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Firm Dynamics and Regional Inequality of Productivity in China

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Abstract

Industrial change processes are underlying forces that determine the change of regional productivity. In developed market economies, less productive firms are more likely to exit while productive firms have more chance to enter and to survive. As a result, spatial inequality of firm dynamics will directly influence the inequality of regional productivity. This study investigates how firm dynamics would affect regional productivity using firm level data during 1998-2007 in China. We first estimate total factor productivity (TFP) for each firm based on the semi-parametric method proposed by Olley and Pakes (1996). Regional productivity is derived by weighing the firm TFP using gross industrial output. There is considerable spatial inequality of TFP paired with a trend of convergence over the time period of 1999-2007. Decomposition of TFP growth shows that firm entry, exit and survival do contribute to TFP change and their contributions vary across prefectures substantially. The between share holds the largest regional difference, as the most important factor contributing to the spatial inequality of regional TFP. The restructuring of SOEs has critically contributed to the spatial inequality of TFP by raising TFP in the traditional industrial bases and by facilitating the development of productive private and foreign sectors particularly in the coastal region. The finding indicates that resource reallocation across firms with different ownerships is the key mechanism to improve regional productivity.

Key Words: Firm Dynamics, Regional Inequality, TFP, Decomposition Method, China

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Introduction

Regional inequality is an important topic of academic inquiry and is one of the major concerns that governments face as it has the potential to threaten national unity and social stability. The trends and forces underlying regional inequality have been the subject of heated debates(Wei and Liefner 2012; Yuen Tsui 1991; Williamson 1965; Lewis and Williams 1981; Hudson 2007; Pike and Tomaney 2009). However, the research findings are inconclusive since regional inequality is sensitive to geographical scale and influenced by multiple mechanisms, and global contexts(Wei 2002; Wei and Ye 2009; Liao and Wei 2012; Zhang and Zhang 2003; Wei, Yu, and Chen 2011). More recently, scholars have examined the effects of agglomeration, capital factor, technology, infrastructure on regional inequality under the context of institutional change and globalization (Florida and Kenney 1988; Malecki 1997; Wei and Liefner 2012; Wan, Lu, and Chen 2007; Huang and Wei 2015; Wei, Yu, and Chen 2011; Wei 2007; Wei 2001; Ye and Wei 2012).

Analysis of regional gaps in output levels requires a comparative evaluation of the quantity of inputs injected and their contribution to output. Growth accounting allows us to identify to what extent the output or growth rate of a given region is due to the accumulation of inputs, and to what extent it is due to Total Factor Productivity (TFP). The Solow (1957) measure of productivity (which is labeled as 'residual' or total factor productivity (TFP)), defined as the rate of output per unit of an aggregate measure of input, is popular among productivity studies. Literature has shown that TFP have contributed significantly to economic growth (Borensztein and Ostry 1996; Baier, Dwyer, and Tamura 2006).

TFP exerts a powerful influence on economic development not only directly, but also indirectly, through its effect on physical and human capital accumulation(Bosworth and Collins 2007; Young 1992, 1994; Kim and Lau 1994; Hsieh and Klenow 2007) . TFP estimation by far is based on production function and growth accounting methodology. Many studies decompose TFP growth into technical efficiency change, technical change and scale effect components, and show that productivity growth was driven mainly by technical changes (Nishimizu and Page 1982; Kumbhakar, Denny, and Fuss 2000; Kim and Han 2001). Alternatively, reallocation dynamics may be vital for TFP growth if new technologies can only be implemented by new and growth firms, or if this implementation is inherently a noisy process with much trial and error which is associated with success and failure(Foster, Haltiwanger, and Syverson 2005). Under this alternative view, the dynamics of technological changes and productivity growth will be closely connected to the reallocation of production factors across firm– dynamics.

Research about the relationship between firm dynamics and TFP growth has shown that a substantial fraction of aggregate productivity growth can be associated

with the reallocation of outputs and inputs from less productive to more productive firms. Disney, Haskel, and Heden (2003) argues that firm dynamics can raise overall productivity in two ways. First, productivity can grow due to changes within existing firms, such as the introduction of new technology and organizational change(Eslava et al. 2004; Disney, Haskel, and Heden 2003; Dosi and Nelson 2010; Young 1992; Griliches and Regev 1995). The second source of productivity growth is the process of market selection, whereby low productivity firms exit and are replaced by higher productivity entrants (Disney, Haskel, and Heden 2003; Lee and Mukoyama 2008; Aghion et al. 2004; Masso, Eamets, and Philips 2004; Aw, Chen, and Roberts 2001). The second process is characterized by creative destruction that Schumpeter (1939,1942) identified as the driving force of economic growth.

A growing empirical literature exploring the link between firm dynamics and productivity has emerged in the last decade. In the United States, Foster, Haltiwanger, and Krizan (2001) decompose aggregate productivity growth into within effect, between effect, cross share, and net entry share to explore contribution of the reallocation in manufacturing industries. They find that productivity growth is accounted for by more productive entrants displacing much less productive firms in the retail trade sector. In Estonia, Masso, Eamets, and Philips (2004) show that the high productivity growth has been mostly from within-firm component, but the reallocation of production factors (especially the exit of low productivity units) has played an important role as well. In Taiwan, Aw, Chen, and Roberts (2001) show that entering and exiting firms accounting for as much as one-half of industry-level productivity growth in some manufacturing industries. In the United Kingdom, Disney, Haskel, and Heden (2003) find that firm dynamics accounts for 80-90% of establishment TFP growth, and much of the effect comes from firms closing down poorly-performing plants and opening high-performing new ones. Overall, industrial dynamic through resource reallocation has contributed to TFP growth, which is also the source of regional inequality. The size of this contribution is an empirical question, but is potentially important in rapidly growing economies, especially in transitional regimes.

Many studies on productivity in developed economies ignore the key role of the institutions. Market forces facilitate the process of resource reallocation, whereas little attention has been directed towards transitional economies. Well-functioning market economies appear to exhibit rapid rates of resource reallocation across production units(Brown and Earle 2004). Few studies have explored the relationship between resource allocation and TFP, and the effect on regional inequality in developing economies(Hsieh and Klenow 2007; Li 2009; Bosworth and Collins 2007). Being the fastest developing economy, China has experienced an increasingly market-based economy transformations since the launch of economic reforms in 1978 (Wei 2001; He, Wei, and Xie 2008). The economic transformation makes China a fertile ground for broadening the investigation of connection between firm dynamics and productivity growth.

Regional allocation and mobility of resources have been an important part of China's reforms. China has followed an investment-driven and export-oriented growth

model in the last three decades (Yu 1998; Liu, Burridge, and Sinclair 2002). A popular argument is that there is only modest growth in efficiency, with just growth driven by inputs, indicating that such a highly-invested extensive growth is not sustainable (Krugman 2015; Young 2000). Borensztein and Ostry (1996) and Bosworth and Collins (2007) have shown that China has achieved an average annual TFP growth rate of about 3%. The gradual, experiential, and uneven transition, however, results in spatial inequality of the resource reallocation capability, which is also the source of uneven TFP growth in China. The existing literature on productivity growth in China is mainly based on aggregate or sectoral data. Fleisher and Chen (1997) show that inferior factor productivity in China's noncoastal provinces is a principal reason for their lower economic growth and TFP is roughly twice as low in the coastal provinces. Brandt et al.(2012) is the first to link industrial dynamic with total TFP growth in China and report that net entry accounts for over two thirds of total TFP growth over 1998-2007. It is evident that TFP in China differs across regions and contribute to regional inequality in economic development. No studies have connected firm dynamics with aggregate TFP growth at the city level and examine the source of TFP growth at the micro level. The link would significantly enrich the understanding of sources for regional inequality in China.

Based on China's Annual Survey of Industrial Firms (ASIF) (1998-2008), this study thus aims to close the gap by assessing the spatial inequality of regional TFP and the sources of regional TFP growth based on firm dynamics. We quantify the inequality of regional TFP using traditional inequality indices and map the spatial distribution of regional TFP. We extend the decomposition method of TFP proposed in Foster, Haltiwanger, and Krizan's (2001) to explore the role of firm entry, exit, and survival in productivity growth. Special attention will be paid to the role of economic transformation in China's widening regional TFP inequality.

This article makes three contributions to the existing literature. First, we shed light on the understanding of regional inequality by exploring the spatial inequality of productivity. Second, we extend the decomposition method of TFP to link firm dynamics and productivity change, identifying the sources of productivity change at the micro-level. Third, we extend Foster, Haltiwanger, and Krizan's (2001)'s theoretical models to allow for the restructuring of SOEs to play a role in the TFP decomposition and find that resource reallocation by SOEs restructuring indeed has contributed to China's regional TFP inequality significantly.

This paper is organized as follows. Following the introduction, the next section will present the data, methods and then report the overall inequality and spatial distribution of regional TFP. The fourth section applies the decomposition method to explore the effect of firm dynamics on TFP growth in China over a multi-year horizon. The fifth section will report this relationship at the city level over 1999-2007 and explore the sources of this inequality. This paper concludes with the summary of empirical findings.

Data Source and Methodology

Data Source

Data are from China's Annual Survey of Industrial Firms (ASIF) (1998-2008). The ASIF is maintained by the National Bureau of Statistics of China and covers all state-owned enterprises and non-state-owned enterprises with annual sales of five million RMB or more in China. The database provides detailed firm-level data with many indicators, including firm name, location, capital structure, exported shipments, intermediary inputs, asset value, employment, sales value, type of investment, output, value added, and wages, among others. But this dataset suffers some problems, such as missing data on indicators, vague definition of variables and measurement errors, we have adopted a systematic method, developed by Brandt, Van Biesebroeck, and Zhang (2012) to clean this dataset and delete some incomplete items.

Estimation and Decomposition of TFP

This study will explore the spatial inequality of regional TFP. The key task is to estimate firm TFP. TFP is the difference of output growth rate and the weighted average of growth rate of input factors. It assumes the contribution from technological progress or institutional changes. TFP is often estimated using the C-D production function with constant return to scale. This estimation however suffers from endogeneity issues derived from simultaneity and selection bias. Olley and Pakes (1996) develop a three-step regression model (the OP model) to solve the endogeneity issues. This study follows the OP model to estimate the TFP of Chinese firms. A detailed description of TFP estimations is reported in Yang and He(2014). Based on the estimated firm TFP, we generate the annual average regional TFP. The often-used method is to weigh the firm TFP to compute the average TFP(Brandt, Van Biesebroeck, and Zhang 2012; Hsieh and Klenow 2009). We use the share of industrial output to weight firm TFP.

Many studies provide the implications of the pace of reallocation and restructuring for productivity growth. Foster, Haltiwanger, and Krizan (2001) propose three methods to decompose the source of TFP growth. This study also considers the cross sectional decomposition method of productivity as follow,

$$TFP_{i,\mathrm{t}} = \sum_{e} TFP_{e,t} * \frac{s_{e,t}}{\sum_{e} s_{e,t}}$$

where *i*, *e*, and *t* denote city, firm, and year, respectively. $TFP_{i,\mathrm{t}}$, is the average weighted TFP in city i year t, $TFP_{e,\mathrm{t}}$ measured as the TFP in firm e in year t, $s_{e,t}$ is the industrial output in firm e in year t. Then, we decompose the regional TFP into five parts as follow:

$$\Delta TFP_{i,\mathrm{t}} = \sum_{e\in \mathrm{C}} w_{\mathrm{e,t-1}} * \Delta TFP_{e,\mathrm{t}} + \sum_{e\in \mathrm{C}} (TFP_{e,\mathrm{t-1}} - TFP_{i,\mathrm{t-1}}) * \Delta w_{\mathrm{e,t}}$$

$$+ \sum_{e\in \mathrm{C}} \Delta w_{\mathrm{e,t}} * \Delta TFP_{e,\mathrm{t}} + \sum_{e\in \mathrm{N}} (TFP_{e,\mathrm{t}} - TFP_{i,\mathrm{t-1}}) * w_{\mathrm{e,t}}$$

$$- \sum_{e\in \mathrm{X}} (TFP_{e,\mathrm{t-1}} - TFP_{i,\mathrm{t-1}}) * w_{\mathrm{e,t-1}}$$

$$w_{\mathrm{e,t}} = \frac{s_{e,t}}{\sum_e s_{e,t}}$$

where *C, N and X* denote survivors, entrants and exiting firms, respectively. The first term in this decomposition represents a within-firm component based on the firm-level TFP change, weighted by the initial share in the city. The second term represents a between-firm component that reflects the changing share, weighted by the deviation of initial firm productivity from the initial regional index. The third term represents a cross share based on the firm-level TFP change, weighted by the changing share, indicating the dynamic shift effect of surviving firms. The last two terms represent the contribution of entrants and exiting firms, respectively. This decomposition differs somewhat from others that combine those two shares into net entry share in the literature in some subtle but important ways.

The second and third term capture the reallocation of market and other resources among the surviving firms, termed as the resource allocation share. The cross share is crucial, especially, in transitional economies. There are more rooms for firm growth, both in share and TFP in the transformation period. This share is mainly to identify the resource reallocation effect. The increase in this share contributes to productivity growth even the productivity is low than initial regional average. If regional productivity growth is primarily driven by productivity improvements of incumbents, then the cross effect should dominate. Alternatively, the between share implies that an increase in the share contributes positively only if the firm has higher productivity than average initial regional productivity. Similarly, reallocation works through firm entry and exit. Many studies find that the productivity level helps to predict firm exit (Baily et al. 1992; Olley and Pakes 1996). Low-productivity plants are more likely to exit even after controlling for other factors such as plant size and age. Also, new entrants are likely to become more productive through a redeployment of resources released by firm exit. An exiting firm contributes positively only if the firm has lower productivity than the initial regional average, and an entrant contributes positively only if the firm has higher productivity than the initial regional average.

Following Brandt, Van Biesebroeck, and Zhang's (2012), we consider a firm as entrant in year t, if firm i is reported in the ASIF in year t but not in year t-1. Likewise, if firm i is reported in the ASIF in year t-1 but not in year t, it is assumed that firm i exits in year t. Since ASIF dataset only includes non-state-owned enterprises with annual sales of five million RMB or more besides state-owned enterprises, firm exit is

likely to be slightly overestimated due to the fact that: non-state-owned enterprise that passes the threshold (annual sales of five million RMB or more) in year t but fails to do so in year t+1 will be treated as an exiting firm. Also, firm occasionally is defined as entering or exiting one as a result of restructuring, merger, or acquisition. Nonetheless, this flaw only slightly affects research results. ASIF has been widely used to study firm exit and entry in China (Brandt, Van Biesebroeck, and Zhang 2012; Yang and He 2014).

Inequality of Regional Productivity

Based on the estimated firm TFP, we calculate the annual average regional TFP weighed by gross industrial output at the prefecture level. A variety of indices can measure regional inequality, such as Gini index, Theil's index, and the coefficient of variation (CV). Table 1 shows the descriptive statistics for the sample, including information on the number of prefectures, mean, standard deviation, coefficient of variation, Gini coefficient, and Theil coefficient. There are several observations. First, the mean of regional TFP increased from 2.40 to 3.56 during 1998-2007. Second, The CV, Gini coefficient and Theil's index indicate that the inequality of regional TFP in China has steadily decreased. This suggests that regional productivity has experienced a trend of convergence.

Table 1 Summary Statistics of Regional TFP（1998-2007）

Year	Obs.	Mean	Std.	Min	Max	CV.	Gini	Theil
1998	308	2.40	0.72	-0.32	6.73	0.30	0.16	0.04
1999	338	2.43	0.70	-0.26	6.56	0.29	0.15	0.04
2000	319	2.58	0.75	0.69	6.50	0.29	0.16	0.04
2001	340	2.69	0.69	0.86	6.38	0.26	0.14	0.03
2002	340	2.83	0.74	0.58	6.21	0.26	0.14	0.03
2003	340	2.96	0.74	0.84	5.84	0.25	0.14	0.03
2004	337	3.03	0.74	0.28	5.61	0.24	0.13	0.03
2005	339	3.15	0.80	-0.25	5.60	0.25	0.13	0.03
2006	339	3.39	0.72	-0.76	5.17	0.21	0.11	0.02
2007	338	3.56	0.65	1.75	5.02	0.18	0.10	0.02

The comparison of the TFP distribution across ten years in box graph indicates that average regional TFP has increased with positive changes of TFP during 1998-2007 (Figure 1, left). All the 25th percentile, median percentile, and 75th percentile of regional TFP have increased steadily, revealing that most of prefectures at different productivity level have experienced a significantly increase. Since 2002, average regional TFP has a relative high growth rate due to China's accession of the World Trade Organization in 2001.To be specific, the regional TFP distribution in 1998 has a clear negative skew turning to a positive skew distribution in 2007(Figure 1, right), which indicates that productivity improvements are widespread across most of the prefectures.

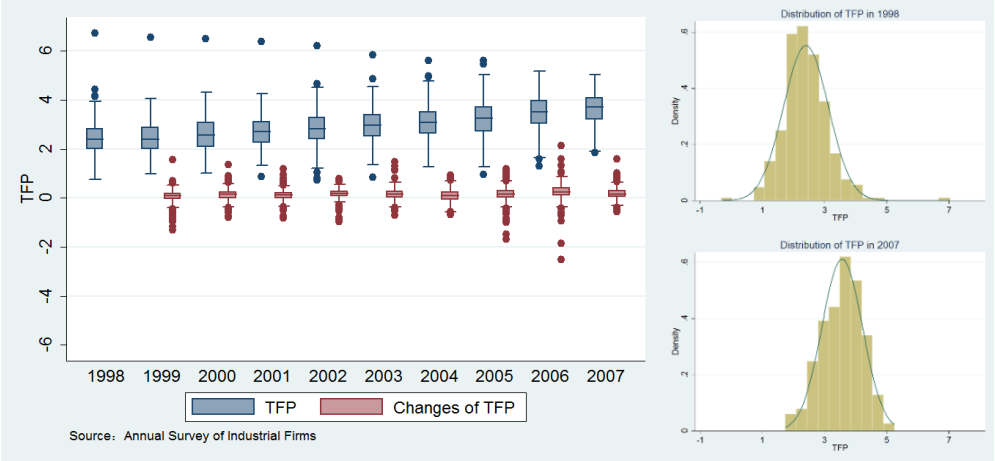


Figure 1 Distribution of Regional TFP in China

There are significant spatial variations in the regional TFP distribution (Figure 2). Firstly, prefectures in three macro-regions all experienced productivity increase during 1999-2007. Secondly, regional TFP differs significantly across the eastern, central, and western China. For the two sample period, prefectures in the eastern region enjoy the highest level of TFP. The central region has the lowest average growth rate, while the western region saw relatively high prefectural TFP and faster TFP change. Thirdly, the average prefectural TFP (the red line) is higher than the median prefectural TFP in the eastern region, indicating that only prefectures, in the 75th percentile in eastern region, have achieved a productivity level higher than the average. Though most of prefectures have experienced productivity improvement, the regional inequality of regional TFP remains outstanding.

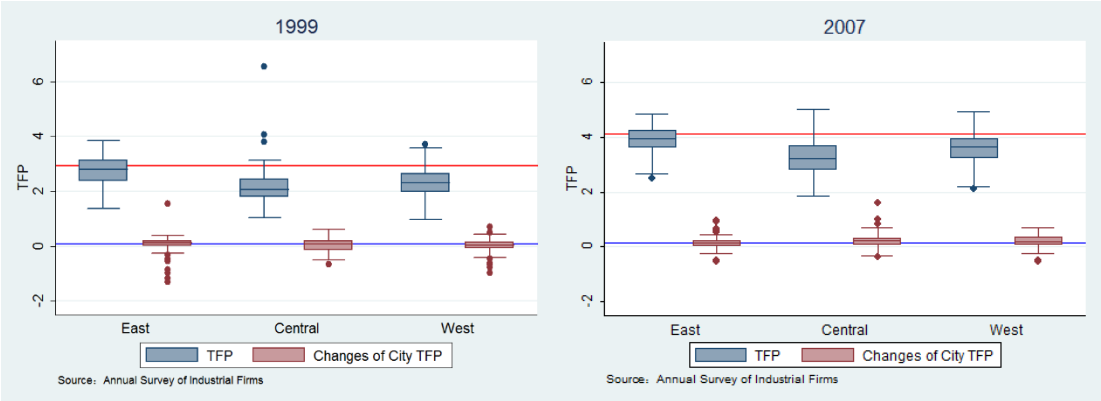


Figure 2 Regional Differences of TFP in China (left: 1999; right: 2007)

Note: the red line is the average regional TFP, the blue line is the average changes of regional TFP

To better understand the geographical patterns of regional TFP in China, we map the spatial distribution of regional TFP at the prefecture level (Figure 3). Prefectural TFP distribution shows a substantial regional difference. In 1999, high TFP was heavily agglomerated in the coastal provinces of Guangdong, Fujian, Shanghai, Jiangsu, Zhejiang, and Shandong. A striking feature is that prefectures in the Pearl

River Delta have enjoyed high TFP, mainly contributed by exporters and foreign firms(Fleisher and Chen 1997). By 2007, high TFP has significantly expanded from the coastal to some inland prefectures, like Chongqing, Chengdu, and Changchun. On the one hand, high TFP in some inland prefectures like Yuxi with small economies and a small number of firms, is mainly contributed by some outstanding productive firms. On the other hand, high TFP in some other prefectures is associated with productive industries. Firm TFP in most industries is higher than the average TFP level in China.

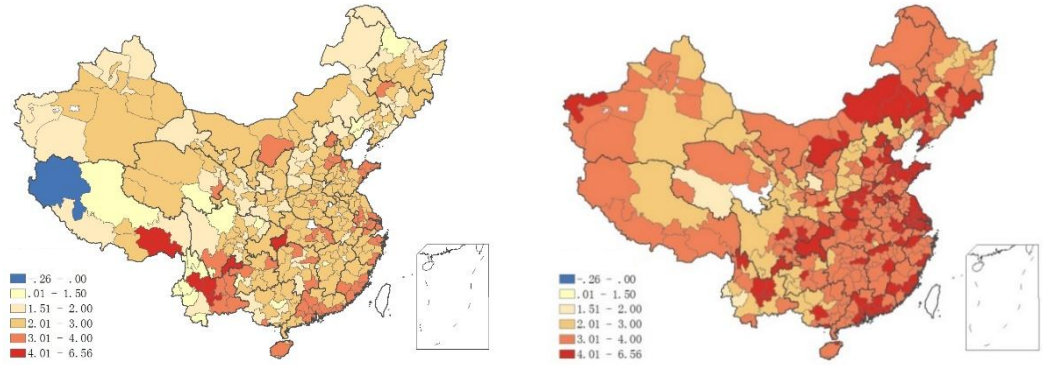


Figure 3 Spatial Distribution of Regional TFP (left: 1999, right: 2007)

Figure 4 shows the prefectural variation of TFP change during 1999-2007. There is considerable spatial differences in prefectural productivity change. The Southeast, the Central and the Northeast China have observed large contiguous areas with productivity growth, while in the coastal region-particularly Pearl River Delta- TFP growth is not outstanding. This indicates that the prefectural variation in TFP growth needs to be understood from a micro perspective and from the perspective of economic transition.

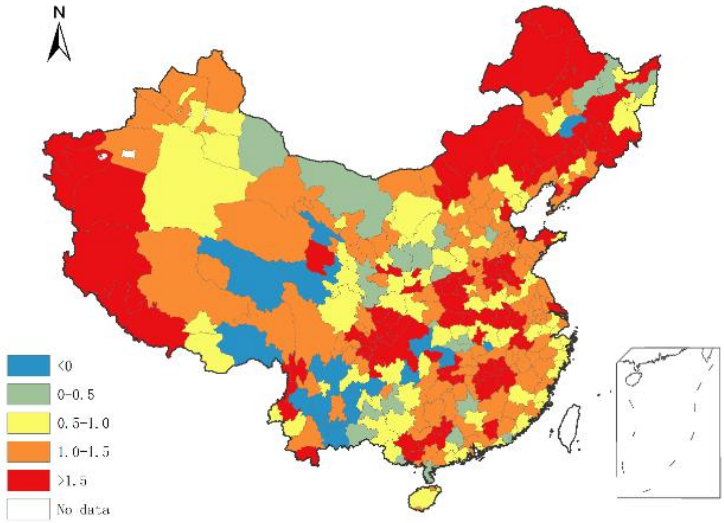


Figure 4 Spatial Distribution of Prefectural TFP Changes

Decomposition of productivity growth in China

We apply the decomposition method to explore the sources of annual TFP growth in China. We decompose the productivity growth into within share, between share, cross share, entry share, and exit share. To understand the source of overall TFP growth in China, we look at the mean of each parts. Also, to shed light on the sensitivity to policy intervention and business cycle, we decompose each component over a multiyear horizon (Table 2 and Figure 5). For the 1999-2007 period, the entry component accounts for more than 68 percent of the average TFP growth in China, which shows a large contribution from the replacement by more productive entrants. Within component explains about one third of average TFP change. Between component is negative but relatively small. Cross share accounts for less than 10 percent of the average TFP change.

Given the time horizon effect(Foster, Haltiwanger, and Krizan 2001), we report five components in two different time periods. Table 2 shows that, entry share accounts for only 44% of the overall productivity growth during 1999-2003. In contrast, within share stands out as the biggest component (account for 46%) during 2003-2007. However, the result is totally different in the annual decomposition shown in Figure 4. It shows that the cross share exerts a predominant influence on TFP growth in every year except 2006, while entry and within share are responsible for less than half of TFP changes. It is also worth noting that exit share shows its creative destruction role with positive term. The small and negative contribution of between component by years is similar when productivity change is measured over four- or ten-year horizons.

Table 2 Decomposition of TFP Growth over Different Periods in China

Years	Within Share(d1)	Between Share(d2)	Cross Share(d3)	Entry Share(d4)	Exit Share(d5)
1999-2007	0.343	-0.056	0.098	0.776	0.031
1999-2003	0.201	-0.006	0.178	0.260	0.050
2003-2007	0.211	-0.086	0.150	0.207	0.026

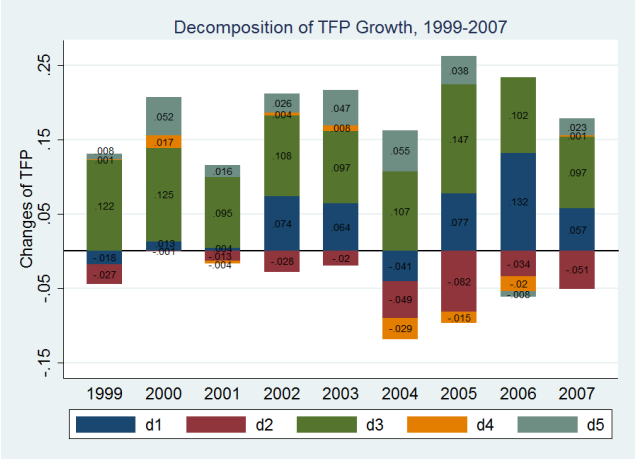


Figure 5 Decomposition of TFP Growth Annually in China, 1999-2007

Within Share

To be specific, the within share (d1), accounting for more than 46 percent of the average TFP change every year during 1999-2007. In other words, on average, firms have become more productive in China, especially during 2003-2007. Figure 6 shows the relative contribution of the within share by ownership for each year. SOEs and private enterprises account for a large share of the within component since 2002. It indeed shows the result of SOEs restructuring. In 1995, the central government decided to further reform SOEs, implementing the policy of "keep the large and let the small go". In the first period, the process of "let the small go" policy has increasingly served as an euphemism for privatization, especially in the case of small firms(Garnaut, Song, and Yao 2006). On the one hand, SOEs began to show the potential in a series of restructuring efforts with the highest TFP growth rate since 2000 (Figure 6, right). On the other hand, the restructured SOEs released a large amount of opportunities for private capital and competitive markets. The reform has encouraged resource reallocation in the industrial sectors and improved productivity.

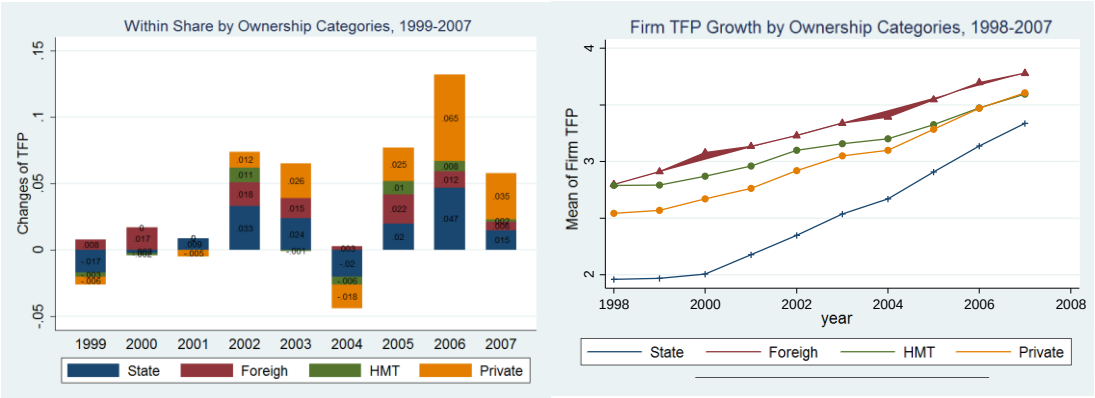


Figure 6 Within Share (left) and Firm TFP growth (right) by ownership, 1999-2007

Between Share

The between share (d2) is negative and relatively small, suggesting that TFP increase has been associated with a process through which productive firms (above average regional TFP) are downsizing faster than the upsizing of less productive firms. This implies that resource reallocation is not in the most optimized way. We categorize firms into productive firm (above average regional TFP) and less productive firm (below average regional TFP). We also categorize firms into downsizing firm ($\triangle w<0$) and upsizing firm($\triangle w>0$) based on the changes of output. Based on the two dimensional classification, we can classify firms into four types. We name them A, B, C and D (Table 3). More than half of firms belong to the categories of C and D, indicating there are more productive firms upsizing (D), and less productive firms downsizing (C). The explanation for the negative d2 is that the contribution of less productive firms are downsizing (0.528) less than upsizing (-0.602). This is reasonable in a large transitional economy with an enormous growth potential. This result is similar to the finding of manufacturing sector in Foster,

Haltiwanger, and Krizan(2001), but inconsistent with the results in retail sector in the United States (Foster et al., 2006). The negative contribution of the between share also shows that resource reallocation is still not in the most optimal state, and demands for further reform.

Table 3 Classification of TFP Growth by Between Share, 1999-2007

	d2<0 △w<0	d2<0 △w>0	d2>0 △w<0	d2>0 △w>0
	A	B	C	D
Number of firm	222620	374886	539042	140995
Mean of △w	-2.58E-06	1.40E-06	-9.98E-07	2.86E-06
Mean of TFP changes	0.676	-1.150	-1.110	0.650
d2	d2_1	d2_2	d2_3	d2_4
-0.305	-0.643	-0.602	0.528	0.411

Cross Share

The cross share tells how much of the productivity change is correlated with the output change. The contribution of cross share is sensitive to the time period. The positive and relatively large cross share indicates that firms become larger and more productive at the same time. However, the positive cross term accounts for smaller share in a longer time horizon. This result is also demonstrated from the existing findings, including Foster, Haltiwanger, and Krizan(2002), Baily et al.(1992) and Haltiwanger, Lane, and Spletzer(1999). We calculate the contribution of firms with different ownerships to capture the source of cross effect, including SOEs (and collectively owned enterprises), foreign enterprises, private enterprises, and Hong Kong, Macao and Taiwan enterprises (Figure 7, left). The definition of firm ownership is based on the sources of firm capital. SOEs were the largest contributor to the change of cross share during 1999-2002. The contribution of private enterprises has been significantly higher than SOEs since 2003, which is also the result of SOEs restructuring. Statistically, more than 86 percent of industrial SOEs had been restructured by the end of 2001, and about 70 percent had been partially or fully privatized. The restructured SOEs declined to less than10% in 2002 (Figure 7, right). Foreign enterprises contributed about 11-26% while HMT enterprises accounted for about 9-13% during 1999-2007. Resource reallocation works better in the private and foreign sectors than the state sector in the transformation period.

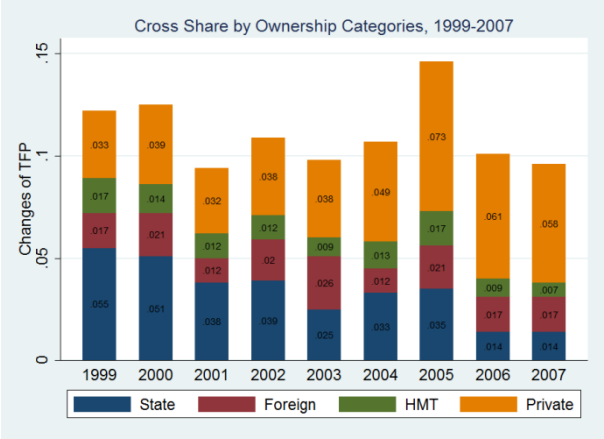


Figure 7 Cross Share by Ownership, 1999-2007

	Firm restructured	Percent （%）
1999	18280	13.80
2000	17660	13.59
2001	15453	10.80
2002	14642	9.66
2003	14207	8.55
2004	11850	5.25
2005	10641	4.70
2006	9226	3.64
2007	8028	2.83

Entry Share

The results in table 2 clearly show that the entry share dominated productivity growth during 1999-2007. The contribution of entry is far more important in China than in the United States. On the one hand, there are larger productivity gap between entrants and exiting firms in China. On the other hand, as Brandt, Van Biesebroeck, and Zhang (2012) pointed that the substantial output share increases for the most productive incumbents in the United States do not count anymore in the productivity contribution of surviving firms. When we examine ten-year or four-year changes, the entry share plays a less important role in accounting for aggregate productivity growth. As a result of SOEs restructuring, increasing high productivity private and foreign enterprises enter the Chinese market, resulting in the largest contribution of productivity growth over a long horizon. However, for annual changes, this contribution is smaller. Davis, Haltiwanger, and Schuh (1996) report that about 20 percent of job destruction and 15 percent of job creation can be accounted for by entry and exit for annual change in the United States. For five-year changes, Foster, Haltiwanger, and Krizan (2001) report that about 26 percent of average industry change are accounted for by net entry in the US. For ten-year changes, the same study reports that about 44 percent of average industry creation and 61 percent of destruction are accounted for by entry and exit, respectively.

Exit Share

The contribution of exit share is relatively small over 1999-2007. The exiting firms tend to be small in starting year and have small productivity change in a longer horizon. However, the evidence seems a little different over one year horizon in figure 5. The role of exit is far more important, especially during 1999-2001, which is the second largest source of TFP growth. In 2000 and 2003, the exit component accounted for about 25% and 20% of productivity growth, respectively. The restructuring of SOEs in the 1990s was one of the key achievements in the transition period. Both the central and local governments began to transform SOEs into limited liability enterprises and adopted a policy called ‘grasp the big, release the small’

(Walder, Luo, and Wang 2013) to maintain the state control of large firms in vital industries (e.g., Petroleum, aerospace) while allowing the privatization of medium and small SOEs. The highest exit rate of SOEs (more than 50%) is the key period of SOEs restructuring during 1999-2001. Also, those exiting SOEs are in among the lowest TFP during 1999-2007. The SOEs reform has resulted in the exit of a large number of SOEs and the exit share turns important in later time period.

Table 4 Exiting Firms by Ownership, 1999-2007

	Percent of exiting firms (%)				TFP of exiting firms			
	SOEs	FID	HMT	Private	SOEs	FID	HMT	Private
1999	64.34	3.74	6.57	25.36	1.80	2.74	2.71	2.48
2000	61.53	3.84	4.90	29.74	1.93	2.86	2.76	2.56
2001	56.01	3.62	5.51	34.87	1.88	3.00	2.81	2.64
2002	49.35	4.94	5.72	40.00	2.17	3.09	2.92	2.78
2003	44.78	4.81	5.34	45.07	2.32	3.16	3.06	2.89
2004	36.08	5.61	6.77	51.55	2.52	3.28	3.14	3.01
2005	21.75	6.47	6.44	65.34	2.63	3.31	3.13	3.07
2006	21.19	7.71	8.07	63.04	2.87	3.47	3.28	3.20
2007	20.56	8.00	7.63	63.82	3.09	3.62	3.43	3.38

Decomposition of Regional TFP Growth

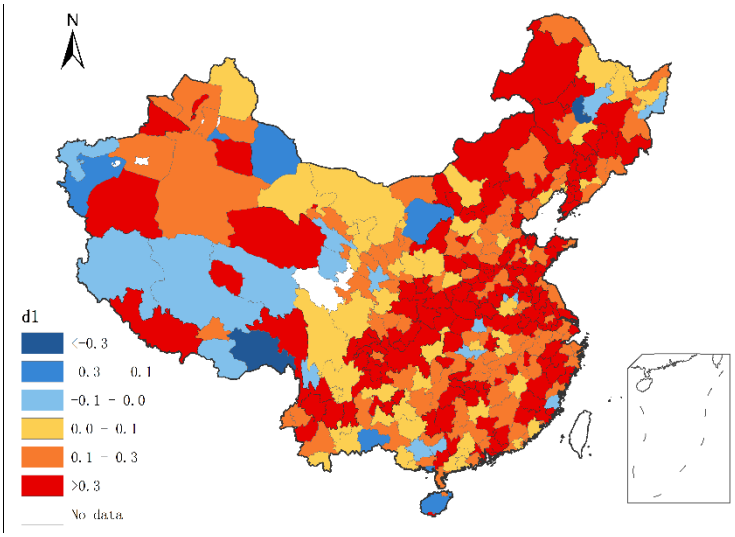
This section makes an effort to explore the source of regional TFP growth inequality by decomposing firm dynamics over the time period of 1999-2007.

Growth of Incumbent's TFP: Within Share

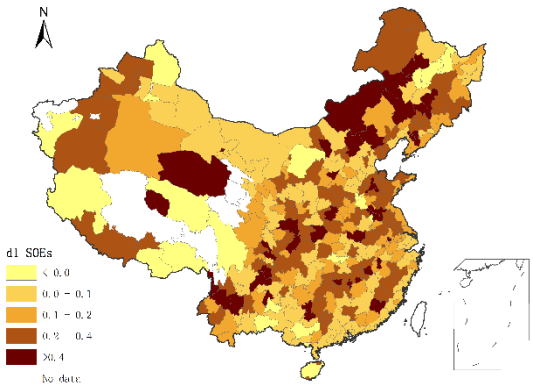
The relative contribution of the within share for each prefecture is mapped in figure 8. The within share accounts for a large share of the regional TFP inequality for many prefectures, especially in Chengdu-Chongqing region, Yangtze River delta, Pearl River delta, and the northeast China (figure 8, A). Those regions are the preferential locations of manufacturing industries in China during the transformation period (He, Wei, and Pan 2007). Based on the above discussion, we know that SOEs and private enterprises are the main contributors of the within share change.

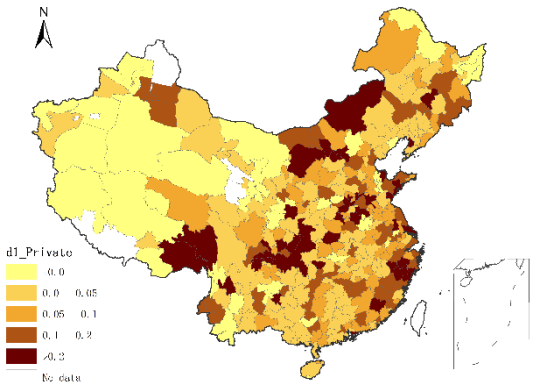
We decompose the within share further by ownership. Figure 8B and 8C show that SOEs and private enterprise play important roles in different prefectures. The similar spatial pattern of within share (figure 8, A) and contribution of SOEs (figure 8, B) also indicates that the restructuring of state-owned firms is one driver for this inequality, which is consistent with the result of Brandt, Van Biesebroeck, and Zhang (2012). SOEs is a significant source of the within share in northeast China, Chengdu and Chongqing region. By contrast, private enterprises are more important in coast regions. This evidence is consistent with the spatial pattern of ownership restructuring in China. China has exhibited drastic geographical disparities in the extent of ownership transformation and ownership structure, which have significantly contributed to the rise of the coast-interior divide(Wei 2004). Coastal prefectures in

general are less controlled by SOEs. Many interior cities, especially in northeast China, still host many SOEs. This has led to the emergence of two "Chinas": the coastal China, dominated by the nonstate sector, and the rest of China, dominated by SOEs(Wei 2004).



A. Within Share





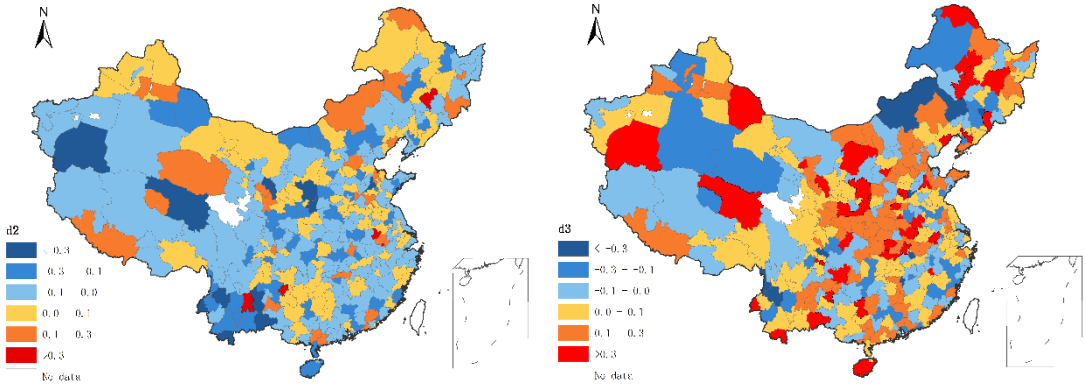
B. SOEs C. Private Enterprises

Figure 8 Distribution and Contribution of within Share over 1999-2007

Resource Reallocation Between Surviving Firms: Between- and cross- share

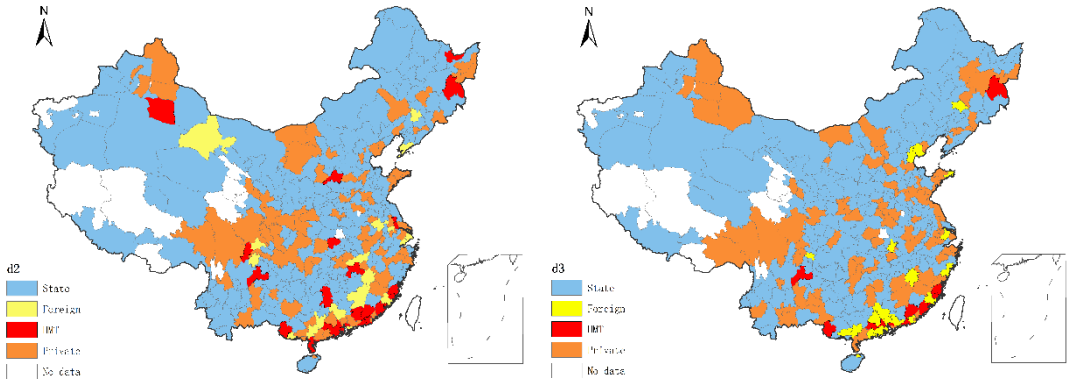
The between and cross share represent the resource reallocation between productive and less productive surviving firms in terms of the size and productivity change. Overall, those two shares have a relative small explanatory power for inequality of regional TFP over 1999-2007. Most prefectures observe a negative between-share. Positive contribution occurs not only in some coastal cities but also in some inland cities. Positive cross-share can be observed in Shannxi-Gansu area, Heilongjiang, Hebei, Henan, Hubei, and Hunan. Most of them are the old industrial bases. Prefectures with negative between-share but positive cross-share are located in southeast, southwest, and central China. This indicate that less productive firms are experiencing productivity and output growth in those regions accompanying with resource reallocation.

Before reform in the early 1980s, China experienced many “civil wars” for market protection of resources, which block up flow of resource factors. Among them, the most notable were wars for wool between Xinjiang, Inner Mongolia and Shanghai, Jiangsu and other eastern regions; wars for silk, cotton and tea, rosin, sugar cane, milk (Forster 1991; Zhang et al. 1991; Watson and Findlay 1992). In the last three decades, reforms have ushered in a host of forces that may potentially enhance efficiency in the spatial allocation of resources (Brandt and Rawski 2008). Actually, those old industrial bases are the representatives of mobility improvement of resource reallocation. We further decompose the between and cross share by ownership (Figure 10). SOEs contribute to most prefectures, not only in the coastal region, but also in some inland areas. SOEs represent the local jurisdictions force. SOE reform have opened up new channels for resource mobility, reflecting market forces. Under the reforming of nation force, and releasing of marketing force, SOE reform play an important role, especially in those old industrial bases. Foreign enterprises contribute in southeast China, while HMTs are dominant in the Pearl River Delta. This pattern is also consistent with the distribution of FDI, which is disproportionately concentrate in costal mega-city regions including the Yangtze River Delta, the Minnan Delta, the Pearl River Delta, the Shandong Peninsula, and the Liaodong Peninsula. (He 2002; He 2003a; He 2003b; He and Xiao 2011). HMTs favors the Pearl River Delta, especially cities in Guangdong, Fujian province(He, Chen, and Zhou 1997).



A. Between Share B. Cross Share

Figure 9 Distribution of Surviving Reallocation Share over 1999-2007

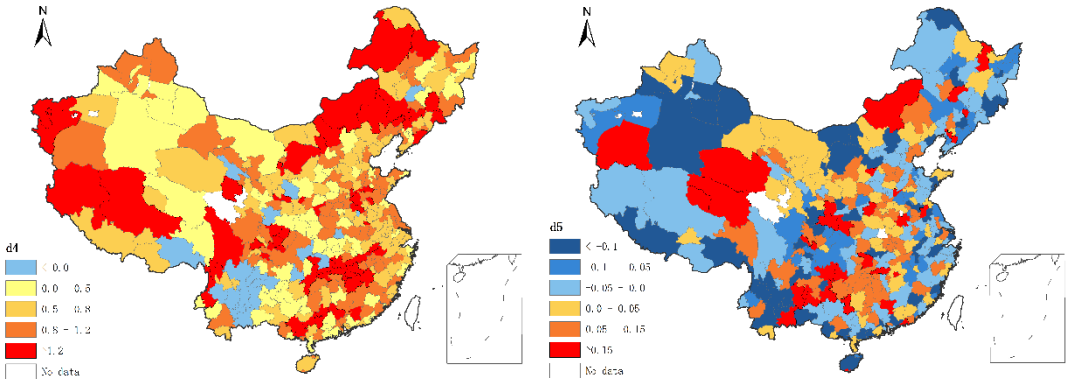


A. Between Share B. Cross Share

Figure 10 Distribution of Reallocation Share between Surviving Firms by Ownership over 1999-2007

Dynamics of Firm Entry and Exit: Entry- and Exit- Share

As noted in the previous discussions, firm entry plays the most important role in accounting for aggregate TFP growth over 1999-2007. Overall, in the east of Inner Mongolia, Sichuan, Chongqing, and Hunan, Jiangxi, and Guangxi, TFP growth in those areas are mainly contributed by the entry share(Figure 11, A). As Guo, He, and Li (2015) also show that cities in Shandong province, the inland of Fujian province, the north of Liaoning province and the regions along the Yangtze River experience significant growing trend of entrepreneurship. Industrial relocation can explain this spatial pattern. Since the early 2000s, the coastal region has confronted by a number of challenges, including labor shortages, slackening global demand especially after the outbreak of the financial crisis, appreciation of China's currency(Henderson and Nadvi 2011). Industries, especially traditional light industries gradually relocate to the inland provinces(He and Wang 2010). By contrast, the exit share makes the large contribution in the central and southwest China (Figure 11, B). Those are also the destination of industrial relocation, indicating that creative destruction process works in non-coastal regions through entry of productive firms and exit of unproductive ones.



A. Entry Share B. Exit Share

Figure 11 Distribution of Entry and Exit Share Over 1999-2007

We further compute the Gini coefficient and Theil index for the five shares. Table 5 report the Gini coefficient and Theil index for the regional inequality in the within share (d1), the between share (d2), the cross share (d3), the entry share (d4) and the exit share (d5). The between share (d2) has the largest Gini coefficient and Theil index, suggesting that the between share bears the largest regional difference, as the most important factor contributing to the spatial inequality of regional TFP. The cross share (d3) and the exit share (d5) rank the second and the third. The entry share (d4) has the smallest spatial inequality, indicating that the entry effect contributes to the TFP growth in most regions so that it is the least important factor contributing to the spatial inequality of regional TFP.

Table 5 Inequality of Decomposition Components Over 1999-2007

	d1	d2	d3	d4	d5
Gini	0.390	0.566	0.518	0.301	0.486
Theil	0.253	0.570	0.479	0.152	0.400

Conclusion

Regional productivity is a critical factor contributing to regional economic performance and thereby linked to regional inequality in economic performance. In the competitive market, less productive firms are more likely to exit while productive firms are more likely to enter and survive. In line with this logic, regional firm dynamics can be directly linked with regional productivity change. This study is among the first to decompose TFP growth into the contribution of firm dynamics in China, shedding light on the understanding of regional inequality and enriching the literature about effects of firm dynamics.

The main findings can be summarized as follow. First, there is considerable spatial inequality of TFP but regional productivity has shown a trend of convergence over the time period of 1999-2007. Secondly, the decomposition of TFP growth shows that firm entry, exit and survival do contribute to TFP change and their contributions vary across prefectures substantially. Between share bears the largest regional difference, as the most important factor contributing to the spatial inequality of regional TFP. There is a creative destruction process through productive firms enter and less productive firms are crowding out of the market. Thirdly, the restructuring of SOEs has critically contributed to the spatial inequality of TFP by raising TFP in the traditional industrial bases and by facilitating the development of productive private and foreign sectors particularly in the coastal region. The finding indicates that resource reallocation across firms with different ownerships is the key mechanism to improve regional productivity.

The findings have important policy implication. First, the empirical evidences show that much of the reallocation is accounted for by entry and exit of firms over a long period, but a substantial fraction of productivity growth is due to cross-firm reallocation in a short period. Facilitating firm entry and liberalizing firm exit will play an important role in aggregate productivity growth for a long period in this regard. Also, policies that strive to maintain failing firms through subsidies or tax credits should be carefully evaluated, as firm exit stimulates resource reallocation. Second, the process of resource reallocation often results in productivity increase after productive firms redeploy resources released by less productive firms. Removal of constraints that underpin productivity differences among existing firms, especially those between the state and non-state sectors should be tackled next. With growth prospects on the transformation, further reforms to enhance efficient resource allocation still provide important growth potential.

This study is among the first to explore the impact of firm dynamics on inequality of regional productivity in China. This research however is not without limitations. Nonstate-owned enterprises with sales revenues below 5 million Yuan are not included, causing possible overestimation of firm TFP. In addition, some of enterprises have split up, spun off assets, exited, or merged with others, we are also unable to follow and cover in our sample. Firm exit in our research is more like firm failure—a firm that is able to meet the threshold in year *t* fails to do so in year *t+1*. Firm failure and firm exit have been also used interchangeably by Caves (1998) to describe firm discontinuance. Nonetheless, this flaw only slightly affects research results since the firms included in the dataset contribute more than 90% of total industry output.

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