Barriers to Entry and Regional Economic Growth in China*

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Abstract

The non-state manufacturing sector has been the engine of China's economic transformation. Up through the mid-1990s, the sector exhibited large regional differences; subsequently we observe rapid convergence in terms of new firm start-up rates, productivity, and wages. To analyze the drivers of this behavior, we construct a Melitz (2003) model that incorporates location-specific capital wedges, output wedges, and a novel entry barrier. Using Chinese Industry Census data for 1995, 2004, and 2008, we estimate these wedges and examine their role in explaining differences in performance across prefectures and over time. Entry barriers turn out to be the salient friction for explaining performance differences. We investigate the empirical covariates of these entry barriers and find that barriers are causally related to the size of the state sector. Thus, the downsizing of the state sector after 1997 may be important in explaining the rapid manufacturing growth over the 1995-2008 period.

JEL Classification: O11, O14, O16, O40, O53, P25, R13, D22, D24, E24.

Keywords: Chinese economic growth; SOEs; firm entry; entry wedges; capital wedges; output wedges; SOE reform.

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1 Introduction

Since the onset of economic reform in the late 1970s, China has gone from one of the poorest economies in the world to being a middle-income country. The main source of this growth has been the expansion of the non-state sector (Zhu (2012)). While the non-state sector has experienced a rapid expansion at the national level, the growth has been highly uneven with significant differences across regions and localities. By the mid-1990s, this was reflected in sizable local differences in productivity, wages, and the number and size of non-state firms. Subsequently, these differences between localities in the non-state sector began to disappear, and from the mid-1990s through 2008 we observe a remarkably rapid economic convergence between localities, not only in value added per worker in non-state firms, but also in TFP, capital per worker, and wage rates.

The purpose of this paper is to examine this convergence process through the lens of a macroeconomic model where the distribution and selection of firms matter for productive efficiency. In particular, we use this framework as an accounting device to determine which factors drove the initial dispersion across locations and the subsequent changes. The theoretical framework is motivated by the empirical observation that the creation and selection of new firms in China's non-state sector have been the most important source of productivity and output growth in China's manufacturing sector (Brandt, Van Biesebroeck and Zhang (2012)). In principle, any one of a number of factors might be responsible for differences in new firm creation and growth between regions. In addition to differences in local endowments, e.g. human capital, and market access, distortions in local capital and output markets might also be important. Indeed, differences in access to capital and the distortions, taxes, and subsidies imposed by local governments figure prominently in most of these discussions (Huang (2003)). Differences across firms and, possibly, locations in the distribution of distortions are also the focus of the literature arguing that misallocation of factor inputs can explain an important share of differences in productivity across countries and firms (Restuccia and Rogerson (2008)).

To quantify the role of various channels we construct a Melitz (2003) model, extended to allow three distortions. Following Hsieh and Klenow (2009) we allow for capital and output wedges. These wedges are prefecture-specific. In addition, we introduce a novel entry barrier which may differ across locations. This entry wedge takes the form of a probability that potential entrepreneurs who would like to enter will be allowed to operate. We solve the general equilibrium model analytically and show that the model aggregates: Namely, the underlying wedges can be derived using data on average wage rates and aggregate allocations of output, capital, and employment in a prefecture. By construction these wedges can account for the observed aggregate allocations in a given prefecture.

We measure the theoretical wedges using firm-level data from the Chinese Industrial Census for 1995, 2004, and 2008. We construct data on value added, employment, capital, and average wage rates for each prefecture in China. These data have some key advantages over other data. First, aggregate data are not available on the prefectural level. Moreover, it is well known that official aggregate statistics are subject to substantial measurement problems (Holz (2003)); however, we overcome these problems by aggregating firm-level data. Second, firm-level data allow us to study theoretical predictions about the number of firm entrants and the firm size distribution. In particular, these data cover the whole manufacturing industry, not only large firms. Third, focusing on distortions at the prefectural level − as opposed to the firm level − makes the analysis robust to measurement error in the firm-level data.[1] To our knowledge ours is the first paper to quantify

[1] Bils, Klenow and Ruane (2017) argue that measurement error is pervasive in firm-level data. To infer distortions at the firm level in the presence of measurement error they assume that the distortions are constant over time, using a balanced panel of firms. This approach is not feasible for us because our focus is precisely on changes in distortions over time. Besides, very few firms can be linked over time in our data because of changes in the assignment of firm

distortions driving regional growth in China and the first paper to address measurement error in firm-level data in the presence of time-varying distortions.

We use this framework to explore what factors are salient for understanding prefecture-level growth in China. To this end we document which wedges are most important for accounting for the aggregate allocations. As it turns out, entry barriers are the main driver of the initial dispersion and the subsequent 1995-2008 convergence in wages and TFP across locations in China. In the cross-section in the mid-1990s, this is reflected in huge differences in these entry costs. Over time, a reduction in their size plays a pivotal role in accounting for the convergence between localities. Output wedges and capital wedges at the prefecture level play a negligible role for understanding the aggregate regional allocations and the regional convergence. Thus, the influence of capital or output market distortions, which in the Chinese context have also been identified as important (Hsieh and Klenow (2009); Song, Storesletten and Zilibotti (2011)) is secondary.[2] Instead we conclude that local variations in the dynamics of entry barriers are the key for understanding the growth and convergence of the non-state sectors in China.

We use the accounting framework to do two exercises. First, we study the measured entry barriers in greater detail and show, in the spirit of Cheremukhin, Golosov, Guriev and Tsyvinski (2017b,a), that these theoretical distortions can be tied to auxiliary empirical evidence for distortions. In particular, our measured entry barriers match up closely with measures of the costs of starting a business in China reported in the "Doing Business in China 2008" report by the World Bank (2008) for provincial cities in China. This provides valuable external validation for our estimates. Moreover, using data on actual creation of new firms − data which we did not target when estimating the wedges − we show that firm creation is primarily explained by the entry barrier.

The second exercise is to use prefecture-level information − beyond data on aggregate allocations in non-state manufacturing sector − to investigate the empirical drivers of the wedges. We are able to systematically link the size of these entry costs and their changes to the size of China's state-owned enterprise (SOE) sector, and to several other variables reflecting local fiscal capacity. In the mid-1990s, entry costs were sizably larger in localities with a larger presence of SOEs. More than half of the differences in the size of the entry wedges is explained by the size of the state sector in a prefecture. As it turns out, in almost every dimension − the rate of start-up of new firms, size of firms, TFP, and wages − we find that new firms are weaker where the SOEs are more dominant.

However, after the mid-1990s the fortune turned to the better for prefectures which originally had a large state sector: on average, output per worker, TFP, and wages in non-state firms grew faster in these prefectures than elsewhere. This process is consistent with our finding that entry wedges are related to the presence state-owned firms. Indeed, we find that the prefectures that experienced large reductions in entry wedges turn out to be those that also experienced large reductions in state sector employment.

These results are robust to potential concerns about endogeneity and omitted variables. We address such concerns with a Bartik (1991) instrumental variable approach. In a major policy change in 1997, the Chinese government allowed SOEs to be crowded out by non-state firms in some but not all industrial sectors. Consequently, interacting the initial local sectoral distribution of SOEs with the industry-specific decline in SOE employment at the national level predicts very accurately the reduction in local SOE employment. Using the 1995 SOE distribution as a Bartik instrument we find that the 1995-2004 reduction in SOE employment is systematically related to the reduction in entry wedges: larger predicted declines in SOE employment are associated with

IDs.

[2]If anything, we find that the output wedges have a negative contribution to understanding wage convergence, in the sense that non-state wages tended to increase in the locations where the output wedge increased, so the evolution of the output wedge would on its own have suggested that wages should have fallen.

larger reductions in entry wedges.

To study the link between entry wedges and SOE employment in the cross-section of prefectures we apply an alternative instrumental variable approach for the initial level of SOE employment, based on various lagged variable instruments. The results confirm the qualitative findings using the Bartik instrument.

Finally, we develop a simple political economy model of local governments' incentives to influence the wedges. This provides a theoretical motivation for the empirical correlation between observed entry barriers and the size of the SOE sector.

Our paper makes a number of contributions. First, we provide an analytical framework that can be used as an accounting device to identify distortions that inhibit or stimulate growth in a development context. Second, we use this framework to provide new insights for understanding growth dynamics in China. We identify new firm behavior and the removal of barriers to entry as the driver of regional wage and TFP growth. Third, we document an important set of new empirical facts on regional economic development, emphasizing the strong convergence in wages, TFP, and capital per worker across regions after the mid-1990s. Fourth, we study the empirical determinants of the prefecture-specific barriers to entry. We document a novel and important channel: the presence of state-owned firms cause larger entry barriers for non-state firms. This finding points to an important side effect of the reforms of the state-owned sector of the late 1990s: as SOEs were scaled back the entry barriers for private firms came down. This in turn paved the way for the subsequent rapid economic growth.

Our paper builds on and contributes to several literatures. There exists an extensive literature analyzing the rise of Chinese manufacturing during the great transformation (see e.g. Brandt and Rawski (2008), Young (2003), Zhu (2012), and references therein). Several papers emphasize the role of the reform of the state sector in the late 1990s (Grab the big, Let go of the small) for understanding this growth (Hsieh and Song (2015), Song et al. (2011)).

Our paper builds on the literature using wedge analysis to infer sources of distortion for understanding economic growth (see e.g. Cole and Ohanian (2004), Chari, Kehoe and McGrattan (2007), and, in a developing economy context, Cheremukhin et al. (2017b,a)). A large literature emphasizes distortions and misallocation of resources for understanding cross-country differences in economic development (see e.g. Restuccia and Rogerson (2008) and Hsieh and Klenow (2009)). This literature identifies a number of distortions that may be important, including implicit taxes on capital, labor, and output. In the Chinese context the literature has emphasized both capital market distortions (Hsieh and Klenow (2009), Song et al. (2011), Brandt and Zhu, 2010)) and labor market distortions (Tombe and Zhu (2017)). Similar to Barseghyan and DiCecio (2011), we also emphasize the role of entry barriers for new firms in accounting for TFP differences, although they focus on cross-country dispersion while we focus on convergence across Chinese regions.

In terms of sources of productivity growth we focus on the role of new firms for growth. An empirical literature has found that births of new firms has been seminal for TFP growth in Chinese manufacturing industries (Brandt et al. (2012)).

Finally, our paper contributes to the large macroeconomic literature studying growth and convergence across countries and regions (Barro, Sala-I-Martin, Blanchard and Hall (1991); Mankiw, Romer and Weil (1992)). To our knowledge ours is the first paper using wedge analysis to analyze cross-region convergence in output, wages, and TFP.

The rest of the paper is organized as follows. Section 2 documents the empirical evidence on economic development across regions and over time. Section 3 lays out a version of the Hopenhayn (1992) and Melitz (2003) model extended to incorporate a set of wedges. Section 5 uses this model to measure the distortions across prefectures. Section 6 studies the empirical drivers of the prefecture-specific measured entry wedges while Section 7.2 analyzes some potential alternative theories for the cross-prefecture data. Section 8 concludes.

2 Empirical evidence

2.1 The size of the state sector.

A constant theme throughout the empirical analysis is the fact that the patterns we observe in the data across prefectures are strongly correlated with the size of the state sector in those prefectures, i.e. a large part of the variation in the variables of interest in the data can be accounted for by the size of the state sector. At this point these correlations will not be interpreted as causal relationships. However, in Section 6 we will revisit this issue and argue that indeed there is a causal relationship between the size of the state sector and the economic development and performance of the non-state sector in a prefecture. Therefore, it will be convenient, for expositional purposes and for the systematic representation of the facts, to use the size of the state sector as a variable which we can use to index all prefectures in the economy. We let s_p denote the size of the state sector in prefecture p and define it as the fraction of output produced in the state sector. Our results do not change if we use instead the fraction of workers employed in the state sector as our measure of the size of the state sector.

2.2 Data description

Chinese Industrial Census. Our main data source is the 1995, 2004, and the 2008 Chinese Industrial Census (CIC) carried out by China's National Bureau of Statistics (NBS).[3] The CIC covers all of the manufacturing sector[4] and provides rich firm-level data on gross output, value added, employment, the gross capital stock, depreciation, total wages, as well as information on firm year of establishment, ownership type, and main sector of business. For these three years, we have firm-level records on 0.53, 1.37 and 2.08 million firms, respectively.[5]

In order to make these data comparable across the three census years, we needed to address a number of issues related to changes that occurred in China's industrial classification system, ownership categories, and prefecture boundaries. We draw on concordances described in Brandt et al. (2012) for ownership types and industrial sectors, and extend the concordance on prefecture boundaries in Baum-Snow, Brandt, Henderson, Turner and Zhang (2017) to cover all prefectures. We also utilize deflators developed by Brandt et al. (2012) for the purposes of constructing real measures of industrial output and estimates of the real capital stock.[6]

The NBS (National Bureau of Statistics) provides a detailed breakdown of firm type by ownership for firms in the Census. In 1995, there are 12 ownership categories, of which one covers state-owned firms. On the basis of the slightly more detailed classification in use in 2004 (and 2008), we define state owned to include firms listed as state-owned, state solely-funded limited liability companies, and shareholding companies. Shareholding companies during this period are largely state-controlled, but a subset of these firms is not. A stricter definition of state-owned would exclude the shareholding companies. In addition, for each firm we have a breakdown of equity in the firm between state, collective, private, legal person, and foreign. Alternative definitions of SOE ownership can be constructed on the basis of these variables, as well as using a combination of the

[3] We also draw on firm-level data for 1992 on all independent accounting units (0.39 million), which covers a slightly smaller subset of firms than the census and has information on a smaller set of variables.

[4] The 2004 and 2008 Census also provide data for the service sector, but unfortunately similar information was not collected in 1995.

[5] The firm-level records are not exhaustive, but cover in upwards of 90 percent of industrial activity.

[6] See Appendix A.

categorical ownership variables and data on ownership equity. The latter information is especially helpful for identifying state-controlled shareholding companies. In our analysis, we have experimented with alternative definitions of state-owned. In general, our results − examining behavior either in the cross-section or over time − are robust to these alternative definitions.

Provincial Level Industrial Output Data. In some of the analysis, we also use province-level data on industrial output collected by the NBS for the period 1978-1995. The NBS reports annual nominal and real gross value of industrial output (GVIO), and separate totals for the state and non-state sectors. The disaggregation by ownership allows us to construct estimates of rate of growth separately for the two sectors.

2.3 The non-state sector between 1978-2008

Divergence: 1978-1995 growth in the non-state sector. Figure 1 shows that the annual rate of growth in industrial output in the non-state sector between 1978 and 1995 differed sizeably across Chinese provinces. Ranking all provinces on the basis of the fraction of industrial output that was produced in the state-owned sector in 1978, we observe that the annual growth was as high as 30% in the low SOE share provinces and as a low as 15% in the high SOE share provinces.[7] The right panel in Figure 1 shows also the annualized rate of growth in industrial output in the state sector as well as in the province as a whole. As the figure indicates, the substantially lower growth rates in the non-state sector translate into lower growth rates in total industrial output in the province.

Figure 1: Annual Output Growth: 1978-1995.

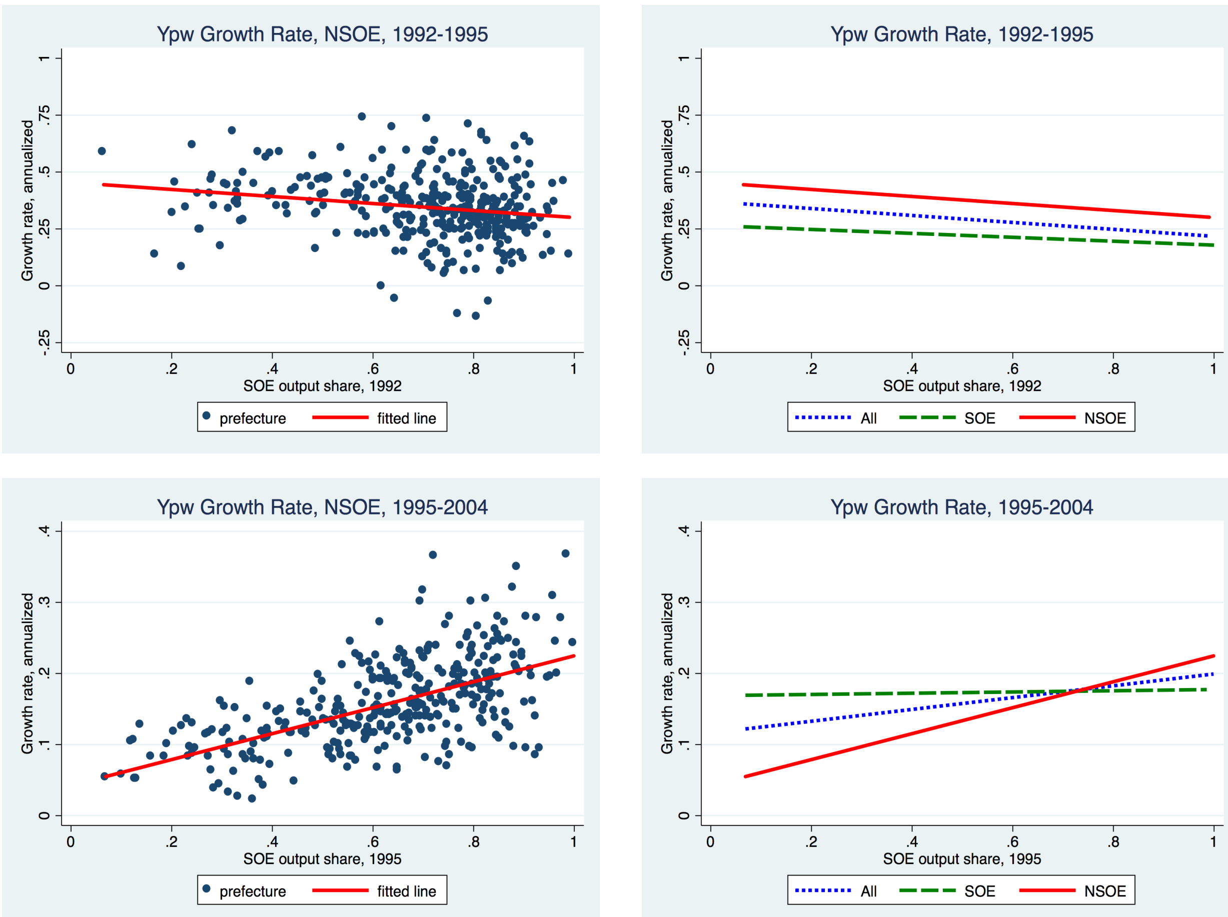
Notes: Each dot represents a province. The left panel in the figure plots the annualized growth rate of output in the non-state sector in 1978-1995, and the solid red line is the fitted regression line. The growth rates are based on province-level annual data between 1978-1995 on the value of industrial output (GVIO) that are collected by the National Bureau of Statistics (NBS). The right panel plots the corresponding annualized growth rates: overall (blue short-dash), state sector (green dash), and non-state sector (solid red). The 1978 SOE output share in a province is on the horizontal axis.

The 1978-1995 provincial data unfortunately do not contain information allowing us to compute any statistics related to output per worker. As a result, we also make use of the 1992 and 1995

[7] A similar picture emerges using total GDP in the province rather than just industrial output. These results are available upon request.

firm-level data to examine these patterns towards the end of that long time window. These data also allow us to move the discussion towards our main geographical unit of analysis in this paper − approximately 350 prefectures in China.

Figure 2: Output per Worker Growth: 1992-1995 and 1995-2004.



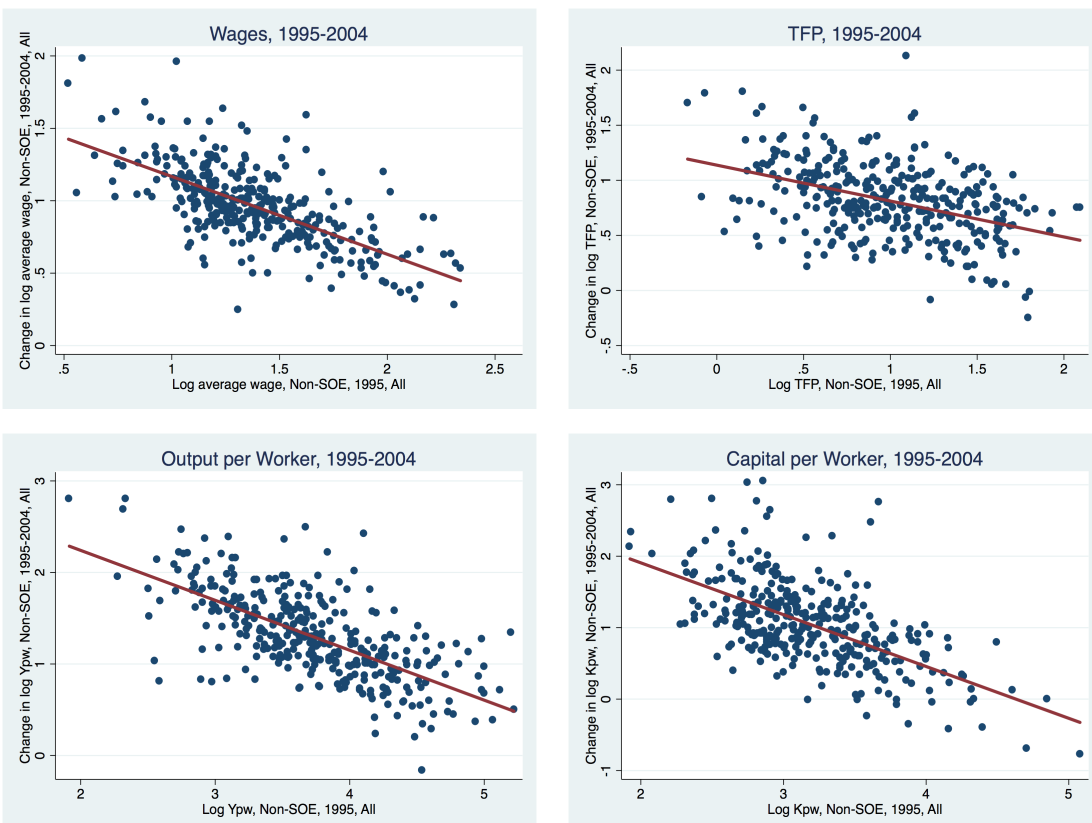
Notes: Each dot represents a prefecture. The left panels in the figure plot the annualized growth rate in output per worker in the non-state sector in 1992-1995 (upper panel) and 1995-2004 (lower panel), and the solid red line is the fitted regression line. The right panels plot the corresponding annualized growth rates: overall (blue short-dash), state sector (green dash), and non-state sector (solid red). The 1992 (1995) SOE output share in a prefecture is on the horizontal axis for the 1992-1995 (1995-2004) period.

The results for 1992-1995, shown in the top panels of Figure 2, convey the same message as the data for 1978-1995. Growth in output-per-worker in the non-state sector between 1992 and 1995 is higher in prefectures with a low share of output in 1992 produced in the state-owned sector. Furthermore, lower 1992-1995 economic growth in the non-state sector again translates into lower economic growth for the whole prefecture.

Convergence: 1995-2008 growth in the non-state sector. The economic performance across prefectures after 1995 is markedly different than the one observed between 1978 and 1995. Most notably, we observe a rapid economic convergence in the non-state sectors across prefectures.

The lower panels in Figure 2 show that in a reversal of behavior between 1978-1995, growth in output per worker between 1995 and 2004 in the non-state sector in the high s_p prefectures is higher than in the low s_p prefectures. As a result, output per worker in the non-state sectors converges across prefectures. This reversal and convergence continues further over the 2004-2008 period, as seen in Figure B-1 in Appendix B. The bottom right panel in Figure 3 reveals that the convergence in the non-state sectors translates into convergence in total prefecture output per worker since growth rates in the state sectors are very similar across all prefectures. Since the 1992 data at the firm level has information on output, but not on value added, we conducted the analysis in this section in terms of output per worker. However, since the 1995, 2004, and 2008 Census data have information on value added, we report the growth rates in value added per worker over the 1995-2004 and 2004-2008 periods in Figure B-2 in Appendix B. The results in terms of value added per worker are similar to those reported for output per worker.

Figure 3: Convergence in the NSOE sector, 1995-2004.



Notes: Each dot represents a prefecture, and the solid red line is the fitted regression line.

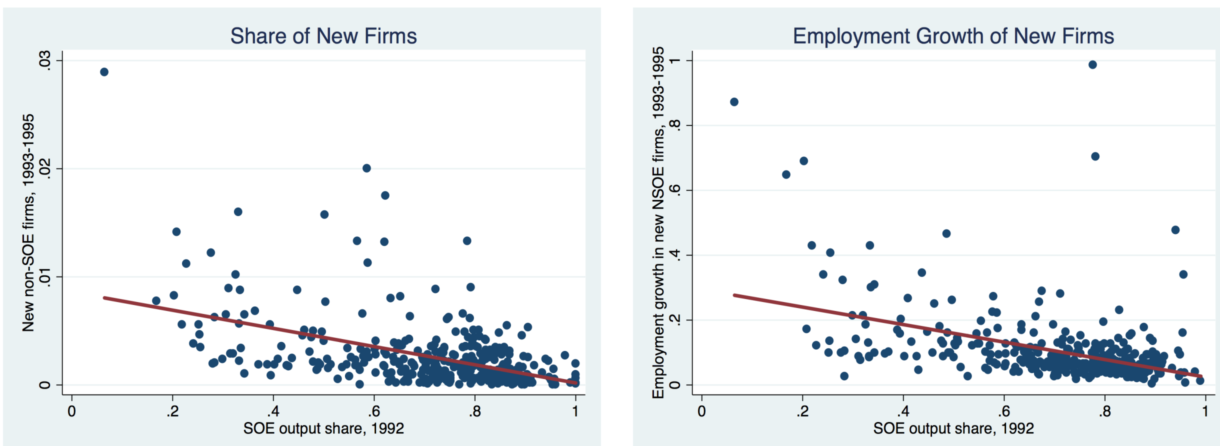
Figure 3 provides further insight into understanding the underlying mechanisms and the level of convergence in the non-state sectors between 1995 an 2004. The annual rate of convergence in output per worker is 8.5%, in wages is 8.3%, in TFP is 4.4%, and in capital per worker is 13.5%.

2.4 The 1995 Industrial Census

As we saw in the previous section, until 1995 growth in the non-state sector was high in prefectures with a low SOE output share and low in prefectures with a high SOE output share. The patterns observed in the 1995 CIC cross-section allow us to obtain a much more detailed picture of the main reasons for these growth differences in the non-state sectors across prefectures. Two important patterns emerge: in (high s_p) prefectures, where growth in the non-state sector was lower, (i) there were relatively fewer non-SOE entrants; and (ii) the non-SOE entrants were much weaker in multiple dimensions − they paid lower wages and had lower total factor productivity, value added per worker, and capital per worker.

Firm entry in the non-SOE sector. There is much less entry in the non-SOE sector in prefectures with high s_p. The left panel in Figure 4 considers the distribution of new NSOE firms in 1995, defined as firms that were established in the 1993-1995 time period, across all prefectures in the economy. The pattern is quite clear: most of the new NSOE entrants were established in the low s prefectures. The right panel in Figure 4 measures employment in new NSOE firms, established between 1993 and 1995, as a fraction of total employment in that prefecture in 1992. The figure provides a sense of where most of the new NSOEs are formed in terms of employment: again, it is clear that most of the new employment in the non-state sector is found in the low s_p prefectures.

Figure 4: NSOE Firm Entry in 1995.



Notes: Each dot represents a prefecture, and the solid red line is the fitted regression line.

Figure B-3 in Appendix B provides several additional measures of entry behavior in the non-state sector for different prefectures: (i) the distribution of new NSOE firms in 1993-1994 in terms of the SOE output share in 1995; and (ii) the entry rate in the NSOE sector, computed as the fraction of NSOE firms that started operating in 1993-1995 relative to the stock of NSOE firms in 1992. The message is similar − the entry rate of NSOE firms is lower in the high s prefectures.

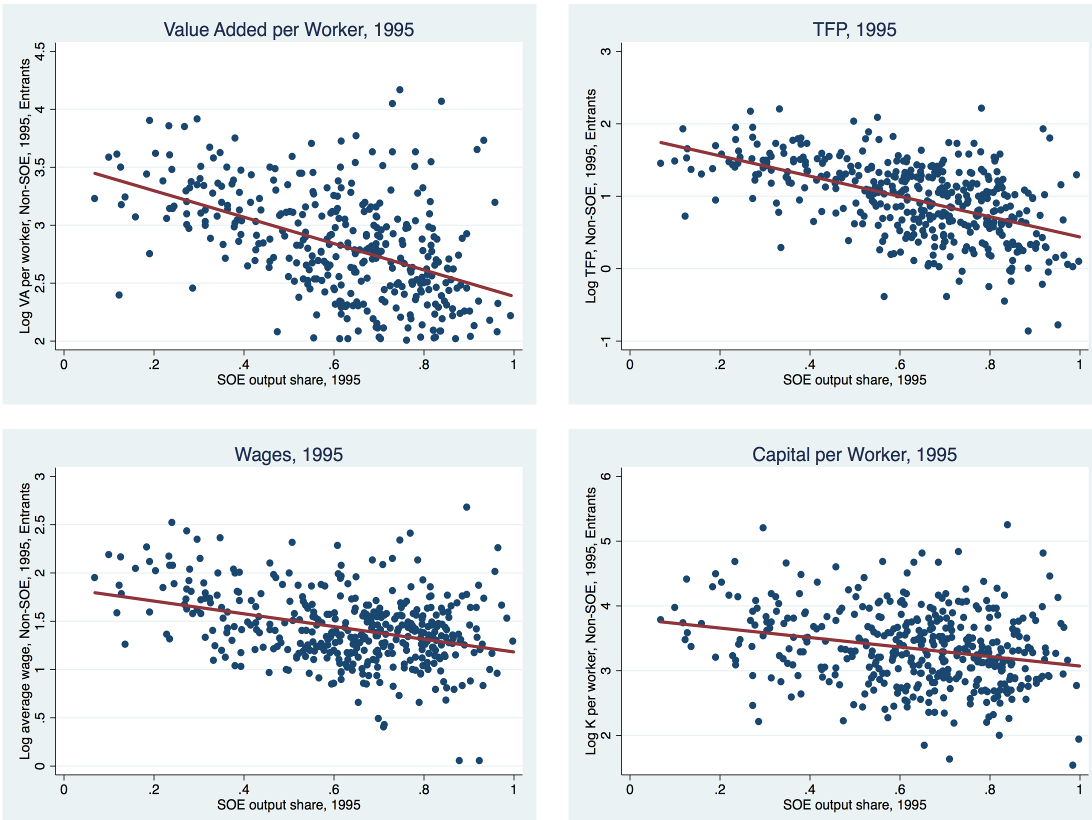
Wages, TFP, value added per worker, and capital per worker of non-SOE entrants. Figure 5 provides more information regarding new firms in the non-state sector. The general pattern reveals that new entrants in the high s prefectures pay lower wages and have lower TFP, value added per worker, and capital per worker.[8,9] On the basis of simple OLS regressions, the

[8]Figure B-4 in Appendix B indicates that the same patterns hold if we look at all non-state firms in these prefectures rather than only the entrants.

[9]One concern is that the negative relationship between the size of the state sector and productivity in the non-state sectors is a product of unobserved heterogeneity at the prefecture level. State owned enterprises might be located in more "backward" prefectures where endowments of human capital are lower. We examine the role of omitted variable bias through the lens of wages in the non-state sector. For 1995, we have information on both

SOE output share in 1995 accounts for 12% of the variation in wages across prefectures, 40% of the variation in TFP (the Solow residual), 39% of the variation in value added per worker, and 9% of the variation in capital per worker.

Figure 5: Characteristics of NSOE Entrants in 1995.



Notes: Each dot represents a prefecture, and the solid red line is the fitted regression line. The 1995 SOE output share in a prefecture is on the horizontal axis.

One of the main the goals of the model developed in the next section is to understand the economic performance of Chinese prefectures between 1978 and 1995. In order to understand the differential growth in the non-state sectors across prefectures, our analysis will look for mechanisms that are consistent with the facts documented on the rate and type of NSOE entrants in the 1995 cross-section of the CIC. Ultimately, the mechanisms we emphasize will help us understand the convergence in the non-state sectors across prefectures in the 1995-2008 period.

wages and human capital (measured as the average years of education of workers in a firm) at the firm level. We aggregate this information to the prefecture-level, and run simple regressions of the log of the average prefecture wage in the non-state sector on the size of the state sector with and without controlling for human capital in the two sectors. Wages in the non-state sector are positively (negatively) related to human capital levels in the non-state (state) sector, however, in the two sets of regressions, the effect of the state sector on non-state sector wages remains strongly negative and statistically significant, and nearly identical in magnitude.

3 A Melitz-Hopenhayn Model of Heterogeneous Entrepreneurs

3.1 Environment

We now present our model of the Non-state (NSOE) sector in a prefecture p. The prefecture is a small open economy with a closed labor market. Labor is supplied inelastically. Let the size of the available labor force for the non-state sector be denoted N.[10]

Firms produce a homogenous good with decreasing returns to scale. The production function is Cobb-Douglas,

$$y_i = z_i^{1-\eta} \left(k_i^{1-\alpha} n_i^{\alpha}\right)^{\eta} , \tag{1}$$

where y_i is the firm's value added, k_i is the firm's capital stock, n_i is the firm's employment, z_i is the firm's total factor productivity, $\eta \in (0, 1)$, and $\alpha \in (0, 1)$. Firms pay a common rental rate $(r + \delta)$ on capital and a (prefecture-specific) wage rate w. In addition, the firm faces distortions on output and capital given by τ_y and τ_k.[11] These wedges are common for all firms in the prefecture.[12] There is a fixed cost ν of operating a firm. This cost is constant across all prefectures.

Following Melitz (2003) the model is static, comprising two stages: a firm entry stage and a production stage. Each prefecture has a measure M of potential entrepreneurs. Each potential entrepreneur can operate one firm and this firm is endowed with a productivity z. The distribution of productivities of potential entrepreneurs is given by $f(z)$ and CDF of F. We assume that f is Pareto distributed, i.e., that $f(z) = \underline{z}\xi z^{-\xi-1}$, where $\xi > 1$, $\underline{z} \geq 1$, and $z \in \left[\underline{z}^{1/\xi}, \infty\right)$.

A key source of heterogeneity across prefectures is that they differ in the *effective* number of potential entrepreneurs. In particular, we assume that a prefecture-specific fraction ψ of entrepreneurs that want to produce will not be allowed to operate (e.g., will not obtain a licence to operate). We refer to $(1 - \psi)$, the fraction of entrepreneurs that will be allowed to operate, as the *gross entry wedge*.[13]

3.2 The Firm Problem

We start by analyzing the production stage and then study the entry decision.

Profit maximization. For convenience we drop the firm subscript i. Firms maximize profits and take as given the wedges and the prices. The firms' objective, conditional on operating, is given by

$$\Pi = \max_{k,n} \left\{ (1 - \tau_y)\, y - wn - (1 + \tau_k)\,(r + \delta)\, k \right\} . \tag{2}$$

[10]We abstract from the state sector (SOE) in the main analysis. The model could be extended to include an SOE sector in each prefecture. However, conditional on the labor supply and the policy distortions (which we will analyze shortly), SOEs do not influence the NSOE problem. Since SOEs tend to pay a significant wage premium over private firms (see Figure B-5), it is natural to assume that all workers prefer to work for the SOE and that the SOE jobs are rationed. Thus the SOEs would first hire as many workers as they prefer, and then the remaining workers would seek employment at the NSOE firms, being offered a market-clearing NSOE wage.

[11]We interpret these wedges as implicit taxes, where these taxes are not recorded as costs and thus do not affect the measured value added y_i. Moreover, following Hsieh and Klenow (2009), we abstract from labor wedges. This amounts to assuming that there is no labor market friction for private firms in a prefecture. This assumption is necessary in order to separately identify the wedges. Note, however, that our formulation still allows wages to differ across prefectures.

[12]In Appendix E we extend the analysis to allow for firm-specific capital and output wedges. Our qualitative and quantitative results are robust to this extension.

[13]We could alternatively follow Hopenhayn (1992) and model the entry barrier as a *fixed cost* of obtaining a potential firm, where the cost is incurred before the productivity level of the potential entrant is revealed. The qualitative properties of such an alternative model are the same as for our benchmark model.

The firm's optimal choices are given by,[14]

$$
\begin{aligned}
y^* &= z \cdot \bar{y}\left(\tau_y, \tau_k, r, w\right) \\
k^* &= z(1-\alpha)\eta \frac{(1-\tau_y)}{(1+\tau_k)(r+\delta)} \cdot \bar{y}\left(\tau_y, \tau_k, r, w\right) \\
n^* &= z\alpha\eta \frac{(1-\tau_y)}{w} \cdot \bar{y}\left(\tau_y, \tau_k, r, w\right) \\
\Pi^* &= \left(1-\tau_y\right)\left(1-\eta\right) z \cdot \bar{y}\left(\tau_y, \tau_k, r, w\right),
\end{aligned}
\tag{3}
$$

where

$$
\bar{y}\left(\tau_y, \tau_k, r, w\right) \equiv \left[\left(1-\tau_y\right)\eta\right]^{\frac{\eta}{1-\eta}} \left(\frac{(1-\alpha)}{\left(1+\tau_k\right)\left(r+\delta\right)}\right)^{\frac{(1-\alpha)\eta}{1-\eta}} \left(\frac{\alpha}{w}\right)^{\frac{\alpha\eta}{1-\eta}}.
$$

The entry decision. Given the vector of distortions and prices (τ_y, τ_k, r, w), there exists a cutoff $z^* = z^*\left(\tau_y, \tau_k, r, w\right)$ such that all potential entrepreneurs with $z \geq z^*$ will choose to operate firms. Given the profit function Π, this cutoff z^* is determined by the condition

$$
\nu = \left(1-\tau_y\right)\left(1-\eta\right) \cdot z^* \cdot \bar{y}\left(\tau_y, \tau_k, r, w\right) .
$$

Then,

$$
z^* = \frac{\nu}{\left(1-\tau_y\right)^{\frac{1}{1-\eta}} \eta^{\frac{\eta}{1-\eta}} \left(1-\eta\right)} \left(\left(\frac{\left(1+\tau_k\right)\left(r+\delta\right)}{1-\alpha}\right)^{1-\alpha} \left(\frac{w}{\alpha}\right)^{\alpha}\right)^{\frac{\eta}{1-\eta}}. \tag{4}
$$

Since z is Pareto distributed, the measure of entrepreneurs Γ that will operate is given by

$$
\Gamma\left(z \geq z^*\right) = (1-\psi) \int_{z^*}^{\infty} \underline{z}^{\xi} \xi z^{-\xi-1} dz = (1-\psi) \underline{z}^{\xi} \left(z^*\right)^{-\xi}. \tag{5}
$$

3.3 Equilibrium

We can now compute the equilibrium wage w and the associated aggregate output, capital, and the measured aggregate TFP in the non-state sector, given a labor supply N.

Note that the term $\int_{z^*}^{\infty} z f(z)\, dz$ is given by

$$
\int_{z^*}^{\infty} z f(z)\, dz = \int_{z^*}^{\infty} \underline{z}^{\xi} z \xi z^{-\xi-1} dz = \frac{\xi}{\xi-1} \underline{z}^{\xi} \left[-z^{-(\xi-1)}\right]_{z^*}^{\infty} = \frac{\xi}{\xi-1} \underline{z}^{\xi} \left(z^*\right)^{1-\xi}.
$$

Market clearing in the labor market then implies,

$$
M(1-\psi) \int_{z^*}^{\infty} n(z) f(z)\, dz = N.
$$

Let L denote the total available labor force in the prefecture, i.e. all workers in the SOE and non-SOE sectors. Define $\tilde{n} = \frac{N}{L}$ as the available workers in the non-SOE sector as a fraction of the total prefecture labor force and $\tilde{m} = \frac{M}{L}$ as the available potential entrepreneurs as a fraction of the total prefecture labor force. The key normalization is that the measure of potential entrepreneurs

[14]See Appendix C.

in a prefecture is proportional to the overall labor force in the prefecture, L. Without loss of generality we assume that $\tilde{m} = 1$.[15] Then the equilibrium condition becomes:

$$(1-\psi)\int_{z^*}^{\infty} n\left(z\right) f\left(z\right) dz = \tilde{n}. \tag{6}$$

Using (6) we can solve for the equilibrium wage:

$$w = \alpha\left(\frac{(1-\psi)\underline{z}^{\xi}}{\tilde{n}}\cdot\frac{\xi}{\xi-1}\left(\frac{1-\eta}{\nu}\right)^{\xi-1}\right)^{\frac{1-\eta}{1-\eta+\xi\alpha\eta}}\left(1-\tau_y\right)^{\frac{\xi}{1-\eta+\xi\alpha\eta}}\eta^{\frac{1-\eta+\xi\eta}{1-\eta+\xi\alpha\eta}}\left(\frac{1-\alpha}{\left(1+\tau_k\right)\left(r+\delta\right)}\right)^{\frac{(1-\alpha)\xi\eta}{1-\eta+\xi\alpha\eta}}. \tag{7}$$

3.4 Equilibrium and comparative statics

The fact that the model is solved analytically provides transparency and allows us to analytically characterize the effects of the gross output, gross capital, and gross entry wedges on wages, TFP, and firm entry. For conciseness, we define $\mu \equiv \frac{1}{1-\eta+\xi\alpha\eta} > 0$.

Wages. Using (7), we can express the log of the equilibrium wage in the prefecture as:

$$\begin{aligned}\ln w &= \mu(1-\eta)\ln\left[\frac{(1-\psi)\underline{z}^{\xi}}{\tilde{n}}\right] - \mu\left(1-\eta\right)\left(\xi-1\right)\ln\left(\nu\right)\\ &\quad +\mu\xi\ln\left(1-\tau_y\right) - \mu\left(1-\alpha\right)\xi\eta\ln\left[\left(1+\tau_k\right)\left(r+\delta\right)\right] + \Omega(\alpha,\eta,\xi),\end{aligned} \tag{8}$$

where $\Omega(\alpha,\eta,\xi)$ is a constant.[16] The average wage in a prefecture depends on the output wedge, the capital wedge, and the entry wedge, as well as parameters such as the cost of operating the firm and the decreasing returns to scale parameter. Since most of these parameters are the same across all prefectures, the variation in wages across prefectures is due to differences in the three wedges. In particular,

$$\begin{aligned}\frac{\partial\ln w}{\partial\ln\left(1+\tau_k\right)} &= \frac{\partial\ln w}{\partial\ln\left(r+\delta\right)} = -\mu\left(1-\alpha\right)\xi\eta < 0,\\ \frac{\partial\ln w}{\partial\ln\left(1-\tau_y\right)} &= \mu\xi > 0,\\ \frac{\partial\ln w}{\partial\ln(1-\psi)} &= -\frac{\partial\ln w}{\partial\ln\tilde{n}} = \mu(1-\eta) > 0.\end{aligned} \tag{9}$$

An increase in the gross capital wedge and in the available workers decreases wages, while an increase in the gross output wedge and in the gross entry wedge increases wages in the prefecture.

TFP, the Solow residual. The analytical expression for the Solow residual, Z, in a prefecture is

$$\begin{aligned}\ln Z &= \mu\alpha\eta\left(1-\eta\right)\ln\left[\frac{(1-\psi)\underline{z}^{\xi}}{\tilde{n}}\right] - \mu\alpha\eta\left(1-\eta\right)\left(\xi-1\right)\ln\left(\nu\right)\\ &\quad -\mu(1-\eta)\ln\left(1-\tau_y\right) + \mu\left(1-\eta\right)\left[1+\left(\xi-1\right)\alpha\eta\right]\ln\left[\left(1+\tau_k\right)\left(r+\delta\right)\right] + \hat{\Omega}(\alpha,\eta,\xi),\end{aligned} \tag{10}$$

[15] Given our identification strategy, discussed in Section 5.2, we assume that $\tilde{m} = 1$ without loss of generality $-$ a different value of $\tilde{m}$ would change the estimate of $\underline{z}$, but would not affect the estimate of $(1-\psi)$.

[16] $\Omega(\alpha,\eta,\xi) = \ln\alpha + \ln\left(\eta^{\frac{1-\eta+\xi\eta}{1-\eta+\xi\alpha\eta}}\right) + \ln\left((1-\alpha)^{\frac{(1-\alpha)\xi\eta}{1-\eta+\xi\alpha\eta}}\right) + \ln\left(\left(\frac{\xi}{\xi-1}\left(1-\eta\right)^{\xi-1}\right)^{\frac{1-\eta}{1-\eta+\xi\alpha\eta}}\right)$.

where $\hat{\Omega}(\alpha,\eta,\xi)$ is a constant. Then,

$$\begin{aligned}
\frac{\partial \ln Z}{\partial \ln(1+\tau_k)} &= \frac{\partial \ln Z}{\partial \ln(r+\delta)} = \mu(1-\eta)\left[1+(\xi-1)\alpha\eta\right] > 0, \\
\frac{\partial \ln Z}{\partial \ln(1-\tau_y)} &= -\mu(1-\eta) < 0, \\
\frac{\partial \ln Z}{\partial \ln(1-\psi)} &= -\frac{\partial \ln Z}{\partial \ln \tilde{n}} = \mu\alpha\eta(1-\eta) > 0.
\end{aligned} \tag{11}$$

An increase in the gross capital wedge and in the gross entry wedge increases TFP in the prefecture, while an increase in the gross output wedge and in the available workers decreases it.

Entry. The analytical expression for the measure of entrepreneurs that will enter and operate in the prefecture, relative to the total available labor force in the prefecture, is:

$$\begin{aligned}
\ln\Gamma &= \mu(1-\eta)\ln\left[(1-\psi)\underline{z}^{\xi}\right] + \mu\alpha\eta\xi\ln(\tilde{n}) - \mu\xi\left[1-\eta(1-\alpha)\right]\ln(\nu) \\
&\quad + \mu\xi\ln(1-\tau_y) - \mu\xi\eta(1-\alpha)\ln\left[(1+\tau_k)(r+\delta)\right] + \overline{\Omega}(\alpha,\eta,\xi),
\end{aligned} \tag{12}$$

where $\overline{\Omega}(\alpha,\eta,\xi)$ is a constant. Then,

$$\begin{aligned}
\frac{\partial \ln\Gamma}{\partial \ln(1+\tau_k)} &< 0, \\
\frac{\partial \ln\Gamma}{\partial \ln(1-\tau_y)} &> 0, \\
\frac{\partial \ln\Gamma}{\partial \ln(1-\psi)} &> 0.
\end{aligned} \tag{13}$$

An increase in the gross capital wedge decreases the measure of entrants, while an increase in the gross output wedge and in the gross entry wedge increases it.

3.5 Mechanism: the effect of entry wedges on wages and TFP

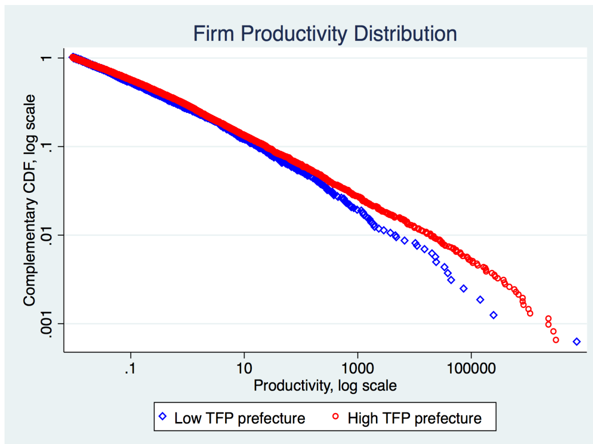
The mechanism in the model through which the entry wedge affects equilibrium wages and TFP in a prefecture is transparent. In a prefecture in which the entry wedge is high (i.e., the gross entry wedge, $\ln(1-\psi)$, is small) fewer firms will enter, relative to the available labor, resulting in lower equilibrium wages. Lower wages imply a lower productivity cutoff z^*: Some firms with lower productivity are able to operate in such an environment since labor is cheaper. This results in lower TFP and output per worker in the prefecture.[17]

One implication is that while the productivity threshold is lower in prefectures with high entry wedges, the top tail of the productivity distribution is the same as in prefectures with low entry wedges. There are productive entrants in high entry wedge prefectures, however there are some additional low productivity entrants and the overall number of entrants across the productivity distribution is smaller. Indeed, the top tails of the productivity distributions are quite similar in low and high TFP prefectures. For example, we separate all prefectures into two groups based on their TFP, the Solow residual. Then, we look at the entire firm distribution in z in 1995, pick

[17] The same mechanism is at work in the Hopenhayn (1992) model through higher entry costs. Barseghyan and DiCecio (2011) study the cross-country differences in entry costs and their effect on entry, TFP, and output per worker.

the productivity z_{90} at the 90th percentile, and analyze the z distribution above that threshold for low and high TFP prefectures. In Figure 6 we plot, in log scales, the resulting complementary cumulative distribution functions for z, in low and high TFP prefectures, for firms in the top 10% of the overall productivity distribution. The two distributions are in fact similar to each other, consistent with the mechanism in the model through which entry wedges affect the firm z distribution and the resulting TFP in a prefecture.

Figure 6: The Truncated Distribution of $\ln z$ for Low and High TFP Prefectures, 1995.



Notes: All prefectures are separated into two groups based on their TFP, the Solow residual. Looking at the entire firm distribution in z in 1995, we pick the productivity z_{90} at the 90th percentile, and plot in log scales the complementary cumulative distribution function for z above that threshold for low and high TFP prefectures.

4 A political economy model of the wedges

This section develops a simple political economy model for the determination of the wedges. The aim is to provide a theoretical motivation for the tight empirical relationship between the observed entry wedges and the size of the SOE sector, which we document in Section 5.

Assume that there is a unit measure of potential SOEs with the same production function as NSOEs, eq. (1). For simplicity we abstract from wedges on output and capital for SOEs (i.e., $\tau_y^{SOE} = \tau_k^{SOE} = 0$). We model the labor market the same way as Song et al. (2011), where the SOEs hire workers in competition with the NSOE sector.[18]

We assume that the three wedges for private firms, (ψ, τ_y, τ_k), are set by the local government in the prefecture. We label the decision maker as the *local cadre*. Before discussing the objective function of the local cadre, we impose two sets of constraints on the choice of wedges. First, the wedges must be non-negative, $\psi \geq 0$, $\tau_y \geq 0$, and $\tau_k \geq 0$.[19] Second, the local cadre must ensure that the equilibrium state employment in the prefecture meets an exogenous target $\Lambda_{SOE} = \bar{\Lambda}_{SOE}$. See e.g. Brandt and Zhu (2000) and Wang (2017) for possible politico-economic motivations for such a requirement on state employment. This target employment is imposed exogenously on the

[18] For simplicity we assume that SOEs and NSOEs pay the same wages. Forcing SOEs to pay an (empirically plausible) wage premium for workers would not affect the qualitative results. The key assumption is that SOEs compete with private firms for some factor in short supply, be it workers, high-skilled workers, managers, land, or other input factors.

[19] The constraint $\psi \geq 0$ is natural. The constraints $\tau_y \geq 0$ and $\tau_k \geq 0$ can be motivated by limited government funds ruling out outright subsidies.

local cadre by, say, the central government and can differ across locations. As we shall see, the cadre can meet this requirement by choosing an appropriate mix of wedges for NSOE firms. The mechanism is that larger distortions on NSOEs make it easier for SOEs to compete for workers. This in turn enables them to increase their employment, allowing the local cadre to ensure that the SOE employment requirement is satisfied.

Following the analysis in Section 3, the aggregate labor demand of SOE is given by

$$\Lambda_{SOE} = \frac{\xi \underline{z}}{\xi - 1} \left(\frac{1-\eta}{\nu}\right)^{\xi - 1} \left(\frac{(1-\alpha)\,\eta}{r+\delta}\right)^{\xi \frac{(1-\alpha)\eta}{1-\eta}} \left(\frac{\alpha\eta}{w}\right)^{1+\xi\frac{\alpha\eta}{1-\eta}}.$$

We focus on the case where $\bar{\Lambda}_{SOE} > 1/2$ to ensure that the SOE employment constraint is relevant, in the sense that state firms need to be favored relative to non-state firms in order to satisfy the SOE hiring constraint. When normalizing the aggregate labor supply to unity, market clearing requires that non-state labor demand is $N = 1 - \bar{\Lambda}_{SOE}$. Substituting NSOE labor demand and the equilibrium wage rate into this market-clearing condition yields a condition linking the wedges to the hiring requirement,

$$\frac{1-\bar{\Lambda}_{SOE}}{\bar{\Lambda}_{SOE}} \frac{1}{(1-\psi)} = (1-\tau_y)^{\frac{\xi}{1-\eta}} \left(\frac{1}{1+\tau_k}\right)^{\xi\frac{(1-\alpha)\eta}{1-\eta}}. \tag{14}$$

It follows that the (target) state employment $\bar{\Lambda}_{SOE}$ is increasing in each of the wedges, (ψ, τ_k, τ_y). The reason is that an increase in any of the wedges lowers NSOE demand for workers and, hence, equlbrium wages. This affects SOE firms along both the extensive and the intensive margin: with lower wages less efficient SOE firms can operate (i.e., more SOE entry), and the lower wages make it optimal for each SOE firm to hire more workers. The result is larger equilibrium SOE employment $\bar{\Lambda}_{SOE}$.

Consider now the objective of the local cadre. We assume that the cadre wants to maximize profits for an entrepreneur, conditional on obtaining a licence and their TFP, z. This captures the idea that the cadre may want to help a friend who is a potential NSOE entrepreneur but that the cadre has limited instruments for achieving this goal. On the one hand, the cadre can subsidize the entrepreneur by choosing low capital or output wedges (although all firms will benefit from these subsidies). On the other hand, the cadre can restrict entry for anonymous potential entrepreneurs by setting a large ψ, while at the same time guarantee that an entrepreneur they know can be allowed to operate.

Conditional on operating the firm the entrepreneur's profits $-$ net of the implicit taxes on capital and output $-$ are given by:

$$\frac{\Pi(z)}{z} = \frac{1}{1-\psi} \frac{1-\bar{\Lambda}_{SOE}}{\left(\bar{\Lambda}_{SOE}\right)^{\frac{1-\eta}{\xi\alpha\eta+1-\eta}}} \cdot \frac{1-\eta}{1+\mu} \left(\frac{\xi \underline{z}}{\xi-1}\left(\frac{1-\eta}{\nu}\right)^{\xi-1}\left(\frac{(1-\alpha)\,\eta}{r+\delta}\right)^{\xi\frac{(1-\alpha)\eta}{1-\eta}}\right)^{\frac{1-\eta}{\xi\alpha\eta+1-\eta}}.$$

The profits $\Pi(z)$ are increasing in the entry barrier. The reason is that entrepreneurial talent is a scarce resource, and with fewer potential entrepreneurs the profits are higher conditional on z. Note that the entrepreneur's expected profits are independent of the output and capital wedges. This is due to the fact that profits $\Pi(z)$ are a monotone function of the right-hand side of equation (14). Thus, given $\bar{\Lambda}_{SOE}$ and ψ, any combination of (τ_k, τ_y) that satisfies equation (14) will give rise to the same profits, so a lower τ_k will have to be offset by a higher τ_y.

Under these assumptions about the local cadre's problem we obtain that the optimal way to satisfy the hiring requirement is to set the capital and output wedges to zero and set ψ so as to satisfy equation (14). This implies a high correlation between SOE employment Λ_{SOE} and entry barriers ψ. We state this result as a formal remark.

Remark 1 *The constrained optimal choice of wedges (ψ, τ_y, τ_k) is to set $\tau_k = \tau_y = 0$ and $\psi > 0$. Moreover, an exogenous increase in $\bar{\Lambda}_{SOE}$ implies a larger entry barrier ψ.*

In the empirical work of Section 6 we propose two drivers (instrumental variables) for $\bar{\Lambda}_{SOE}$. First, the central and provincial government may want the local government to maintain current level of SOE employment, thereby upholding the legacy of the state sector. In this case the historical level of state employment in the prefecture can be expected to influence $\bar{\Lambda}_{SOE}$. Second, as we discuss in detail below, the 1997-1998 SOE reforms ("Catch the Large, Release the Small"), which were driven by the central government, involved large-scale reductions in state employment in non-strategic industries. We interpret this as an exogenous reduction in $\bar{\Lambda}_{SOE}$. The implication of Remark 1 and the instruments for the hiring constraint $\bar{\Lambda}_{SOE}$, is that the entry barrier should be larger in areas with historically large state employment and should fall more in the areas where state employment was more scaled back after 1998. We explore these empirical predictions below.

5 Measuring the Wedges

5.1 Log gross output and capital wedges

Using the first-order conditions for k_i and n_i from the firm problem in (2), the wedges τ_y and τ_k can be measured as:[20]

$$\begin{aligned} 1 - \tau_y &= \frac{1}{\alpha\eta} \frac{w_i n_i}{y_i} \ , \\ 1 + \tau_k &= \frac{1-\alpha}{\alpha} \cdot \frac{w_i n_i}{(r+\delta)\, k_i} \ . \end{aligned}$$

This allows us then to compute the gross output wedge and the gross capital wedge in a given prefecture. In deriving the wedges, we take into account the particular industrial structure in each prefecture. Let $Y_{j,p} = \sum_{i \in (j,p)} y_i$ be the total value added for all firms in industry j in prefecture p, and let $Y_p = \sum_{j=1}^{J} Y_{j,p}$ be the total value added in prefecture p. Then, the gross output wedge in prefecture p, Δ_p^y, is the weighted average of the gross output wedge for each firm in that prefecture, weighted by the firm's relative value added:

$$\Delta_p^y = \sum_{j=1}^{J} \left(\frac{1}{\alpha_j \eta} \sum_{i \in (j,p)} \frac{w_i n_i}{y_i} \frac{y_i}{Y_{j,p}} \right) \frac{Y_{j,p}}{Y_p}, \tag{15}$$

where $\alpha_j \eta$ is the labor share of industry j.

Similarly, the gross capital wedge in prefecture p, Δ_p^k, is computed as the weighted average of the gross capital wedge for each firm in that prefecture, weighted by the firm's relative capital stock. Let $K_{j,p} = \sum_{i \in (j,p)} k_i$ be the total capital for all firms in industry j in prefecture p, and let $K_p = \sum_{j=1}^{J} K_{j,p}$ be the total capital in prefecture p. Then:

$$\Delta_p^k = \sum_{j=1}^{J} \left(\frac{1-\alpha_j}{\alpha_j} \sum_{i \in (j,p)} \frac{w_i n_i}{k_i} \frac{k_i}{K_{j,p}} \right) \frac{K_{j,p}}{K_p}. \tag{16}$$

[20] See Appendix C.1 for details.

For each firm in the Chinese Industrial Census we have data on the wage bill ($w_i n_i$), on the firm's value added (y_i), and on the firm's capital stock (k_i).[21] We use the information on the labor shares of 2-digit industries ($\alpha_j \eta$) used in Hsieh and Klenow (2009) and a decreasing returns to scale parameter of $\eta = 0.85$ as in Restuccia and Rogerson (2008). Figure 7 plots the results for the gross output and gross capital wedges in each prefecture in 1995.[22]

Figure 7: Gross Output and Gross Capital Wedges, 1995, All Firms, NSOE Sector.

Notes: Each dot represents a prefecture. The left (right) panel plots the gross output (capital) wedge in the NSOE sector in 1995. The SOE output share in 1995 in each prefecture is on the horizontal axis.

The left panel in Figure 7 shows the gross output wedge in 1995 for each prefecture as a function of the 1995 SOE output share in that prefecture. The gross output wedge is increasing in s – the 1995 SOE output share in the prefecture. This implies that in 1995 non-SOE firms in some of the high s prefectures are receiving subsidies while non-SOE firms in the low s prefectures are being significantly taxed. The right panel in Figure 7 shows the gross capital wedge in 1995 for each prefecture as a function of the 1995 SOE output share in that prefecture. The gross capital wedge is only slightly increasing with s.

A gross capital wedge, Δ_p^k, that is only slightly increasing with s, and a gross output wedge, Δ_p^y, that is strongly increasing with s imply that in the high s prefectures, as compared to the low s prefectures, we should observe more firm entry, as well as higher wages and higher value added per worker among the non-SOE entrants. This is exactly the opposite of the empirical evidence presented in Section 2, and is suggestive of the fact that the entry wedge incorporated in the model is crucial for accounting for the patterns in the data.

5.2 Log gross entry wedge, $\ln(1 - \psi)$

The theoretical framework outlined in Section 3 allows us to measure the entry wedge for each prefecture. Using the expression for the equilibrium wage in a prefecture (8), we can analytically

[21] See Appendix A for a discussion of the procedure to construct the real capital stock at the firm level.

[22] Appendix B shows the results for 2004 and 2008. We compute the gross output and gross capital wedges using all firms in a given cross-section. The results based on the sample of new entrants are very similar and are provided in Appendix B.

derive the expression for the log gross entry wedge in a prefecture:

$$\begin{aligned}\ln(1-\psi_p) &= \frac{1-\eta+\xi\alpha\eta}{1-\eta}\ln w_p - \frac{\xi}{1-\eta}\ln\Delta_p^y + \frac{\xi\eta(1-\alpha)}{1-\eta}\ln\Delta_p^k \\ &\quad \ln\tilde{n} + (\xi-1)\ln\nu + \tilde{\Omega}(\alpha,\eta,\xi,\underline{z}),\end{aligned} \tag{17}$$

where $\tilde{\Omega}(\alpha,\eta,\xi,\underline{z})$ is a constant. We observe the average wage in each prefecture w_p; in section 5.1 we already derived the prefecture gross output and capital wedges Δ_p^y and Δ_p^k; and we continue to use the same value of $\eta = 0.85$. We obtain a value for the labor share $\alpha\eta$ in a given prefecture by averaging over the labor share of all industries in that prefecture, weighting by the industry's share in total value added. Finally, $\tilde{n}$ is obtained as the fraction of workers employed in the non-SOE sector.

The remaining parameters, which are common across all prefectures, are chosen as follows. The Pareto parameter, ξ is obtained by focusing on the 30% of the most productive firms and the fact that:

$$\frac{E(z|z\geq z^*)}{z^*} = \frac{\xi}{\xi-1}.$$

The implied value is $\xi = 1.05$.

In order to determine the value of the fixed cost of operating a firm, ν, we use the expression for n^* evaluated at the threshold level of productivity z^* (and using also (4)):

$$\begin{aligned}n^*(z^*) &= z^*\alpha\eta\frac{(1-\tau_y)}{w}\bar{y} \\ n^*(z^*) &= \frac{\nu}{(1-\tau_y)(1-\eta)\bar{y}}\alpha\eta\frac{(1-\tau_y)}{w}\bar{y} \\ n^*(z^*) &= \frac{\nu\alpha\eta}{(1-\eta)w}\end{aligned} \tag{18}$$

We assume that the optimal firm size for firms at the threshold level z^* in prefectures with $s \in [0, 0.1]$ is one worker: $n^*(z^*) = 1$.

Then the period fixed cost of operating ν is

$$\nu = \left(\frac{1-\eta}{\alpha\eta}\right)w. \tag{19}$$

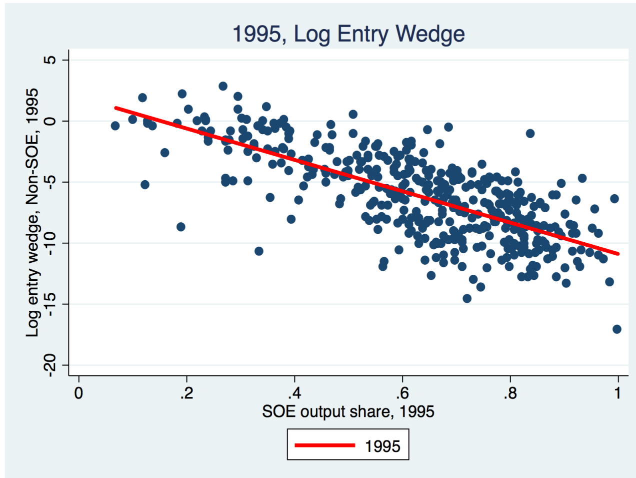
We use the equilibrium wage equation (17) in order to identify $\underline{z}$. In particular, we assume that all applicants obtain a licence to operate in the low s prefectures; i.e. $\psi = 0$ in prefectures with $s \in [0, 0.1]$.

Finally, using equation (17), we are now able to compute the log gross entry wedge $\ln(1-\psi_p)$ for all prefectures in the economy. Figure 8 presents the results for each prefecture in 1995. We can use the same procedure in order to compute the log gross entry wedges in 2004 and 2008. The resulting wedges are plotted in Figure 9.

5.3 External validation: the 2008 costs of starting a business in China

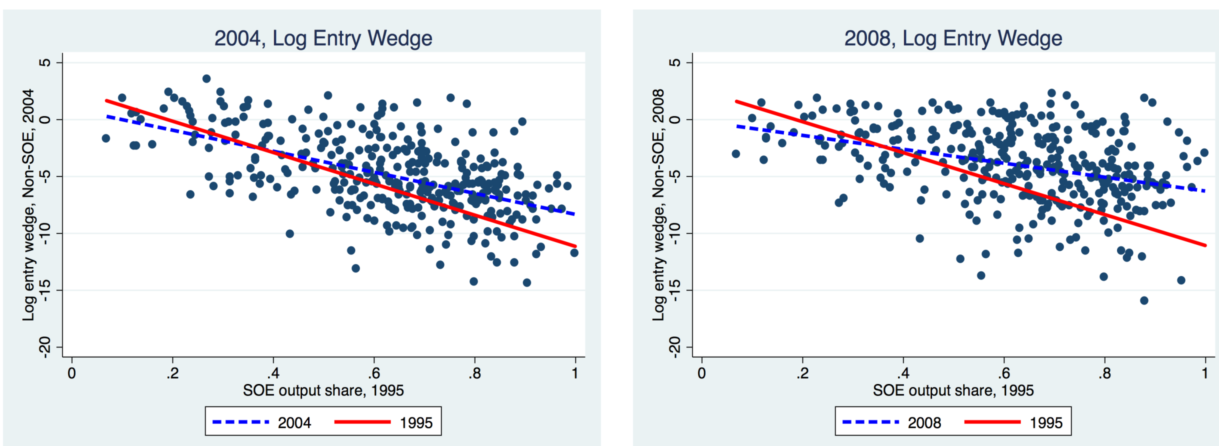
The "Doing Business in China 2008" report by the World Bank (2008) provides various measures of the extent to which government activity affects private business activity. The report outlines differences in various regulations in the capital cities of the 26 Chinese provinces and 4 centrally administered municipalities. We focus on the following reported indicators of the ease of starting

Figure 8: Log Gross Entry Wedges, $\ln(1-\psi)$, 1995.



Notes: Each dot represents a prefecture. The figure plots the log gross entry wedge in the NSOE sector in 1995, and the solid red line is the fitted regression line. The 1995 SOE output share in a prefecture is on the horizontal axis.

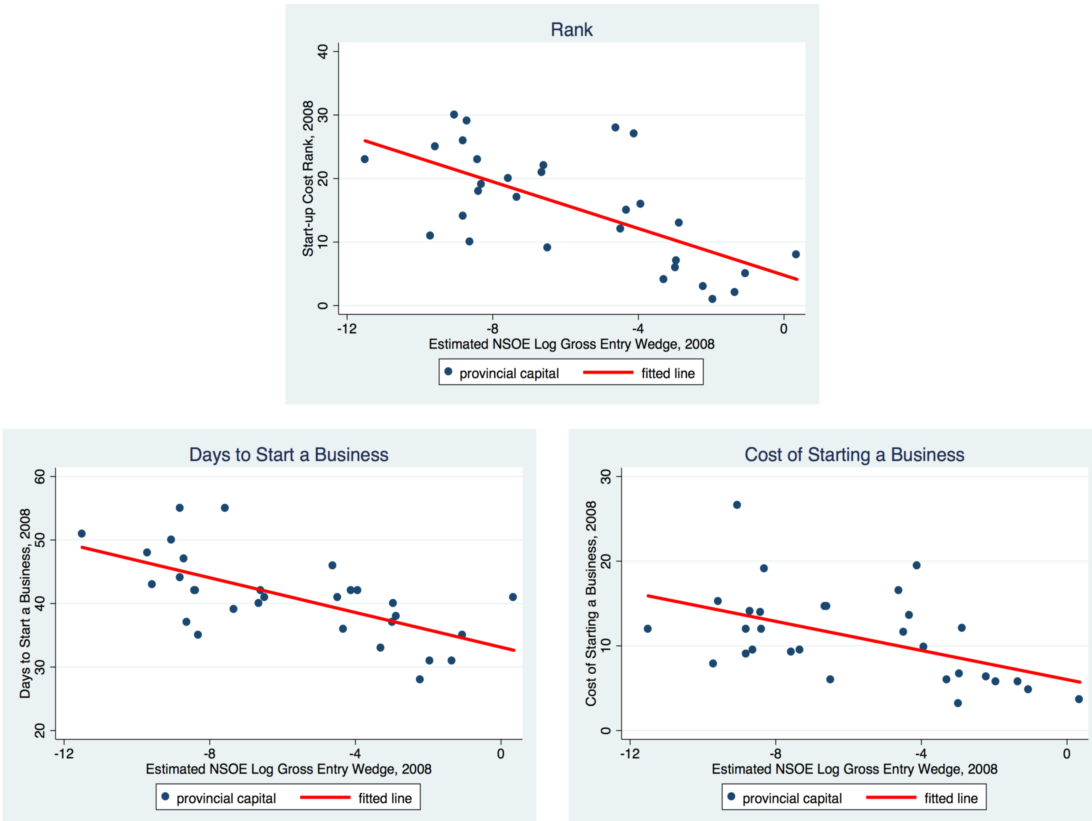
Figure 9: Log Gross Entry Wedges, $\ln(1-\psi)$, 2004 and 2008.



Notes: Each dot represents a prefecture. The left (right) panel plots the log gross entry wedge in the NSOE sector in 2004 (2008), and the dotted blue line is the corresponding fitted regression line. The solid red line is the fitted regression line for the log gross entry wedge in 1995. The 1995 SOE output share in a prefecture is on the horizontal axis.

a business: (i) a rank computed in the report based on all available information on how easy it is to start a business, (ii) the number of days it usually takes to start a business, and (iii) the cost of starting a business, as a percent of GDP per capita. The results, reported in Figure 10, clearly indicate that in localities where the measured entry wedges in our analysis in 2008 are higher are also the localities where the report finds high costs of starting a business. These results provide a valuable external validation for our estimates.

Figure 10: "Doing Business in China" and Entry Wedges, 2008.



Notes: Each dot represents a provincial capital city or a centrally administered municipality. Three measures of the cost of doing business in China in 2008 – rank (top panel), days to start a business (bottom left panel), and cost of starting a business (bottom right panel) – are plotted against the estimated log gross entry wedge for 2008. The solid red line is the fitted regression line.

5.4 Entry rates and wedges

The benchmark model has clear predictions on the effect of the output, capital, and entry wedges on firm entry in the non-state sector. In particular, as derived in section 3.4, an increase in the gross entry and output wedges increases entry while an increase in the gross capital wedge decreases entry. The entry rates were not specifically targeted in the parametrization of the model, and thus the model is not forced to be consistent with these patterns. It is therefore of interest to see whether that is the case. In order to take the model to the data we define an employment-based measure of entry in prefecture p in year $t = 1995, 2004, 2008$, $\Gamma^e_{p,t}$:

$$\Gamma^e_{p,t} = \frac{N^e_{p,t}}{N_{p,t} - N^e_{p,t}},$$

where $N^e_{p,t}$ is employment in new non-SOE firms while $N_{p,t}$ is total employment. We define as new those firms that were started in year $t-1$ or in $t-2$, and we drop all firms started in year t. The top panel in Table 1 reports the results from the following regression in levels:

$$\ln \Gamma^e_{p,t} = \beta_0 + \beta_1 \ln(1 - \tau_{y,p,t}) + \beta_2 \ln[(1 + \tau_{k,p,t})(r + \delta)] + \beta_3 \ln(1 - \psi_{p,t}) + \epsilon_{p,t},$$

while the bottom panel reports the results from the same regression in first differences:

$$\Delta \ln \Gamma^e_{p,t} = \gamma_0 + \gamma_1 \Delta \ln(1 - \tau_{y,p,t}) + \gamma_2 \Delta \ln[(1 + \tau_{k,p,t})(r + \delta)] + \gamma_3 \Delta \ln(1 - \psi_{p,t}) + \epsilon_{p,t}.$$

Table 1: The Entry Rate and Wedges in 1995, 2004, and 2008.

	$\ln(1-\tau^y)$		$\ln(1+\tau^k)$		$\ln(1-\psi)$	
	β_1	$1sd$	β_2	$1sd$	β_3	$1sd$
1995	0.188*	9.5%	-0.161*	-9.3%	0.106**	36.9%
2004	0.086	3.8%	0.045	2.2%	0.042**	14.9%
2008	0.221**	12%	-0.065	-5.0%	0.037**	13.1
	$\Delta\ln(1-\tau^y)$		$\Delta\ln(1+\tau^k)$		$\Delta\ln(1-\psi)$	
	γ_1	$1sd$	γ_2	$1sd$	γ_3	$1sd$
1995-2004	-0.083	-4.2%	-0.201*	-13.6%	0.035*	9.1%
2004-2008	0.160*	8.9%	-0.086*	-6.8%	0.044**	9.8%

Notes: The table reports the results from a regression of log gross entry rates on log gross output, capital, and entry rates in 1995, 2004, and 2008. The table also reports the percentage change in the log entry rate as a result of a one standard deviation in the variable.
** – statistically significant at 1%; * – statistically significant at 5%.

The effects of the wedges on entry rates are consistent with the dynamics in the benchmark model. In the cross-section in 1995, 2004, and 2008, higher gross output wedges increase entry rates, higher gross capital wedges decrease entry rates, while higher gross entry wedges increase entry rates. In terms of changes over time, the results are similar: an increase in the gross output wedge increases entry, an increase in the gross capital wedge decreases entry, while an increase in the gross entry wedge increases entry.

5.5 Relative Importance of Wedges in the Cross-Section and over Time

Variance in TFP and wedges. Using equation (10), the variance in log TFP across prefectures can be approximated as:

$$Var[\ln Z] \approx a_1^2 Var[\ln(1-\psi)] + a_1^2 Var[\ln \tilde{n}] + a_3^2 Var[\ln(1-\tau_y)] + a_4^2 Var[\ln(1+\tau_k)(r+\delta)].$$

The covariance terms and the variation in α across prefectures play a minor role. A similar expression holds when decomposing the variance of the change in prefecture log TFP over time.[23] We

[23] Appendix D shows the decomposition results for the effect of the wedges on wages and the capital-output ratio.

divide all terms by $Var[\ln Z]$ and report in Table 2 the relative importance of each of the four terms in the variance of prefecture-level log TFP or the change in log TFP over time. Clearly, the entry wedge accounts for most of the variation in log TFP, both in the cross-section and over time. The output wedge, the capital wedge, and the available labor force quantitatively have a small effect.

Table 2: Variance in TFP and Wedges in 1995, 2004, and 2008.

	ψ	$\tilde{n}$	τ^y	τ^k
1995	0.76	0.02	0.06	0.07
2004	0.68	0.03	0.03	0.05
2008	0.62	0.02	0.05	0.09
1995-2004	0.63	0.03	0.05	0.10
2004-2008	0.60	0.01	0.10	0.15

Notes: The table reports the relative importance of the variation in (the change in) log gross entry, output, and capital wedges and in the available labor force in accounting for the variance in (the change in) log TFP across prefectures in 1995, 2004, and 2008.

Convergence in TFP and wages. As we documented in Section 2, there was enormous dispersion in wages and TFP across prefectures in 1995 and a subsequent convergence between 1995 and 2004. We now analyze quantitatively the convergence in wages and TFP in the 1995-2004 and 2004-2008 time periods and decompose the importance of different forces for the observed convergence.

Table 3 reports that the annual rate of convergence for TFP was 3.1% between 1995 and 2004.[24] Using equation (10), we compute what the prefecture TFP would have been in 2004 had the only change in a prefecture between 1995 and 2004 been in the (i) average labor share, (ii) available labor force, (iii) output wedge, (iv) capital wedge, and (v) entry wedge. The change in the entry wedge between 1995 and 2004 alone would have lead to an annual rate of convergence of 2.9%, accounting for most of the convergence in TFP across prefectures between 1995 and 2004. All the other factors have a much smaller effect on the convergence in TFP $-$ e.g., changes in the available labor force had basically no effect on the convergence in TFP while the changes in the capital wedge alone would have lead to TFP divergence. The pattern is similar for the 2004-2008 time period $-$ the annual rate of convergence in TFP was 3.8% and the changes in the entry wedge accounted for most of that convergence.

The same analysis is performed for the rate of convergence in wages, and Table 3 reports the findings. The annual rate of convergence in wages between 1995 and 2004 was 6%. Using equation (8) we analyze the importance of the changes in the average labor share, available labor force, and three wedges, and quantitatively the most important factor for that convergence was the change in

[24] We regress the change in log TFP between 1995 and 2004 on log TFP in 1995 and report the absolute value of the coefficient, adjusted for the length of the time period to obtain an annualized value.

the entry wedges. The change in the available labor force contributed to only 10% of the observed wage convergence while changes in the output wedge only would have implied a wage divergence. The pattern for the 2004-2008 time period contributes a quantitatively much larger role for the changes in the entry wedge − the annual rate of convergence in wages was 10.9% and the changes in the entry wedge accounted for most of that convergence.

Table 3: Annual Rate of Convergence in TFP and Wages: 1995-2004 and 2004-2008.

	TFP		Wages	
Change in	1995-2004	2004-2008	1995-2004	2004-2008
all	0.031	0.038	0.060	0.109
$\alpha\eta$	-0.003	-0.007	0.023	0.006
$\tilde{n}$	0.001	-0.001	0.006	-0.009
$(1+\tau^k)$	-0.006	0.003	0.005	0.015
$(1-\tau^y)$	0.009	0.013	-0.001	-0.028
$(1-\psi)$	0.029	0.029	0.024	0.081

Notes: The table reports the annual rate of convergence in TFP and wages across prefectures for the 1995-2004 and 2004-2008 time periods. The table reports what the convergence in TFP and wages would have been had only one of the listed variables changed.

6 The Entry Wedges and the Size of the State Sector

The analysis so far is suggestive of a strong positive relationship between the size of the SOE sector and the size of the entry wedges in a prefecture. However, this was not interpreted as a causal relationship, but rather employed as a useful way to present systematically the empirical facts. In this section, we make the argument that there is a causal relationship between the size of the SOE sector and the entry wedges in a prefecture − large SOE sectors in a prefecture are associated with large entry wedges in the cross section, and prefectures that experienced larger declines in their SOE sector shares saw larger decreases in their entry wedges. We further establish that large entry wedges are also associated with lower SOE profitability and smaller fiscal revenues per government worker in a prefecture.

In order to examine the effect of the size of the state sector on entry costs at the prefecture level, we estimate Equation (20) in the cross section for each of the years 1995, 2004, and 2008, where $\ln(1-\psi)_{p,t}$ is the log gross entry wedge in prefecture p in year t, $e_{p,t}^{SOE}$ is the employment share of the state sector in prefecture p in year t, $X_{p,t}$ is a vector of prefecture characteristics that might also influence entry costs, and $\epsilon_{p,t}$ is an idiosyncratic error term:

$$\ln(1-\psi)_{p,t} = \beta_0 + \beta e_{p,t}^{SOE} + X_{p,t}\gamma' + \epsilon_{p,t}\,. \tag{20}$$

For 1995, we have information on the profitability of the state sector, as well as fiscal revenue per government worker. For 2004, we also have fiscal data, but do not have information from the enterprise census on profitability. With the number of government workers "fixed" by policy as a percentage of the registered population, and mobility limited, differences in fiscal revenue per worker largely reflect differences on the revenue side.[25] Because of potential concerns of endogeneity in the share of the state sector, we also estimate equation (20) using three IV variable specifications. IV_{lag} uses as an instrument the lagged value, $e^{SOE}_{p,t-1}$, of the SOE employment share of prefecture p, where the lagged value refers to the SOE employment share observed in the previous Chinese Manufacturing Census. The next two instruments exploit information on the size of the state sector in 1978. As argued earlier, the share of the state sector in a province (and thus a prefecture) heavily reflects historical factors, most notably, the 3rd Front policies in the 1960s under the Chinese Communist Party (CCP) (Naughton (1988)), and the decision of the National People's Party (KMT) to move industrial capacity inland during the Sino-Japanese War (1936-1945) and the Civil War (1945-1949) (Brandt, Ma and Rawski (2017a)). Reflecting these policies, coastal provinces had much smaller state sectors than the interior when reforms began in the late 1970s. We construct the IV_{1978} instrument by using the 1995 Chinese Industrial Census[26], restricting the sample to firms established in or before 1978, and using this sample to compute an SOE employment share for prefecture p. Finally, we run the analysis at the province level and construct the IV_{prov} instrument at the province level using 1978 GDP provincial data on SOE output shares.

We report the cross-sectional results in Table 4. In the individual cross-sections for 1995, 2004 and 2008, the OLS coefficient on the size of the state sector is consistently negative and highly significant, and declines slightly over time. The results suggest that prefectures with the largest (smallest) state sectors had the highest (lowest) entry costs. The IV results suggest slightly larger effects, and less attenuation in these effects over time. Overall, the effect of the size of the state sector on entry costs is highly robust to the inclusion of additional prefecture controls and the use of province fixed effects.

We also find for 1995 that entry costs were lower in prefectures in which the state sector was more profitable, and in which fiscal revenue per government worker was larger. We do not have information on SOE profitability, but fiscal revenue continues to be important in 2004. These effects could we working through a number of alternative channels. In prefectures where SOEs were less profitable, local governments may have been more concerned about competition from the non-state that could have reduced SOE profitability. Fewer rents in the SOEs may have also made local officials more predatory towards the non-state sector. More fiscal resources, some of which came from SOEs, may have had the same effect, and made it easier for local governments to make complementary investments. There is obvious endogeneity here as more entry of dynamic non-state firms would have also likely increased local fiscal revenue.

A potential concern for the cross-section results in Table 4 is that our estimates of the effect of the state sector are contaminated by the effect of unobserved heterogeneity. There are several possible solutions. To eliminate any potential time-invariant fixed effects at the prefecture level that might be correlated with e^{SOE}_{it}, we can exploit the panel dimension of the data and estimate Equation (20) in first differences, or Equation (21).

$$\Delta \ln(1-\psi)_{it} = \beta_0 + \beta_1 \Delta e^{SOE}_{it} + \Delta X_{it}\gamma' + \Delta\epsilon_{it}\,. \tag{21}$$

Conditional on prefecture fixed effects, changes in the share of SOEs in a prefecture are still

[25] For all three years, we also have prefecture-level information on average educational attainment of the working age population, the percentage of the population of working age, and the percentage of the labor force working in agriculture, which we can be used to control for unobserved heterogeneity that might be correlated with the size of the state sector and entry costs.

[26] The results are similar if we were to use the 1992, 2004, or 2008 census.

Table 4: The Entry Wedge in 1995, 2004, and 2008.

	$\ln(1-\psi)$	*OLS*	IV_{lag}	IV_{1978}	IV_{prov}
1995	e^{soe}	-11.64**	-14.13**	-12.96**	-11.72**
		(1.12)	(1.36)	(1.36)	(3.84)
	$\ln FREV$	1.31**	0.93*	1.11**	1.69*
		(0.38)	(0.40)	(0.40)	(0.99)
	$\ln PROF^{soe}$	0.31*	0.32*	0.32*	0.13
		(0.15)	(0.14)	(0.15)	(0.38)
First stage:					
	IV coefficient		0.73**	0.97**	0.97**
	st. error		(0.04)	(0.05)	(0.33)
	R^2		0.74	0.73	0.64
2004	e^{soe}	-9.61**	-13.39**	-16.06**	-17.47**
		(1.17)	(1.84)	(2.09)	(6.15)
	$\ln FREV$	2.16**	1.89**	1.70**	0.40
		(0.35)	(0.37)	(0.39)	(0.99)
First stage:					
	IV coefficient		0.62**	0.68**	0.79**
	st. error		(0.05)	(0.06)	(0.24)
	R^2		0.45	0.38	0.60
2008	e^{soe}	-8.10**	-9.63**	-14.60**	-16.71**
		(1.04)	(1.20)	(1.82)	(6.02)
First stage:					
	IV coefficient		0.88**	0.78**	1.05**
	st. error		(0.03)	(0.06)	(0.30)
	R^2		0.76	0.36	0.30

Notes: The table reports the OLS and IV results from a regression of the log gross entry wedge on the SOE employment share (e^{soe}), fiscal revenues per government worker ($FREV$), and SOE profitability ($PROF^{soe}$) in a prefecture in 1995, 2004, and 2008. e^{soe} available in all years, $FREV$ – in 1995 and 2004, and $PROF^{soe}$ in 1995. Standard errors are in parentheses. ** – statistically significant at 1%; * – statistically significant at 5%.

potentially endogenous: Unobserved shocks may affect both the share of the state sector in a prefecture and entry costs. We also cannot rule out totally the possibility of reverse causality: changes in entry costs influencing the share of the state sector.

To address these concerns, we take advantage of the major 1997 policy reform embedded in the Ninth Five Year plan in 1997, restructuring the state sector. The program was to close down loss-making state-owned firms under the slogan "Catch the Large, Release the Small" (Zhuada

Fangxiao). In addition to reducing its size in terms of the number of firms and workers, a major objective of this SOE reform was to concentrate state industry activity in sectors identified as strategic or pillar. Typically, these were more capital and skill-labor intensive sectors that were often upstream in the value chain. We construct Bartik (1991) instruments for the changes in the size of the state sector using national-level data on the changes between 1995 and 2004 in SOE employment at the sector level. At the prefecture level, a weighted average of changes at the national level in SOE sector employment, where the weights, $S_{1995,k}$, are the share of SOE employment in a prefecture in 1995 in sector k, should be a good predictor of changes in employment. Since we do not have a good IV for the changes in the size of the state sector between 2004 and 2008, we limit our estimation to the changes between 1995 and 2004.

In Table 5, we report the results from the fixed effects regression using the data for 1995 and 2004, along with the first stage regressions for the change in the size of the state sector. Results for the simple first-differences reported in columns (1) and (2) continue to suggest that entry costs were much higher in prefectures with larger state sectors, but the magnitude of the effect is significantly smaller–only one-third to one-quarter–than that suggested by results in Table 4. Columns (3) and (4) report IV results, with first stage results reported in column (5). Changes at the national level in SOE employment by sector are a very good predictor of changes in the share of the SOEs by prefecture. The IV coefficient on the size of the state sector is significantly larger than the OLS estimates in (1) and (2), and now about half of our estimates from the cross-sections. These estimates imply economically significant effects of the size of the state sector on entry costs at the prefecture level.

Table 5: Change in the Entry Wedge, 1995-2004.

$\Delta \ln(1-\psi)$	*OLS*	*OLS*	IV_p^{ind}	IV_p^{ind}
Δe^{soe}	-3.13**	-2.54*	-5.38*	-6.14*
	(1.00)	(1.18)	(2.20)	(2.38)
$\Delta \ln FREV$		1.13**		0.84*
		(0.37)		(0.41)
First stage:				
IV coefficient			0.67**	0.71**
st. error			(0.07)	(0.07)
R^2			0.21	0.30

Notes: The table reports the OLS and IV results from a regression of the change in the log gross entry wedge on the change in the SOE employment share (e^{soe}) and in the log fiscal revenues per government worker ($\ln FREV$) in a prefecture between 1995 and 2004. Standard errors are in parentheses. ** $-$ statistically significant at 1%; * $-$ statistically significant at 5%.

6.1 The nature of the entry wedges: How SOEs can inhibit new start-ups

In this section we elaborate further on how the presence of state owned firms inhibit entry of private firms, and the important role played by local cadres for explaining this link.

A key premise in the politico-economic model of the determination of wedges in Section 4 is that the local government faces pressure to meet an exogenous target for state employment, $\bar{N}_{SOE}$. We motivate this assumption as follows. Local officials, e.g. party secretaries and mayors, are appointed by higher levels of government and are tasked with multiple objectives. Much of the focus in the literature − see e.g. Li and Zhou (2005) and Xu (2011) − is on the high-powered incentives local leaders have to promote economic growth, but equally important through the nomenklatura system is their role in supporting state-owned enterprises.

State owned firms themselves have multiple mandates. As a major source of employment in the cities, SOEs have been critical to maintaining social stability, especially during economic downturns. Although the aggregate share of state-sector employment has fallen over time, it remained in upwards of forty-five percent through the mid-1990s, and the absolute level of state employment in industry has been highly persistent (Brandt and Zhu (2000)).

Endowed with the best human resources and capabilities, SOEs also take on leading roles in sectors identified by the state as "pillar and strategic." Included here are upstream sectors such as electricity and telecommunications, newly emerging sectors in high-tech, as well as sectors tied to the military-industrial complex.

Local cadres are beneficiaries of the success of SOEs in meeting the objectives of higher levels of government and of the Communist Party. SOEs are also potentially important sources of local government revenue and rents for local officials, often in the form of valuable jobs for family members and relatives as well as through highly lucrative business relationships with these same firms.

A key premise of our paper is that local government has access to policy instruments that may suppress the entry of private firms, and that local cadre often apply such policies, especially in areas where the state sector is prevalent.

Market liberalization and easier entry for new private firms arguably pose threats to the position of the SOEs through pressures in the product market, and more importantly, through the competition for local scarce factors. Thus, by mitigating the growth of private firms, local cadre can prevent the flight of the most capable managers and workers (and other scarce factors) from the SOEs to the private sector. In Section 4 we presented a formal model for how private sector growth can be curtailed by directly suppressing firm entry or by distorting the factor demand of NSOE (by for example imposing distortions on capital and output). Whiting (2006) documents that local officials erect various forms of barriers to entry and argues that the motivation for engaging in such behavior is that they seek to protect firms owned by local governments. This behavior manifests itself in the form of making it more difficult to obtain access to land, electricity and other scare intermediate inputs, over which local governments have some discretion and control. In addition, in newly emerging sectors, ministries have often restricted entry by issuing few liciences and by allocating these licenses to SOEs (Huang (2003)). More generally, local cadre can use their discretion over granting business licenses and influence over access to critical inputs to enrich family and friends in their networks, and thus themselves.

Barriers to entry in environments in which SOEs are dominant also take more indirect forms. Suppliers to state-owned firm must typically go through a lengthy certification process. On paper, this certification is to ensure that the supplier has the capabilities to meet the requirements laid out by the SOE. However, in practice the purpose of this process is to limit the access to act as a supplier to the SOEs to firms linked through personal networks either to officials in the state sector or local government (Interviews, 2017).

7 Robustness

We first develop a verison of the model with heterogeneity of wedges across firms and show that the implied entry wedges are very similar to those measured in Section XXX. We then consider various alternative theories for the large differences across prefectures in firm entry, wages, and TFP in 1995.

7.1 Extension: Heterogeneity of wedges across firms

In the model of Section 3 we assumed that the capital and output wedges were the same for all firms in a prefecture. We now extend the model to allow the capital and output wedges to be firm specific. Namely, there is heterogeneity in τ_{ik} and τ_{iy} across firms within each labor market.

Each potential entrepreneur can see both her potential TFP z_i and her potential wedges $\{\tau_{ik}, \tau_{iy}\}$ before deciding to enter. We make two key assumption to ensure that the problem is analytically tractable. First, the distribution of potential firm-specific TFP is independent of the realized wedges.[27] Second, the distribution of *potential* wedges Δ_k and Δ_y are jointly log-normal across firms in each prefecture. Denote the density function as $g(\tau_k, \tau_y)$, with

$$\begin{aligned} E(\ln \Delta_k) &= \ln(1+\bar{\tau}_k) \\ E(\ln \Delta_y) &= \ln(1-\bar{\tau}_y) \\ var(\ln \Delta_j) &= \sigma_j \\ cov(\ln \Delta_k, \ln \Delta_y) &= \sigma_{ky} \end{aligned}$$

Conditional on the individual state $s_i = \{z_i, \tau_{ik}, \tau_{iy}\}$ the optimal firm choices are still given by equations (3)-(4). Note in particular that the cutoff decision $z^*(\tau_{ik}, \tau_{iy})$ now differs across firms. Given the distributional assumptions it is possible to solve analytically for the wage that clears the labor market. We then solve for the implied distribution of observed allocations and wedges. As it turns out, we can identify the distribution of potential wedges using the observed first and second moments of these wedges. We summarize these results in the following proposition.

Proposition 2 *The equilibrium wage rate in the economy with within-prefecture heterogeneity in capital and output wedges is given by*

$$\begin{aligned} \ln w = & -\frac{1-\eta}{(1-\eta+\alpha\eta\xi)} \ln\left(\frac{N}{M}\underline{z}^{\xi}\nu^{1-\xi}\right) + \frac{1-\eta}{(1-\eta+\alpha\eta\xi)}\ln(1-\psi) \\ & + \frac{\xi}{(1-\eta+\alpha\eta\xi)}\ln(1-\bar{\tau}_y) - \frac{\xi\eta(1-\alpha)}{(1-\eta+\alpha\eta\xi)}\ln((1+\tau_k)(r+\delta)) + \Omega \\ & + \frac{\xi^2}{(1-\eta+\alpha\eta\xi)}\frac{1}{1-\eta}\frac{\sigma_y}{2} + \frac{(\xi\eta(1-\alpha))^2}{(1-\eta+\alpha\eta\xi)}\frac{1}{1-\eta}\frac{\sigma_k}{2} - \frac{(1-\alpha)\xi^2}{(1-\eta+\alpha\eta\xi)}\frac{\eta}{1-\eta}\sigma_{ky}. \end{aligned} \tag{22}$$

Moreover, the parameters of the joint log-normal distribution of potential wedges, $\{\bar{\tau}_k, \bar{\tau}_y, \sigma_k, \sigma_k, \sigma_{ky}\}$, *can be identified by the following cross-sectional first and second moments for observed wedges.*

[27] As we shall see, the entry decision of the potential entrepreneur depends on the entrepreneur's realized wedges $\{\tau_{ik}, \tau_{iy}\}$. Therefore, the equilibrium distribution of observed TFP will be correlated with the wedges, even though the distribution of potential TFP is independent of the wedges.

$$\frac{std\left\{(1+\tau_k)(r+\delta)\left|z\geq z^*\right.\right\}}{E\left\{(1+\tau_k)(r+\delta)\left|z\geq z^*\right.\right\}} = \sqrt{\exp(\sigma_k)-1} \tag{23}$$

$$\frac{std\left\{(1-\tau_y)\left|z\geq z^*\right.\right\}}{E\left\{(1-\tau_y)\left|z\geq z^*\right.\right\}} = \sqrt{\exp(\sigma_y)-1} \tag{24}$$

$$\frac{cov\left\{(1+\tau_k)(r+\delta),(1-\tau_y)\left|z\geq z^*\right.\right\}}{E\left\{(1-\tau_y)\left|z\geq z^*\right.\right\}\cdot E\left\{(1+\tau_k)(r+\delta)\left|z\geq z^*\right.\right\}} = \exp(-\sigma_{ky})-1 \tag{25}$$

$$E\left\{(1-\tau_y)\left|z\geq z^*\right.\right\} = (1-\bar{\tau}_y)\exp\left(\left(1+2\frac{\xi}{1-\eta}\right)\frac{\sigma_y}{2}-\left(\xi(1-\alpha)\frac{\eta}{1-\eta}\right)\sigma_{ky}\right) \tag{26}$$

$$E\left\{(1+\tau_k)(r+\delta)\left|z\geq z^*\right.\right\} = (1+\bar{\tau}_k)(r+\delta)\exp\left(\left(1+2\xi(1-\alpha)\frac{\eta}{1-\eta}\right)\frac{\sigma_k}{2}-\frac{\xi}{1-\eta}\sigma_{ky}\right) \tag{27}$$

Note that if there is no heterogeneity in wedges (i.e., $\sigma_y=\sigma_k=\sigma_{ky}=0$), then the equilibrium wage rate would be given by the first two lines of equation (22), which is the same wage expression as in the model without cross-sectional dispersion (cf. eq. (8)).

7.2 Alternative theories

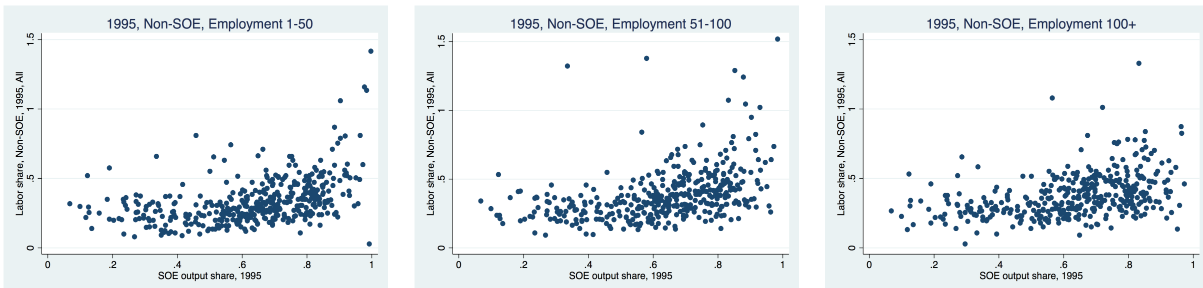
We already alluded in previous sections to several possible alternative explanations for the large differences across prefectures in firm entry, wages, and TFP in 1995. Here we provide a brief summary of these alternative explanations and highlight how they fall short in accounting for the patterns observed in the 1995 cross-section.

Different z distributions. One reasonable conjecture is that in less developed prefectures potential new entrants are drawn from a productivity distribution that is worse than the productivity distributions in the more developed prefectures. This would explain the low TFP and wages in prefectures in which firms systematically draw from worse underlying distributions of firm productivity z. As we pointed out in Section 3.5 this is inconsistent with the fact that in both high and low TFP prefectures in 1995 the upper top tail of the firm productivity distributions look almost identical − there are high productivity firms entering and operating in the low TFP prefectures, but there are relatively more less-productive firms in operation in the low TFP prefectures than in the high TFP prefectures.

Different costs of operating a business, ν. The costs of operating a business, ν, might be higher in the low TFP prefectures, consistent with lower non-SOE entry and potentially lower wages in those prefectures. However, entrants in those prefectures would be positively selected since only the most productive firms would be able to operate in an environment with high costs of operating a business. As a result, the TFP in those prefectures should be higher while we see the opposite pattern in the data.

Different production technologies. Suppose that potential entrants can choose from two available technologies to operate: (i) an inefficient and low-productivity technology that is labor intensive, and exhibits a high labor share, that is suitable for small-scale firms, and (ii) an efficient high-productivity technology that is less labor (more capital) intensive that is suitable for large-scale firms. A possible conjecture that would fit the empirical facts is that in the high SOE share (low TFP) prefectures firms choose to be small and use the first technology. Note also that we did find a higher overall labor share in those prefectures. The prediction of the theory is that (i) within prefectures smaller firms have a higher labor share; and (ii) across prefectures, conditional on size, firms have the same labor share.

Figure 11: Labor Share in 1995, NSOE Sector, by Firm Size.



Notes: Each dot represents a prefecture in 1995. Firms in each prefecture are divided into three groups: 1-50 (left panel), 51-100 (middle panel), and 100+ (right panel) employees. The figure plots the average labor share for firms in a particular prefecture-size cell. The 1995 SOE output share in a prefecture is on the horizontal axis.

As Figure 11 shows, that does not seem to be the case. We divide all firms in the non-SOE sector in a prefecture in 1995 into three groups depending on their employment size: 1-50, 51-100, and 100+ employees. We then report in Figure 11 the average labor share for the firms in each of the three categories in each prefecture. Two patterns are immediately obvious. First, within each prefecture, firms with different employment sizes have the same labor share. Second, across prefectures, conditional on size, the labor share is higher in the high SOE share prefectures, which are also on average the low TFP prefectures.

Different intermediate-input prices. A potentially promising theory is that the prices of intermediate inputs that firms face in the low TFP prefectures are higher than those in the high TFP prefectures resulting in less entry, lower measured TFP, and lower wages in the non-SOE sector. Intuitively, higher prices of intermediate inputs might be more likely in prefectures with a large SOE sector because of monopoly prices or less efficient suppliers of key inputs such as electricity.

We experimented with a version of our benchmark model that incorporates intermediate inputs in production. The first key observation from this model is that in order for the input prices to have a large effect, it must be difficult for non-SOE entrants to substitute away from the intermediate input. For example, if substitution possibilities differs across industries, new entrants can always choose to enter industries where the substitution is high so that they can partially avoid the higher input prices. Entry wedges affect all industries in a prefecture in the same way. For the input price of a particular intermediate input to have an effect, that intermediate input has to affect all industries in a prefecture as well − it has to be an important input in most industries' production functions, and it has to be difficult to substitute away from them. There are certain inputs that are likely important in all industries, and if the prices of those inputs are high, then it would be hard for potential entrants to avoid them regardless of the industry of entry. Two possible examples come to mind: electricity and land. However, for the case of electricity two points are worth making:

- In 1995 prices paid by SOEs and non-SOEs within a prefecture did not likely differ much. Differences across provinces were also likely small. The price of electricity is mostly determined by regulatory authorities at the national and provincial level. Therefore, new potential entrants in low TFP (and high SOE share) prefectures were not facing higher electricity prices, both relative to the SOEs in that prefecture and relative to potential non-SOE entrants in other prefectures.

- More likely, however, electricity could be rationed – the local governments determined who obtains power. SOEs usually would have a priority, and non-SOEs would then get whatever is available.[28] This mechanism would then work very much like the entry wedges in our baseline model: there might be many potential entrants in a prefecture, but with electricity rationed and facing an unpredictable supply of electricity, potential entrants were effectively prevented from entering that prefecture. If we were to use the input price model, we will infer high input prices for non-SOEs (since they will be using very little from that intermediate input) and low entry wedges while in fact the actual mechanism is high entry wedges (due to the rationing of electricity).

Similar arguments hold for the case of land. In general, there was no market for land in 1995, and it does not seem to be the case that there were large differences in the price of land across prefectures during that time. Instead, however, local governments might have decided to whom to give land. This kind of rationing again works more like an entry wedge than a higher price for an intermediate good.

8 Conclusion

This paper studies regional economic growth in China and analyzes the factors behind the initial dispersion and subsequent strong convergence in wages, TFP, and capital per worker. To this end we propose a tractable version of the Hopenhayn (1992) model of firm heterogeneity and new firm creation extended to incorporate three wedges – standard capital and output wedges, common for all firms in a prefecture, and a novel entry wedge. The general equilibrium model is solved analytically. It features endogenous aggregate TFP and allows us to measure the three wedges using data on aggregate allocations for wages, output, employment, and capital.

Our second contribution is to use firm-level data from the Chinese Industrial Census to construct prefecture-level aggregate data for manufacturing. These data are in turn used to measure the distortions. We document that entry barriers play a central role in accounting for regional dispersion and subsequent convergence in China. Finally, we study the empirical drivers of the entry barrier and find that the presence of state-owned firms give rise to larger entry barriers for non-state firms.

We examine and rule out a number of alternative explanations for the observed behavior, including differences across prefectures in the kinds of technology non-state sector firms can access; differences in the quality of entrants; and finally, differences in the fixed costs of doing business. The predictions of these models are not borne out by the data. In the context of the recent marked slowdown in economic growth in China, our analysis provides a potential mechanism for the recent slowdown in economic growth, namely that the resurgence in the state sector following the Global Financial Crisis may have contributed to larger entry barriers and, hence, lower non-state sector growth.

[28] Even though we do not have hard evidence on these two facts, there is anecdotal support for them. Further, over the period of interest for us, there was usually an excess demand for electricity at administrative prices that were set well below market clearing levels.

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APPENDICES

A Data Description

A.1 Dataset.

Our main data source is the 1995, 2004, and the 2008 Chinese Industrial Census (CIC) carried out by China's National Bureau of Statistics (NBS).[29] The CIC covers all of the manufacturing sector[30] and provides rich firm-level data on gross output, value added, employment, the gross capital stock, depreciation, total wages, as well as information on firm year of establishment, ownership type, and main sector of business. For these three years, we have firm-level records on 0.53, 1.37 and 2.08 million firms, respectively.[31]

In order to make these data comparable across the three census years, we needed to address a number of issues related to changes that occurred in China's industrial classification system, ownership categories, and prefecture boundaries. We draw on concordances described in Brandt et al. (2012) for ownership types and industrial sectors, and extend the concordance on prefecture boundaries in Baum-Snow et al. (2017) to cover all prefectures. We also utilize deflators developed by Brandt et al. (2012) for the purposes of constructing real measures of industrial output, and estimates of the real capital stock.

A.2 Constructing real capital in 1995, 2004, and 2008.

We use a procedure similar to the one in Brandt, Van Biesebroeck, Wang and Zhang (2017b) and Hsieh and Song (2015).

- Use the 1980 and 1985 Industrial Census in order to obtain the nominal capital stock, $\widetilde{k}$, at the original purchase price, in a 2-digit industry in a given province.
- Then, compute the annual growth in $\widetilde{k}$ for each 2d industry/province cell between 1980 and 1985 using the information from the 1980 and 1985 Manufacturing Census:

$$g_{\widetilde{k}} = \left(\frac{\widetilde{k}_{1985}}{\widetilde{k}_{1980}}\right)^{\frac{1}{5}} - 1 \tag{A-1}$$

- Use the further the 1995, 2004, and 2008 Industrial Census to compute the annual growth in $\widetilde{k}$ for each 2d industry/province cell between 1985 and 1995, 1995 and 2004, and 2004 and 2008.
- For each firm in 1995, we infer its initial level of capital, $\widetilde{k}_0$, in the year when the firm was established using the imputed above $g_{\widetilde{k}}$:

$$\widetilde{k}_{t-1} = \left(\frac{\widetilde{k}_t}{1 + g_{\widetilde{k},t-1}}\right) \tag{A-2}$$

  Therefore, for each year from its establishment until 1995 we have $\widetilde{k}_t$.
- We compute the real capital stock in the year of birth of the firm as:

$$k_0 = \frac{\widetilde{k}_0}{p_{k,t}}, \tag{A-3}$$

  where $p_{k,t}$ is the capital price deflator from Brandt and Rawski.
- Finally, the real capital stock for the firm in year t is computed as:

$$k_t = (1-\delta)k_{t-1} + \frac{\widetilde{k}_{t-1} g_{\widetilde{k},t-1}}{p_{k,t}}. \tag{A-4}$$

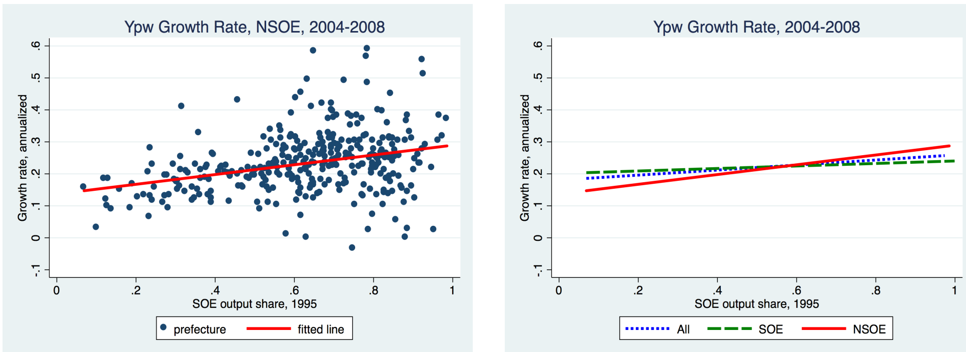
[29] We also draw on firm-level data for 1992 on all independent accounting units (0.39 million), which covers a slightly smaller subset of firms than the census and has information on a smaller set of variables.

[30] The 2004 and 2008 Census also provide data for the service sector, but unfortunately similar information was not collected in 1995.

[31] The firm-level records are not exhaustive, but cover in upwards of 90 percent of industrial activity.

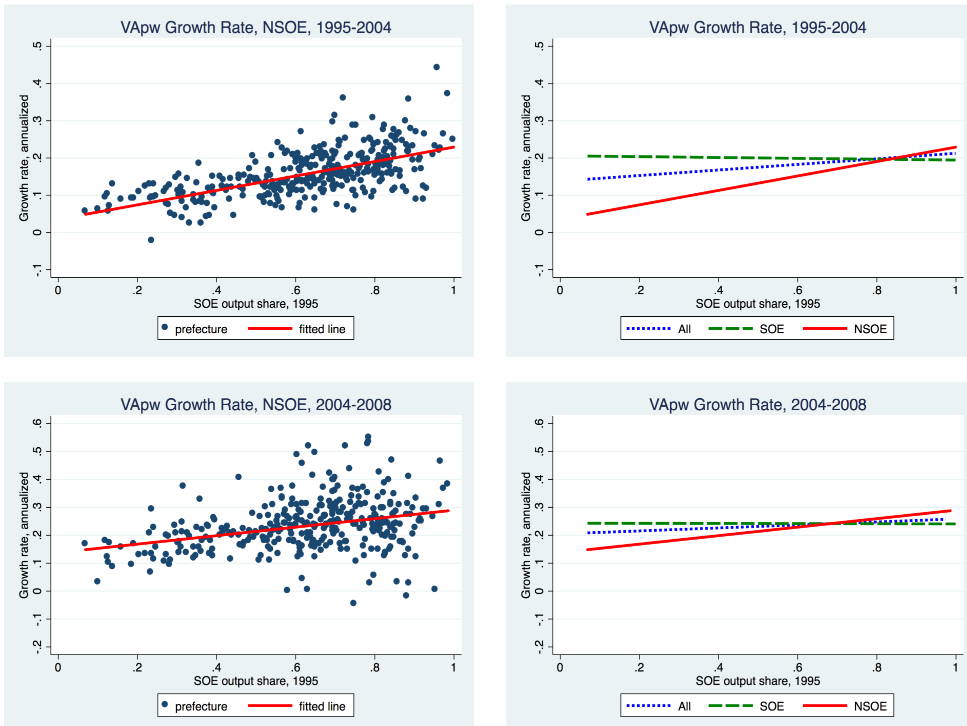
B Figures and Tables.

Figure B-1: Output per Worker Growth: 2004-2008.



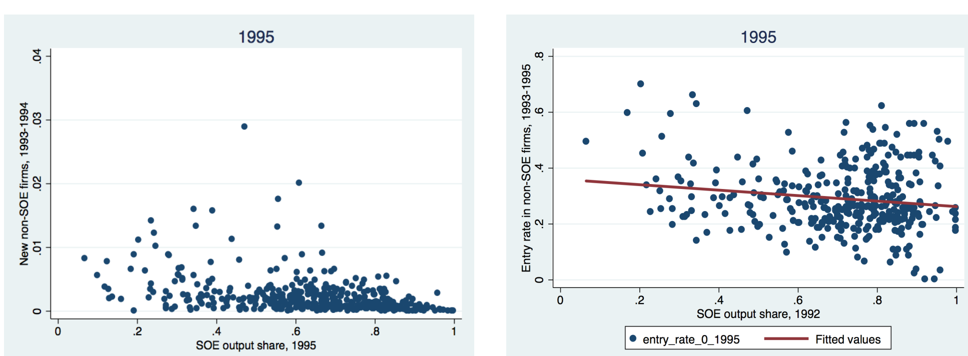
Notes: Each dot represents a prefecture. The left panel in the figure plots the annualized growth rate in output per worker in the non-state sector in 2004-2008, and the solid red line is the fitted regression line. The right panel plots the corresponding annualized growth rates: overall (blue short-dash), state sector (green dash), and non-state sector (solid red). The 1995 SOE output share in a prefecture is on the horizontal axis.

Figure B-2: Value Added per Worker Growth: 1995-2004 and 2004-2008.



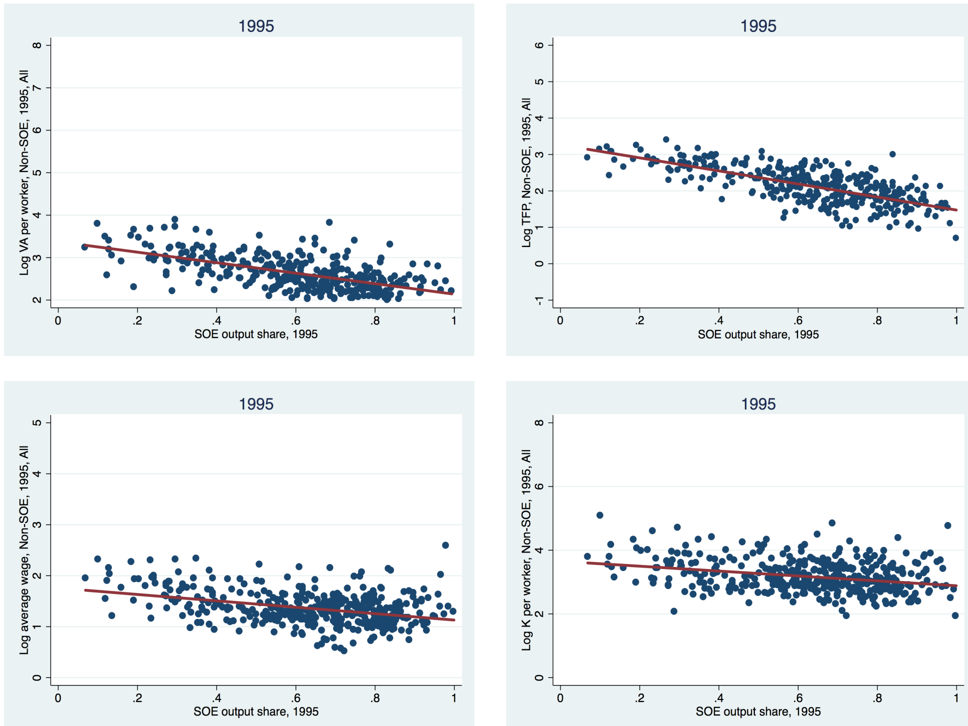
Notes: Each dot represents a prefecture. The left panels in the figure plot the annualized growth rate in value added per worker in the non-state sector in 1992-1995 (upper panel) and 1995-2004 (lower panel), and the solid red line is the fitted regression line. The right panels plot the corresponding annualized growth rates: overall (blue short-dash), state sector (green dash), and non-state sector (solid red). The 1992 (1995) SOE output share in a prefecture is on the horizontal axis for the 1992-1995 (1995-2004) period.

Figure B-3: NSOE Firm Entry in 1995.



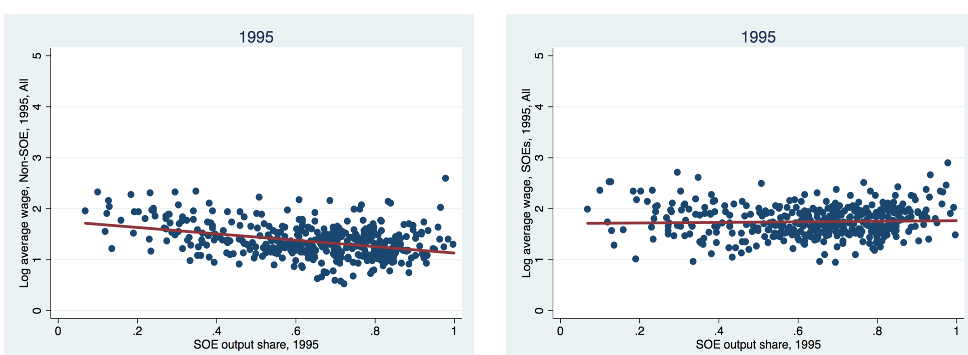
Notes: Each point represents a Chinese prefecture.

Figure B-4: Characteristics of NSOE Firms in 1995.



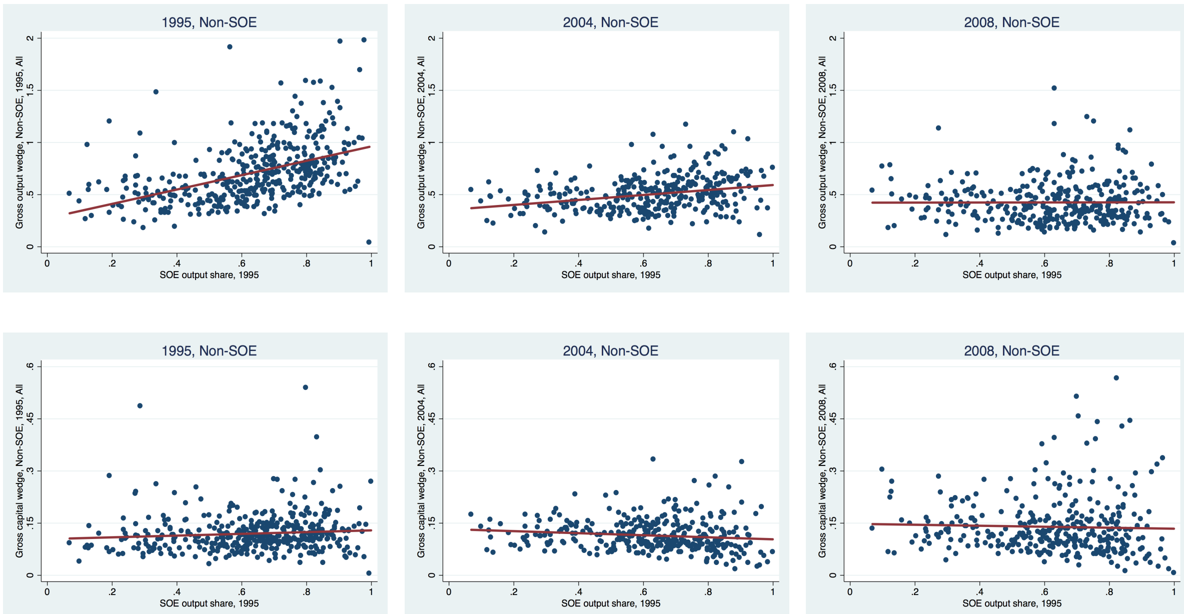
Notes: Each dot represents a prefecture, and the solid red line is the fitted regression line. The 1995 SOE output share in a prefecture is on the horizontal axis.

Figure B-5: Wages of NSOE and SOE Firms in 1995.



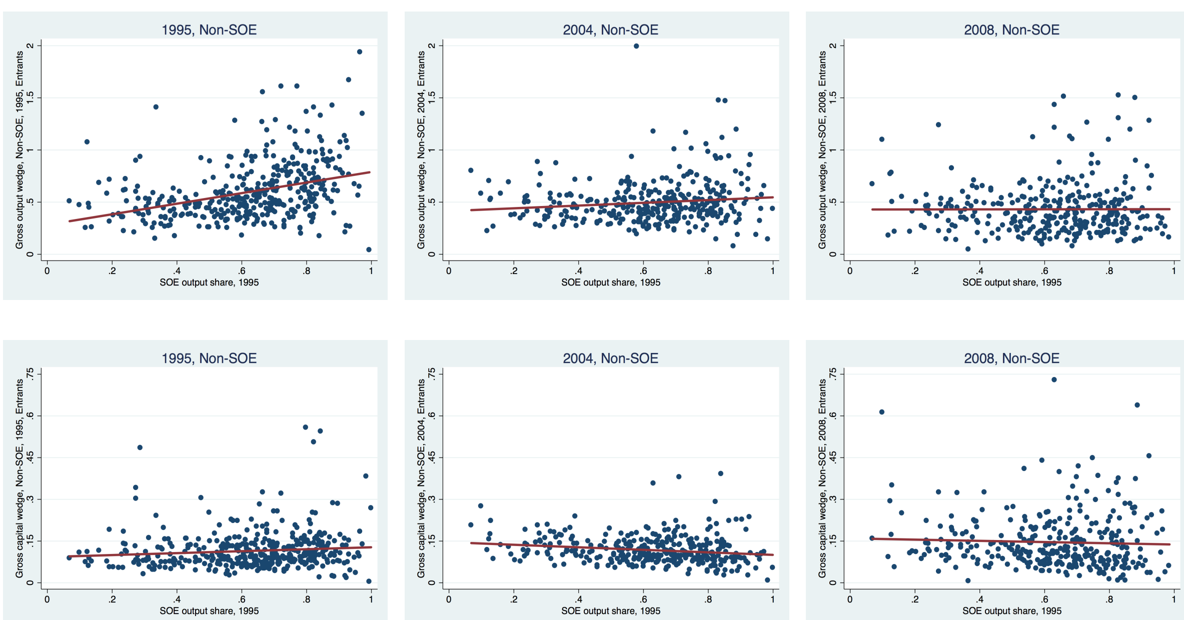
Notes: Each point represents a Chinese prefecture.

Figure B-6: Gross Output and Gross Capital Wedges, 1995, 2004 and 2008, All Firms, NSOE.



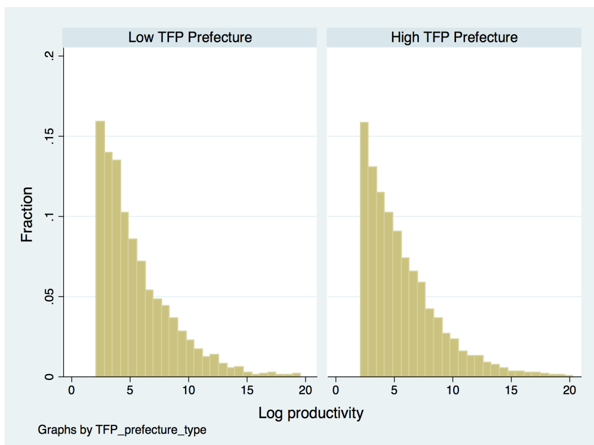
Notes: Each dot represents a prefecture. The panels plot the gross output and gross capital wedges for all firms in the NSOE sector in 1995, 2004, and 2008. The SOE output share in 1995 in each prefecture is on the horizontal axis.

Figure B-7: Gross Output and Gross Capital Wedges, 1995, 2004 and 2008, Entrants, NSOE.



Notes: Each dot represents a prefecture. The panels plot the gross output and gross capital wedges for new firms in the NSOE sector in 1995, 2004, and 2008. The SOE output share in 1995 in each prefecture is on the horizontal axis.

Figure B-8: The Truncated Distribution of $\ln z$ for Low and High TFP Prefectures, 1995.



Notes: All prefectures are separated into two groups based on their TFP, the Solow residual. Looking at the entire firm distribution in z in 1995, we pick the productivity z_{90} at the 90th percentile, and plot the z distribution above that threshold for low (left panel) and high (right panel) TFP prefectures.

C A Hopenhayn Model of Heterogeneous Entrepreneurs with an Entry Wedge: Details.

We assume that firms have a Cobb-Douglas production function with decreasing returns to scale

$$y_i = z_i^{1-\eta}\left(k_i^{1-\alpha} n_i^{\alpha}\right)^{\eta}, \tag{C-1}$$

where y_i is the firm's value added, k_i is the firm's capital stock, n_i is the firm's employment, z_i is the firm's total factor productivity, $\eta \in (0,1)$, and $\alpha \in (0,1)$. Therefore, $\alpha\eta$ is the labor share for firms in the prefecture. Moreover, assume that firm i pays a common rental rate $(r+\delta)$ on capital and a (possibly prefecture-specific) wage rate w_i. In addition, the firm faces firm-specific taxes on output and capital given by τ_i^y and τ_i^k. We assume that these taxes are not recorded as costs and do not affect the measured value added y_i. For convenience we drop the i and p subscripts. The firm's objective, for those that choose to operate, is given by

$$\Pi = \max_{k,n}\left\{\left(1-\tau^y\right) y - wn - \left(1+\tau^k\right)(r+\delta) k\right\}. \tag{C-2}$$

The first-order conditions are given by

$$\begin{aligned}\left(1-\tau^y\right)\alpha\eta y &= wn, &\text{(C-3)}\\ \left(1-\tau^y\right)(1-\alpha)\eta y &= \left(1+\tau^k\right)(r+\delta) k. &\text{(C-4)}\end{aligned}$$

Combining the two FOCs yields a labor-capital ratio

$$\frac{n}{k} = \frac{\alpha}{(1-\alpha)}\frac{\left(1+\tau^k\right)(r+\delta)}{w}. \tag{C-5}$$

Plugging this back into the production function yields an expression of output in terms of capital only:

$$y = z^{1-\eta}\left(\frac{\alpha}{(1-\alpha)}\frac{\left(1+\tau^k\right)(r+\delta)}{w}\right)^{\alpha\eta} k^{\eta}. \tag{C-6}$$

Combining equation (C-6) with the first-order condition for capital, equation (C-4), yields the optimal capital stock:

$$\begin{aligned}k^* &= z\cdot\left(\frac{1-\tau^y}{1+\tau^k}\frac{(1-\alpha)\eta}{r+\delta}\right)^{\frac{1}{1-\eta}}\left(\frac{\alpha}{(1-\alpha)}\frac{\left(1+\tau^k\right)(r+\delta)}{w}\right)^{\frac{\alpha\eta}{1-\eta}}\\ &\equiv z\cdot\bar{k}\left(\tau^y,\tau^k,r,w\right), &\text{(C-7)}\end{aligned}$$

and in equilibrium the output will be

$$\begin{aligned}y &= \frac{1+\tau^k}{1-\tau^y}\frac{r+\delta}{(1-\alpha)\eta}\cdot z\cdot\bar{k}\left(\tau^y,\tau^k,r,w\right)\\ &= z\left(\frac{1-\tau^y}{1+\tau^k}\frac{(1-\alpha)\eta}{r+\delta}\right)^{\frac{\eta}{1-\eta}}\left(\frac{\alpha}{(1-\alpha)}\frac{\left(1+\tau^k\right)(r+\delta)}{w}\right)^{\frac{\alpha\eta}{1-\eta}}\\ &= z\left(\frac{\left(1-\tau^y\right)\eta(1-\alpha)^{1-\alpha}\alpha^{\alpha}}{\left(\left(1+\tau^k\right)(r+\delta)\right)^{1-\alpha} w^{\alpha}}\right)^{\frac{\eta}{1-\eta}}\\ &= z\left(\left(1-\tau^y\right)\eta\right)^{\frac{\eta}{1-\eta}}\left(\frac{(1-\alpha)}{\left(1+\tau^k\right)(r+\delta)}\right)^{\frac{(1-\alpha)\eta}{1-\eta}}\left(\frac{\alpha}{w}\right)^{\frac{\alpha\eta}{1-\eta}}\\ &\equiv z\cdot\bar{y}\left(\tau^y,\tau^k,r,w\right). &\text{(C-8)}\end{aligned}$$

The profits are therefore given by

$$\begin{aligned}\Pi &= \left(1-\tau^y\right) y - \left(1-\tau^y\right)\alpha\eta y - \left(1-\tau^y\right)(1-\alpha)\eta y\\ &= z\cdot\left(1-\tau^y\right)^{\frac{1}{1-\eta}}(1-\eta)\left(\frac{\eta(1-\alpha)^{1-\alpha}\alpha^{\alpha}}{\left(\left(1+\tau^k\right)(r+\delta)\right)^{1-\alpha} w^{\alpha}}\right)^{\frac{\eta}{1-\eta}}\\ &\equiv \left(1-\tau^y\right)(1-\eta)\cdot z\cdot\bar{y}\left(\tau^y,\tau^k,r,w\right) &\text{(C-9)}\end{aligned}$$

To summarize, the firm's optimal choices are:

$$
\begin{aligned}
y^* &= z\bar{y}\left(\tau^y, \tau^k, r, w\right) \\
k^* &= z(1-\alpha)\eta\frac{(1-\tau^y)}{(1+\tau^k)(r+\delta)}\bar{y}\left(\tau^y, \tau^k, r, w\right) \\
n^* &= z\alpha\eta\frac{(1-\tau^y)}{w}\bar{y}\left(\tau^y, \tau^k, r, w\right) \\
\Pi^* &= (1-\tau^y)(1-\eta)\cdot z\cdot\bar{y}\left(\tau^y, \tau^k, r, w\right) \qquad \text{(C-10)}
\end{aligned}
$$

C.1 Output and Capital Wedges: Details.

The FOCs from the firm's problem imply:

$$
w = (1-\tau^y)\,\alpha\eta\cdot\frac{z\left(k^{1-\alpha}n^{\alpha}\right)^{\eta}}{n}\ , \qquad \text{(C-11)}
$$

$$
\frac{wn}{y} = \alpha\eta\,(1-\tau^y)\,, \qquad \text{(C-12)}
$$

and then

$$
\left(1+\tau^k\right)(r+\delta) = (1-\tau^y)\,(1-\alpha_j)\eta\cdot\frac{z\left(k^{1-\alpha}n^{\alpha}\right)^{\eta}}{k} \qquad \text{(C-13)}
$$

$$
\frac{y}{k} = \frac{1+\tau^k}{1-\tau^y}\frac{r+\delta}{(1-\alpha)\eta}. \qquad \text{(C-14)}
$$

Combining the FOCs yields:

$$
\frac{y}{k} = \frac{1}{\frac{wn}{y}}\frac{\alpha}{1-\alpha}(r+\delta)\left(1+\tau^k\right) \qquad \text{(C-15)}
$$

$$
\frac{k}{n} = \frac{1-\alpha}{\alpha}\frac{1}{1+\tau^k}\cdot\frac{w}{r+\delta} \qquad \text{(C-16)}
$$

Finally,

$$
1-\tau^y = \frac{1}{\alpha\eta}\frac{wn}{y} \qquad \text{(C-17)}
$$

$$
1+\tau^k = \frac{1-\alpha}{\alpha}\cdot\frac{wn}{(r+\delta)\,k} \qquad \text{(C-18)}
$$

D Additional Results.

D.1 Variance in wages and K/Y and wedges.

Variance in wages and wedges.

$$\begin{aligned} Var[\ln w] &\approx a_1^2 Var[\ln(1-\psi)] + a_1^2 Var[\ln \tilde{n}] \\ &+ a_3^2 Var[\ln(1-\tau^y)] + a_4^2 Var[\ln(1+\tau^k)(r+\delta)] \\ &+ 2a_1 a_3 Cov[\ln(1-\psi), \ln(1-\tau^y)] \\ &- 2a_3 a_4 Cov[\ln(1-\tau^y), \ln(1-\tau^k)] \end{aligned}$$

Table D-1: Variance in Wages and Wedges in 1995, 2004, and 2008.

	ψ	$\tilde{n}$	τ^y	τ^k	ψ, τ^y	τ^y, τ^k
1995	5.34	0.13	4.36	0.71	-7.57	-2.13
2004	10.45	0.43	5.54	1.07	-11.88	-2.26
2008	6.15	0.24	5.27	1.28	-6.56	-3.46
1995-2004	5.14	0.28	4.46	1.23	-6.73	-2.62
2004-2008	2.39	0.03	4.24	0.90	-3.74	-2.62

Notes: t statistics are in parentheses. ** − statistically significant at 1%; * − statistically significant at 5%.

Variance in K/Y and wedges.

$$\begin{aligned} Var\left[\ln \frac{K}{Y}\right] &= Var[\ln(1-\tau^y)] + Var[\ln(1+\tau^k)(r+\delta)] \\ &- 2Cov[\ln(1-\tau^y), \ln(1-\tau^k)] \end{aligned}$$

Table D-2: Variance in K/Y and Wedges in 1995, 2004, and 2008.

	τ^y	τ^k	τ^y, τ^k
1995	1.14	1.28	-1.42
2004	0.81	1.08	-0.89
2008	1.05	1.75	-1.80
1995-2004	0.72	1.38	-1.10
2004-2008	1.18	1.72	-1.90

Notes: t statistics are in parentheses. ** $-$ statistically significant at 1%; * $-$ statistically significant at 5%.