Capital	6	6	6	6
	North's Labor	1	1	1	1
	z' (multiples of z*)	NA	0.65	0.65	0.68
	d2 (ratio of capital price faced by PF over SOE)		2.9	3	2.9
Endogenous variable	Cutoff between N and S z* (benchmark) (1)	0.4679	NA		
	z'' (multiples of z*)	NA	1.013	1.010	1.005
	% real output ratio (2)		98.73	98.22	97.80
	% loss of GDP (3) = 100-(2)		1.27	1.78	2.20
	% South's Utility ratio (4)		98.23	97.78	97.57
	% of K of South in SOE (5)		71.10	72.44	69.97
	% of L of South in SOE (6)		13.04	13.27	12.44
	% of K of South in PF (7) = 100-(5)		28.90	27.56	30.03
	% of L of South in PF (8) =100-(6)		86.96	86.73	87.56
	d1 (wage of PF as % of SOE) (9)		62.79	61.87	60.84
	Whether comparative advantage inequalities satisfied?	Yes	Yes	Yes	Yes

Notes: $\boldsymbol{z}^*$ is the cutoff point between North and South in the benchmark model. $\boldsymbol{z}'$ and $\boldsymbol{z}''$ are cutoff points between $\boldsymbol{PF}$ versus $\boldsymbol{SOE}$ and $\boldsymbol{SOE}$ versus the North respectively in the distorted model.

Table 1.6 Descriptive statistics

	min	median	mean	max	S.D.
log (Wage_ratio)	-0.88	-0.28	-0.27	0.31	0.25
log (Capital_Distort)	2.92	3.87	3.83	4.51	0.33
SOE share (%)	1.47	33.58	36.00	80.00	19.23
Foreign share (%)	0.00	8.78	17.17	91.57	20.53
Effective tax rate (%)	3.80	12.50	12.46	18.40	2.58
log (city population, in 10^4)	4.84	6.26	6.20	7.93	0.53
log (city mean wage, RMB)	8.79	9.55	9.58	10.37	0.30
Road index	0.88	2.36	2.41	2.64	4.21
log (city output, in 10^6 RMB)	8.61	10.48	10.57	13.10	0.79
log (SOE_size) (income based)	-6.50	-0.48	-0.72	0.00	0.90
log(SOE_size) (asset based)	-6.50	-0.52	-0.78	-0.03	0.88
SOE investment share (%)	0.12	55.76	53.98	100.00	32.37
Old_Industrial_Base (yes=1)	0.00	0.00	0.37	1.00	0.48

Table 1.7 First-stage regression for the instrumental variable: ***State_prop***

Dependent variable: log (Capital_Distort)				
	(1)		(2)	
Intercept	40.7007	***	62.0394	***
	(3.3157)		(18.9560)	
State_prop	0.2123	**	0.2110	**
	(0.0838)		(0.0846)	
Effective tax rate			-0.4416	
			(0.5997)	
log (city population)			-2.5476	
			(2.7128)	
Observations	120		120	
Adjusted R-square	0.0668		0.0646	

Notes: Robust standard errors are shown in the parentheses. Capital_Distort is the share of small firms without access to loans. State_prop, is the ratio between the number of SOEs and the sumof SOEs and PFs in city *i*.

*** Significant at the 1% level.

**Significant at the 5% level.

Table 1.8 Relationship between wage inequality and capital market distortion

Dependent variable: ln (Wage_ratio)

	(1)		(2)		(3)		(4)	
Intercept	1.7517		2.3002		1.5954		3.0635	
	(1.1299)		(1.9768)		(1.0857)		(2.1685)	
ln (Capital_Distort)	-0.5287	*	-0.4790	*	-0.5016	*	-0.4519	*
	(0.2947)		(0.2855)		(0.2856)		(0.2700)	
Share of foreign firms					0.0031	**	0.0043	**
					(0.0012)		(0.0020)	
ln (city mean wage)			-0.0797				-0.1983	
			(0.0978)				(0.1324)	
Effective tax and fee rate			-0.0145				0.0010	
			(0.0094)				(0.0108)	
ln (city population)			0.0331				0.0333	
			(0.0527)				(0.0485)	
Observations	120		120		120		120	

Notes: Robust standard errors are in the parentheses. The dependent variable is the wage ratio of workers from private firms and state-owned enterprises.

** Significant at the 5% level.

*Significant at the 10% level.

Table 1.9 First-stage regression for the instrumental variable: $Old\_Industrial\_Base$

Dependent variable: ln(SOE_size)

Intercept	-0.9210	***	-5.4018	***
	(0.1187)		(2.0565)	
Old_Industrial_Base	0.3889	***	0.3174	**
	(0.1371)		(0.1415)	
ln (city population)			-0.2372	**
			(0.1120)	
Shipping cost to port			0.0002	
			(0.0001)	
CEO schooling			0.4127	***
			(0.1401)	
Effective tax and fee rate			-0.0366	
			(0.0500)	
Road length index			0.0045	
			(0.1301)	
Observations	120		120	
Adjusted R-square	0.0376		0.1163	

Notes: Robust standard errors are in the parentheses. The dependent variable is the (log) share of state-firms' net fixed asset among both state and private firms in a city. "Old_Industrial_Base" is a dummy variable that equals to 1 if a city used to be designated as industrial based city.

*** Significant at the 1% level.

** Signifcant at the 5% level.

Table 1.10 Relationship between log of city aggregate output and state sector's relative size

Dependent variable: ln (city aggregate GDP)						
	IV Estimation					
	(1)		(2)		(3)	
Intercept	9.7770	***	-6.9684	*	-4.1669	
	(0.3595)		(3.8831)		(3.5257)	
ln (SOE_size)	-1.0208	**	-1.0667	*	-0.8941	*
	(0.5122)		(0.5467)		(0.5157)	
ln (city population)			0.4512	**	0.4829	***
			(0.1856)		(0.1651)	
Shipping cost to port			-0.0003	**	-0.0003	*
			(0.0002)		(0.0002)	
CEO schooling			0.9169	***	0.7840	***
			(0.2628)		(0.2270)	
Effective tax and fee rate					-0.0544	
					(0.0489)	
Road length index					-0.0672	
					(0.1600)	
Observations	120		120		120	

Notes: Robust standard errors are in the parentheses. SOE_size stands for the share of state firms' net fixed asset among state and private firms.

*** Significant at the 1% level.
** Significant at the 5% level.
* Significant at the 10% level.

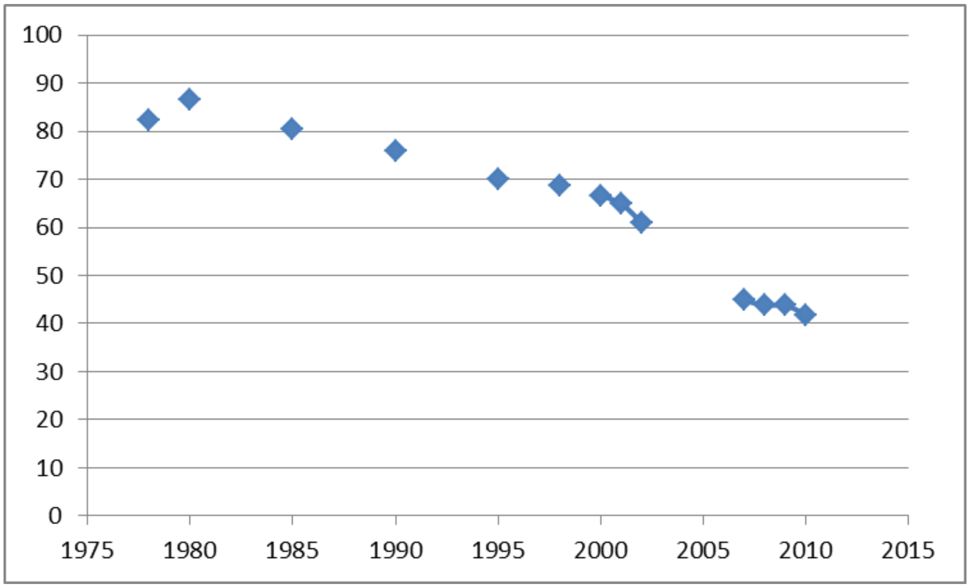


Figure 1.1 Proportion (%) of aggregate assets from industrial SOEs among all Chinese industrial firms

Source: Adapted from Chen (2012, p144).

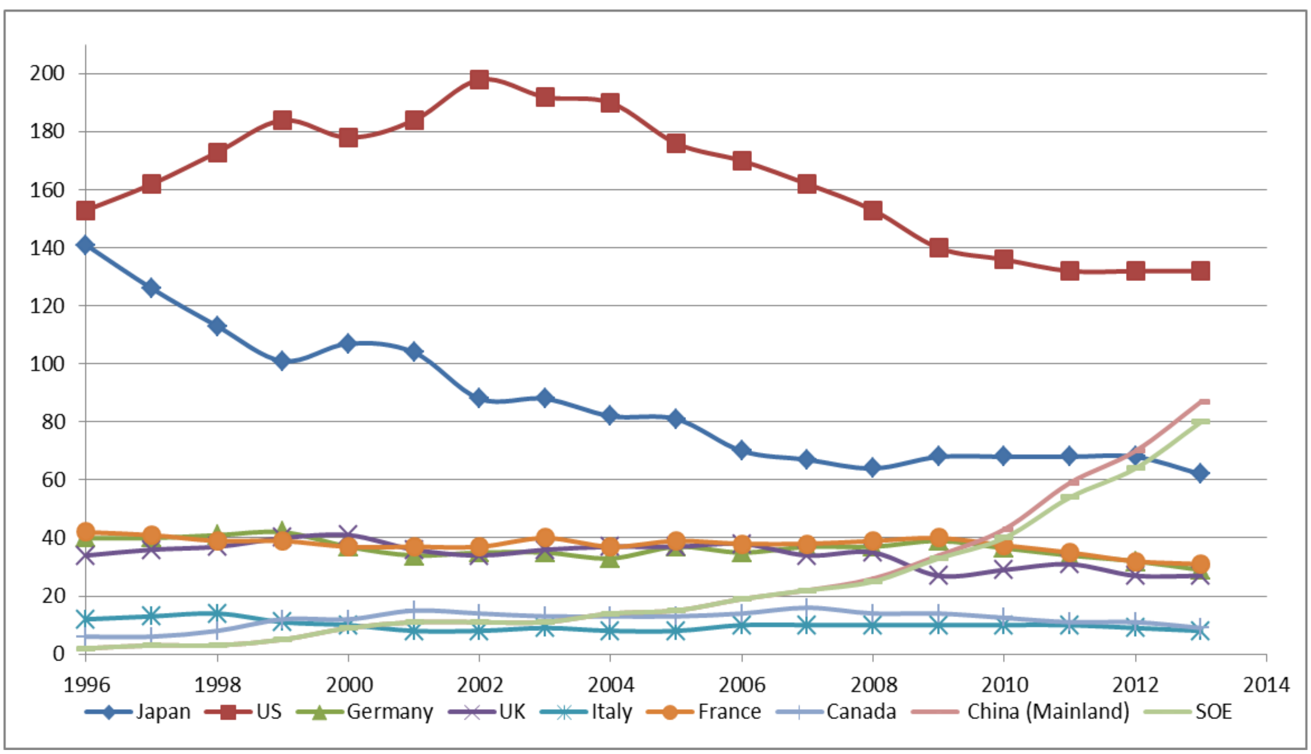


Figure 1.2 Number of firms in Global 500 (500 largest firms in the world by revenue) from G7 countries and China (mainland). Source: Calculated from Fortune Magazine (Chinese edition) Global 500 database.

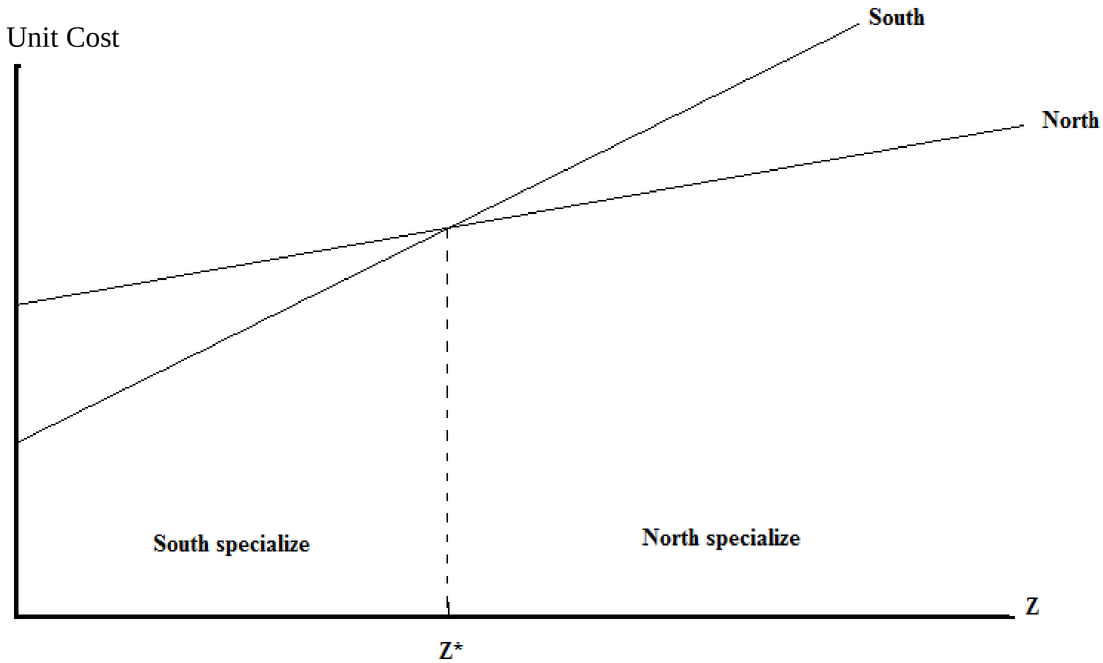


Figure 1.3 Division of specialization zones between the North and the South at z*

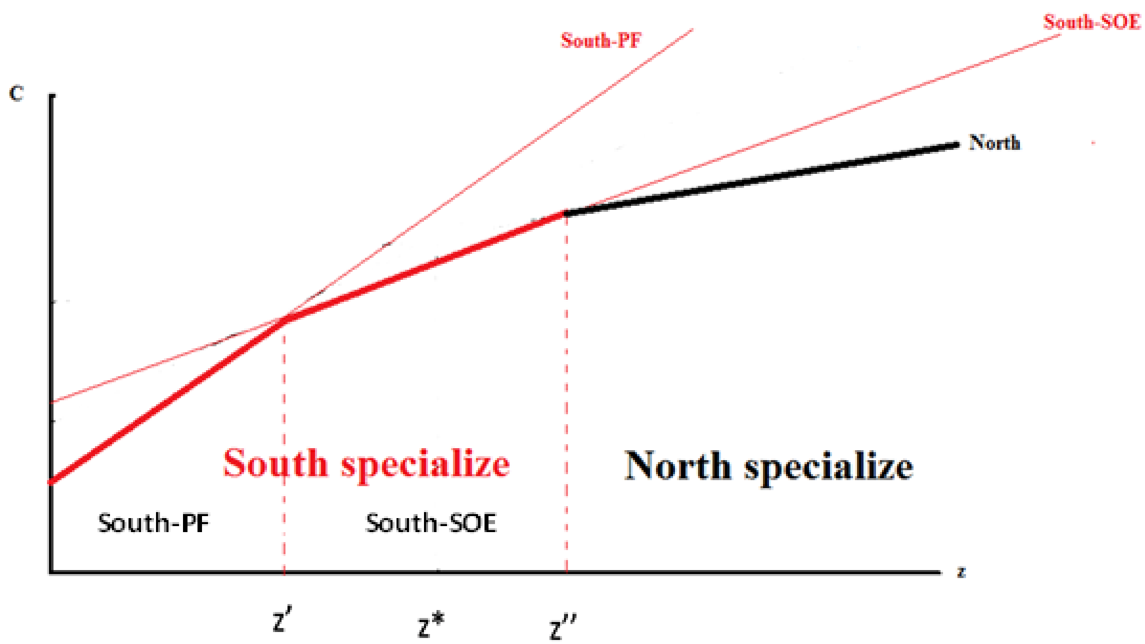


Figure 1.4 Division of specialization zones between Southern private firm (PF) and state-owned enterprise (SOE) at z', and between Southern SOE and the North at z''.

Appendix 1.A Technical Proof of Solution Existence for the Benchmark Model

Laying out the question

The equilibrium is characterized by three equations: two factor market clearing conditions and one trade balance condition. Define $n_i = \frac{r_i}{w_i}, i = S, N$, $\beta(z)$ is the budget share of consumer for good z.

Factor market clearing condition for the South (rearranged):

$$n_S = \frac{\int_0^{z^*} \beta(z)x(z)dz}{h_S \int_0^{z^*} \beta(z)[1 - x(z)]dz} \qquad (1) \quad ,$$

Factor market clearing condition for the North (rearranged):

$$n_N = \frac{\int_{z^*}^1 \beta(z)x(z)dz}{h_N \int_{z^*}^1 \beta(z)[1 - x(z)]dz} \qquad (2) \quad ,$$

Trade balance between N and S is defined as:

$$B(z^*) \equiv \frac{(w_S L_S + r_S K_S) \int_{z^*}^1 \beta(z)dz}{(w_N L_N + r_N K_N) \int_0^{z^*} \beta(z)dz}$$

Following ZT, this expression yields:

$$\frac{L_S}{L_N} \frac{L_N(z^*)}{L_S(z^*)} \frac{1 + n_S h_S}{1 + n_N h_N} \frac{1 + n_N h_N(z^*)}{1 + n_S h_S(z^*)} \frac{\int_{z^*}^1 \beta(z)dz}{\int_0^{z^*} \beta(z)dz} = 1 \qquad (3)$$

The search for a competitive equilibrium can be reduced to the search for a triplet (n_S, n_N, z^*) that soles Eq. (1),(2),(3). Equation (3) has 5 components, let simplify the first four terms.

First term: Define $C = \frac{L_S}{L_N}$

Second term: $\frac{L_N(z^*)}{L_S(z^*)} = \frac{a_{L,N}(r,w,z^*)\cdot Q(z^*)}{a_{L,S}(r,w,z^*)\cdot Q(z^*)} = \frac{a_{L,N}(r,w,z^*)}{a_{L,S}(r,w,z^*)} = \frac{\left[\frac{1-x(z^*)}{x(z^*)}\frac{r_N}{w_N}\right]^{x(z^*)}}{\left[\frac{1-x(z^*)}{x(z^*)}\frac{r_S}{w_S}\right]^{x(z^*)}} = \left(\frac{n_N}{n_S}\right)^{x(z^*)}$

$$= \left[\frac{\frac{\int_{z^*}^{1}\beta\,(z)x(z)dz}{h_N\int_{z^*}^{1}\beta\,(z)[1-x(z)]dz}}{\frac{\int_{0}^{z^*}\beta\,(z)x(z)dz}{h_S\int_{0}^{z^*}\beta\,(z)[1-x(z)]dz}}\right]^{x(z^*)} = \left[\frac{h_S}{h_N}\cdot\frac{\frac{\int_{z^*}^{1}\beta\,(z)x(z)dz}{\int_{z^*}^{1}\beta\,(z)[1-x(z)]dz}}{\frac{\int_{0}^{z^*}\beta\,(z)x(z)dz}{\int_{0}^{z^*}\beta\,(z)[1-x(z)]dz}}\right]^{x(z^*)}$$

where $a_{L,i}$ is the unit labor requirement in region i.

Third term:

Using Eq. (1) and (2)

$$1+n_S h_S = 1+\frac{\int_{0}^{z^*}\beta\,(z)x(z)dz}{h_S\int_{0}^{z^*}\beta\,(z)[1-x(z)]dz}h_S = 1+\frac{\int_{0}^{z^*}\beta\,(z)x(z)dz}{\int_{0}^{z^*}\beta\,(z)[1-x(z)]dz}$$

$$1+n_N h_N = 1+\frac{\int_{z^*}^{1}\beta\,(z)x(z)dz}{h_N\int_{z^*}^{1}\beta\,(z)[1-x(z)]dz}h_N = 1+\frac{\int_{z^*}^{1}\beta\,(z)x(z)dz}{\int_{z^*}^{1}\beta\,(z)[1-x(z)]dz}$$

Fourth term (I just write $x(z^*)$ as x):

$$h_N(z^*) = \frac{a_{K,N}(r,w,z^*)\cdot Q(z^*)}{a_{L,N}(r,w,z^*)\cdot Q(z^*)} = \frac{a_{K,N}(r,w,z^*)}{a_{L,N}(r,w,z^*)} = \frac{[\frac{1-x}{x}\frac{r_N}{w_N}]^{x-1}}{[\frac{1-x}{x}\frac{r_N}{w_N}]^{x}} = (\frac{1-x}{x}\frac{r_N}{w_N})^{-1} = \frac{x}{1-x}\frac{1}{n_N}$$

$1+n_N\cdot h_N(z^*) = 1+n_N\frac{x}{1-x}\frac{1}{n_N} = \frac{1}{1-x}$, so similarly for the South, we have:

$1+n_S\cdot h_S(z^*) = \frac{1}{1-x}$.

So the fourth terms cancel out.

Now we have:

$$C \cdot \left(\left[\frac{h_S}{h_N} \cdot \frac{\frac{\int_{z^*}^{1} \beta(z)x(z)dz}{\int_{z^*}^{1} \beta(z)[1-x(z)]dz}}{\frac{\int_{0}^{z^*} \beta(z)x(z)dz}{\int_{0}^{z^*} \beta(z)[1-x(z)]dz}} \right]^{x(z^*)} \right)^{x(z^*)} \cdot \frac{1+\frac{\int_{0}^{z^*} \beta(z)x(z)dz}{\int_{0}^{z^*} \beta(z)[1-x(z)]dz}}{1+\frac{\int_{z^*}^{1} \beta(z)x(z)dz}{\int_{z^*}^{1} \beta(z)[1-x(z)]dz}} \cdot \frac{\int_{z^*}^{1} \beta(z)dz}{\int_{0}^{z^*} \beta(z)dz} = 1 \qquad (4)$$

Let's define:

$$B_1 = \int_0^{z^*} \beta(z)dz \in [0,1] \quad B_2 = 1 - B_1 = \int_{z^*}^{1} \beta(z)dz \in [0,1] \quad D = \frac{h_S}{h_N} \quad \in (0,1)$$

$$A = \int_0^1 \beta(z)x(z)dz \quad A_1 = \int_0^{z^*} \beta(z)x(z)dz \in [0,1] \quad A_2 = A - A_1 = \int_{z^*}^{1} \beta(z)x(z)dz \in [0,1]$$

where we can see that $B_1 > A_1$, $B_2 > A_2$. A_1, A_2, B_1 and B_2 are functions of z^*.

Therefore Eq. (4) can be written as:

$$C \cdot \left[D \cdot \frac{A_2(B_1 - A_1)}{A_1(B_2 - A_2)} \right]^{x(z^*)} \cdot \frac{1+\frac{A_1}{B_1 - A_1}}{1+\frac{A_2}{B_2 - A_2}} \cdot \frac{B_2}{B_1} = 1$$

This can be simplified as:

$$C \cdot D^{x(z^*)} \left(\frac{A_2}{A_1}\right)^{x(z^*)} \cdot \left(\frac{B_1 - A_1}{B_2 - A_2}\right)^{x(z^*)-1} = 1 \qquad (5)$$

The question now transforms into the univariate Eq. (5) where we are only required to prove the existence of z^*. Once $z^*$is proved, n_S, n_N can calculated by plugging z^* into Eq. (1) and (2).

Rearrange the terms in Eq. (5) we have:

$$C \cdot D^{x(z^*)}(A_2)^{x(z^*)}(B_1 - A_1)^{x(z^*)-1} = (B_2 - A_2)^{x(z^*)-1}(A_1)^{x(z^*)}$$

Taking logarithm on both sides we have:

$$\ln LHS = \ln C + x \ln D + x \ln A_2 + (x-1)\ln(B_1 - A_1)$$

$$\ln RHS = (x-1)\ln(B_2 - A_2) + x \ln A_1$$

The strategy here is to show that the $\ln LHS$ and $\ln RHS$ curves crosses on the range of [0,1].

<u>Examine the property of $\ln LHS$</u>

Taking derivative of $\ln LHS$ with respect to z^* (I will just write z from now on) we have:

$$\frac{\partial \ln LHS}{\partial z} = 0 + x'(z)\ln D + x'(z)\ln A_2 + x(z)\cdot\frac{A_2'}{A_2} + x'(z)\ln(B_1 - A_1) + [x(z)-1]\frac{B_1' - A_1'}{B_1 - A_1}$$

We know:

$$x'(z) > 0 \qquad B_1' = \beta(z)$$

$$B_2' = -B_1' < 0 \qquad A_1' = \beta(z)x(z)$$

$$A_2' = A' - A_1' = -A_1' < 0$$

Let's analyze each term of $\frac{\partial \ln LHS}{\partial z}$.

1. The first term is 0.
2. Negative, $x'(z) > 0$ and $\ln D < 0$. $D = \frac{h_S}{h_N}$ $where\ h_i = \frac{K_i}{L_I}$.
3. Negative, $x'(z) > 0$ and $\ln A_2 < 0$.
4. Negative, $x(z) > 0$ and $\frac{A_2'}{A_2} = -\frac{A_1'}{A_2} < 0$.
5. Negative, $x'(z) > 0$ and $\ln(B_1 - A_1) < 0$.
6. Negative, $[x(z) - 1] < 0$ and $\frac{B_1' - A_1'}{B_1 - A_1} > 0$.

There we see that $\ln LHS$ is strictly decreasing in z on [0,1].

Next let's examine the range of $\ln LHS$.

When $z \to 0$, we can see that:

$$\lim_{z\to 0} \ln LHS = \ln C + 0^+ \ln D + 0^+ \ln A + (-1) \ln 0^+ = +\infty.$$

0^+means the number approaches 0 from the positive side.

When $z \to 1$, we can see that:

$$\lim_{z\to 1} \ln LHS = \ln C + 1 \cdot \ln D + 1 \cdot \ln 0^+ + 0^- \ln(1 - A) = -\infty$$

0^-means the number approaches 0 from the positive side. Thus we conclude that $\ln LHS$ is a strictly decreasing function from $+\infty$ to $-\infty$ on [0,1].

<u>Examine the property of ln RHS.</u>

When $z \to 0$, we can see that:

$$\lim_{z\to 0} \ln RHS = -1 \cdot \ln(1 - A) + 0^+ \ln 0^+$$

It does not matter whether 0^+ or $\ln 0^+$ dominates over the other term, rendering the limit equals to $-\ln(1 - A)$ or $-\infty$, the bottom line is that it **<u>must</u>** be lower than $+\infty$ which $\ln LHS$ approaches when $z \to 0$.

When $z \to 1$, we can see that:

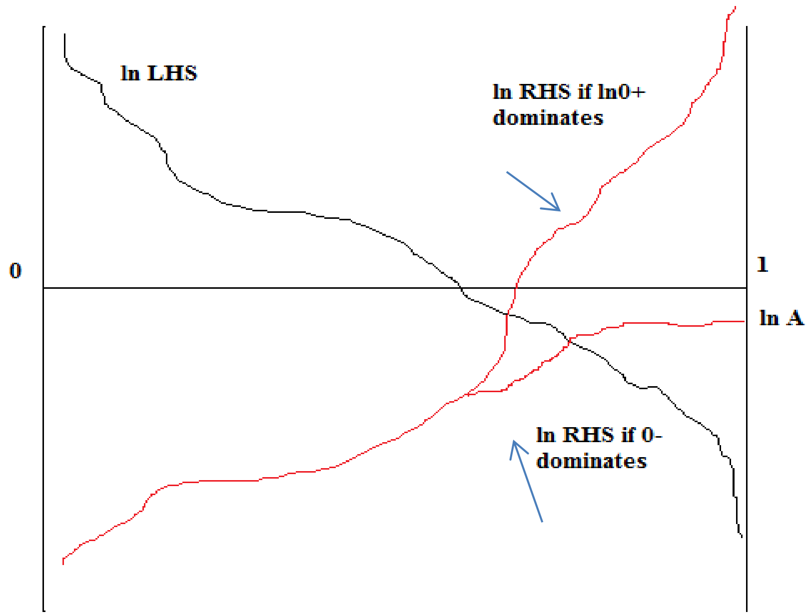
$$\lim_{z\to 1} \ln RHS = 0^- \ln 0^+ + 1 \cdot \ln A$$

Two cases may rise here:

1) If 0^- dominates over $\ln 0^+$, then $\lim_{z\to 1} \ln RHS = \ln A$

2) If $\ln 0^+$dominates over 0^-, then $\lim_{z\to 1} \ln RHS = +\infty$

But regardless which case arises, the bottom line is that it **must** be greater than $-\infty$ which $\ln LHS$ approaches when $z \to 1$. See Appendix Figure 1A for a schematic illustration of the existence of equilibrium. Therefore, we know that $\ln LHS$ and $\ln RHS$ must cross at least once. Thus we finished proving the existence of equilibrium.



Appendix Figure 1A: A schematic illustration of the existence of equilibrium
Notes: LHS = Left-high-side, RHS = Right-hand-side

Proving the uniqueness of z^* is easy. Recall that:

$$\frac{\partial[\frac{C_N(z)}{C_S(z)}]}{\partial z} < 0 \quad ,$$

This inequality ensures that the Northern and Southern unit cost curve will cross only once. Thus I proved that there exists a unique equilibrium. (Unique z^* and subsequently unique n_S and n_N).

Appendix 1.B Table Number of firms by ownership among 120 Chinese cities

No.	City Name	# State	# Private	# Foreign	No.	City Name	# State	# Private	# Foreign
1	anqing	26	45	8	61	nanning	35	26	7
2	anshan	33	30	3	62	nantong	8	43	14
3	baoding	22	32	4	63	nanyang	19	39	2
4	baoji	30	27	0	64	ningbo	3	26	18
5	baotou	28	16	4	65	qingdao	11	41	16
6	beijing	16	7	15	66	qinhuangdao	20	30	16
7	benxi	31	28	0	67	qiqihaer	32	35	1
8	binzhou	20	42	3	68	quanzhou	4	17	42
9	cangzhou	11	35	2	69	qujing	32	30	2
10	changchun	28	22	10	70	sanming	20	56	6
11	changde	12	54	4	71	shanghai	10	36	33
12	changsha	24	38	7	72	shangqiu	7	45	0
13	changzhou	8	53	5	73	shangrao	11	59	2
14	chengdu	7	29	8	74	shantou	3	34	23
15	chongqing	45	63	8	75	shaoxing	16	36	2
16	chuzhou	14	57	6	76	shenyang	29	20	15
17	dalian	16	4	35	77	shenzhen	1	12	50
18	daqing	50	13	1	78	shijiazhuang	34	22	4
19	datong	34	29	6	79	suzhou	4	19	55
20	deyang	7	53	3	80	taian	24	44	6
21	dongguan	5	2	76	81	taiyuan	42	22	2
22	foshan	9	14	22	82	taizhou	5	46	4
23	fushun	36	26	4	83	tangshan	15	32	8
24	fuzhou	7	25	29	84	tianjin	60	22	36
25	ganzhou	6	31	27	85	tianshui	39	23	2
26	guangzhou	8	6	28	86	weifang	8	37	7
27	guilin	26	25	7	87	weihai	24	28	16
28	guiyang	30	21	6	88	wenzhou	1	67	3
29	haerbing	32	15	6	89	wuhan	28	12	5
30	haikou	22	13	17	90	wuhu	14	42	7
31	handan	28	35	3	91	wulumuqi	27	35	2
32	hangzhou	6	25	10	92	wuxi	11	46	14
33	hefei	28	18	15	93	wuzhong	17	58	0
34	hengyang	38	31	1	94	xiamen	4	18	48
35	huanggang	17	38	6	95	xian	32	14	8
36	huhehaote	12	43	5	96	xiangfan	23	31	5
37	huizhou	3	6	57	97	xianyang	23	20	4
38	huzhou	7	50	6	98	xiaogan	15	38	5
39	jiangmen	3	18	53	99	xining	29	23	2
40	jiaxing	4	50	11	100	xinxiang	24	39	5
41	jilin	24	30	6	101	xuchang	6	51	2
42	jinan	33	27	4	102	xuzhou	15	42	5
43	jingmen	18	38	9	103	yancheng	3	64	4
44	jingzhou	16	46	4	104	yangzhou	14	51	10
45	jinhua	2	54	1	105	yantai	21	35	16
46	jining	13	45	5	106	yibin	11	55	1
47	jinzhou	28	37	8	107	yichang	19	39	7
48	jiujiang	26	41	5	108	yichun	13	61	3
49	kunming	30	21	3	109	yinchuan	17	49	2
50	langfang	16	30	11	110	yueyang	28	31	5
51	lanzhou	50	19	2	111	yuncheng	24	32	2
52	leshan	6	56	4	112	yuxi	20	38	5
53	lianyungang	11	46	19	113	zhangjiakou	30	29	6
54	linyi	13	47	10	114	zhangzhou	5	33	32
55	liuzhou	18	28	5	115	zhengzhou	18	54	7
56	luoyang	23	45	1	116	zhoukou	8	51	3
57	maoming	13	29	8	117	zhuhai	5	9	54
58	mianyang	17	42	6	118	zhuzhou	21	42	2
59	nanchang	30	36	10	119	zibo	18	47	5
60	nanjing	18	23	14	120	zunyi	32	31	2

Source: World Bank Investment Climate Survey of China (2005).

2. Chapter 2: Testing Capital-Skill Complementarity: Firm-Level Evidence from China

Abstract

The hypothesis of capital-skill complementarity (CSC) has been widely supported and commonly used to explain wage inequality across skill types in developed countries. This study examines whether or not this hypothesis is valid in China. Using a large firm-level manufacturing panel data set, the result does not show systematic support for the hypothesis with only weak positive evidence in a few industrial sectors. Various skilled-labor definitions applicable to the Chinese labor market context have been used. This finding is consistent with the classic findings of Goldin and Katz (1998) that countries at different development stages may have different capital-skill relationships.

2.1 Introduction

The hypothesis of capital-skill complementarity (CSC), proposed by Griliches (1969), states that capital and skilled labor are more complementary (or less substitutable) as inputs than capital and unskilled labor. Perhaps the most important application of the CSC phenomenon over the decades is to explain wage inequality across skill types in developed countries (e.g., Berman et al., 1998 and Krussel et al., 2000).[37] The theory is that as a country's capital stock accumulates, more unskilled labor relative to skilled labor will be replaced; this change drives down relative demand for unskilled labor and pushes up the wage ratio between the skilled and unskilled. In recent decades, the CSC hypothesis has been extended to build sophisticated economic growth models or study cross-country inequality issues in the context of international trade (Papageorgiou and Saam, 2005; Ben-Gad, 2007; Parro, 2013).

This paper takes a step back and tests whether or not the CSC phenomenon is present in China. There are three motivations. First, studies directly testing the validity of the CSC hypothesis mainly focus on developed countries while those on developing countries, particularly China, are rare. Krussel et al. (2000), Polgreen and Silos (2008) and Lindquist (2005) support the CSC hypothesis with U.S. and

[37] Wage inequality in this strand of literature defined as the wage ratio between the skilled and unskilled labor.

Swedish manufacturing sector-level data. Duffy et al. (2004), using cross-country data containing both developed and developing countries, also find some weak supportive empirical evidence; however, no direct analysis has been conducted exclusively on developing countries.[38] Counter-evidence includes Papageorgiou and Chmelarova (2005), who find that the CSC hypothesis is supported in non-OECD countries but not in OECD countries. Since developing economies in general differ from developed ones in aspects such as education quality and labor market conditions, it is of great interest to understand whether or not this classic economic hypothesis remains applicable at a different development stage. If not, then interpreting income inequality phenomena in China should rely more on other explanations. For example, Xing (2006) and Whalley and Xing (2010) find that firm ownership types play an important role in influencing skill premiums in China.

As pointed out by Goldin and Katz (1998), the strength of CSC may be different for countries at different stages of development. They document that in the late 19th and early 20th century, production technology has evolved from an artisanal shop mode, where the relationship between capital and skilled labor is more complementary, to a traditional assembly line production mode, where they are more substitutive, before switching back to being more complementary in a highly automated production mode. As China is still in the process of industrialization, its capital-skill relationship might be different from that of the advanced economies. This study focusing on China will presumably contribute to a fresh understanding of the production pattern for a large developing country in the midst of industrialization.

Second, past studies investigating the validity of the CSC hypothesis suffer from several drawbacks, which include small sample size, limited number of industries examined, lack of disaggregated data, lack of panel data and limited skill type definitions. An important issue with past studies on developed countries is that they typically assume workers with college degree as skilled labor; whereas due to differences in education coverage and quality in developing countries, it could be that workers with a lower education degree might still be qualified as skilled labor (Duffy et al., 2004). My

[38] For developing countries, Yasar and Paul (2008) using Turkish manufacturing data find some indirect supportive evidence for the CSC hypothesis.

study is one of the first ones using large-scale firm-level panel data from multiple Chinese manufacturing industries to directly test this hypothesis under three types of "skilled labor" definitions: college or above, high school or above and permanent worker status (as opposed to "temporary worker").

Third, an emerging strand of international trade literature has begun investigating the impact of CSC on the cross-country skill premium and its implications for social inequality (Perro, 2013; Burstein et al., 2013). Their model calibration choices of elasticity of substitution parameters for the countries involved, both developed and developing, is often based on past studies of developed countries. Such over-generalization might be inappropriate and calls for more effort in country-specific CSC estimation. This research attempts to fill some voids from China's perspective.

The current study uses Chinese firm-level manufacturing panel data from the World Bank Investment Climate Survey of 2005. It closely follows Duffy et al. (2004), where a two-level constant elasticity of substitution (CES) production is used to empirically test the CSC hypothesis.[39] The primary advantage of this approach is that the task of deciding which pair of elasticities of substitution (capital vs. skilled labor or capital vs. unskilled labor) is bigger can be easily reduced to directly comparing the values of two parameter estimates obtained from the production function estimation. In contrast, translog or generalized Leontief production specifications require further transformations and complex nonlinear hypothesis testing in post-estimation.

My result shows that at the pooled sample level of firms from all industries, the point estimates are in favor of the hypothesis and are statistically significant when skilled labor is defined as "permanent worker." However, when examining each industry individually, the evidence does not support systematic existence of the CSC phenomenon with the exception of one or two manufacturing industries, depending on the definition of "skilled labor" used. This qualitative conclusion still holds after three robustness checks. First, a quite unique Chinese labor market phenomenon is that a substantial portion of workers employed by firms from certain ownership types are "dispatched labor": from a legal perspective,

[39] The two-level CES production function was proposed by Yasar (1967) to estimate the substitution between plant and equipment, two important components of aggregate capital stock in the US manufacturing industry from 1929 to 1960.

workers in this category are hired by an employment agency and dispatched to designated factories; they should only be assigned with subsidiary and temporary production tasks, and do not enjoy full entitlement as regular workers. However, in reality, in order to save labor costs, firms will keep hiring some dispatched labor for many years and have them perform tasks similar to regular workers. The impact on studying the CSC hypothesis is that these dispatched workers whose working experiences are no less than well-trained formal employees, are counted as unskilled temporary workers. To mitigate the potential impact of this miscounting, firms whose ownerships are prevalently associated with dispatched labor are removed from the sample. Regression results from this subsample do show a slight increase of cases in favor of the CSC hypothesis, but the evidence is still weak. Second, an indirect approach testing the validity of the CSC hypothesis has also been conducted: intuitively, if the CSC hypothesis is valid, a necessary condition is that there should exist a positive correlation between skilled-unskilled labor ratio and the relative size of a firm's capital stock (Flug and Hercowitz, 2000). Controlling for both firm and time fixed effects, I do not find this correlation statistically significant in most industries examined; in fact, some counter-evidence with statistically significant negative coefficients is found. This is consistent with Zou et al. (2009) who find that the skill premium is not influenced by domestic capital stock formation in China. Third, firms at different sophistication levels presumably should have heterogeneous technology, such that imposing the same set of production function parameters might be too restrictive. So I conduct the same analysis on firms with different levels of capital-labor ratio, which is used as a proxy for their technological sophistication. Except for one industry in support of the CSC hypothesis, I do not find much systematic supportive evidence.

The paper is organized as follows. Section 2.2 is the literature review. Section 2.3 introduces the empirical estimation frameworks. Section 2.4 is data description. Section 2.5 presents results and discussion. Section 2.6 concludes.

2.2 Literature Review

2.2.1 A brief background of the capital-skill complementarity hypothesis

The hypothesis of CSC was formally proposed by Griliches (1969). Using a cross-section of US manufacturing industry-level data, the author finds that the degree of complementarity between capital and skilled labor is higher than that between capital and unskilled labor. He shows that this difference is able to explain the wage inequality between the two types of workers.

The historical origin of the CSC phenomenon in the manufacturing sector is thoroughly discussed by Goldin and Katz (1998). They view the production process as two distinct stages: “machine installation and maintenance segment” (or machine-maintenance) and “production or assembly portion” (or production). Capital and skilled labor are always complementary in the machine-maintenance stage for any technology: skilled labor (e.g., mechanist or technician) is in charge of installing and maintaining the machine. The “workable” machines generated by skilled labor are then used by unskilled labor to produce final products. An increase in deployment of machines (in quality or quantity) will lead to an increase in demand for skilled labor to perform maintenance; meanwhile it also incurs an increase in the demand for unskilled labor to operate this extra workable capital: if the resulting relative increase of skilled labor is more than that of unskilled labor, then we say the CSC hypothesis is valid.[40]

The authors argue that the transition from artisanal shop (1st stage) to traditional factory/assembly line (2nd stage) in the 19th century caused capital and skill to be relative substitutes, the transition from the latter to robotized assembly line methods (3rd stage) in the 20th century caused capital and skill to be relative complements.

Artisanal shops are usually operated by skilled craftsmen who are responsible for most of the tools set-up, maintenance and production; demand for unskilled labor is relatively low. The transition towards factory production marks the increasing degree of substitutability of unskilled labor and capital for skilled labor. Factories are larger, more capital intensive and have a higher degree of labor division. The move towards more advanced technology (e.g., the batch/continuous method) makes the CSC

[40] Of course, capital may also substitute some unskilled labor in the production process.

phenomenon return. More technology personnel are required to attend the machines. Thus, as production units become more capital intensive, the relative demand for skilled labor increases in the transition from the 2nd to the 3rd stage of technology.[41]

2.2.2 Issues in testing the capital-skill complementarity hypothesis

The two-level CES production function is written as:

$$Q = A\{a[\lambda K^{\theta} + (1-\lambda)L_S^{\theta}]^{\rho/\theta} + (1-a)L_U^{\rho}\}^{1/\rho} \qquad (\theta \le 1, \rho \le 1), \qquad (1)$$

where Q, K, L_U and L_S stand for output, capital equipment, unskilled labor and skilled labor respectively. The classical CSC hypothesis is valid if $\rho > \theta$.[42] Testing it has always been an important theme in CSC related research, not only due to its intrinsic value in understanding technology advancement in human history, but also because it is the prerequisite for using the CSC phenomenon to explain wage inequality.[43] The current specification with skilled labor along with capital in the bracket of Eq. (1) is preferred over putting unskilled labor in the bracket with capital (Duffy et al., 2004). Weaknesses of previous studies are discussed from two aspects: data and estimation issues.

Data Issues

First, common data types are single-country industry sectorial time series data or country-level panel data. In the latter case, the national data would implicitly include all economic activities including manufacturing. It seems firm-level panel data is rarely used to estimate the CSC hypothesis. An issue with aggregate data pointed out by Bartelsman and Doms (2000), is that properties such as factor substitution exhibited by aggregate production "do not represent marginal responses of the industry (nor the plant)"; instead, the elasticity of substitution represents a mixture between "some average of micro-level production technology" and "the effects of past changes in composition within the industry." From

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[41] The typical example for this series of changes Goldin and Katz (1998) provide is the automobile industry.

[42] See Duffy et al. (2004) for detailed derivation and proof. The difference between the elasticity of substitution between capital and unskilled labor and that between capital and skilled labor is equal to $\left(\frac{1}{1-\theta} - \frac{1}{1-\rho}\right)$ times a positive constant. In order for the CSC hypothesis to be valid, this difference must be positive. This leads to ρ must be greater than θ.

[43] See Duffy et al. (2004) for more comprehensive review.

this viewpoint, testing the validity of the CSC hypothesis using micro-level data is justified as a complementary approach to aggregate-level studies. To be clear, although parameter estimation in this paper is at the sectorial level, the unit of analysis is at the firm level; and it is possible to break the sample into smaller groups based on capital intensity similarity and focus on a more homogeneous group if necessary. Furthermore, the usual focus is either on individual developed countries or groups of countries where both developed and developing countries are combined. To the best of my knowledge so far, China has neither been *directly* tested with the CSC hypothesis nor appeared in the developing country group of past studies.

Second, many studies suffer from small sample size. Since the primary equation of interest, the two-level CES production function, is highly nonlinear, the curvature of the function can only be accurately estimated with sufficient data points. For example, Fallon and Layard (1975) conducted a cross-section developing countries regression with only 9 nations in this world subsample. To mitigate this problem, past studies resort to Monte Carlo experiments for further results. Also, for those testing the hypothesis at the sectorial level, the number of sectors examined is quite small.[44]

To overcome these data weaknesses, the present study uses a large firm-level panel data set that contains 12,400 Chinese manufacturing firms ranging across 30 sectors from 2002 to 2004.

Model Estimation Issues

A crucial assumption used by past CSC studies is perfectly competitive markets (e.g., Griliches, 1969; Fallon and Layard, 1975; Krussel et al., 2000; Lindquist, 2005). This assumption allows people to conveniently use factor price to proxy for marginal product when working with the first order condition of the production function, especially for gauging capital stock (Duffy et al., 2004). However, as pointed out by Duffy et al. (2004), this assumption may be appropriate for developed countries with more mature capital markets, whereas it is less appropriate for developing countries imbued with factor immobility and market incompleteness issues.

[44] For example, there were only 8 sectors examined in Bergström and Panas (1992).

This paper follows Duffy et al. (2004) in CSC estimation which requires only production output, capital equipment and labor force data. Nonlinear least squares (NLLS) with fixed effects and the generalized method of moments (GMM) approach are applied in estimating the two-level CES production function. Since my country of interest is China, the largest developing country whose economy has been suffering from labor mobility and market incompleteness problems (e.g., Li and Coxhead, 2011), this more direct approach without the perfectly competitive markets assumption is presumably better.[45]

2.3 Empirical Estimation Framework

Similar to Duffy et al. (2004), firm i's two-level CES production function, where the error term takes the multiplicative form can be written as:

$$Y_{i,t} = A_i\{a\left[bK_{i,t}^{\theta} + (1-b)S_{i,t}^{\theta}\right]^{\frac{\rho}{\theta}} + (1-a)N_{i,t}^{\rho}\}^{1/\rho}e^{t_{03}\cdot D03 + t_{04}\cdot D04 + \varepsilon_{i,t}}, \qquad (2)$$

where $Y_{it}, K_{it}, S_{it}, N_{it}$ are real value added, capital, quantity of skilled labor and quantity of unskilled labor of firm i at year t respectively.[46] D03 and D04 are dummy variables, which take the value of 1 if time t equals to 2003 and 2004 respectively; the base year in the sample is 2002. A_i is firm i's technology level in the base year. Input weights a, b are between 0 and 1. Key parameters governing capital-skill complementarities are $\theta, \rho \in (-\infty, 1]$. It follows Duffy et al. (2004) that for the CSC hypothesis to be valid, ρ must be greater than θ. The error term, $\varepsilon_{i,t}$, is assumed to be the sum of a time invariant firm fixed effect η_i and a white noise term $\epsilon_{i,t}$.[47]

To remove the fixed effect, take the log-first difference of Eq. (2) of year 2004 versus 2003, and year 2003 versus year 2002:

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[45] The archetypical example of China's factor mobility issue is its *hukou* system that restricts labor mobility across the country. Boyreau-Debray and Wei (2005) show that 1) in the current financial system, capital mobility is low in China, and 2) in general, the capital misallocation problem is severe.

[46] Duffy et al. (2004) besides using the quantity of labor also uses education-level adjusted labor to account for the efficiency labor unit and do not find any significant evidence that favors the CSC hypothesis across all skilled labor definitions. My study does not adjust labor for education since the data does not contain information on the specific number of workers in each education category.

[47] The basic conclusion does not change when the error term structure is assumed to be additive instead of multiplicative.

$$\ln\left(\frac{Y_{i,04}}{Y_{i,03}}\right) = \ln h_{i,04} - \ln h_{i,03} - t_{03} + t_{04} + \epsilon_{i,2004} - \epsilon_{i,2003} \qquad \text{Eq. (3a)}$$

$$\ln\left(\frac{Y_{i,03}}{Y_{i,02}}\right) = \ln h_{i,03} - \ln h_{i,02} + t_{03} + \epsilon_{i,2003} - \epsilon_{i,2002} \qquad \text{Eq. (3b)}$$

where $h_{i,t} = \{a\left[bK_{i,t}^{\theta} + (1-b)S_{i,t}^{\theta}\right]^{\frac{\rho}{\theta}} + (1-a)N_{i,t}^{\rho}\}^{1/\rho}$.

Two estimation methods are used. The first one is the NLLS estimation with fixed effects which could remove firms' time-invariant characteristics (e.g., management, local culture) that potentially correlate with inputs. Second, following Duffy et al. (2004), GMM, which is another common approach to address the endogeneity issue of inputs is used.[48] Instrumental variables used include firm-specific ones including one-period lagged output, capital, skilled and unskilled labor, as well as city-level business environment variables including effective tax and fee rates, access to loans, and shipping costs to port.[49] Note that using lagged input greatly reduces the number of observations and only Eq. (3a) can be used: in this case t_{04} and t_{03} cannot be identified separately; only their difference can be identified. In both the NLLS and GMM methods, the p-value of the null hypothesis test of interest, $\rho - \theta = 0$, is derived from the bootstrapping procedure.[50,51]Three definitions of skilled labor are used:

Definition 1: Workers with a college degree or above

Definition 2: Workers with a high school degree or above

Definition 3: Workers with permanent worker status

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[48] Since GMM uses a subset of samples plus instruments and its objective function is different from NLLS, it is not surprising that the point estimates between GMM and NLLS are somewhat different.

[49] A purpose of adding business environment variables is to make the total number of instrumental variables be comparable with Duffy et al. (2004), whose longer panel data allow them to use lagged input up to t-3.

[50] The specific estimation algorithm used is called "differential evolution," invented by Mullen et al. (2011). There are two advantages associated with this somewhat time-consuming method. First, it does not require differentiability of the underlying function being optimized. Second, it can solve global optimization problems in constrained coefficient sets.

[51] Ideally, the lower bound of parameters should be negative infinity; for practical purposes in constrained optimization processes, it is set at -10. An even smaller lower bound does not change the basic result. In fact, ρ and θ seldom reach this lower bound.

Workers that are not covered within each skilled category are then counted as unskilled labor. College education has been historically used as a skilled labor criterion in many developed country CSC studies. Duffy et al. (2004) in studying world CSC phenomenon enlarge this definition and include workers with secondary and primary education as skilled labor. Since the overall education level in developing countries is less than that in developed countries, it is not surprising that workers with only secondary and even primary education could also be counted as skilled labor. Beyond educational attainment, I also use permanent worker status as a skilled labor definition. In the context of the Chinese labor market, workers are granted permanent worker status if their skill and experience have reached a certain level. This factory-based classification approach might better reflect an employee's actual skill level than educational attainment.

2.4 Data Description

The raw firm-level panel data set comes from the "Investment Climate Survey" published by the World Bank Enterprise Analysis Unit. It contains information about 12,400 Chinese enterprises located in 120 cities that covers 30 two-digit manufacturing industries and 9 types of firm ownership around the country from 2002 to 2004. Sector classification is based on the Chinese Industrial Classification System (2002 version).[52] Ownership types include state-owned enterprises (SOEs), collectively owned enterprises, share joint-owned units, limited liability corporations (LLC), shareholding corporations, private-owned enterprises, enterprises invested by Hong Kong, Macau and Taiwan (HMT), foreign invested enterprises (FIE) and others. The variety of manufactured product is diverse, ranging from food and beverage production to electronic and telecommunication equipment.

[52] More specifically, this economic activity classification is based on the "GB/T 4754-2002" standard. It can be accessed at: http://www.stats-sh.gov.cn/tjdm/viewDm.xhtml?type=hyfl. The current economic activity classification standard is based on "GB/T 4754-2011," which is not much different from the 2002 version. This can be accessed at: http://www.stats.gov.cn/tjbz/.

The sector-manufactured product price deflator at the two-digit level and the fixed asset investment price deflator are typically available at the provincial level.[53] However, since some provincial statistical yearbooks do not have price information at the desired level, plus a few industries have too few firm observations, the raw full sample is reduced to a working dataset, which contains about 4100 firms covering 20 industries in 12 provinces.[54] See Table 2.1 for the summary statistics for each industry.

The survey was filled out jointly by the company manager, accountant and human resource manager. The primary aim was to get a comprehensive understanding about the quality of investment and production environment that firms perceive. Key production information includes items like value-added, net fixed asset and investment, and quantities of labor under various skill definitions. In addition, firm ownership structure, industry and location are also provided.[55] The report of the World Bank (2006) associated with this Chinese manufacturing survey also contains some city-level information, which the authors define as key city competitiveness indicators that affect business prosperity. Three key business environment variables are used in this study: effective tax rate, access to loans, shipping cost to port.[56] They are assumed to be exogenous to firm decisions. See Table 2.1 for the summary statistics of these three variables decomposed by industry.

[53] From various issues of provincial statistical yearbooks.

[54] Provinces include: Beijing, Tianjin, Shanxi, Jilin, Heilongjiang, Zhejiang, Fujian, Jiangxi, Shandong, Guangdong, Guizhou, and Ningxia.

[55] Real firm value-added can be backed out from a firm's deflated value-added tax payment. Value-added tax rate in China is categorized into two tiers. The low tier (13%) applies to tax corporate payer engaging in activities in agriculture, forestry, products of animals, husbandry, and aquatic products. The high tier (17%) applies to all firms engaging in activities other than the above-mentioned. All firms in my data set belong to the high tier.

[56] Effective tax and fee rate is defined as all types of tax and fee paid by a firm as a share of its revenue. Access to loans is defined as the share of firms in a region that have obtained bank loans. Shipping cost to port is the cost of sending a 20-foot standard container to a typical seaport. First-stage OLS regressions (see Appendix 2) indicate that they are usually highly correlated with the right-hand side variables. In Panels 2 and 3 of this table, we can see that when skilled labor is defined as high school or above and permanent worker status, the coefficient for effective tax and fee rate is not statistically significant, thus making it not a good choice of instrumental variable.

2.5 Results and Discussion

Table 2.2 presents the NLLS estimation of ρ and θ. In the pooled sample of firms from all industries, the point estimates of ρ are indeed greater than those of θ regardless of skill definition used. However, only under *Definition 3* do we find their difference statistically significant (at the 1% level). At the industry level, there are not many cases in favor of the CSC hypothesis under all three skilled labor definitions. Out of 20 manufacturing sectors examined, under *Definition 1*, only Industry 9 (Raw chemical materials and chemical products, CSIC 26) shows support for the hypothesis with p-value significant at the 5% level. When using *Definition 3*, Industry 14 and Industry 17 (Smelting and pressing of non-ferrous metals, CSIC 33; and Equipment for special purposes, CSIC 36) both show support for the CSC hypothesis at the 5% and 10% levels respectively. This result is starkly different from that of Bergström and Panas (1992). Using the industrial sector as the unit of analysis, they find strong support for the CSC hypothesis in 8 US manufacturing industries.

Table 2.3 presents the GMM estimation of ρ and θ. The point estimates are understandably different from those obtained using the NLLS approach since they are based on subsets of observations and optimization criteria. Neither the pooled sample of all firms nor the industry level coefficient estimates support the CSC hypothesis across any skilled labor definitions. A similar result was also reported by Duffy et al. (2004). All GMM-based estimation results in this study have passed the over-identification test at the 10% level.

Robustness check #1*: *confounding effects from dispatched labor

The validity of the result above is potentially confounded by issues in counting dispatched laborers, who are substantially involved in many Chinese manufacturing firms, especially SOEs, FIEs and HMTs. According to the All-China Federation of Trade Unions (ACFTU) (2012), dispatched laborers are usually undereducated rural migrant workers; they are recruited by employment agencies and dispatched to work in designated enterprises. As regulated by the labor law, dispatched workers should only assume positions that are temporary, subsidiary and facilitative; accordingly, they do not enjoy full pension entitlement and receive lower wages than regular workers. Many firms who try to keep labor costs down would employ some dispatched laborers for long periods and assign them production tasks similar to regular workers. This phenomenon could potentially create a counting problem: an undereducated and legally "temporary" dispatched worker who was able to perform just as well as a college educated and/or permanent worker due to his accumulated working experience may still be counted as unskilled labor. This miscounting could potentially invalidate the CSC hypothesis. ACFTU (2012) in a survey study points out that 13.1% or 37 million enterprise workers in China are dispatched labor, and 40% of them have been working in the same enterprise for more than 6 years.

In contrast, this issue is not prevalent for many other countries (Table 2.4). The International Confederation of Private Employment Agency or CIETT (2013), points out that the global average of dispatched labor as a share of the working population is only about 1%. For the US, this is about 2%; the share in South Africa has increased rapidly in recent years from 2.3% in 2005 to 7.2% in 2013. Large developing countries like India and Mexico have shares of about 0.3%. Although countries may have slight differences in defining dispatched labor, it is evident that China stands out sharply in overusing dispatched labor.

Since there is no accurate official reporting of firm-level dispatched labor usage, it is hard to make firm-specific adjustments in the number of skilled and unskilled laborers. To mitigate this problem, I exclude SOEs, FIEs and HMTs, which are supposedly the major users of dispatched labor, from the sample and redo the estimations. Presumably, the remaining firms are the ones without the dispatched labor problem.

Similar to Table 2.2, we continue to observe the point estimates of ρ being greater than those of θ; and under *Definition 3*, their difference is statistically significant (Table 2.5). It turns out that we do observe an increased number of cases in favor of the CSC hypothesis under all three definitions. For *Definition 1*, besides Industry 9, two additional sectors show ρ being statistically greater than θ: Industry 5 (Leather, furs, down, and related products, CSIC 19) and Industry 17. Under *Definition 2*, in contrast to Table 2.3 where there is no industry showing support, estimates from both Industry 9 and

Industry 17 are now in favor of the hypothesis. Under *Definition 3*, besides Industry 14 and Industry 17, Industry 8 (Petroleum processing and coking, CSIC 25) now shows support. This result shows that the involvement of dispatched labor does play an important role in influencing the CSC estimation. For the GMM estimation in Table 2.6, nothing was significant.

Robustness check #2*: *correlation between skilled-unskilled labor and capital stock

A key necessary condition for the validity of the CSC hypothesis is that greater relative employment of capital should be associated with a relative increase in the usage of skilled labor. In other words, the correlation between $\frac{S_{i,t}}{N_{i,t}}$ and $\frac{K_{i,t}}{Y_{i,t}}$ should be positive. Following the spirit of Flug and Hercowitz (2000), the linear regression below is conducted for small, medium and large firms based on total employment size:

$$\ln(\frac{S_{i,t}}{N_{i,t}}) = \alpha_i + c_t + \beta \ln \frac{K_{i,t}}{Y_{i,t}} + \epsilon_{i,t} \qquad (4)$$

where α_i and c_t are firm and time fixed effects respectively. Note that if the CSC hypothesis is true, it is necessary that $\beta > 0$.

Table 2.7a, using *Definition 1*, shows that only in Industry 18 (Transportation equipment, CSIC 37) in the small-firm group and Industry 20 (Electronic and telecommunications equipment, CSIC 40) in the large-firm group do we find $\beta > 0$ statistically significant. Their magnitudes suggest that for a 10% increase in the relative size of capital usage, the ratio between skilled and unskilled workers will increase by 1.2% and 1.1% respectively. In contrast, the remaining 58 cases do not support the CSC hypothesis. In fact, there even exist two pieces of counter-evidence: the β coefficients in Industry 15 (Metal products, CSIC 34) for the large-firm group and Industry 20 for the small-firm group are actually statistically negative, which suggests that as relative capital usage goes up, the demand for unskilled labor becomes higher. This finding is consistent with Zou et al. (2009), who find a slightly negative and statistically insignificant correlation between skill premium (college educated versus high school educated workers) and capital formation with Chinese provincial level data. Using *Definition 2* does not result in any statistically significant coefficients for the relative capital variable (Table 2.7b). This is consistent with the result in Table 2.2 for the same definition.

Table 2.7c shows the results using the permanent-worker-status definition. Among 60 cases for all firm size groups, 3 industries show a statistically significant $\beta < 0$: Industry 3 (Textiles manufacturing, CSIC 17), Industry 2 (Food production, CSIC 16) and Industry 16 (General machinery, CSIC 35) in the small, medium and large size firm groups respectively. Only Industry 16 in the medium group exhibits a statistically significant positive β.

Again, we do not see much consistent evidence in support of the CSC hypothesis.

Robustness check #3*: *heterogeneity of technology among firms with different capital intensity

Another concern is that for a given industrial sector, due to heterogeneity of technology among firms, the hypothesis of CSC may be valid for some firms but not for other firms. In other words, it is too restrictive to impose the same production function parameters for all firms in the sample. If we assume that in a particular sector, more advanced firms (proxied by greater capital-labor ratio), have different production patterns than less advanced firms, then the phenomenon of CSC might manifest differently.

Table 2.8 presents the NLLS and GMM estimations of ρ and θ for all firms, classified under four quartiles of capital-labor ratio.[57] Only under *Definition 1* does the GMM approach shows that in the second quartile, ρ is statistically greater than θ at the 10% level. In contrast, the pooled estimations in Table 2.5 and 2.6 under *Definition 1* do not show any support for the hypothesis. At the industry level, Tables 2.9a-c show NLLS estimation results for selected sectors under three capital-labor ratio terciles.[58] Table 2.9a shows that using *Definition 1*, ρ is only greater than θ in the low capital-labor ratio tercile of Industry 10 (Medical and pharmaceutical products, CSIC 27) at the 1% significance level. Neither the medium nor high capital-labor ratio terciles has any industry that supports the hypothesis.

[57] Firms used in robustness check #3 do not include SOE, HMT and FIE, which are presumably more affected by the aforementioned dispatched labor phenomenon.

[58] To ensure the number of observations (number of firms times three) in each tercile is appropriate, only some industries are analyzed here.

A few more cases supporting the CSC hypothesis emerge when using *Definition 2* (Table 2.9b). These include Industry 9, Industry 10 and Industry 15 in the low capital tercile; Industry 1, Industry 9 and Industry 17 in the middle tercile; and Industry 8 in the high tercile. When we use *Definition 3,* no industry supports the hypothesis (Table 2.9c).

Again, GMM estimation is also used in this robustness check. Table 2.10a-c present the results with the three skilled labor definitions. The only sector that shows support for the CSC hypothesis is Industry 9 under *Definition 1* and *Definition 2* (see Table 2.10a and b).

Some further discussion

Among all evidence obtained so far, we find that the hypothesis of CSC is not as widely supported among the majority Chinese manufacturing sectors as in developed countries. Only a small number of industries in this analysis exhibit rather consistent support out of 20 industries examined: Industry 9 (Raw chemical materials and chemical products, CSIC 26) and Industry 10 (Medical and pharmaceutical products, CSIC 27).

A natural follow-up question is then why the CSC hypothesis is not widely supported in China. First, it is possible that the effect from the dispatched labor was not completely teased out. From Robustness Check #1, we do observe that the number of cases in favor of the hypothesis increases after eliminating firms whose ownerships are closely related with high levels of dispatched labor employment. However, since we do not know exactly which firm has dispatched labor, our subsample may still contain dispatched labor. Future research in studying Chinese CSC phenomena may seek more firm-specific dispatched labor data and make appropriate skilled labor counting adjustments. Second, it could be that the capital used by many Chinese manufacturing firms is of early vintage and not at the technology frontier, such that the capital-skill complementarity effect is not strong. This phenomenon pertains well to the notion of Goldin and Katz (1998) that countries at different development stages may have different capital-skill relationships; perhaps for China, the status of the majority of its manufacturing industry remains at the traditional assembly line mode (the 2nd stage), where the effect of CSC is low. Indirect supportive evidence for this notion can be found in Bergström and Panas (1992, Table 2); their results imply that the difference in elasticity of substitution between capital-unskilled labor and capital-skilled labor is generally greater in capital-intensive industries (e.g., machinery and equipment) than in labor-intensive industries (e.g., textiles and wood products).

2.6 Conclusion

This study examines the hypothesis of capital-skill complementarity using Chinese firm-level panel data. The results do not show systematic support for the hypothesis of the CSC phenomenon in Chinese manufacturing sectors with the exception of a few cases under certain "skilled labor" definitions. Sectors with weak support of the hypothesis include Raw chemical materials and chemical products (CSIC 26) and Medical and pharmaceutical products (CSIC 27). This conclusion is further verified by several robustness checks.

The study may be subject to several data and estimation weaknesses.[59] First, firm-level price data is not available and only industry or provincial level price deflators are used. It is possible that prices may vary across firms, which could potentially bias the quantity measures and subsequent coefficient estimates. Second, the panel data only has three years of information, which greatly reduces the availability of instrumental variables. Panel data with longer time periods can also help us better study how the CSC phenomenon has evolved as the nation develops. Third, the present study uses a fixed effects approach, which requires the assumption that the unobservables, particularly productivity, be constant over time (Ackerberg et al., 2006). This might be a restrictive assumption that could potentially bias the coefficient

[59] There is also an issue with small sample size in a few industries. When estimating highly nonlinear specifications like two-level CES production, it is desirable to have more data points to accurately pin down the parameter estimates. The pooled sample analysis result does find some cases in support of the CSC hypothesis, but the evidence is still weak even when we examine the full sample by capital-labor ratio quartiles.

estimates due to correlation between inputs and productivity.[60] Several prominent studies such as Olley and Pakes (1996) and Levinsohn and Petrin (2003) provide proxy variable solutions in linear settings.[61]

Despite these weaknesses, this study contributes to the literature by testing the CSC hypothesis on a large scale using firm-level panel data in a large developing country setting. Two potential explanations of why the CSC phenomenon is not supported in China are proposed. First, employment of dispatched labor is rather prevalent for firms under some ownership types; well-trained but undereducated dispatched laborers whose experience allows them to match the skills of formal skilled employees are typically counted as unskilled temporary workers. Though in a robustness check I eliminate firms whose ownerships are more closely associated with dispatched labor, there is no guarantee the remaining sample contains no dispatched labor due to a lack of related firm-level information. Second and more fundamentally, it is possible that the technological status of Chinese manufacturing sectors is still at the "assembly line" stage described in Goldin and Katz (1998), where the strength of CSC is low.

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[60] Since the panel data has only three years, the overall change in productivity within this short window is presumably not large.

[61] Recent work from Gandhi et al. (2013) argues that structural estimation methods like that of Levinsohn and Petrin (2003) still suffer from an identification problem: that inputs without dynamic implications (e.g., raw materials) are static decision variables, and their lagged variables do not have a direct effect on current production decisions.

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Table 2.1 Summary statistics for 20 manufacturing industries in China

Industry ID in this study	CSIC code	Activity name	Value-added (RMB million)	Capital stock (RMB million)	Total employment	Workers with college degree or above	Workers with high school degree or above
1	13	Agricultural and side-line food processing	12.5	42.0	523.5	63.0	201.3
			(27.7)	(82.4)	(939.6)	(139.5)	(389.7)
2	14	Food production	28.5	45.5	706.8	93.1	282.9
			(75.6)	(91.9)	(1958.2)	(225.7)	(663.)
3	17	Textiles manufacturing	19.4	47.8	695.7	71.6	280.8
			(34.6)	(79.7)	(1038.2)	(166.6)	(593.2)
4	18	Garment, shoes, and caps manufacturing	28.7	36.2	950.4	71.3	263.1
			(83.8)	(91.6)	(2223.6)	(173.)	(587.9)
5	19	Leather, furs, down, and related products	27.7	21.0	818.1	72.7	190.9
			(70.2)	(44.8)	(1026.5)	(176.1)	(297.1)
6	20	Timber processing, bamboo, cane, palm fiber and straw products	9.9	20.6	431.6	46.5	111.1
			(21.1)	(53.9)	(926.8)	(155.3)	(280.5)
7	22	Papermaking and paper products	63.8	167.7	680.4	128.6	407.6
			(148.3)	(403.8)	(1132.3)	(286.9)	(892.3)
8	25	Petroleum processing and coking	252.5	565.9	1315.6	358.7	975.5
			(611.8)	(1404.3)	(2663.6)	(821.6)	(2134.5)
9	26	Raw chemical materials and chemical products	58.8	89.5	565.6	115.4	334.7
			(343.2)	(242.4)	(1180.1)	(274.8)	(783.7)
10	27	Medical and pharmaceutical products	61.4	52.4	608.3	199.4	413.2
			(136.1)	(95.9)	(1107.3)	(414.)	(738.8)
11	30	Plastic products	17.7	47.1	407.8	44.4	188.0
			(51.3)	(87.5)	(676.3)	(73.0)	(467.8)
12	31	Nonmetal mineral products	25.1	61.9	564.0	94.5	295.2
			(54.8)	(137.5)	(993.3)	(254.9)	(671.7)
13	32	Smelting and pressing of ferrous metals	287.2	536.3	2650.3	506.0	1599.8
			(853.8)	(1781.7)	(7991.8)	(1918.1)	(5180.4)
14	33	Smelting and pressing of non-ferrous metals	75.6	154.3	883.8	144.0	476.9
			(268.3)	(445.4)	(1733.7)	(362.9)	(1196.9)
15	34	Metal products	19.5	37.2	572.9	96.3	261.6
			(41.7)	(71.8)	(911.5)	(190.4)	(493.3)
16	35	General machinery	33.0	38.8	579.4	124.3	331.8
			(77.3)	(75.1)	(928.4)	(245.5)	(650.5)
17	36	Equipment for special purposes	44.8	64.3	765.3	153.9	433.9
			(99.6)	(121.7)	(1012.)	(230.9)	(621.8)
18	37	Transportation equipment	93.4	114.6	1168.4	272.2	708.2
			(260.9)	(262.5)	(2226.1)	(589.1)	(1552.8)
19	39	Electrical equipment and machinery	66.1	55.6	857.8	169.9	462.7
			(179.4)	(104.1)	(1771.1)	(465.4)	(1190.6)
20	40	Electronic and telecommunications equipment	150.4	132.2	1266.2	337.0	850.3
			(340.7)	(266.4)	(1670.2)	(515.4)	(1280.4)

Notes: Summary statistics is based on the World Bank's Investment Climate Survey for China published in 2005. CSIC: China Standard Industrial Classification (2002 version). Standard deviations are in the parentheses.

Table 2.1 Summary statistics for 20 manufacturing industries in China (Continue)

Industry ID in this study	CSIC code	Activity name	Workers with permanent worker status	Effective tax and fee rate (%)	Access to loan (%)	Shipping cost to port (RMB)	Number of firms
1	13	Agricultural and side-line food processing	343.8	0.11	0.54	346.64	207
			(585.5)	(0.03)	(0.17)	(291.0)	
2	14	Food production	455.8	0.12	0.39	559.01	89
			(983.)	(0.03)	(0.21)	(360.44)	
3	17	Textiles manufacturing	618.7	0.12	0.55	251.59	319
			(964.9)	(0.02)	(0.18)	(248.73)	
4	18	Garment, shoes, and caps manufacturing	790.7	0.13	0.46	188.77	95
			(2377.)	(0.03)	(0.18)	(173.6)	
5	19	Leather, furs, down, and related products	710.1	0.13	0.44	116.11	80
			(1026.7)	(0.04)	(0.17)	(55.55)	
6	20	Timber processing, bamboo, cane, palm fiber and straw products	547.1	0.14	0.54	435.57	50
			(1511.7)	(0.03)	(0.16)	(256.71)	
7	22	Papermaking and paper products	654.7	0.12	0.6	220.88	74
			(1233.5)	(0.02)	(0.2)	(217.76)	
8	25	Petroleum processing and coking	1198.3	0.14	0.46	458.68	78
			(2539.3)	(0.03)	(0.22)	(313.82)	
9	26	Raw chemical materials and chemical products	516.3	0.12	0.47	341.37	457
			(1061.1)	(0.03)	(0.21)	(287.79)	
10	27	Medical and pharmaceutical products	590.4	0.13	0.46	473.37	139
			(1081.4)	(0.02)	(0.16)	(285.59)	
11	30	Plastic products	384.6	0.12	0.43	270.68	109
			(785.2)	(0.03)	(0.19)	(328.95)	
12	31	Nonmetal mineral products	447.1	0.13	0.5	381.22	376
			(790.)	(0.02)	(0.19)	(287.27)	
13	32	Smelting and pressing of ferrous metals	2567.0	0.13	0.49	344.1	86
			(7755.1)	(0.03)	(0.21)	(292.22)	
14	33	Smelting and pressing of non-ferrous metals	800.8	0.14	0.57	387.23	84
			(1689.9)	(0.02)	(0.14)	(274.1)	
15	34	Metal products	465.6	0.11	0.46	203.62	116
			(782.4)	(0.04)	(0.24)	(238.25)	
16	35	General machinery	573.1	0.12	0.5	319.3	341
			(1119.8)	(0.03)	(0.2)	(279.03)	
17	36	Equipment for special purposes	704.9	0.13	0.46	348.9	115
			(950.2)	(.03)	(.21)	(278.49)	
18	37	Transportation equipment	1047.5	0.13	0.45	386.61	281
			(1820.6)	(0.02)	(0.20)	(285.38)	
19	39	Electrical equipment and machinery	755.6	0.12	0.48	198.89	287
			(1679.9)	(0.03)	(0.20)	(208.38)	
20	40	Electronic and telecommunications equipment	1248.3	0.1	0.42	133.35	206
			(1909.5)	(0.02)	(0.21)	(136.81)	

Table 2.2 Two-level CES nonlinear least squares estimation of ρ and θ

	Skilled = College or above					Skilled = high school or above					Skilled = Permanent worker status				
Industry	ρ	θ	p-value (ρ-θ>0)		No. Firms	ρ	θ	p-value (ρ-θ>0)		No. Firms	ρ	θ	p-value (ρ-θ>0)		No. Firms
Pooled	0.39	0.33	0.27		3495	0.52	0.38	0.16		3502	1.00	0.32	0.00	***	3623
1	0.24	0.00	0.44		196	0.13	0.42	0.69		202	-0.30	0.53	0.94		207
2	-2.41	1.00	0.46		86	-0.38	0.77	0.49		86	-7.62	-0.08	0.72		89
3	-0.17	-0.28	0.50		301	0.01	-0.09	0.39		314	0.19	0.29	0.65		319
4	1.00	1.00	0.80		85	0.39	1.00	0.66		94	1.00	1.00	0.45		95
5	1.00	-10.00	0.25		77	1.00	1.00	0.69		80	1.00	1.00	0.70		80
6	0.80	-10.00	0.23		45	-0.10	1.00	0.59		50	-10.00	1.00	0.96		50
7	-0.12	0.23	0.58		66	1.00	-0.07	0.18		73	1.00	0.08	0.12		74
8	-0.76	0.00	0.39		78	1.00	0.08	0.19		77	1.00	-0.82	0.20		78
9	0.65	0.07	0.03	**	450	0.47	0.27	0.34		435	1.00	0.31	0.22		457
10	1.00	1.00	0.72		137	1.00	1.00	0.91		130	0.41	1.00	0.93		139
11	0.40	0.00	0.28		104	0.57	0.14	0.38		108	1.00	1.00	0.51		109
12	0.78	1.00	0.70		347	0.72	1.00	0.96		371	1.00	0.69	0.50		376
13	-10.00	0.35	0.80		84	0.47	0.66	0.58		85	-3.71	0.26	0.87		86
14	1.00	-1.02	0.20		83	-9.76	-0.16	0.63		83	1.00	-0.70	0.04	**	84
15	1.00	0.79	0.47		115	1.00	1.00	0.58		113	1.00	0.79	0.50		116
16	0.68	1.00	0.73		329	0.69	0.80	0.45		330	0.62	0.75	0.59		341
17	0.33	-10.00	0.10		115	0.19	-5.68	0.27		109	-0.46	-1.11	0.10	*	115
18	1.00	0.90	0.55		281	0.41	-0.06	0.13		275	0.77	1.00	0.38		281
19	0.66	0.64	0.63		281	-9.91	0.33	0.76		272	1.00	0.56	0.33		287
20	-0.21	0.66	0.79		202	-0.39	1.00	0.90		181	1.00	-0.16	0.28		206

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result.

** Significant at the 5% level.

* Significant at the 10% level.

Table 2.3 Two-level CES GMM Estimation of ρ and θ

	Skilled = College or above				Skilled = high school or above				Skilled = Permanent worker status			
Industry	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms
Pooled	1.00	1.00	0.19	3495	1.00	1.00	0.25	3502	1.00	1.00	0.55	3623
1	1.00	-5.49	0.12	196	1.00	-3.99	0.35	202	-4.45	0.99	0.85	207
2	-2.68	-3.87	0.38	86	-10.00	-4.44	0.77	86	-3.88	-3.20	0.62	89
3	-6.19	-4.72	0.45	301	1.00	-5.06	0.30	314	-10.00	-4.94	0.72	319
4	-6.88	-0.71	0.56	85	0.00	-1.54	0.50	94	0.25	-4.05	0.32	95
5	1.00	-4.30	0.16	77	-4.94	1.00	0.28	80	0.00	0.84	0.46	80
6	-10.00	0.15	0.75	45	1.00	-2.39	0.46	50	-10.00	1.00	0.57	50
7	1.00	0.00	0.47	66	-0.96	0.00	0.52	73	1.00	1.00	0.37	74
8	-5.57	-0.36	0.76	78	-7.85	-9.95	0.46	77	-0.11	-4.97	0.38	78
9	1.00	-7.16	0.27	450	1.00	-3.25	0.24	435	-3.28	-5.88	0.39	457
10	1.00	0.00	0.53	137	-0.31	0.39	0.66	130	0.00	1.00	0.84	139
11	-3.07	0.00	0.43	104	1.00	1.00	0.76	108	0.00	1.00	0.78	109
12	1.00	1.00	0.73	347	1.00	0.99	0.44	371	1.00	-4.64	0.62	376
13	-6.28	-0.19	0.77	84	0.18	-3.80	0.56	85	-5.97	1.00	0.86	86
14	-6.98	-2.61	0.76	83	-10.00	-10.00	0.69	83	-10.00	-5.96	0.71	84
15	-10.00	-10.00	0.55	115	-9.38	0.99	0.59	113	-10.00	1.00	0.82	116
16	1.00	1.00	0.79	329	1.00	1.00	0.59	330	1.00	-2.85	0.58	341
17	0.69	1.00	0.72	115	1.00	1.00	0.52	109	1.00	-2.25	0.50	115
18	-0.21	-9.94	0.41	281	-5.92	-2.37	0.75	275	1.00	-4.17	0.38	281
19	-6.93	-6.62	0.56	281	-10.00	-10.00	0.77	272	0.32	-7.33	0.37	287
20	-10.00	-5.32	0.95	202	1.00	0.00	0.63	181	1.00	0.00	0.29	206

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result.

Table 2.4 Dispatched labor as a share of working population (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Argentina	0.3	0.3	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4
Australia										2.8	2.7	2.8
Brazil							0.9	1	0.9	1	1	1.1
Canada	0.6	0							0	0	0.6	
Chile							1.3	0.5	0.4	0.4	0.4	
Colombia										3.3	2.7	
India												0.3
Japan	0.8	1	1.1	1.2	1.4	1.7	1.9	2.1	2.2	1.8	1.5	1.5
Mexico										0.1	0.3	0.3
New Zealand						0.5	0.5	0.4	0.6	0.6	0.3	0.3
Peru										0.3	0.6	
South Africa						2.3	2.2	2.1	3.4	6.4	7.1	7.2
South Korea					0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.5
USA	2.3	1.9	1.8	2	2.1	2.2	2.2	2.1	1.9	1.5	1.8	1.9
Europe	1.5	1.4	1.4	1.5	1.6	1.6	1.8	1.9	1.7	1.4	1.6	1.6

Source : International Confederation of Private Employment Agency (2013, p.29)

Table 2.5 Two-level CES nonlinear least squares estimation of ρ and θ without SOE, FIE AND HMT

	Skilled = College or above					Skilled = high school or above					Skilled = Permanent worker status				
Industry	ρ	θ	p-value (ρ-θ>0)		No. Firms	ρ	θ	p-value (ρ-θ>0)		No. Firms	ρ	θ	p-value (ρ-θ>0)		No. Firms
Pooled	0.55	0.53	0.53		2448	0.66	0.52	0.16		2490	1.00	0.47	0.00	***	2561
1	0.03	1.00	0.79		139	-10.00	0.51	0.90		145	-0.37	0.55	0.94		148
2	-3.70	1.00	0.85		71	0.14	0.12	0.45		71	-9.49	0.35	0.64		74
3	-0.21	-0.05	0.66		220	-0.27	0.06	0.84		234	0.00	0.39	0.71		236
4	1.00	-6.04	0.06		51	1.00	0.68	0.19		56	1.00	1.00	0.75		57
5	1.00	-6.66	0.10	*	37	1.00	-3.61	0.25		40	1.00	-2.70	0.34		40
6	1.00	-10.00	0.25		38	1.00	-10.00	0.18		42	-10.00	1.00	0.93		42
7	-0.24	-0.17	0.53		48	1.00	-1.13	0.31		54	1.00	0.05	0.34		55
8	-2.62	-1.03	0.55		67	1.00	-0.22	0.21		67	1.00	-2.72	0.09	*	67
9	1.00	0.10	0.01	***	340	1.00	0.16	0.05	**	334	1.00	0.49	0.18		345
10	1.00	1.00	0.71		103	1.00	1.00	0.80		100	1.00	1.00	0.89		104
11	0.91	0.00	0.24		66	0.77	1.00	0.66		69	1.00	0.90	0.50		70
12	1.00	1.00	0.89		279	0.61	1.00	0.94		304	1.00	0.02	0.16		309
13	-10.00	0.34	0.78		54	-10.00	0.75	0.91		55	-0.84	0.24	0.98		56
14	0.14	-10.00	0.22		70	-1.11	0.09	0.69		70	1.00	-0.76	0.09	*	71
15	1.00	1.00	0.59		68	0.87	1.00	0.52		67	1.00	0.58	0.42		68
16	0.81	1.00	0.76		245	0.80	0.87	0.44		250	0.76	0.84	0.52		258
17	1.00	-10.00	0.01	**	82	1.00	-5.92	0.07	*	77	0.36	-0.56	0.06	*	82
18	1.00	0.66	0.58		175	0.02	0.00	0.56		171	1.00	0.15	0.36		175
19	1.00	1.00	0.63		192	1.00	1.00	0.84		189	1.00	1.00	0.64		197
20	-10.00	1.00	0.94		70	-7.88	0.95	0.92		60	1.00	-0.42	0.32		72

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. SOE: State-owned enterprise, FIE: Foreign invested enterprise, HMT: Enterprises owned by Hong Kong, Macau and Taiwan firms.

*** Significant at the 1% level.

** Significant at the 5% level.

* Significant at the 10% level.

Table 2.6 Two-level CES GMM Estimation of ρ and θ without SOE, FIE AND HMT

	Skilled = College or above				Skilled = high school or above				Skilled = Permanent worker status			
Industry	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms
Pooled	1.00	1.00	0.25	2448	1.00	1.00	0.20	2490	1.00	1.00	0.53	2561
1	1.00	-7.21	0.30	137	1.00	-5.26	0.39	145	-9.89	1.00	0.68	148
2	-4.23	-8.24	0.55	71	-10.00	-4.99	0.76	71	-10.00	1.00	0.66	74
3	-10.00	-1.08	0.32	220	-9.94	-9.40	0.42	234	-8.65	-4.04	0.51	236
4	1.00	-10.00	0.17	51	-10.00	-7.90	0.32	56	1.00	0.00	0.32	57
5	1.00	-9.44	0.11	37	1.00	-10.00	0.30	40	1.00	-3.83	0.27	40
6	0.72	1.00	0.61	38	0.00	-0.26	0.35	42	1.00	1.00	0.59	42
7	1.00	-6.69	0.46	48	0.94	-2.48	0.45	54	0.42	-4.53	0.32	55
8	-5.33	0.24	0.72	67	1.00	-7.19	0.41	67	-0.16	-5.21	0.34	67
9	1.00	-5.20	0.42	340	1.00	-3.08	0.35	334	0.07	-4.91	0.43	345
10	0.53	0.00	0.48	103	-0.68	0.00	0.75	100	0.00	1.00	0.82	104
11	0.41	0.00	0.48	66	0.44	-10.00	0.58	69	-7.06	-2.08	0.40	70
12	1.00	1.00	0.50	279	1.00	-9.77	0.14	304	1.00	-4.50	0.27	309
13	-3.18	0.56	0.59	54	0.45	-10.00	0.51	55	-10.00	1.00	0.81	56
14	-6.61	-3.22	0.68	70	-6.17	-10.00	0.52	70	-9.99	-7.43	0.49	71
15	1.00	0.26	0.53	68	-10.00	1.00	0.71	67	-10.00	1.00	0.69	68
16	1.00	1.00	0.76	245	-10.00	1.00	0.68	250	1.00	1.00	0.74	258
17	-9.87	0.00	0.46	82	0.53	-10.00	0.24	77	-5.05	-10.00	0.34	82
18	1.00	-8.16	0.46	175	-8.94	-3.41	0.70	171	1.00	-3.03	0.30	175
19	1.00	-9.98	0.42	192	1.00	-4.35	0.58	189	1.00	-6.31	0.37	197
20	1.00	-7.18	0.64	70	1.00	-3.00	0.46	60	-10.00	-3.51	0.56	72

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. SOE: State-owned enterprise, FIE: Foreign invested enterprise, HMT: Enterprises owned by Hong Kong, Macau and Taiwan firms.

Table 2.7a Estimated effects of relative capital usage on relative skilled labor (college or above) employment

Dependent Variable: ln (Skilled labor/Unskilled labor)

Industry	Small Firms				Medium Firms			Large Firms			
	Coef. of ln (K/Y)	T-stat		No. Firms	Coef. of ln (K/Y)	T-stat	No. Firms	Coef. of ln (K/Y)	T-stat		No. Firms
1	0.16	1.53		65	0.02	0.33	64	0.03	0.77		64
2	0.11	0.88		28	0.08	0.85	28	0.01	0.10		27
3	0.01	0.19		102	-0.03	0.62	102	-0.02	0.46		101
4	0.06	1.12		29	0.06	0.83	29	-0.08	1.42		29
5	0.11	1.16		26	0.10	1.11	26	-0.08	0.66		25
6	0.25	1.28		16	-0.09	0.67	16	-0.01	0.30		16
7	-0.08	0.73		24	0.02	0.22	25	0.04	0.50		24
8	0.02	0.38		26	0.00	0.00	26	0.00	0.03		26
9	0.02	0.47		154	0.04	1.17	156	-0.03	1.06		155
10	0.01	0.17		46	-0.03	0.51	48	0.06	1.19		47
11	0.10	1.04		37	0.08	0.83	36	-0.02	0.24		36
12	0.02	0.38		121	0.05	0.76	120	0.01	0.29		120
13	-0.03	0.51		28	0.01	0.16	28	-0.01	0.36		27
14	0.02	0.32		29	-0.04	0.55	29	0.01	0.20		28
15	-0.01	0.10		40	0.03	0.45	39	-0.16	2.61	***	39
16	0.01	0.19		117	0.05	0.81	117	0.00	0.12		117
17	0.03	0.54		39	0.01	0.09	38	0.05	0.63		38
18	0.12	2.26	**	97	-0.02	0.49	97	-0.03	0.96		97
19	-0.03	0.55		96	0.01	0.28	96	0.00	0.09		95
20	-0.07	1.65	*	64	0.10	1.10	64	0.11	2.19	**	64

Notes: All estimations include firm and time fixed effects. Firms are divided into three terciles based on their total employment size. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

*** Significant at the 1% level.

** Significant at the 5% level.

* Significant at the 10% level.

Table 2.7b Estimated effects of relative capital usage on relative skilled labor (high school or above) employment

Dependent Variable: ln (Skilled labor/Unskilled labor)

Industry	Small Firms			Medium Firms			Large Firms		
	Coef. of ln (K/Y)	T-stat	No. Firms	Coef. of ln (K/Y)	T-stat	No. Firms	Coef. of ln (K/Y)	T-stat	No. Firms
1	0.05	0.62	67	-0.06	1.14	66	0.05	1.24	66
2	0.07	1.21	28	0.11	1.43	28	-0.02	0.23	27
3	-0.07	1.01	107	-0.01	0.40	107	0.02	0.46	106
4	0.07	1.37	32	0.02	0.37	32	-0.04	0.68	32
5	-0.05	0.62	27	0.11	1.15	27	0.03	0.28	26
6	0.08	0.29	18	-0.03	0.30	18	0.06	0.52	17
7	-0.03	0.41	27	0.08	0.65	27	-0.16	1.14	27
8	0.06	0.70	26	-0.04	0.60	26	-0.01	0.10	25
9	-0.03	0.69	150	0.02	0.48	150	0.00	0.02	149
10	-0.07	0.55	45	-0.09	1.18	45	-0.04	0.71	44
11	-0.06	0.87	38	0.08	0.82	38	0.04	0.39	37
12	-0.01	0.08	129	0.03	0.52	129	-0.02	0.50	129
13	-0.03	0.39	28	0.00	0.02	28	-0.01	0.34	28
14	0.01	0.16	29	-0.06	1.29	29	-0.05	1.16	28
15	0.07	0.91	39	0.01	0.15	38	-0.05	0.61	38
16	0.05	0.93	117	-0.01	0.30	117	0.03	0.76	116
17	0.05	0.78	37	0.01	0.09	36	-0.01	0.12	36
18	0.04	0.75	96	-0.01	0.32	95	-0.02	0.84	95
19	-0.01	0.31	94	-0.02	0.50	93	0.00	0.09	93
20	0.01	0.12	57	0.06	1.28	57	0.07	1.44	57

Notes: All estimations include firm and time fixed effects. Firms are divided into three terciles based on their total employment size. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

Table 2.7c Estimated effects of relative capital usage on relative skilled labor (permanent worker status) employment

Dependent Variable: ln (Skilled labor/Unskilled labor)

Industry	Small Firms				Medium Firms				Large Firms			
	Coef. of ln (K/Y)	T-stat		No. Firms	Coef. of ln (K/Y)	T-stat		No. Firms	Coef. of ln (K/Y)	T-stat		No. Firms
1	0.10	0.92		52	-0.04	0.63		51	0.04	0.53		51
2	-0.01	0.12		20	-0.09	1.81	*	19	0.01	0.06		19
3	-0.18	2.30	**	73	-0.02	0.25		72	0.01	0.13		72
4	0.00	0.01		24	-0.01	0.14		24	-0.03	0.36		24
5	0.03	0.13		21	0.06	0.48		21	-0.10	0.54		21
6	-0.20	1.32		12	0.03	0.19		12	-0.08	0.53		11
7	0.10	0.60		19	-0.03	0.21		19	0.16	0.45		18
8	-0.15	1.14		18	0.02	0.08		17	-0.04	0.45		17
9	-0.06	1.03		88	-0.04	0.62		88	-0.12	1.32		88
10	0.10	0.89		26	0.08	0.72		26	-0.08	0.62		26
11	-0.04	0.40		29	-0.09	0.68		29	0.04	0.58		29
12	0.09	0.65		89	-0.01	0.08		88	-0.01	0.10		88
13	-0.19	1.18		15	-0.01	0.06		15	0.27	1.14		15
14	-0.02	0.53		18	0.05	0.29		18	0.08	0.41		18
15	-0.02	0.15		25	0.04	0.74		24	-0.12	0.86		24
16	-0.02	0.38		66	0.14	1.78	*	68	-0.16	1.92	*	67
17	-0.04	0.42		17	-0.17	0.75		17	0.14	0.57		16
18	0.11	0.85		50	0.12	1.55		50	0.01	0.06		50
19	0.01	0.15		57	0.03	0.35		57	-0.11	0.74		56
20	0.05	0.60		28	0.01	0.06		28	0.08	0.67		27

Notes: All estimations include firm and time fixed effects. Firms are divided into three terciles based on their total employment size. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

** Significant at the 5% level.

* Significant at the 10% level.

Table 2.8 Two-level CES nonlinear least squares and GMM estimation of ρ and θ for firms with capital-labor ratios in quartiles

Definition of skilled labor	Quartile (K/L)	NLLS			GMM				No. Firms
		ρ	θ	p-value (ρ-θ>0)	ρ	θ	p-value (ρ-θ>0)		
College or above	1	0.19	0.48	0.50	1.00	1.00	0.31		612
	2	1.00	0.98	0.26	1.00	-2.69	0.07	*	612
	3	0.45	1.00	0.79	1.00	1.00	0.27		612
	4	1.00	1.00	0.41	0.28	1.00	0.49		612
High school or above	1	0.73	0.37	0.24	0.33	0.97	0.57		623
	2	1.00	1.00	0.43	1.00	-2.35	0.11		622
	3	1.00	1.00	0.54	1.00	1.00	0.26		622
	4	0.49	1.00	0.93	-0.03	1.00	0.57		623
Permanent worker status	1	0.98	0.53	0.11	-10.00	1.00	0.79		640
	2	1.00	1.00	0.51	1.00	0.97	0.43		640
	3	1.00	1.00	0.84	0.27	1.00	0.52		640
	4	1.00	1.00	0.47	1.00	1.00	0.45		641

Notes : Ideally, the lower bound of parameters should be negative infinity; for practical purpose in the constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. Each firm has three years of data. Total number of observations for each quartile of an industry equals the number of firms times three.

* Significant at the 10% level.

Table 2.9a Two-level CES nonlinear least squares estimation of ρ and θ for firms with capital-labor ratios in terciles (Skilled = college or above)

Industry	Low					Medium				High			
	ρ	θ	p-value (ρ-θ>0)		No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms
1	-0.94	1.00	0.65		47	1.00	1.00	0.48	46	-10.00	1.00	0.84	47
2	1.00	1.00	0.57		24	-7.44	-4.78	0.59	23	1.00	1.00	0.25	24
3	0.94	0.10	0.26		74	0.17	1.00	0.53	73	0.61	0.44	0.39	74
8	-2.84	-0.89	0.66		23	0.39	1.00	0.75	22	-7.89	0.97	0.85	23
9	1.00	-10.00	0.10		114	0.36	-5.49	0.18	113	1.00	0.38	0.38	114
10	1.00	-10.00	0.00	***	35	1.00	1.00	0.25	34	1.00	1.00	0.62	35
11	1.00	-10.00	0.13		22	1.00	0.98	0.16	22	1.00	1.00	0.43	22
12	-0.02	1.00	0.31		93	1.00	-10.00	0.28	93	-0.08	-0.30	0.61	93
14	0.42	-2.04	0.20		24	0.37	-1.65	0.45	23	-3.73	-10.00	0.31	24
15	1.00	-2.43	0.40		23	-1.98	1.00	0.82	22	-5.77	0.81	0.61	23
16	1.00	1.00	0.57		82	1.00	1.00	0.28	81	1.00	1.00	0.60	82
17	1.00	0.00	0.12		28	1.00	1.00	0.39	27	-0.58	-10.00	0.31	28
18	-1.36	-2.76	0.38		59	0.96	-5.31	0.20	58	1.00	1.00	0.82	59
19	0.10	-0.16	0.33		64	1.00	0.43	0.31	64	-10.00	1.00	0.93	64
20	0.00	0.41	0.67		24	1.00	-10.00	0.36	23	1.00	-7.43	0.45	24

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in the constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

*** Significant at the 1% level

Table 2.9b Two-level CES nonlinear least squares estimation of ρ and θ for firms with capital-labor ratios in terciles (Skilled = high school or above)

Industry	Low					Medium					High				
	ρ	θ	p-value (ρ-θ>0)		No. Firms	ρ	θ	p-value (ρ-θ>0)		No. Firms	ρ	θ	p-value (ρ-θ>0)		No. Firms
1	-1.18	1.00	0.79		49	1.00	1.00	0.12		48	-10.00	1.00	0.98		49
2	1.00	-4.50	0.21		24	0.00	-1.82	0.22		23	1.00	1.00	0.54		24
3	-0.62	0.45	0.77		78	0.71	1.00	0.24		78	-0.78	0.23	0.75		78
8	-3.04	-1.40	0.52		23	-0.22	-0.78	0.59		22	1.00	0.00	0.09	*	23
9	1.00	-0.07	0.01	**	112	1.00	-2.94	0.08	*	111	1.00	1.00	0.62		112
10	1.00	-2.45	0.06	*	34	1.00	1.00	0.28		33	1.00	1.00	0.85		34
11	1.00	-1.61	0.39		23	-0.10	0.00	0.45		23	0.00	0.36	0.80		23
12	1.00	1.00	0.72		102	0.84	1.00	0.38		101	0.24	1.00	0.81		102
14	-10.00	-3.97	0.90		24	1.00	0.00	0.39		23	-1.93	-10.00	0.45		24
15	1.00	-8.18	0.09	*	23	1.00	1.00	0.50		22	1.00	0.00	0.14		23
16	0.59	1.00	0.83		84	1.00	0.78	0.11		83	0.75	1.00	0.32		84
17	1.00	-9.19	0.41		26	1.00	-5.21	0.08	*	25	-2.13	0.00	0.81		26
18	-0.32	-0.51	0.47		57	1.00	-2.88	0.35		57	1.00	0.00	0.12		57
19	-3.04	-5.37	0.40		63	1.00	-0.35	0.27		63	-10.00	1.00	0.95		63
20	-10.00	1.00	0.87		20	-6.59	1.00	0.76		20	-10.00	1.00	0.74		20

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in the constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

** Significant at the 5% level.

* Significant at the 10% level.

Table 2.9c Two-level CES nonlinear least squares estimation of ρ and θ for firms with capital-labor ratios in terciles
(Skilled = permanent worker status)

Industry	Low				Medium				High			
	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms
1	-7.80	1.00	0.95	50	0.98	1.00	0.84	49	1.00	1.00	0.81	50
2	1.00	1.00	0.78	25	-5.00	-7.40	0.78	24	1.00	1.00	0.64	25
3	1.00	1.00	0.84	79	0.00	1.00	0.89	78	0.41	0.52	0.86	79
8	1.00	1.00	0.74	23	-7.80	-0.28	0.94	22	0.24	0.00	0.78	23
9	1.00	1.00	0.75	115	0.00	0.39	0.81	115	-3.38	1.00	0.94	115
10	-0.18	0.29	0.90	35	1.00	1.00	0.78	34	-5.33	1.00	0.98	35
11	1.00	0.35	0.80	24	1.00	-6.19	0.61	23	1.00	-10.00	0.66	24
12	1.00	0.64	0.73	103	1.00	-4.43	0.72	103	1.00	-0.15	0.76	103
14	0.58	-3.00	0.66	24	-0.20	-0.51	0.75	23	1.00	-5.09	0.63	24
15	1.00	1.00	0.85	23	1.00	1.00	0.72	22	0.00	0.53	0.91	23
16	1.00	0.57	0.65	86	-0.10	1.00	0.99	86	1.00	1.00	0.77	86
17	1.00	1.00	0.91	28	-0.30	1.00	0.87	27	-0.27	0.00	0.84	28
18	0.46	-1.68	0.60	59	1.00	1.00	0.82	58	1.00	1.00	0.87	59
19	-1.20	-2.82	0.66	66	1.00	-0.39	0.61	65	-0.94	1.00	0.95	66
20	-8.27	-5.21	0.95	24	1.00	0.00	0.85	24	1.00	0.00	0.70	24

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in the constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

Table 2.10a Two-level CES GMM Estimation of ρ and θ for firms with capital-labor ratios in terciles (Skilled = college or above)

Industry	Low				Medium				High			
	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms
1	1.00	1.00	0.43	47	1.00	-10.00	0.38	46	1.00	1.00	0.43	47
2	1.00	0.00	0.28	24	-4.32	-10.00	0.32	23	1.00	0.00	0.28	24
3	1.00	-10.00	0.32	74	-9.86	-10.00	0.35	73	1.00	-10.00	0.32	74
9	1.00	-10.00	0.38	114	1.00	0.00	0.05 *	113	1.00	-10.00	0.38	114
10	1.00	-0.27	0.28	35	0.00	1.00	0.67	34	1.00	-0.27	0.28	35
11	-8.02	1.00	0.77	22	-7.08	-0.56	0.40	22	-8.02	1.00	0.77	22
12	-7.38	1.00	0.46	93	1.00	1.00	0.46	93	-7.38	1.00	0.46	93
14	-6.26	0.36	0.52	24	-5.07	1.00	0.53	23	-6.26	0.36	0.52	24
15	0.00	-10.00	0.25	23	1.00	1.00	0.57	22	0.00	-10.00	0.25	23
16	0.00	1.00	0.73	82	0.00	-6.60	0.36	81	0.00	1.00	0.73	82
17	0.00	-10.00	0.29	28	1.00	-10.00	0.48	27	0.00	-10.00	0.29	28
18	-10.00	-10.00	0.55	59	0.00	-9.66	0.27	58	-10.00	-10.00	0.55	59
19	1.00	0.00	0.34	64	-9.99	-9.39	0.58	64	1.00	0.00	0.34	64
20	1.00	0.00	0.38	24	0.38	-8.96	0.33	23	1.00	0.00	0.38	24

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in the constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

* Significant at the 10% level

Table 2.10b Two-level CES GMM Estimation of ρ and θ for firms with capital-labor ratios in terciles (Skilled = high school or above)

Industry	Low				Medium					High			
	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)		No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms
1	1.00	1.00	0.57	49	-6.11	1.00	0.24		48	1.00	1.00	0.57	49
2	-10.00	0.00	0.64	24	-1.15	-8.90	0.34		23	-10.00	0.00	0.64	24
3	1.00	-9.87	0.41	78	-10.00	-10.00	0.41		78	1.00	-9.87	0.41	78
9	-7.65	1.00	0.47	112	1.00	-6.33	0.04	**	111	-7.65	1.00	0.47	112
10	1.00	1.00	0.43	34	0.00	1.00	0.86		33	1.00	1.00	0.43	34
11	-10.00	-10.00	0.46	23	-6.52	1.00	0.59		23	-10.00	-10.00	0.46	23
12	0.76	0.00	0.31	102	1.00	0.00	0.33		101	0.76	0.00	0.31	102
14	1.00	1.00	0.55	24	-10.00	-7.80	0.42		23	1.00	1.00	0.55	24
15	-10.00	-10.00	0.46	23	1.00	1.00	0.75		22	-10.00	-10.00	0.46	23
16	1.00	0.00	0.36	84	-0.53	0.00	0.47		83	1.00	0.00	0.36	84
17	-0.35	-10.00	0.75	26	1.00	-6.28	0.15		25	-0.35	-10.00	0.75	26
18	-10.00	0.28	0.51	57	1.00	-4.56	0.40		57	-10.00	0.28	0.51	57
19	-7.91	0.94	0.66	63	-10.00	-9.99	0.58		63	-7.91	0.94	0.66	63
20	0.00	-1.47	0.91	20	0.12	-5.62	0.37		20	0.00	-1.47	0.91	20

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in the constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

** Significant at the 5% level

Table 2.10c Two-level CES GMM Estimation of ρ and θ for firms with capital-labor ratios in terciles (Skilled = permanent worker status)

Industry	Low				Medium				High			
	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms	ρ	θ	p-value (ρ-θ>0)	No. Firms
1	-10.00	-4.24	0.63	50	-0.06	-6.34	0.68	49	-0.31	0.00	0.36	50
2	1.00	1.00	0.40	25	-3.53	-6.03	0.81	24	-10.00	1.00	0.55	25
3	-10.00	-6.76	0.48	79	-10.00	-1.60	0.90	78	1.00	-5.72	0.54	79
9	-6.53	-4.87	0.57	115	-10.00	-5.54	0.56	115	-10.00	1.00	0.83	115
10	-10.00	-1.70	0.38	35	0.43	1.00	0.76	34	-6.19	1.00	0.82	35
11	-7.36	1.00	0.34	24	-0.12	-6.55	0.36	23	1.00	1.00	0.33	24
12	1.00	0.89	0.34	103	0.15	-4.48	0.24	103	0.00	0.00	0.57	103
14	-10.00	1.00	0.87	24	-10.00	-2.33	0.69	23	-7.72	-4.94	0.50	24
15	-4.97	-0.41	0.75	23	-10.00	1.00	0.40	22	1.00	-10.00	0.28	23
16	1.00	-0.13	0.23	86	-10.00	1.00	0.81	86	-6.40	1.00	0.46	86
17	1.00	1.00	0.60	28	-7.57	-6.28	0.35	27	-10.00	-0.51	0.44	28
18	1.00	0.00	0.50	59	1.00	-9.99	0.41	58	1.00	0.10	0.32	59
19	1.00	0.00	0.50	66	1.00	-10.00	0.20	65	-10.00	1.00	0.80	66
20	0.00	-1.65	0.48	24	-0.23	-5.51	0.61	24	1.00	-9.98	0.29	24

Notes: Ideally, the lower bound of parameters should be negative infinity; for practical purpose in the constrained optimization process, it is set at -10. An even smaller lower bound does not change the basic result. Each firm has three years of data. Total number of observations for each tercile of an industry equals the number of firms times three.

Appendix 2 Table First-stage OLS regression of potential instrumental variables

	ln(K_2004)		ln(K_2003)		ln(S_2004)		ln(S_2003)		ln(N_2004)		ln(N_2003)	
Skilled = College or above												
Intercept	-0.1001	*	-0.0156		0.6516	***	0.4287	***	0.5874	***	0.3848	***
	(0.0578)		(0.0397)		(0.0631)		(0.0446)		(0.048)		(0.0335)	
ln(S_2002)	0.0203	***	0.0123	**	0.8737	***	0.9223	***	-0.0558	***	-0.0288	***
	(0.0076)		(0.0052)		(0.0083)		(0.0059)		(0.0063)		(0.0044)	
ln(N_2002)	0.05	***	0.0225	***	-0.0020		-0.0067		0.9349	***	0.9508	***
	(0.0094)		(0.0064)		(0.0102)		(0.0072)		(0.0078)		(0.0054)	
ln(K_2002)	0.9018	***	0.9478	***	0.0332	***	0.0235	***	0.0345	***	0.0206	***
	(0.0073)		(0.005)		(0.008)		(0.0056)		(0.0061)		(0.0042)	
ln(V_2002)	0.034	***	0.0169	***	0.0358	***	0.0248	***	0.0191	***	0.0143	***
	(0.0064)		(0.0044)		(0.007)		(0.0049)		(0.0053)		(0.0037)	
Tax and Fee	0.4066		0.1746		-0.4514		-0.6017	**	-0.4661	*	-0.356	*
	(0.3276)		(0.2249)		(0.3576)		(0.2526)		(0.2719)		(0.19)	
Loan Accss	0.1156	***	0.0731	**	0.1285	***	0.0539		0.0633	*	0.0642	**
	(0.0434)		(0.0298)		(0.0474)		(0.0335)		(0.036)		(0.0252)	
Port Cost	-0.0001	*	0.0000		-0.0001	***	0.0000		-0.0001	***	-0.0001	***
	(0.0000)		(0.0000)		(0.0000)		(0.0000)		(0.0000)		(0.0000)	
Skilled = High school or above												
ln(S_2002)	0.027	***	0.015	***	0.8433	***	0.9055	***	-0.0772	***	-0.0416	***
	(0.0079)		(0.0054)		(0.008)		(0.0056)		(0.0076)		(0.0054)	
ln(N_2002)	0.0319	***	0.0181	***	0.0233	***	0.009		0.9666	***	0.9762	***
	(0.0079)		(0.0054)		(0.0079)		(0.0056)		(0.0075)		(0.0054)	
ln(K_2002)	0.9124	***	0.9526	***	0.0415	***	0.0284	***	0.0252	***	0.0115	**
	(0.0071)		(0.0049)		(0.0072)		(0.0051)		(0.0068)		(0.0049)	
ln(V_2002)	0.0338	***	0.016	***	0.0275	***	0.0178	***	0.0133	**	0.0111	**
	(0.0063)		(0.0043)		(0.0063)		(0.0045)		(0.0061)		(0.0043)	
Tax and Fee	0.4556		0.2311		-0.3647		-0.3631		-0.3453		-0.3220	
	(0.3260)		(0.2223)		(0.3264)		(0.2303)		(0.3114)		(0.2227)	
Loan Accss	0.1104	**	0.0747	**	0.0881	*	0.0745	**	0.0390		0.0500	*
	(0.0433)		(0.0295)		(0.0434)		(0.0306)		(0.0414)		(0.0296)	
Port Cost	-0.0001	**	0.0000	*	-0.0001	***	0.0000	**	-0.0001	***	-0.0001	**
	(0.0000)		(0.0000)		(0.0000)		(0.0000)		(0.0000)		(0.0000)	
Skilled = permanent worker status												
ln(S_2002)	0.0456	***	0.0244	***	0.9296	***	0.9580	***	-0.0631	***	-0.0370	***
	(0.0074)		(0.0050)		(0.0064)		(0.0044)		(0.0112)		(0.0071)	
ln(N_2002)	0.0203	***	0.0123	***	0.0068	**	0.0000		0.9555	***	0.9810	***
	(0.0038)		(0.0026)		(0.0033)		(0.0023)		(0.0059)		(0.0037)	
ln(K_2002)	0.9127	***	0.9520	***	0.0122	**	0.0059		0.0357	***	0.0171	***
	(0.0068)		(0.0047)		(0.0059)		(0.0040)		(0.0103)		(0.0065)	
ln(V_2002)	0.0361	***	0.0185	***	0.0083		0.0078	**	0.0109		0.0072	
	(0.0061)		(0.0042)		(0.0052)		(0.0036)		(0.0092)		(0.0058)	
Tax and Fee	0.2516		0.0795		-0.0108		-0.2641		-0.7505		0.0307	
	(0.3201)		(0.2193)		(0.2764)		(0.1896)		(0.4875)		(0.3079)	
Loan Accss	0.1103	***	0.0691	**	0.0764	**	0.0775	**	-0.1081	*	0.0016	
	(0.0424)		(0.0290)		(0.0366)		(0.0251)		(0.0645)		(0.0407)	
Port Cost	-0.0001	**	0.0000		-0.0002	***	-0.0001	***	0.0000		0.0000	
	(0.0000)		(0.0000)		(0.0000)		(0.0000)		(0.0000)		(0.0000)	

Notes: The dependent variables are capital stock (K), skilled (S) and unskilled labor (N) in 2004 and 2003. Independent variables are skilled labor, unskilled labor, capital stock and output (V) in 2002, effective tax and fee rate, access to loan and shipping cost to port. See Section 4 for detailed variable description.

3. CHAPTER 3: The Impact of Investment Climate on Firm Productivity and Employment Growth: A Quantile Regression Approach

Abstract

This paper tests heterogeneous effect of investment climate factors on firms with productivities and employment growth locate at different distribution segments using a quantile regression approach. Using the World Bank Investment Climate Survey data on three highly tradable sectors in three developing countries, the result shows that, improving credit availability is more effective than say making electricity supply more reliable in enhancing aggregate industrial productivity by reducing productivity dispersion as firms at the lower quantiles are disproportionally more benefitted. For employment growth, the impact of longer import custom clearance time is more severe for firms at high quantiles for the Apparel and Textiles industries, while credit availability is more important for fast growing firms. This paper complements previous studies using OLS as it is able to find bottleneck effects of some investment climate factors for firms locate at certain quantiles of productivity and employment growth distributions while the same factors are somehow found insignificant under OLS approach.

3.1 Introduction

Total factor productivity (hereafter TFP or productivity) growth and employment growth are two essential components in economic development, and are of great interest to both academic researchers and policymakers. Both are critical in improving living standard and poverty alleviation: although factor accumulation is important, productivity growth is regarded as the long-run growth engine of per capita income (Bastos and Nasir, 2007); the *Doing Business* report of the World Bank (2004) finds that the method used by the vast majority of people to escape poverty is via employment in a decent job. Much research effort has been devoted to studying how government policy can foster a better investment climate (hereafter IC) or business environment to support firm growth. IC involves hard infrastructure such as electricity power and water provision, and soft infrastructure such as bureaucratic efficiency, property right protection, and financial development. This research focus is particularly important for the developing world, where both types of infrastructure are often underdeveloped (Aterido et al., 2007).

Studies on productivity analysis can be framed at cross-country level, country-industry level and firm-level (see Section 3.2). Growing availability of firm-level data in recent years makes this last category the most noteworthy. It allows researchers to directly link the impact of a region's IC factors to firms' performance. Many studies find heterogeneous effects of IC factors on firms of various sizes, and then make corresponding policy recommendations (e.g. Dollar et al., 2005, Beck et al., 2008). Aterido et al. (2007) find that small firms are more constrained by capital financing, while large firms face the bottlenecks of dealing with government officials and red tape. Ayyagari et al. (2008) show that small firms tend to suffer more from street crime, financing constraints, and inflation.

Another strand of literature is also based on firm-level productivity but takes a step further by examining how the distribution of firm productivity, via resource (mis)allocation, can influence aggregate industrial productivity. This bottom-up perspective is important since it is aggregate productivity that determines overall social living standards. Pioneering studies by Hsieh and Klenow (2009) and Banerjee and Moll (2010), show that aggregate industrial productivity is determined not only by individual firm level productivity (which is the focus of the prior literature), but also by resource misallocation, represented by the variance of the productivity distribution. Put differently, if for some reason the productivity of already highly efficient firms becomes even higher and nothing else changes, then aggregate industrial productivity may actually be negatively affected due to a greater degree of resource misallocation. In fact, Song et al. (2011) point out that the process of undoing resource misallocation is an important feature of Chinese economic growth in the past several decades.

This study attempts to connect these two strands of literature by using a quantile regression approach to examine the heterogeneous impacts of IC factors on firms with productivities locate at different points in the TFP distribution. An important implication is that an IC variable will have unambiguous positive effect on aggregate productivity if it can disproportionally enhance TFP of firms in the lower quantiles of the productivity distribution by both improving the mean *and* reducing the variance. Hsieh and Klenow (2009) regress cross sectoral productivity variance on IC variables such as entry/exit and size restrictions and find statistically significant impacts. This paper complements their study by examining how productivity variance is influenced at each individual sector; also, the quantile regression approach provides us a more comprehensive overview of how firms at different productivity levels are heterogeneously affected. A quantile regression approach is also used to investigate heterogeneous effects of IC on employment growth, and this complements Aterido et al. (2007), who rely on ordinary least squares (OLS) for the same topic. From a methodological perspective, quantile regression gives more robust result than OLS, which can be severely influenced by outliers (Greene, 2012, p. 203).

As in other IC studies, the approach I use is straightforward. First, I construct firm-level productivity and employment growth as dependent variables. Then I regress these on a set of IC variables of interest in a quantile regression framework. An IC factor affects firm performance if its coefficient estimate is statistically significant; the existence of heterogeneous effects of an IC variable can be confirmed if its coefficient estimate is statistically significant at some quantile levels but not others. This study closely follows Dollar et al. (2005) in choosing IC variables of interest. I focus on three Asian rapidly developing and industrializing economies with good data availability in comparable time periods: Malaysia (2004-2006), Vietnam (2002-2004) and China (2002-2004). Firm-level production data from three highly tradable and standardized industries (Apparel, Textiles, Equipment and Machinery) as well as IC information come from the World Bank Investment Climate Survey database which contains three years of recall data. IC variables are based on firms' self-reported objective information which includes time needed for import and export clearance, access to bank overdraft facility, number of times a firm experiences power outage, and crime experience.[62]

Although IC variables are presumably exogenous to firms operating in an area, it is likely that larger firms might have great access to credit due to better relationships with banks. To mitigate this endogeneity problem, a common practice is to have firms' self-reported IC variables converted into city-

[62] Crime experience is only used for the Textiles industry as it is not significant in other two industries.

sector averages before use (e.g. Dollar et al., 2005 and Aterido et al., 2007). Dollar et al. (2005) point out a drawback in this approach, that coefficient estimates can be biased if, for example, more efficient firms self-select into locations with better IC. They propose a robustness check method which reruns the same set of regressions but focuses on a subsample with only small domestic private firms, since these are usually less mobile than large state-owned enterprises or foreign firms. This study conducts this robustness check and finds qualitatively similar conclusions. Another robustness check for the original productivity analysis with more flexible production functional form is also conducted and again the same basic conclusion is preserved (see Appendix 3).

My result confirms the existence of heterogeneous impacts of IC factors on firms with productivity and employment growth rates at different quantiles. Regarding productivity, power outages seem to be an important issue for most firms in the Apparel industry. Credit availability is crucial for firms at low quantiles, with diminishing importance for more efficient firms. Import/export custom clearance times are important concerns for low and middle quantile firms. An interesting policy implication is that improving credit availability seems a more effective way *both* to improve the productivity of individual firms and reduce resource misallocation than improving power supply or bureaucratic efficiency. For employment growth, the impact of longer import custom clearance times is more severe for firms at high quantiles for the Apparel and the Textiles industries. Credit availability is more important for fast growing firms. These results should be viewed as complementary to findings based on OLS: in some cases, the OLS approach is unable to detect statistically significant IC coefficients; while quantile regression finds statistically significant result for firms locate at some ranges of the distribution. A robustness check does detect the existence of self-selection, but the basic qualitative conclusion remains the same.

Improving all aspects of the institutional environment simultaneously can be challenging for all governments, and policymakers should prioritize their reform efforts to ensure the quickest and most effective return (Bastos and Nasir, 2004; World Bank, 2005). This paper complements and enriches this line of research by calling for more targeted efforts for firms at different quantiles (particularly the lower level) of the productivity distribution to enhance aggregate productivity and reduce resource misallocation. One recurring theme in almost every IC study is the advocacy to improve firms' access to credit or capital financing. Firms in developing countries generally lack capital financing due to reasons such as legal restrictions of pledging collateral (World Bank, 2006), crowding out effect by more influential firms with the banking system (Bai et al., 2001; Haggard and Huang, 2008), poor contract enforcement (Erosa and Cabrillana, 2008), lack of protection for creditors (Qian et al., 2005), and inefficient credit information of borrowers (World Bank, 2006, 2013).[63] Difficulties in accessing external capital from banks have pushed many firms to informal credit markets, where financing costs are much higher than formal credit sources (Tsai, 2004; Ayyagari et al., 2010). The World Bank *Doing Business* reports (2013, 2014) has compiled many detailed policy recommendations for countries to improve access to credit, such as expanded range of assets that can be used as collateral, unified property registries, and online access to credit data.

The rest of the paper is organized as follows. Section 3.2 is literature review. Section 3.3 is data description. Section 3.4 provides the estimation framework. Section 3.5 discusses the empirical regression results including the robustness check. Section 3.6 concludes.

3.2. Literature Review

3.2.1 Effects of investment climate on business performance from aggregate perspectives

There is a large and growing literature examining the impacts of business environment or IC, such as infrastructure or bureaucratic efficiency, on the performance of economic agents. Depending on the level of analysis, studies can be classified into cross-country level, country-industry level and firm-level. Knack and Keefer (1995) show that protection of property rights has a substantial impact on economic growth at the national level. Other cross-country studies such as Botero et al. (2004), Djankov et al. (2002) and Loayza et al. (2005) show that heavier regulation in labor and product markets reduces economic and employment growth, and induces corruption and informality. These studies, as pointed out by Aterido et

[63] World Bank (2006) points out that Chinese enterprises hold more than $2 trillion worth of assets which could not be used as collateral due to legal restrictions (e.g. property law). China has initiated a new property law in 2007 which has greatly improved the legal status of private property for used as collateral.

al. (2007) suffer from endogeneity issues such as omitted variable bias. Acemoglu et al. (2001) use colonial settlers' mortality rates as an instrument for institutional quality and confirm the importance of good institutions to economic growth. But the authors admit that their framework treats institutions as a "black box" and does not really guide specific policy steps for improvement. In addition, Dollar et al. (2006) argue that since the absolute number of countries in the world is limited, statistically regression result may not be robust.

Studies at the country-industry level delve a step further and aim at illustrating how different industries are heterogeneously affected by IC factors. Rajan and Zingles (1998) show a financially sound business environment contributes disproportionally more benefit to sectors which rely heavily on external financing. Buera et al. (2011) reach similar results for manufacturing sectors with inherent large scales of operation. They argue that financial frictions may account for a substantial portion of observed cross-country productivity differences. Beck et al. (2008) focus on heterogeneous effects over firm size and show that financial development has more benefit for small firms' output growth. Micco and Pages (2006) find that more restrictive labor regulation significantly slows down job turnover rate; this effect is more pronounced in sectors that require more flexibility in labor demand.

3.2.2 Effects of investment climate on business performance using firm-level data

This paper along with many previous studies such as Dollar et al. (2005, 2006), Bastos and Nasir (2004), and Subramanian et al. (2005), uses firm-level data to examine how IC conditions actually affect firm performance. This line of research is highly policy oriented and may offer specific recommendations for institutional improvement. Although the common procedure is to regress firm performance as the dependent variable on a set of IC variables taken as exogenous, plus some firm specific variables (e.g. size), the same regression result can be interpreted from two policy perspectives. One is to examine how a given IC variable can heterogeneously affect firms of different types (typically size); the other is to see how different IC variables have differential effects on firms belonging to a specific category. Both approaches are important. The former allows policymakers to design more targeted policy to support firms of certain type. The latter can help policymakers to prioritize their policy reform efforts: improving business environment simultaneously can be quite challenging and time consuming, therefore identifying and implementing reforms which could have the quickest return is essential (Demirgüç-Kunt and Maksimovic, 1998; Bastos and Nasir, 2004; World Bank, 2005; Ayyargari et al., 2008).

Perhaps the single most frequently investigated and confirmed IC condition that has substantial effect on firm performance is the ease of capital financing or credit availability. Beck et al. (2005, 2008) show that improving a location's financing condition may disproportionally help small firms' sales growth. Aterido et al. (2007) find similar result for small firms' employment growth. Several studies explore the issue of credit constraints from a legal perspective. Galindo and Micco (2005) show that inefficient legal protections to investors tend to disproportionally increase financial friction for small firms due to their lack of collateral. In addition, due to fixed monitoring costs per loan, banks tend not to monitor small firms; this makes them more likely to undertake risky production technology and go bankrupt. Similar findings are also reported in Davydenko and Franks (2005) and Qian and Strahan (2005). Erosa and Cabrillana (2008) establish the linkage between capital market imperfections and firm productivity. They show that better contract enforceability allows entrepreneurs to adopt more advanced technology, which in turn improves aggregate productivity. Manova et al. (2011) use Chinese firm-level data and show that credit constraints, most notably for private domestic firms, have negative effects on firms' international activity. Moll (2014) offers a new perspective, arguing that a financing gap and the associated productivity shortfall can be mitigated by firms' self-financing activities such as retained earnings. Specific policy recommendations on improving credit availability are provided by the World Bank's Doing Business report series. Good practices include eliminating legal barriers for sharing credit information, maintaining a public unified registry, making credit information electronically available and so on (World Bank, 2006, 2014). The reports did not provide any information regarding the costs of these reforms.

Beyond financial development, other IC soft infrastructure such as bureaucratic efficiency and hard infrastructure such as reliability of electric power also have significant influence on firms' performance.[64] Dollar et al. (2006) show that inefficient government service, proxied by the days needed to obtained a landline phone service, reduces firms' international trade activities. Dollar et al. (2005) find evidence that longer custom clearance times have negative impacts on firm productivity. Bastos and Nasir (2004) identify competitive pressure as the single most important factor influencing productivity. They call for policymakers to reduce barriers of entry and create a more open and competitive market environment. Fisman and Svensson (2007) find that a one percentage point increase in the rates of bribery and taxation can reduce firm growth by three and one percentage points respectively. In Subramanian et al. (2005), the authors argue that customs clearance delays and utility services interruption exert significant drags on firm productivity. Using Indian retail store data, Amin (2008) shows that more flexible labor regulations can lead to more job creation.

About hard infrastructure, there is a strand of literature dedicated to studying the impact of utility interruption on firm production. Using Indian manufacturing firm-level data, Allcott et al. (2014) find that power shortages reduce output by about five percent on average while plants that are small or lacking generators experience much greater loss; Abeberese (2013) establish a linkage between productivity loss and electricity shortage. The author argues that as electricity becomes more inaccessible, firms tend to switch to activities with less electricity-intensive production processes, which have fewer productivity-enhancing opportunities. Alby et al. (2011) use World Bank enterprise survey data from 87 countries and find nonlinear effects of electricity shortage on firms of various sizes and industries.

3.3 Data Description

The firm-level production information and IC measures I use come from the World Bank Investment Climate Survey (Enterprise Survey Database) from three countries: China, Malaysia and Vietnam. The original raw dataset has 12400 firms in China, 1115 firms in Malaysia and 1150 firms in Vietnam. Each country has three years of recall production data: 2002-2004 for China and Vietnam, and 2004-2006 for Malaysia. IC variables are only available for the end year of each period.

[64] There are many studies investigating the impact of improvement of infrastructure (reducing trade cost) on trade activity and economic growth (e.g. Limão and Venables, 2001; Donaldson, 2010; Banerjee et al., 2012).

To ensure the quality of products and production processes are well standardized when estimating TFP, three important and highly tradable manufacturing sectors are chosen for analysis: Apparel (ISIC 18), Textiles (ISIC 17), and Equipment and Machinery (ISIC 29).[65] Firms' production information used for computing firm-level TFP and employment growth include sales, intermediary materials, fixed assets (including building and machinery), salaries, and employment size (Table 3.1). Revenue and intermediary material costs are deflated based on industry-wide price indexes. To avoid uncertain counting issues regarding temporary workers, only permanent employees are considered.[66]

A noteworthy pattern from the survey is that significant share of firms in all industries have trade related activities. Table 3.2 presents shares of sampled firms conducting international trade related activities in those sectors. Firms can engage in trade activity either directly by exporting or importing goods or indirectly through intermediary distributors. Particularly, for Vietnamese firms, the shares of trade related activities are up to 90% and 80% for the Apparel and Textile industries respectively.

The survey contains a large set of objective and subjective measurements of business environment variables that cover areas such as infrastructure, financial development and government efficiency. Although Hallward-Driemeier and Aterido (2007) point out that subjective rating may work well under some circumstances, the vast majority of papers on IC's impacts on firm performance use objective data. Objective data presumably provides a more uniform and non-arbitrary account of the IC. This paper follows the same approach.

The choice of IC measurement variables in this paper is primarily based on Dollar et al. (2005) and a few other studies, such as Bastos and Nair (2004) and Aterido et al. (2007). As pointed out by Ayyargari et al. (2008), many IC variables are highly correlated. It can be well anticipated that having too many of them can reduce the degrees of freedom and make a regression suffer from multicollinearity problems. This study uses five IC variables: power outage, access to finance, import custom clearance

[65] In the Chinese Investment Climate Survey, industrial classification is based on China Standard Industrial Classification System (2002 version).

[66] The share of temporary workers among firms' total labor force is not high.

time, export custom clearance time, and crime experience. They can roughly represent the three commonly researched IC areas: infrastructure, financial development, and institutional quality (Subramanian et al., 2005). An IC variable mentioned in Dollar et al. (2005): the number of times a firm experiences governmental inspection as a proxy for government inefficiency, is not used in this paper.[67] The reason is that it is hard to standardize the nature or content of government inspections: having officials visiting a firm may exploit time which otherwise can be used by the firm's management to better attend to the business; but at the same time, it also provides the management a good opportunity to build a better relationship with the government. This can actually turn inspection into a productive activity for the company. Turning to selecting import/export custom clearance time as proxy for government efficiency, it is true that not all firms engage in international trade activity, but these two variables still measure governments' speed in completing fairly standardized comparable tasks.[68] Second, many firms participate in international trade indirectly by interacting with foreign enterprises' affiliates where important TFP spillover effects take place (Javorcik, 2004).

Specific definitions of the aforementioned variables are as follows. The Investment Climate Survey asks firms about the number of times they have experienced electricity power outage in a year.[69] For access to finance, I use the binary question asking whether firms have bank overdraft facility or line of credit.[70] Firms also report the average amount of time for their export and/or import goods to clear

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[67] Another government efficiency proxy variable, days needed to obtain fixed line phone service, is also not used. Dollar et al. (2005) find its coefficient is either statistically positive or not important when used as an explanatory variable for TFP estimated from LP method.

[68] For example, see the custom import/export procedures for China: <http://english.customs.gov.cn/service/guide?c=cf4d843e-6f24-4aa2-ba98-f4f575c68fc9> and Vietnam: <http://www.itpc.gov.vn/importers/how_to_import/procedures/folder_listing/?set_language=en>. The tasks are very similar.

[69] The specific format of this question may vary. For example, in Malaysia, the question is "how many times per months did your establishment experience power outage or surge". This number is multiplied by 12 to obtain the yearly basis number. In China, subjects are asked in the number of power outages their establishments have experienced on average in the past three years.

[70] In Malaysia, this question is asked as: "Do you have bank overdraft facility?" In China, it is asked as: "Does your company enjoy favorable terms on overdraft or have a loan quota?" In Vietnam, it is asked as: "Does your establishment have a line of credit."

customs. Crime experience also takes a binary form, it equals to 1 if the firm suffers positive damage due to activities such as robbery and theft. Table 3.3 shows the summary statistics of these IC measurements for three industries of interest for each country. It is obvious that Malaysia stands out clearly in the provisioning of credit, which is perhaps the single most important factor in boosting productivity and employment growth: in the Textiles industry, more than 60% of firms surveyed in Malaysia have overdraft facility; in contrast, this number is only 30% to 40% for firms in China and Vietnam.[71] Again, in the actual analysis, these variables are first converted into city-sector averages before being used.

3.4 Empirical Estimation

Estimation of IC's impact on TFP and employment growth is divided into two steps. First, TFP is estimated based on the well-known Levinsohn and Petrin (2003) (hereafter LP) method; the employment growth variable is constructed using data from the second and third year of the recall window period. Then, predicted TFP or employment growth is regressed on a set of IC variables in a quantile regression framework at quantile levels equal to 0.2, 0.5 and 0.8.

3.4.1 Estimate the impact of investment climate on TFP -- a quantile regression approach[72]

Estimating firm-level TFP[73]

As illustrated in Petrin, Poi and Levinsohn (2004) and LP (2003), a firm's production function can be estimated using either a value-added approach or a gross revenue approach. Estimations below implicitly assume the production function takes the Cobb-Douglas form, which is somewhat restrictive.

[71] A legitimate concern here is that firms may actually not need overdraft facility. Although this information is not directly available from the survey, we can obtain some sense from firms' need of termed loans. Simple averages of share of firms which do not need bank loans in Malaysia, Vietnam and China are 27.2%, 23.6% and 3.7% respectively. Compare to overdraft facility, termed loans have more intense requirements on paperwork, collaterals, minimum starting amount, and longer time for approval; so the shares presented above can be viewed as upper bounds for overdraft facility.

[72] This subsection relies heavily on Petrin, Poi and Levinsohn (2004).

[73] The value added LP approach is used for estimating production functions for Equipment/Machinery. Gross revenue LP approach is used for Apparel and Textiles industry. Parameter estimates under this arrangement are plausible and not extreme when compared to the alternative approach.

The Appendix shows the result using the translog functional form and the basic qualitative conclusions are preserved.

(a) *Value-added approach*

Assuming the production function to be Cobb-Douglas, it can be specified as follows:

$$v_t = \beta_0 + \beta_l l_t + \beta_k k_t + \omega_t + \eta_t \qquad (1)$$

where v_t is the logarithm of the value added (different between sales and intermediary material); l_t is the logarithm of the freely variable inputs of labor measured in monetary terms; and k_t is the logarithm of the state variable capital.[74] The unobservable component ω_t is a productivity shock that can influence firm input decision rules; ignoring this may lead to the well-known endogeneity problem with the OLS approach. The last component, η_t, is a simple error term, which is uncorrelated with input choices.

We assume that demand for intermediary material m_t (in logarithm) is determined by the firm's state variables k_t and ω_t,

$$m_t = m_t(k_t, \omega_t),$$

If we further assume that capital and the productivity shock are strictly positively correlated with intermediary input such that this function becomes invertible, ω_t can then be expressed as:

$$\omega_t = \omega_t(k_t, m_t)$$

Following Ollay and Pakes (1996), LP assumes that ω_t is determined by a first-order Markov process

$$\omega_t = E[\omega_t | \omega_{t-1}] + \xi_t$$

where ξ_t is an innovation to productivity which is uncorrelated with k_t, but not necessarily with l_t. Rewriting Eq. (1) as

$$v_t = \beta_l l_t + \emptyset_t(k_t, m_t) + \eta_t$$

where

$$\emptyset_t(k_t, m_t) = \beta_0 + \beta_k k_t + \omega_t(k_t, m_t),$$

[74] Alternatively, one could also model the labor input as physical units adjusted by education levels as done by Dollar et al. (2005). However, it seems difficult to ensure homogenous education quality across countries. In addition, education levels across worker types are not very well specified in the Chinese survey.

function $\emptyset_t(k_t, m_t)$ can be approximated by a third-order polynomial, which allows us to consistently estimate the value added equation using the OLS method:

$$v_t = \delta_0 + \beta_l l_t + \sum_{i=0}^{3} \sum_{j=0}^{3-i} \delta_{ij} k_t^i m_t^j + \eta_t$$

where the coefficient β_l can be identified.[75] This completes the first stage of the estimation.

The second stage aims at identifying β_k. First, we compute an estimated value of $\emptyset_t$,

$$\widehat{\emptyset_t} = \widehat{v_t} - \widehat{\beta_l} l_t$$

$$= \widehat{\delta_0} + \sum_{i=0}^{3} \sum_{j=0}^{3-i} \widehat{\delta_{ij}} k_t^i m_t^j + \eta_t - \widehat{\beta_l} l_t \quad ,$$

For a candidate value β_k^*, a predicted value of ω_t can be expressed as:

$$\widehat{\omega_t} = \widehat{\emptyset_t} - \beta_k^* k_t \quad ,$$

Having constructed the set of $\widehat{\omega_t}$, a consistent nonparametric approximation to $\mathrm{E}[\omega_t | \omega_{t-1}]$ is given by the predicted value from the regression

$$\widehat{\omega_t} = \mathrm{E}[\widehat{\omega_t | \omega_{t-1}}] = \gamma_0 + \gamma_1 \widehat{\omega_{t-1}} + \gamma_2 \widehat{\omega_{t-1}}^2 + \gamma_3 \widehat{\omega_{t-1}}^3 + \epsilon_t$$

Given $\widehat{\beta_l}$, β_k^*, and $\mathrm{E}[\widehat{\omega_t | \omega_{t-1}}]$, the residual of the original production function is

$$\widehat{\eta_t + \xi_t} = v_t - \widehat{\beta_l} l_t - \beta_k^* k_t - \mathrm{E}[\widehat{\omega_t | \omega_{t-1}}]$$

The estimate of $\widehat{\beta_k}$ is the solution to

$$\min_{\beta_k^*} \sum_t (v_t - \widehat{\beta_l} l_t - \beta_k^* k_t - \mathrm{E}[\widehat{\omega_t | \omega_{t-1}}])$$

A bootstrap approach is used to construct standard errors for $\widehat{\beta_l}$ and $\widehat{\beta_k}$. Fitted values of $\ln \mathrm{TFP}$ are then computed as

$$\ln \mathrm{TFP} = v_t - \widehat{\beta_l} l_t - \widehat{\beta_k} k_t$$

(b) *Gross revenue approach*

The production function in the form of gross revenue can be written as

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + \omega_t + \eta_t$$

$$= \beta_l l_t + \emptyset_t(k_t, m_t) + \eta_t$$

[75] β_0 is included within the intercept of $\emptyset_t(k_t, m_t)$.

$$\emptyset_t(k_t, m_t) = \beta_0 + \beta_k k_t + \beta_m m_t + \omega_t(k_t, m_t)$$

where y_t is the logarithm of revenue. Again, $\widehat{\beta_l}$ can be estimated as before using OLS where $\emptyset_t(k_t, m_t)$ is approximated as a third-order polynomial.

The second stage aims at identifying β_k and β_m. First, we compute an estimated value of $\emptyset_t$,

$$\widehat{\emptyset_t} = \widehat{v_t} - \widehat{\beta_l} l_t$$

$$= \widehat{\delta_0} + \sum_{i=0}^{3} \sum_{j=0}^{3-i} \widehat{\delta_{ij}} k_t^i m_t^j + \eta_t - \widehat{\beta_l} l_t \quad ,$$

For candidate values β_k^* and β_m^*, a predicted value of ω_t can be expressed as

$$\widehat{\omega_t} = \widehat{\emptyset_t} - \beta_k^* k_t - \beta_m^* m_t$$

$\mathrm{E}[\omega_t \widehat{|\omega_{t-1}}]$ can be estimated the same way as before. The residual of the production function given the candidate values of β_k^* and β_m^* can be expressed as

$$\widehat{\eta_t + \xi_t} = v_t - \widehat{\beta_l} l_t - \beta_k^* k_t - \beta_m^* m_t - \mathrm{E}[\omega_t \widehat{|\omega_{t-1}}] \quad ,$$

Since the residual in period t should not be correlated with the current state variable k_t (determined by the previous period's investment decision) and m_{t-1}, we have two moment conditions,

$\mathrm{E}[\eta_t + \xi_t | k_t] = 0$ and $\mathrm{E}[\eta_t + \xi_t | m_{t-1}] = 0$

The coefficients β_k and β_m can be estimated via

$$\min_{(\beta_k^*, \beta_m^*)} \sum_h \left\{ \sum_t (\widehat{\eta_t + \xi_t}) \, Z_{ht} \right\}^2$$

where $Z_t \equiv (k_t, m_{t-1})$ and h indicates the elements of Z_t. More instruments such as labor, intermediary input and capital in earlier periods can be used as overidentification restrictions to improve efficiency. Again, the bootstrap approach is used to construct standard errors for $\widehat{\beta_l}$, $\widehat{\beta_k}$ and $\widehat{\beta_m}$. Fitted values of ln TFP are then computed as

$$\ln \mathrm{TFP} = v_t - \widehat{\beta_l} l_t - \widehat{\beta_k} k_t - \widehat{\beta_m} m_t$$

<u>Employment growth variable</u>

Besides predicted TFP, the other key dependent variable is employment growth. Here it is computed as

$$Employment\ Growth_t = \left[\frac{Employment\ size\ in\ t}{Employment\ size\ in\ (t-1)} - 1\right] \times 100\%$$

Specifically, the time periods are 2003-2004 for China and Vietnam and 2005-2006 for Malaysia. Only one employment growth variable is computed for each firm as there is only one year the IC report is available. This is quite common for other studies using the Investment Climate Survey (e.g., Dollar et al., 2005). A slightly different approach is used by Aterido et al. (2007), who defines employment growth as the change of employment size between year t and $t-3$ divided by the average in those periods. Our approach presumably matches better with the IC variables in year t.

3.4.2 Quantile regression of impact of investment climate on TFP and employment growth

The quantile regression is specified as follows

$$\text{Prob}[Y_i \le X_i'\beta] = \tau$$

where Y_i represents predicted TFP or employment growth of firm i; X_i contains the IC variables faced by the firm; τ stands for the quantile levels, which are set at 0.2, 0.5 and 0.8 respectively. Again, because we only have one year of IC variables, Year 2004 for China and Vietnam and Year 2006 for Malaysia, only those years' predicted TFP is used.

To mitigate the endogeneity concern, all IC variables are average values at the industry-city level. The IC variables involved in this paper are the number of power outages experienced in a year, access to overdraft facility, and export/import custom clearance time. In addition, some firm-specific characteristics such as firm age are included in X_i. Furthermore, to control any level effect of employment size on its growth, we also include employment size in year $t-1$ as an explanatory variable (Aterido et al., 2007).

3.5 Results and Discussion

Table 3.4 presents the results of production function estimation for the three industries using the LP (2003) method.[76] Provided with production function coefficient estimates, predicted values of TFP (in

[76] In a few cases, the regression coefficients are not statistically significant.

logarithm terms) can be computed. Table 3.5 presents the summary statistics of the logarithm of TFP for the three industries in the three years of the recall window.

There are several noteworthy aspects. First, Malaysian firms' overall ln TFP performance is better than those of China and Vietnam. Hsieh and Klenow (2009) point out that an industry's aggregate TFP depends on two things: firms' individual TFP and their dispersion. From Table 3.5, we can see that the means of Malaysian firms' ln TFP is much higher than those of China and Vietnam in the Apparel and Equipment/Machinery industries.[77] Dispersions of ln TFP among the three countries are quite similar. Second, when comparing China and Vietnam, besides Apparel, the difference between the two countries ln TFP in mean and variance is not too large, with China doing slightly better.

These two aspects match relatively well with the Doing Business Index from the World Bank (2006) (Table 3.6). Malaysia ranked 21st while China and Vietnam stay quite close at 91st and 99th respectively. For the sake of comparison, the fourth column shows the rank of the US at the 3rd position. Table 6 shows that Malaysia outperforms China and Vietnam quite significantly in "Getting Credit": high protection of legal rights including those of creditors ensures sufficient funding opportunities for Malaysian firms as pointed out by Galindo and Micco (2005). In turn, firms with sufficient capital financing will be able to adopt advanced equipment or acquire more human capital, which can boost productivity (Erosa and Cabrillana, 2008). The ranks of China and Vietnam in 2014 are not very much different from 2004; the rank of Malaysia has jumped from 21 to 6 in ten years.

3.5.1 Impact of investment climate on TFP -- quantile regression

Resource misallocation represented by dispersion of TFP can be reduced if the ln TFP of firms at the lower end of the distribution can be improved. Therefore, from a policy perspective, it is important to identify IC conditions that affect these firms the most; or more broadly, identify how firms' TFP at different distribution quantiles are heterogeneously influenced by IC variables.

[77] Although the data recall window for Malaysia is two years later than that of China and Vietnam, which presumably gave more room for Malaysian firms to grow, the comparison is quite similar.

In the Apparel industry (Table 3.7a), Columns 1 and 2 show the quantile regression result with quantile level set at 0.2. Without firm-specific control variables, the coefficient for power outage is negative and statistically significant at the 10% level; this conforms to our expectation: more frequent occurrences of power outage tend to reduce productivity. Similar magnitudes are retained when employment size and firm age are added in Column 2.[78] Except Column 5, power outage coefficients are also statistically negative for middle ($\tau = 0.5$) and high quantiles ($\tau = 0.8$). The OLS results in Column 7 and 8 also support this result.

The coefficient for overdraft (or credit availability) in Column 1 is positive and statistically significant at the 5% level. Naturally, a more accommodating financial environment tends to increase productivity. Notice that at other quantile levels (middle and high), it becomes insignificant. This shows that firms at the lower end of the productivity distribution tend to be more strongly affected by an improvement of credit availability. From a policy perspective, a useful way of reducing resource misallocation would be to improve credit availability in the market, such that inefficient firms can catch up with those more efficient ones. The coefficients of overdraft in the OLS results are not statistically significant (Table 6a, Column 7 and 8). This outcome complements results from OLS in the sense that we are able to detect overdraft's differential impacts on firms locate at different productivity segments.

Figure 3.1 shows the confidence intervals of coefficients of overdraft (upper panel) and power outage (lower panel) at quantile levels ranging from 0.15 to 0.85. In the Apparel industry (upper and lower left), except for τ between 0.55 and 0.7, we can see that the coefficients for these two variables gradually decline, although they are insignificant as τ goes up.

At the middle quantile level ($\tau = 0.5$), Column 3 shows that the coefficient for import custom clearance time is statistically negative at the 10% level: a greater hold-up period for intermediary inputs could make other productive resources idle and reduce overall productivity. The result indicates that for a 1% increase in import clearance time, productivity would fall by 0.32%, though when firm-specific

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[78] Although coefficients for power outage and overdrafts are not statistically significant in Column 2, the corresponding p-values are relatively small at 0.18 and 0.14 respectively.

characteristics are added, this coefficient is no longer significant. The OLS result in Column 7 confirms the significance of this coefficient.[79] In contrast, this coefficient is insignificant at both low ($\tau = 0.2$) and high quantile ($\tau = 0.8$) levels. Firms whose productivity locate at the middle range of the distribution may face different problem from those in the low and high ranges. The coefficient for export clearance time is not statistically significant in all regressions. The null hypothesis of joint equality of slopes of all variables is rejected at the 1% level.

One noticeable feature for all industries is that productivity is positively correlated with employment size, although the absolute magnitude seems rather small. The highest effect is observed in the Apparel industry's middle quantile, which is equal to 0.145. It implies that a 10% increase in a firm's employment size tends to increase productivity by 1.45%.[80]

For the Textiles industry (Table 3.7b), first, we can see that the coefficient for power outage is negative with similar magnitudes across all three quantile levels but is only statistically significant at the middle quantile level ($\tau = 0.5$). Second, overdraft or credit availability is only a limiting factor for firms locate at the lower and middle segment of the productivity distribution. From Column 1 to 4, the coefficients of overdraft range from 0.45 to 0.50 and are statistically significant at the 1% level. These large magnitudes indicate that if credit becomes more available by 10% (i.e., the increase in the share of firms with access to a line of credit), productivity would increase by nearly 5%. Firms that are already highly productive ($\tau = 0.8$) have slightly negative and insignificant coefficients (Column 5 and 6). Figure 1 (upper middle) shows a clear downward trend for the overdraft coefficient, particularly at the high quantile in the Textiles industry.

Coefficients for import custom clearance time are negative and statistically significant from low to high quantiles at the 10% level (except Column 5) with growing magnitudes. A small surprise is that a statistically significant positive coefficient for export custom clearance time is observed at the high quantile level; of course, this does not mean that longer time is beneficial for productivity improvement.

[79] In Column 8, the p-value for the coefficient of import clearance time is 0.12, close to the 10% level.
[80] Tybout (2000) points out small firms are not necessarily less efficient than big firms as long as the scale effect of industries they operate in is limited.

Intuitively, longer import time for intermediary inputs is more troublesome for productivity because it directly slows down the production process by making other productive resources inefficiently used; on the other hand, finished products once sold (even before being physically shipped out of customs) could be considered as accounts receivable.[81] The null hypothesis of joint equality of slopes of all variables is rejected at the 1% level.

Table 3.7c shows regression results for the Equipment and Machinery industry. Coefficients for power outage and overdraft are statistically significant for low and middle quantiles but not at the high quantile level, which suggest heterogeneous effects of IC variables for firms at different productivity quantiles. Figure 3.1 (upper right) shows a clear downward trend for the overdraft coefficient at the low quantile range. Coefficients for export custom clearance time are negative and statistically significant at 5% for low and high quantiles.[82] A feature common to all quantiles is that the coefficients of firm age are negative and significant at the 1% level. It could well be that older firms are less dynamic in innovation or willing to update their management strategies. This characteristic makes them less competitive in the rapidly changing equipment industry.

In a nutshell, we can see the heterogeneous influence of IC variables on firms whose productivities locate at different quantile levels. Power outage seems an important issue for most firms. Credit availability is most important for firms at low quantiles while import/export custom clearance times are important concerns for low and middle quantile firms. Our result complements findings from the conventional OLS approach in the sense that we are able to detect IC variables' differential impacts on firms locate at different productivity segments. This has important policy implications: for example, improving overall credit availability can disproportionally improve productivity of inefficient firms, whose catch-up reduces capital misallocation and ultimately boosts industry-level aggregate productivity.

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[81] Occasional IC variable with abnormal sign also appears in Dollar et al. (2005), who find a positive coefficient for time to obtain telephone service.

[82] For middle quantile level, the p-value for export custom clearance time is 0.105, close to the 10% significance level.

3.5.2 Impact of investment climate on employment growth -- quantile regression

Heterogeneous influence of IC variables is also found on firms locate at different quantile levels of employment growth. A negative and statistically significant coefficient for power outage appears in the low quantile of the Apparel industry (Table 3.8a, Column 1); and a positive, statistically significant coefficient is found in the low quantile of the Equipment industry (Table 3.8c, Column 1). They become insignificant when additional firm-specific explanatory variables are added. A potential explanation for the observed positive (though insignificant in most cases) coefficient for power outage could be that energy and labor are substitutes: greater unavailability of power represents higher energy prices, which push up demand for labor. This finding is consistent with Shen and Whalley (2013), who find positive elasticity of substitution between energy and labor using Chinese data.

The coefficient for overdraft is positive and statistically significant for the middle quantile of the Equipment and Machinery industry (Table 3.8c, Column 3). A noticeable feature for all industries examined is that overdraft's point estimate is higher for firms at higher employment growth quantiles. This implies that firms that are already growing fast in employment size will grow faster when credit becomes more available. Figure 3.2 shows that for the Textiles and Equipment/Machinery industries the coefficients for overdraft (upper middle and right) gradually increase as τ goes up.

The coefficients for import custom clearance time are negative and statistically significant for middle and high quantiles of the Textiles industry (Table 3.8b, Column 3- 6). Intuitively, greater hold-up time for intermediary inputs or raw material tend to reduce employment growth for firms with faster expansion between 3.5% and 6.9%. A statistically significant, negative coefficient is also observed at the high quantile level in the Apparel industry (Table 3.8a, Column 6).

Higher initial employment size tends to reduce employment growth rates for all industries except for the Apparel industry. Intuitively, firms cannot expand infinitely; their expansion speed should decline as they get bigger. The coefficients of initial employment size range between -3% (Table 3.8b, Column 6) and -0.6% (Table 8d, Column 4). Similarly, the coefficients for firms' age are found to be negative and statistically significant for most cases in industries other than Apparel. This finding is consistent with Navaretti et al. (2012), who show that young firms grow faster than old firms.

In employment growth quantile regressions, the null hypothesis of joint equality of slopes of all variables is rejected at the 1% level for the Textiles and Equipment/Machinery industries; the null is not rejected for the Apparel industry.

3.5.3 Robustness check

Dollar et al. (2005) point out that using city-sector averages of IC variables cannot fully address the endogeneity problem when examining productivity if, for example, more efficient firms tend to self-select into locations with better IC. In order to assess this potential degree of self-selection, the authors rerun the same set of regressions with a subsample of firms that excludes large state-owned enterprises and foreign-invested firms who have more resources and willingness to choose firm location. Their subsample in turn includes only small (less than 150 employees) private firms, which are found to be less likely to migrate.[83] The idea is that if there exists self-selection mentioned above, which implies that IC has little impact on firms' productivity objectively, then we should not be able to detect statistically significant IC coefficients in this subsample of small domestic firms. In this subsection, we will conduct a similar exercise.

Indeed, one can see that the number of cases where IC coefficients are statistically significant is greatly reduced (Table 3.9a-c). This result does suggest the existence of self-selection. The coefficient for power outage becomes insignificant for all cases. The coefficients for overdraft are positive and statistically significant at low and middle quantiles of the Textiles industry (Table 3.9b, Column 1-4). The impact of import custom clearance time is limited to the middle quantile of the Apparel industry (Table 3.9a, Column 3) and the Equipment industry (Table 3.9c, Column 4). Last but not least, we do not see the

[83] The authors point out that location choice of domestic firms is usually determined by the location of the firm's founder's hometown.

coefficient for export clearance time being statistically significant in any industries.[84] The null hypotheses of joint equality of slopes of all variables are rejected at the 10% and 5% levels for the Apparel and the Textiles industries.

In sum, the phenomenon of more efficient firms self-selecting into locations with better business environments seems to exist. This result is consistent with the robustness check findings in Dollar et al. (2005), whose set of statistically significant coefficients reduces to power outage. Despite this, one can still observe heterogeneous effects of IC variables on firms with productivities locate at different quantiles in this study. This qualitative conclusion remains the same.

3.6 Conclusion

While much literature has been emphasizing how IC can shape an individual firm's productivity, a growing literature on resource misallocation takes a step further and argues that industrial aggregate productivity is not only positively influenced by firms' average productivity but also negatively influenced by the variance of its distribution. This paper connects these two strands of literature by examining the heterogeneous impacts of IC factors on firms with productivities locate at different distribution segments using quantile regression. It also uses the same approach to investigate the impact of IC on employment growth, which aims at identifying more targeted policies to help firms with slow employment growth. The result confirms the existence of heterogeneous effects of IC factors on firm productivity and employment growth.

There are several caveats to this study. First, having an IC policy that generates Pareto improvement for all firms with particularly large benefits to already efficient firms does not necessarily mean that this policy is a bad one. This paper suggests that policymakers should take the distributional effect on productivity of a policy into consideration when making reforms. Second, identifying efficient versus inefficient firms is certainly less straightforward than identifying large versus small firms based on their sales or employment size. This somehow poses obstacles for examining firms based on their

[84] The coefficient for export clearance time is negative and close to the 10% significance level at the middle quantile of the Equipment industry (Table 3.9c, Column 3).

productivity. Perhaps a more convenient way would be looking at measurements that presumably have high correlation with productivity, such as firms' profitability indicators like return on assets or equity. Third, like many other studies in this field, this paper does not have firm-specific prices and is unable to control for differentiated products and input quality (Katayama et al., 2009).

Improving IC requires governments to overcome inertia and build the capacity to reform (World Bank, 2004); and many studies have found the returns of the reform usually outweigh its cost by a large margin (e.g., Klapper et al., 2004; World Bank, 2005). Resources saved from lessening unnecessary regulations could then be used in areas where governments should do more, such as improving infrastructure. Perhaps the greatest obstacles along the way are vested interest groups from business and governments (World Bank, 2004).

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Table 3.1 Sample summary statistics of production information for three industries

	Sample Means								
	Apparel			Textiles			Equipment		
	China	Malaysia	Vietnam	China	Malaysia	Vietnam	China	Malaysia	Vietnam
Sale ($000')	28743	3193	3487	22287	9847	5783	23097	6138	4071
	(76021)	(8625)	(7654)	(54718)	(37537)	(15664)	(61026)	(21974)	(6246)
Labor cost ($000')	1749	566	851	1181	973	595	1324	827	309
	(4465)	(1401)	(1581)	(2756)	(3104)	(1064)	(2827)	(2793)	(484)
Capital ($000')	8427	556	1663	8134	1935	2816	13560	1099	1206
	(27375)	(2773)	(3272)	(21698)	(7944)	(6186)	(125196)	(3423)	(1651)
Material ($000')	13808	1918	1989	12298	4034	4021	11116	2254	2463
	(46279)	(6736)	(4805)	(30539)	(13133)	(13692)	(31555)	(6635)	(4059)
Employment size	171	911	1222	159	717	1052	105	218	766
	(502)	(1387)	(2657)	(399)	(1194)	(2035)	(209)	(262)	(1496)
Firm age (years)	17.4	10.7	9.3	17.1	12.6	10.6	17.7	14.4	17.8
	(11.0)	(10.5)	(9.0)	(9.1)	(16.7)	(11.9)	(9.2)	(15.0)	(17.0)
Obs.	523	246	162	2380	104	208	2537	241	155

Notes: Standard errors are in parentheses.

Table 3.2 Share of firms with export and import related activities (%)

		Malaysia	Vietnam	China
Apparel	Exp.	49.4	91.8	69.3
	Imp.	42.2	88.5	56.3
Textiles	Exp.	52.9	79.7	54.0
	Imp.	50.0	75.7	45.8
Equipment	Exp.	62.2	50.0	36.9
	Imp.	48.8	73.2	35.8

Notes: Activities include exporting or importing both directly or indirectly via distributors

Table 3.3 Sample investment climate indicators in four industries

	Apparel			Textiles			Equipment		
	Malaysia	Vietnam	China	Malaysia	Vietnam	China	Malaysia	Vietnam	China
Export Custom	5.81	3.24	3.59	10.75	3.3	4.8	7.06	7.86	6.24
Clearance (Days)	(8.21)	(6.24)	(5.67)	(12.54)	(5.68)	(6.93)	(8.35)	(11.99)	(11.7)
Import Custom	4.43	2.82	3.62	5.92	3.53	5.45	4.00	7.00	7.12
Clearance (Days)	(5.62)	(4.49)	(3.19)	(11.87)	(3.4)	(6.6)	(5.44)	(10.77)	(12.4)
Annual Power Outage	11.85	10.21	16.62	7.5	19.68	13.68	14.62	8.94	10.94
(times)	(14.7)	(11.59)	(22.65)	(9.02)	(83.11)	(22.32)	(36.27)	(9.21)	(25.44)
Have Overdraft Facility	0.57	0.39	0.39	0.68	0.42	0.3	0.68	0.48	0.27
(Yes=1)	(0.5)	(0.49)	(0.49)	(0.47)	(0.5)	(0.46)	(0.47)	(0.5)	(0.45)
Experienced Crime	0.23	0.11	0.34	0.26	0.07	0.28	0.34	0.14	0.34
(yes=1)	(0.42)	(0.32)	(0.48)	(0.45)	(0.25)	(0.45)	(0.48)	(0.35)	(0.47)

Notes: Standard deviations are in the parentheses.

Table 3.4 Estimation of Production Functions for three industries

Panel A: Apparel

	Malaysia		Vietnam		China	
Labor	0.414	***	0.478	***	0.363	***
	(0.048)		(0.069)		(0.061)	
Capital	0.245	*	0.109		0.094	
	(0.129)		(0.103)		(0.109)	
Material	0.126		0.448	***	0.505	***
	(0.246)		(0.113)		(0.141)	
Wald test of constant return to scale:						
χ^2	0.59		0.04		0.05	
P-value	0.44		0.84		0.83	
Obs.	246		162		523	
No. firms	83		62		176	

Panel B: Textiles

	Malaysia		Vietnam		China	
Labor	0.175	**	0.336	***	0.359	***
	(0.077)		(0.046)		(0.031)	
Capital	0.585	*	0.060		0.150	*
	(0.339)		(0.343)		(0.082)	
Material	0.356		0.571	**	0.486	**
	(0.285)		(0.240)		(0.136)	
χ^2	0.05		0.01		0.00	
P-value	0.82		0.94		0.96	
Obs.	104		208		2380	
No. firms	35		74		809	

Panel C: Equipment and Machinery

	Malaysia		Vietnam		China	
Labor	0.612	***	0.468	***	0.690	***
	(0.148)		(0.088)		(0.053)	
Capital	0.208	*	0.561	**	0.320	**
	(0.116)		(0.27)		(0.156)	
χ^2	0.87		0.01		0.00	
P-value	0.35		0.91		0.95	
Obs.	241		155		2537	
No. firms	83		56		902	

Notes: Estimation is based on Levinsohn and Petrin (2003) and Petrin et al. (2004). Standard errors are in the parentheses. Apparel and Textiles industries used gross revenue approach while Equipment and Machinery industry is based on valueadded approach.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 3.5—Summary statistics of productivity in three industries

	Malaysia				Vietnam				China			
	Year	Mean	Median	Std.Dev	Year	Mean	Median	Std.Dev	Year	Mean	Median	Std.Dev
Apparel	2004	4.211	4.059	0.645	2002	0.562	0.41	0.426	2002	1.996	1.854	0.703
	2005	4.253	4.232	0.662	2003	0.753	0.665	0.416	2003	2.029	1.864	0.685
	2006	4.275	4.178	0.61	2004	0.753	0.667	0.404	2004	2.05	1.862	0.718
Textiles	2004	0.342	0.271	0.882	2002	1.64	1.559	0.619	2002	1.587	1.479	0.69
	2005	0.297	0.144	0.939	2003	1.607	1.544	0.403	2003	1.639	1.503	0.642
	2006	0.137	-0.013	1.06	2004	1.596	1.531	0.481	2004	1.639	1.507	0.635
Equipment	2004	3.434	3.281	0.765	2002	0.771	0.747	0.878	2002	0.611	0.706	1.238
	2005	3.386	3.253	0.716	2003	0.68	0.858	0.901	2003	0.848	0.844	1.165
	2006	3.201	3.246	0.761	2004	-0.067	0.108	1.000	2004	1.237	1.183	0.959

Notes: Productivity here is the logarithm of total factor productivity.

Table 3.6 Ease of Doing Business in four countries

		China	Malaysia	Vietnam	United States
Overall Rank in 2014 report		96	6	99	4
Overall Rank and below in 2006 report		91	21	99	3
Starting a Business	Procedures (number)	13	9	11	5
	Time (days)	48	30	50	5
	Cost (% of income per capita)	13.6	20.9	50.6	0.5
	Minimum capital (% of income per capita)	946.7	0	0	0
Dealing with Licenses	Procedures (number)	30	25	14	19
	Time (days)	363	226	143	70
	Cost (% of income per capita)	126	82.7	64.1	16.9
Hiring and Firing Workers	Difficulty of hiring index (0-100)	11	0	44	0
	Rigidity of hours index (0-100)	40	20	40	0
	Difficulty of firing index (0-100)	40	10	70	10
	Rigidity of employment index (0-100)	30	10	51	3
	Hiring cost (% of salary)	30	13	17	8
	Firing Cost (Weeks of salary)	90	65	98	0
Registering Property	Procedures (number)	3	4	5	4
	Time (days)	32	143	67	12
	Cost (% of property value)	3.1	2.3	1.2	0.5
Getting Credit	Strength of legal rights index (0-10)	2	8	3	7
	Depth of credit information index (0-6)	3	6	3	6
	Public registry coverage (% of adults)	0.4	33.7	1.1	0
	Private bureau coverage (% of adults)	0	—	0	100
Protecting Investors	Extent of disclosure index (0-10)	10	10	4	7
	Extent of director libiability index (0-10)	1	9	1	9
	East of shareholder suits index (0-10)	2	7	2	9
	Strength of investor protection index (0-10)	4.3	8.7	2.3	8.3
Paying Taxes	Payments (number)	34	28	44	9
	Time (hours per year)	584	—	1050	325
	Total tax payable (% of gross profit)	46.9	11.6	31.5	21.5
Trading across Borders	Documents for export (number)	6	6	6	6
	Signatures for export (number)	7	3	12	5
	Time for export (days)	20	20	35	9
	Documents for import (number)	11	12	9	5
	Signatures for import (number)	8	5	15	4
	Time for import (days)	24	22	36	9
Enforcing Contracts	Procedures (number)	25	31	37	17
	Time (days)	241	300	343	250
	Cost (% of debt)	25.5	20.2	30.1	7.5
Closing a Business	Time (years)	2.4	2.3	5	2
	Cost (% of estate)	22	14.5	14.5	7
	Recovery rate (cents on the dollar)	31.5	38.8	19.2	76.2

Source: World Bank (2006, 2014)

Table 3.7a Explaining productivity in the Apparel industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	-0.075 *	-0.076	-0.123 **	-0.113 *	-0.128	-0.296 **	-0.124 *	-0.124 *
	(0.045)	(0.057)	(0.055)	(0.066)	(0.123)	(0.135)	(0.071)	(0.069)
ln(Overdraft)	0.382 **	0.308	0.229	-0.108	0.304	-0.376	0.261	-0.123
	(0.175)	(0.207)	(0.222)	(0.26)	(0.421)	(0.477)	(0.246)	(0.261)
ln(Import custom clearance time)	-0.202	-0.153	-0.320 *	-0.135	-0.309	-0.237	-0.268 *	-0.219
	(0.137)	(0.156)	(0.18)	(0.161)	(0.198)	(0.215)	(0.144)	(0.141)
ln(Export custom clearance time)	0.083	0.043	0.138	0.060	0.194	-0.093	0.121	0.083
	(0.121)	(0.118)	(0.123)	(0.116)	(0.171)	(0.177)	(0.097)	(0.091)
ln(Employment Size)		0.115 ***		0.145 ***		0.129 **		0.129 ***
		(0.032)		(0.037)		(0.062)		(0.032)
ln(Firm Age)		-0.015		-0.006		0.062		0.033
		(0.053)		(0.068)		(0.091)		(0.058)
Adjusted R squared							0.77	0.78
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	286	286	286	286	286	286	286	286

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 4.24***.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 3.7b Explaining productivity in the Textiles industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	-0.015	-0.022	-0.056**	-0.056**	0.000	-0.038	-0.006	-0.005
	(0.027)	(0.027)	(0.024)	(0.026)	(0.057)	(0.056)	(0.033)	(0.033)
ln(Overdraft)	0.505***	0.549***	0.447***	0.503***	-0.038	-0.015	0.388**	0.377**
	(0.13)	(0.131)	(0.173)	(0.177)	(0.301)	(0.336)	(0.156)	(0.157)
ln(Import custom clearance time)	-0.049	-0.048	-0.078	-0.095*	-0.192	-0.196	-0.121**	-0.127**
	(0.033)	(0.031)	(0.055)	(0.051)	(0.137)	(0.13)	(0.053)	(0.054)
ln(Export custom clearance time)	0.025	0.013	0.059	0.058	0.225*	0.209*	0.118**	0.115**
	(0.041)	(0.038)	(0.051)	(0.051)	(0.118)	(0.115)	(0.051)	(0.052)
ln(Crime)	-0.252*	-0.212*	-0.020	-0.009	-0.298	-0.266	-0.184	-0.174
	(0.134)	(0.123)	(0.172)	(0.185)	(0.295)	(0.305)	(0.172)	(0.172)
ln(Employment Size)		0.022		-0.006		-0.042		-0.002
		(0.014)		(0.016)		(0.034)		(0.015)
ln(Firm Age)		-0.039		-0.034		-0.052		-0.040
		(0.024)		(0.023)		(0.073)		(0.028)
Adjusted R squared							0.12	0.12
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	862	862	862	862	862	862	862	862

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 2.22***.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 3.7c Explaining productivity in the Equipment and Machinery industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	τ = 0.2		τ = 0.5		τ = 0.8			
ln(Number of power outage)	-0.071 *	-0.091 **	-0.121 ***	-0.088 **	-0.064	-0.027	-0.068 *	-0.060
	(0.04)	(0.042)	(0.046)	(0.042)	(0.07)	(0.058)	(0.038)	(0.038)
ln(Overdraft)	0.910 **	0.799 **	0.712 **	0.498 *	0.325	0.367	0.827 ***	0.640 **
	(0.398)	(0.346)	(0.299)	(0.248)	(0.364)	(0.351)	(0.28)	(0.278)
ln(Import custom clearance time)	0.193 **	0.154 *	0.154 *	0.106	0.129	0.120	0.182 ***	0.168 **
	(0.08)	(0.09)	(0.086)	(0.075)	(0.093)	(0.093)	(0.068)	(0.068)
ln(Export custom clearance time)	-0.181 **	-0.204 **	-0.125	-0.044	-0.136 **	-0.091	-0.159 **	-0.142 **
	(0.097)	(0.094)	(0.077)	(0.07)	(0.061)	(0.063)	(0.062)	(0.063)
ln(Employment Size)		0.072 **		0.082 ***		0.062		0.062 **
		(0.034)		(0.031)		(0.038)		(0.026)
ln(Firm Age)		-0.160 ***		-0.196 ***		-0.241 ***		-0.196 ***
		(0.05)		(0.037)		(0.073)		(0.038)
Adjusted R squared							0.30	0.32
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	927	927	927	927	927	927	927	927

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is not rejected with F-stat = 1.47 with p-value equals to 0.101.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 3.8a Explaining employment growth in the Apparel industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: Employment growth rate	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	-3.508 *	-3.020	-0.974	0.030	-2.928	-5.071	-2.568	-2.341
	(1.951)	(2.129)	(1.95)	(1.87)	(3.911)	(4.17)	(2.041)	(2.091)
ln(Overdraft)	-1.596	-2.413	3.472	1.399	19.012	16.701	6.208	4.830
	(6.703)	(7.68)	(7.955)	(8.196)	(11.674)	(12.972)	(6.725)	(7.303)
ln(Import custom clearance time)	3.786	3.138	1.795	1.424	-9.843	-12.976 *	-1.184	-0.940
	(4.023)	(3.875)	(4.134)	(4.012)	(6.472)	(7.401)	(3.504)	(3.607)
ln(Export custom clearance time)	0.681	0.003	-0.430	0.651	6.760	7.024	1.904	2.169
	(3.757)	(3.381)	(3.15)	(3.126)	(5.891)	(5.96)	(2.846)	(2.895)
ln (Initial TFP)		-1.293		-0.408		-2.377		-0.303
		(2.011)		(1.935)		(3.832)		(1.615)
ln(Employment Size)		1.941 *		0.641		0.857		0.881
		(0.996)		(0.856)		(1.387)		(0.835)
ln(Firm Age)		-1.504		-2.705		0.852		-1.716
		(1.965)		(2.093)		(2.824)		(1.914)
Adjusted R squared							0.01	0.01
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	239	239	239	239	239	239	239	239

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is not rejected with F-stat = 0.88 without region dummies.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 3.8b Explaining employment growth in the Textiles industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: Employment growth rate	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	0.390	0.323	-0.942	-0.455	0.031	0.014	0.116	0.138
	(0.66)	(0.702)	(0.687)	(0.596)	(1.207)	(1.125)	(0.557)	(0.551)
ln(Overdraft)	-0.223	0.708	5.115	4.346	7.968	0.393	2.928	2.617
	(4.521)	(4.012)	(3.61)	(3.409)	(7.099)	(7.814)	(3.451)	(3.374)
ln(Import custom clearance time)	-1.346	-1.764	-3.901 ***	-3.455 ***	-6.886 ***	-6.316 ***	-3.135 ***	-3.273 ***
	(1.28)	(1.142)	(0.903)	(1.062)	(1.694)	(1.892)	(1.007)	(1.001)
ln(Export custom clearance time)	0.691	0.892	2.794 **	1.676	2.655	1.831	1.625 *	1.260
	(1.022)	(0.855)	(1.195)	(1.156)	(1.689)	(1.828)	(0.938)	(0.925)
ln (Initial TFP)		0.458		0.244		0.880		0.519
		(0.891)		(0.786)		(1.041)		(0.638)
ln(Employment Size)		-0.834 **		-1.048 ***		-3.047 ***		-1.445 ***
		(0.362)		(0.396)		(0.778)		(0.329)
ln(Firm Age)		-1.207 **		-1.364 **		0.107		-0.884
		(0.602)		(0.545)		(1.374)		(0.598)
Adjusted R squared							0.01	0.04
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	730	730	730	730	730	730	730	730

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 1.79**.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 3.8c Explaining employment growth in the Equipment and Machinery industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: Employment growth rate	Quantile regression						OLS	
	τ = 0.2		τ = 0.5		τ = 0.8			
ln(Number of power outage)	0.850 *	0.679	0.226	-0.428	0.197	-0.398	0.139	0.256
	(0.46)	(0.422)	(0.654)	(0.559)	(1.139)	(1.016)	(0.529)	(0.523)
ln(Overdraft)	0.904	1.063	5.862 *	1.582	11.165	1.576	6.764 *	2.686
	(3.819)	(2.594)	(3.42)	(3.898)	(7.714)	(6.241)	(3.568)	(3.506)
ln(Import custom clearance time)	-0.418	0.495	1.179	0.477	1.710	0.560	0.889	0.579
	(0.825)	(0.693)	(1.04)	(0.841)	(2.609)	(2.4)	(0.954)	(0.927)
ln(Export custom clearance time)	0.707	0.445	-0.259	-0.640	-0.692	-1.170	-0.238	-0.423
	(0.611)	(0.659)	(0.781)	(0.7)	(1.528)	(1.651)	(0.761)	(0.735)
ln (Initial TFP)		0.849 **		0.624		2.013 **		1.148 ***
		(0.389)		(0.556)		(0.853)		(0.429)
ln(Employment Size)		-1.098 ***		-0.998 **		-2.306 ***		-1.600 ***
		(0.267)		(0.446)		(0.689)		(0.356)
ln(Firm Age)		-0.364		-2.468 ***		-5.747 ***		-2.403 ***
		(0.463)		(0.689)		(1.175)		(0.544)
Adjusted R squared							0.02	0.10
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	741	741	741	741	741	741	741	741

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 4.94***.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 3.9a Explaining productivity in the Apparel industry for small private firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	-0.241	-0.290	-0.212	-0.221	-0.187	-0.199	-0.201	-0.187
	(0.295)	(0.229)	(0.331)	(0.297)	(0.449)	(0.437)	(0.18)	(0.172)
ln(Overdraft)	1.016	0.072	1.067	0.028	-0.563	-1.652	1.030	0.353
	(0.999)	(0.972)	(1.163)	(1.337)	(2.129)	(2.35)	(0.761)	(0.807)
ln(Import custom clearance time)	-0.595	-0.610	-0.785 *	-0.646	-0.466	-0.324	-0.672 **	-0.529 **
	(0.521)	(0.385)	(0.448)	(0.513)	(0.709)	(0.715)	(0.269)	(0.26)
ln(Export custom clearance time)	0.341	0.183	0.356	0.240	0.140	0.095	0.258	0.194
	(0.272)	(0.246)	(0.297)	(0.321)	(0.464)	(0.49)	(0.169)	(0.162)
ln(Employment Size)		0.275 ***		0.252 ***		0.328		0.239 ***
		(0.072)		(0.094)		(0.241)		(0.084)
ln(Firm Age)		-0.050		0.038		0.081		0.066
		(0.126)		(0.174)		(0.207)		(0.117)
Adjusted R squared							0.88	0.90
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	73	73	73	73	73	73	73	73

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 1.74* without region dummies.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 3.9b Explaining productivity in the Textiles industry for small private firms

Dependent variable: ln(Total factor productivity)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	-0.099	-0.041	-0.094	-0.092	-0.110	-0.036	0.012	0.014
	(0.089)	(0.1)	(0.106)	(0.106)	(0.163)	(0.15)	(0.109)	(0.11)
ln(Overdraft)	1.014 ***	0.519	0.861 **	0.905 **	-0.033	0.377	0.879 **	0.850 **
	(0.342)	(0.383)	(0.425)	(0.447)	(0.834)	(0.78)	(0.344)	(0.353)
ln(Import custom clearance time)	-0.041	-0.115	-0.064	-0.066	-0.241	-0.246	-0.138	-0.147
	(0.116)	(0.133)	(0.181)	(0.189)	(0.347)	(0.301)	(0.131)	(0.137)
ln(Export custom clearance time)	0.136	0.213	0.146	0.147	0.196	0.134	0.203	0.204
	(0.16)	(0.165)	(0.166)	(0.171)	(0.305)	(0.285)	(0.142)	(0.145)
ln(Crime)	-0.588	-0.514	-0.182	-0.223	1.005	0.762		-0.349
	(0.562)	(0.595)	(0.727)	(0.736)	(1.07)	(1.131)		(0.725)
ln(Employment Size)		0.090		0.003		0.171	-0.425	0.056
		(0.069)		(0.098)		(0.138)	(0.694)	(0.076)
ln(Firm Age)		-0.090		-0.007		0.177		-0.061
		(0.121)		(0.116)		(0.232)		(0.106)
Adjusted R squared							0.35	0.35
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	166	166	166	166	166	166	166	166

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 1.83**.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.

Table 3.9c Explaining productivity in the Equipment and Machinery industry for small private firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	0.087	0.094	-0.007	-0.041	0.066	0.077	0.015	0.014
	(0.078)	(0.092)	(0.073)	(0.067)	(0.129)	(0.133)	(0.081)	(0.083)
ln(Overdraft)	0.670	0.591	0.025	0.171	0.157	0.240	0.539	0.545
	(0.934)	(0.942)	(0.566)	(0.592)	(0.801)	(0.813)	(0.599)	(0.602)
ln(Import custom clearance time)	0.225	0.231	0.252	0.285 *	0.263	0.253	0.228 *	0.225
	(0.166)	(0.17)	(0.153)	(0.145)	(0.188)	(0.193)	(0.122)	(0.123)
ln(Export custom clearance time)	-0.148	-0.176	-0.234	-0.197	-0.173	-0.155	-0.151	-0.145
	(0.165)	(0.156)	(0.146)	(0.151)	(0.116)	(0.127)	(0.1)	(0.101)
ln(Employment Size)		0.103		-0.035		-0.058		0.047
		(0.146)		(0.073)		(0.142)		(0.097)
ln(Firm Age)		0.031		0.060		-0.027		0.001
		(0.146)		(0.113)		(0.173)		(0.116)
Adjusted R squared							0.44	0.43
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	211	211	211	211	211	211	211	211

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is not rejected with F-stat = 1.15.

* Significant at the 10 percent level.

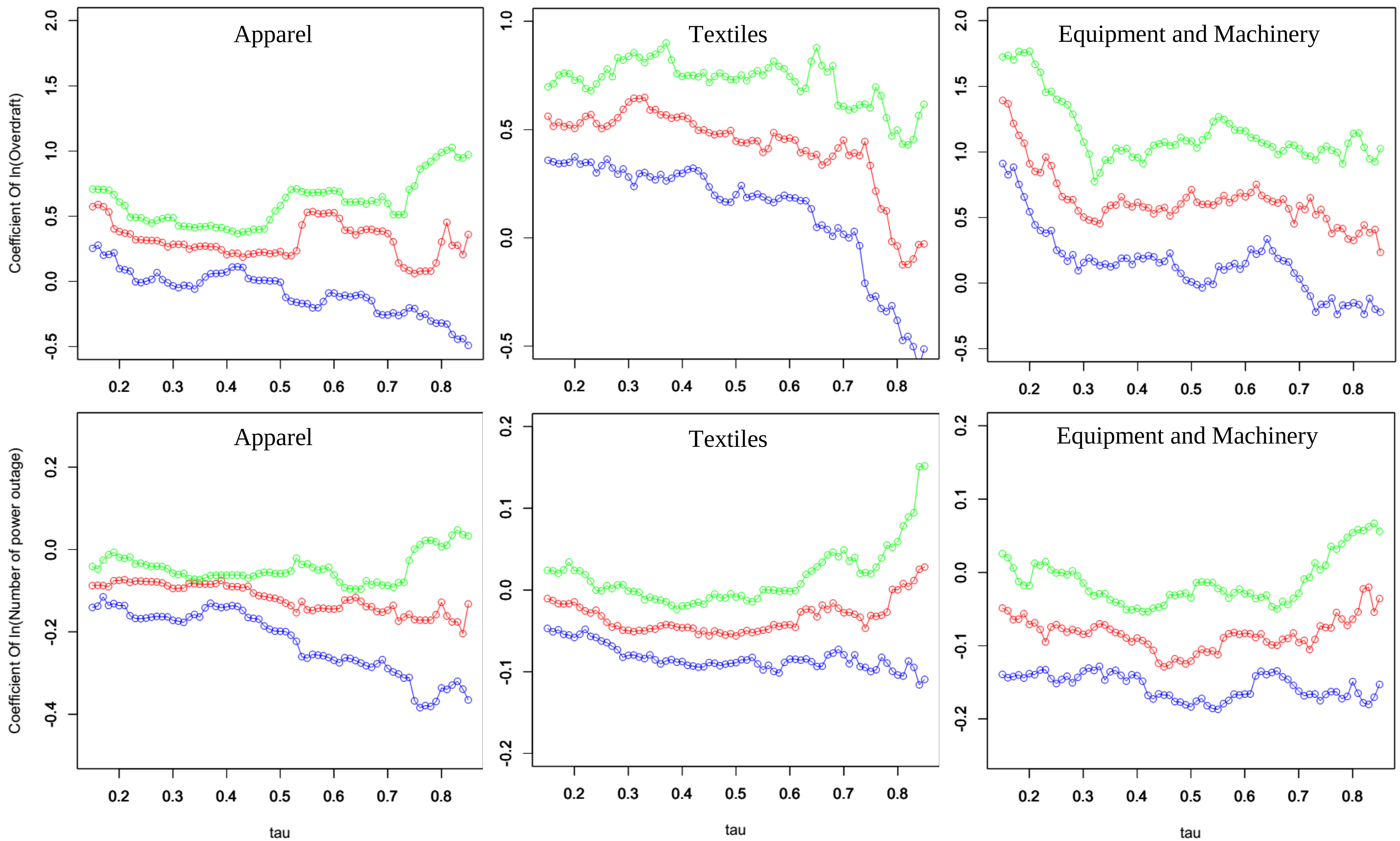

Figure 1—Confidence intervals for coefficients of overdraft and power outage at different quantile levels in total factor productivity quantile regression

Notes: The confidence intervals are at the 90% level. Red: coefficient estimates. Green and blue: upper and lower bounds respectively.

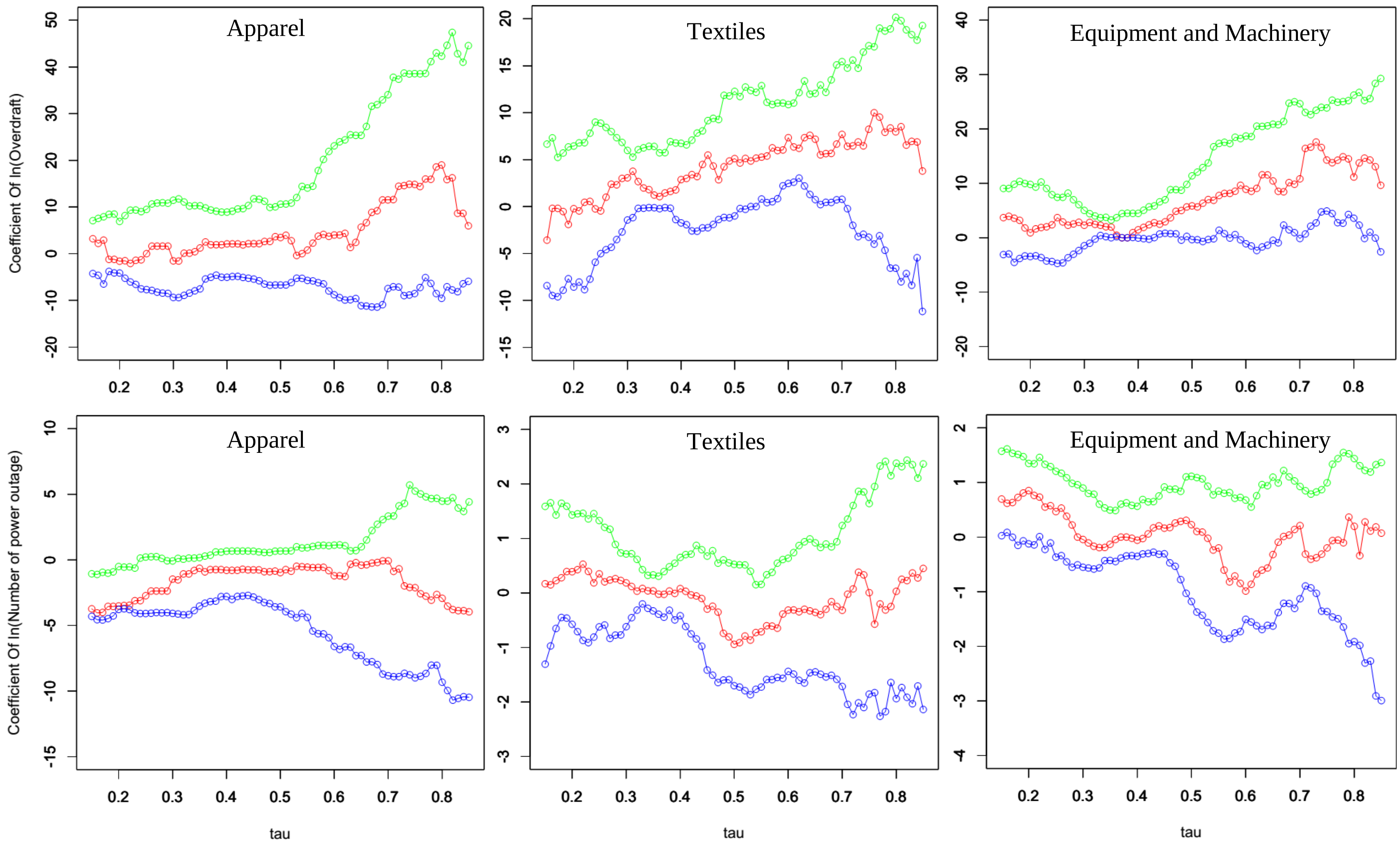

Figure 2—Confidence intervals for coefficients of overdraft and power outage at different quantile levels in employment growth quantile regression

Notes: The confidence intervals are at the 90% level. Red: coefficient estimates. Green and blue: upper and lower bounds respectively.

Appendix 3

The Appendix 3 shows the same productivity quantile regression result with productivity estimated using translog production function with fixed effect. Table 1 below shows that the productivities computed using this method and the ones with Cobb-Douglas specification in Section 3.4 are highly correlated (except Malaysian Textiles industry). Table 2a-2c and Table 3a-3c (for small private firms) confirm heterogeneous effects of IC variables on firms with productivities locate at different quantile levels.

Appendix 3.A Table 1—Correlation of productivity computed using Cobb-Douglas and Translog functional forms

	Malaysia	Vietnam	China
Aparrel	0.79	0.55	0.91
Textiles	0.35	0.63	0.87
Equipment	0.72	0.86	0.85

Notes:productivity is ln(TFP). Translog production function is estimated using fixed-effect model.

Appendix 3.B Table 1a Explaining productivity in the Apparel industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	-0.087 **	-0.087 *	-0.077 *	-0.075 *	-0.095	-0.087	-0.087	-0.090
	(0.04)	(0.045)	(0.04)	(0.042)	(0.078)	(0.078)	(0.06)	(0.059)
ln(Overdraft)	0.245 *	0.003	0.156	0.043	0.348	0.051	0.225	-0.011
	(0.136)	(0.152)	(0.141)	(0.161)	(0.379)	(0.37)	(0.209)	(0.216)
ln(Import custom clearance time)	-0.087	-0.092	-0.140 *	-0.032	-0.220	-0.199	-0.081	-0.053
	(0.091)	(0.102)	(0.084)	(0.099)	(0.18)	(0.186)	(0.122)	(0.12)
ln(Export custom clearance time)	0.044	-0.006	0.093	0.044	0.110	0.060	0.061	0.031
	(0.08)	(0.083)	(0.064)	(0.075)	(0.133)	(0.123)	(0.079)	(0.075)
ln(Employment Size)		0.053 **		0.072 ***		0.075 **		0.075 ***
		(0.022)		(0.025)		(0.037)		(0.027)
ln(Firm Age)		0.011		-0.020		0.064		0.048
		(0.037)		(0.043)		(0.057)		(0.048)
Adjusted R squared							0.28	
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	286	286	286	286	286	286	286	286

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 10.02***.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Appendix 3.B Table 1b Explaining productivity in the Textiles industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	-0.013	-0.015	-0.029	-0.042	0.000	0.016	-0.005	-0.002
	(0.027)	(0.023)	(0.021)	(0.021)	(0.046)	(0.051)	(0.028)	(0.028)
ln(Overdraft)	0.487 ***	0.441 ***	0.631 ***	0.560 ***	0.232	0.256	0.470 ***	0.440 ***
	(0.123)	(0.139)	(0.162)	(0.119)	(0.327)	(0.251)	(0.154)	(0.148)
ln(Import custom clearance time)	-0.035	-0.030	-0.121 **	-0.150 ***	-0.211 **	-0.286 ***	-0.134 ***	-0.140 ***
	(0.046)	(0.033)	(0.057)	(0.049)	(0.082)	(0.086)	(0.049)	(0.046)
ln(Export custom clearance time)	0.020	0.008	0.051	0.083 *	0.143 *	0.182 **	0.056	0.079 *
	(0.044)	(0.036)	(0.052)	(0.049)	(0.076)	(0.079)	(0.046)	(0.045)
ln(Crime)	-0.071	-0.029	-0.048	0.017	-0.170	0.048	-0.044	0.019
	(0.161)	(0.118)	(0.157)	(0.129)	(0.308)	(0.237)	(0.151)	(0.143)
ln(Employment Size)		0.109 ***		0.130 ***		0.138 ***		0.122 ***
		(0.012)		(0.013)		(0.024)		(0.013)
ln(Firm Age)		-0.035		-0.012		-0.028		-0.030
		(0.024)		(0.022)		(0.054)		(0.025)
Adjusted R squared							0.80	0.81
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	862	862	862	862	862	862	862	862

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 2.92***.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Appendix 3.B Table 1c Explaining productivity in the Equipment and Machinery industry

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
Dependent variable: ln(Total factor productivity)	Quantile regression												OLS			
	$\tau = 0.2$				$\tau = 0.5$				$\tau = 0.8$							
ln(Number of power outage)	-0.003		-0.043		-0.144	***	-0.106	**	-0.190	***	-0.064		-0.119	**	-0.089	**
	(0.064)		(0.054)		(0.053)		(0.047)		(0.066)		(0.061)		(0.047)		(0.038)	
ln(Overdraft)	0.828	*	1.077	***	1.085	***	0.961	***	0.994		0.484		1.126	***	0.958	***
	(0.458)		(0.404)		(0.355)		(0.282)		(0.628)		(0.446)		(0.359)		(0.283)	
ln(Import custom clearance time)	0.332	***	0.177		0.316	***	0.178	**	0.213		0.224	**	0.284	***	0.235	***
	(0.101)		(0.107)		(0.091)		(0.078)		(0.145)		(0.102)		(0.077)		(0.067)	
ln(Export custom clearance time)	-0.276	***	-0.150	*	-0.313	***	-0.099		-0.328	***	-0.194	**	-0.323	***	-0.191	***
	(0.088)		(0.087)		(0.073)		(0.071)		(0.127)		(0.079)		(0.069)		(0.057)	
ln(Employment Size)			0.534	***			0.560	***			0.546	***			0.535	***
			(0.039)				(0.031)				(0.041)				(0.028)	
ln(Firm Age)			-0.190	***			-0.223	***			-0.276	***			-0.220	***
			(0.055)				(0.04)				(0.08)				(0.039)	
Adjusted R squared													0.91		0.94	
Region dummies	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Number of observations	927		927		927		927		927		927		927		927	

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is not rejected with F-stat = 0.98.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Appendix 3.B Table 2a Explaining productivity in the Apparel industry for small private firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	0.009	-0.255	-0.254	-0.218	-0.260	-0.112	-0.223	-0.233 *
	(0.229)	(0.189)	(0.247)	(0.331)	(0.291)	(0.345)	(0.143)	(0.128)
ln(Overdraft)	1.006	-0.120	0.215	-0.487	-0.915	-1.481	0.278	-0.762
	(0.862)	(0.801)	(0.932)	(0.996)	(1.54)	(1.483)	(0.602)	(0.602)
ln(Import custom clearance time)	-0.133	-0.147	-0.351	-0.264	-0.225	0.069	-0.267	-0.160
	(0.341)	(0.288)	(0.34)	(0.553)	(0.467)	(0.573)	(0.213)	(0.194)
ln(Export custom clearance time)	0.181	0.095	0.158	0.062	0.089	0.019	0.076	0.001
	(0.254)	(0.193)	(0.274)	(0.255)	(0.37)	(0.355)	(0.133)	(0.121)
ln(Employment Size)		0.187 **		0.204 ***		0.186		0.245 ***
		(0.073)		(0.066)		(0.152)		(0.063)
ln(Firm Age)		-0.108		-0.163 *		-0.274		-0.122
		(0.117)		(0.086)		(0.179)		(0.087)
Adjusted R squared							0.14	0.31
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	73	73	73	73	73	73	73	73

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is not rejected with F-stat = 0.45.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Appendix 3.B Table 2b Explaining productivity in the Textiles industry for small private firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	-0.075	-0.059	-0.117 **	-0.104 *	0.016	-0.063	-0.035	-0.037
	(0.056)	(0.057)	(0.056)	(0.06)	(0.139)	(0.16)	(0.084)	(0.081)
ln(Overdraft)	0.358	0.420 *	0.579 **	0.550 **	-0.293	-0.535	0.505 *	0.453
	(0.288)	(0.248)	(0.241)	(0.264)	(0.704)	(0.621)	(0.298)	(0.308)
ln(Import custom clearance time)	-0.034	-0.017	-0.182	-0.213	-0.335	-0.523	-0.141	-0.142
	(0.074)	(0.074)	(0.12)	(0.142)	(0.289)	(0.32)	(0.11)	(0.116)
ln(Export custom clearance time)	0.055	0.043	0.209 *	0.215	0.205	0.285	0.176	0.173
	(0.093)	(0.096)	(0.119)	(0.138)	(0.27)	(0.278)	(0.121)	(0.126)
ln(Crime)	-0.216	0.025	0.424	0.321	0.477	1.468	0.605	0.755
	(0.332)	(0.299)	(0.409)	(0.368)	(1.047)	(1.096)	(0.472)	(0.472)
ln(Employment Size)		0.098 **		0.035		0.189		0.132 **
		(0.042)		(0.058)		(0.144)		(0.064)
ln(Firm Age)		-0.019		-0.015		-0.062		-0.080
		(0.061)		(0.08)		(0.212)		(0.094)
Adjusted R squared							0.89	0.89
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	166	166	166	166	166	166	166	166

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is rejected with F-stat = 8.45***.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

Appendix 3.B Table 2c Explaining productivity in the Equipment and Machinery industry for small private firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: ln(Total factor productivity)	Quantile regression						OLS	
	$\tau = 0.2$		$\tau = 0.5$		$\tau = 0.8$			
ln(Number of power outage)	0.161 *	0.110	0.069	0.037	0.096	0.063	0.030	0.023
	(0.096)	(0.079)	(0.077)	(0.097)	(0.13)	(0.114)	(0.08)	(0.08)
ln(Overdraft)	0.075	0.543	0.579	0.447	1.190	0.543	0.767	0.827
	(0.983)	(0.956)	(0.69)	(0.694)	(0.856)	(0.699)	(0.611)	(0.59)
ln(Import custom clearance time)	0.276 *	0.356 **	0.357 **	0.370 **	0.347 **	0.279	0.297 **	0.271 **
	(0.151)	(0.152)	(0.157)	(0.163)	(0.169)	(0.176)	(0.119)	(0.12)
ln(Export custom clearance time)	-0.136	-0.217	-0.131	-0.201	-0.220 *	-0.016	-0.190 *	-0.155
	(0.16)	(0.153)	(0.145)	(0.148)	(0.114)	(0.131)	(0.1)	(0.103)
ln(Employment Size)		0.331 **		0.247 **		0.416 ***		0.311 ***
		(0.142)		(0.115)		(0.123)		(0.089)
ln(Firm Age)		0.076		0.121		0.016		0.043
		(0.119)		(0.131)		(0.137)		(0.103)
Adjusted R squared							0.97	0.97
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	211	211	211	211	211	211	211	211

Notes: Standard errors are shown in the parentheses. The null hypothesis of equal slopes is not rejected with F-stat = 0.87.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.