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# China's Declining Business Dynamism*

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January 14, 2022

**Abstract**

After impressive growth in the 2000s, China's productivity has more recently stagnated. We use firm-level data to analyze productivity and firm dynamism trends from 2003 to 2018. We document six facts that together show a decline in China's business dynamism. We show that (i) the revenue share of young firms has declined, (ii) the life-cycle growth of young firms relative to older incumbents has slowed, (iii) weaker life-cycle growth can be explained by slower productivity growth and weaker investment in intangibles, (iv) younger and smaller firms are more capital constrained than their older and larger counterparts, (v) the responsiveness of capital growth to the marginal product of capital has declined, and (vi) large productivity gaps between SOEs and private firms persist. We find that business dynamism is weaker in provinces where SOEs account for a larger share of the capital stock. Our results suggest that declining private business dynamism is an important factor in explaining China's sluggish TFP growth and that SOE reform could boost productivity growth indirectly by stimulating business dynamism.

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# 1. Introduction

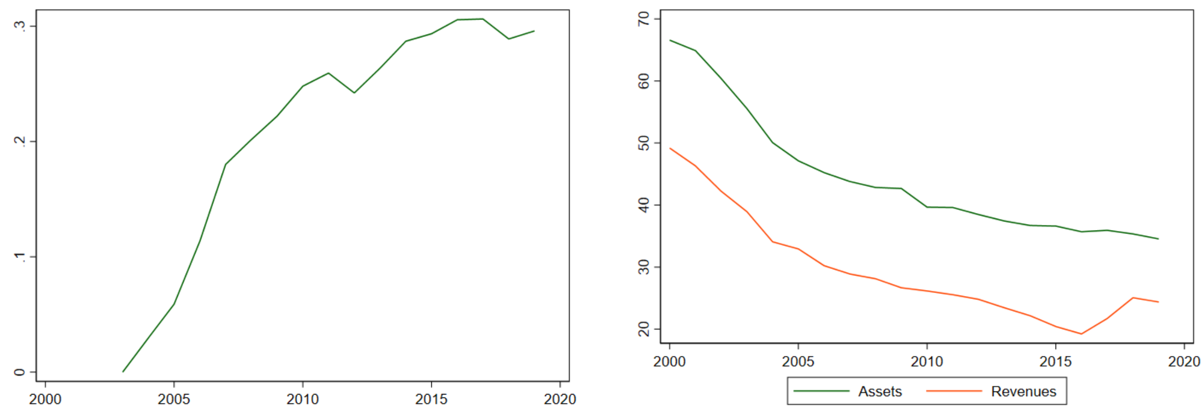
After impressive growth in the 2000s, largely driven by the rapid growth of young private firms (Brandt, Van Biesebroeck and Zhang, 2012), China's productivity growth has stagnated in recent years. While this slowdown in aggregate total factor productivity (TFP) has also occurred in other countries, China's productivity deceleration in the post-GFC period has been particularly dramatic, with TFP rising by around 22 percent between 2003 and 2011 and a mere 5 percent between 2011 and 2019 (see Figure 1a). Given looming demographic headwinds and diminishing returns to state-led investment, China's medium and long-term growth prospects are set to become increasingly dependent on its ability to reignite productivity growth. However, a lack of firm-level data in the post-GFC period has made it difficult to diagnose the causes of the productivity slowdown in recent years.

We fill this gap by using novel firm-level data from Bureau Van Dijk's Orbis database to analyze productivity and firm dynamism trends for China's manufacturing sector from 2003 to 2018. We document six facts. The first fact is that the share of young firms declined – the revenue share of firms under 10 years of age fell from around 70% in 2004/5, to around 30% in 2017/8. The second fact is that the life-cycle growth of firms declined – the 3-year growth rate of young firms relative to old firms fell between the mid-2000s and the mid-2010s. The third fact is that this weaker life-cycle growth is explained by a relative decline in productivity growth among young firms, as well as a relative decline in investment in intangible capital. The fourth fact is that younger and smaller firms have higher average products of capital than their older and larger counterparts. The fifth fact is that the responsiveness of capital growth to firms' average product of capital has declined. The sixth fact is there are large and persistent revenue productivity gaps between state-owned enterprises (SOEs) and private firms.

Together, these findings suggest that business dynamism has been declining in China. Declining business dynamism has been documented and studied both in the U.S. (Decker, Haltiwanger, Jarmin and Miranda, 2016; Akcigit and Ates., 2019a; Pugsley, Sedlacek and Sterk, 2021) and for a larger set of countries (Akcigit, Chen, Díez, Duval, Engler, Fan, Maggi, Tavares, Schwarz, Shibata and Villegas-Sánchez, 2021), however we are the first to document it in China over such an extensive time period. While exploring all the possible drivers of this decline in dynamism is beyond the scope of our paper, we examine the role of the state presence, which the existing literature has shown to be associated with a lower entry rates of new firms (Brandt, Kambourov and Storesletten, 2020). As further motivation, we note that the productivity slowdown coincides with the plateauing of the participation of the private sector in the economy (see Figure 1b), with SOEs

Figure 1: Trends in China's Aggregate Productivity and State Presence

(a) Aggregate TFP (b) State-Owned Enterprise Share




**Notes**: The left sub-figure plots aggregate TFP on a log-scale and normalized to 0 in 2003, from the Penn World Tables. The right sub-figure plots the revenue and asset share of state-owned enterprises among above-scale industrial firms, from CEIC.

still accounting for 39 percent of assets in 2019 despite substantially lower capital productivity (see Jurzyk and Ruane (2021)). We find that state presence, measured by the SOE share of assets in a province, is associated with both weaker life-cycle growth of firms and less responsive capital reallocation among private firms. Our results provide support for the view that the slowdown in the pace of SOE reform (Rosen, Leutert and Guo, 2018) and plateauing of the SOE share may be contributing to China's slower TFP growth.

Our data is from Bureau Van Dijk's Orbis database, which has been commonly used to study issues related to productivity and firm dynamics in other countries (e.g. Gopinath, Kalemli-Özcan, Karabarbounis and Villegas-Sanchez (2017)). The main benefit of Orbis relative to the commonly used Chinese Industrial Survey (CIS) is that Orbis has extensive coverage of manufacturing firms from 2003 to 2018, while the CIS coverage ends in 2013. In order to have such an extensive time coverage, other researchers have often focused on listed firms only (e.g. Jurzyk and Ruane (2021)). However, Orbis has much greater representativeness, with data on 221,180 manufacturing firms per year on average. This makes Orbis particularly well-suited for comparisons of firm dynamics during both China's period of rapid TFP growth and during the slowdown. For most our results we restrict our attention to the manufacturing sector because of data availability. We take care to account for changes in sampling methodology over time. Reassuringly, we also find a slowdown in TFP growth when aggregated from the firm-level Orbis data.

We use these data to document six main stylized facts which are informative about trends in firm dynamics in China. The first fact is that the revenue share of young firms declined substantially between 2004/5 and 2017/18. Through the lens of standard growth models, this implies that the portion of growth attributable to young firms declined over time (Garcia-Macia, Hsieh and Klenow, 2019). The second and third findings relate to the life-cycle growth of firms, which can have large impacts on aggregate TFP (Hsieh and Klenow, 2014). We measure the life-cycle growth as the 3-year revenue and productivity growth of young firms relative to older firms, similarly to Eslava, Haltiwanger and Pinzón (2019). We find that life-cycle revenue growth of young firms was substantially lower between 2011 and 2018 than between 2003 and 2010. This reflected weaker technical efficency or quality improvements, which we refer to as TFPQ following Foster, Haltiwanger and Syverson (2008) and Hsieh and Klenow (2009). Consistent with lower TFPQ growth being driven by firms investing less in improving their efficiency or product quality, we find that the life-cycle growth of intangible investment is also lower post-2010.

The fourth fact is that young and small firms have considerably higher average products of capital (capital productivity) than older and larger firms. This is consistent with evidence from Bai, Lu and Tian (2018), who focus on industrial firms between 1998 and 2007. Our findings suggest that the large financial frictions estimated by Bai et al. (2018) have remained an important constraint for young firms over the last decade. Our fifth fact is that the responsiveness of capital growth to the average product of capital has declined over time. We estimate this by regressing capital growth on the average product of capital by sub-period. An efficiency-enhancing allocation of capital should imply that capital reallocates towards those firms with higher marginal products of capital. A decline in the capital responsiveness elasticity we estimate could therefore reflect worsening frictions to capital reallocation, which is consistent with our finding that the dispersion of capital growth across firms has also declined over time.

Our sixth fact is that SOEs have lower revenue productivity (revenue over inputs) and capital productivity (revenue over capital) than private firms. This fact has been extensively documented in for Chinese industrial firms prior to 2013, including by Brandt et al. (2012); Hsieh and Song (2015); Bai et al. (2018). Jurzyk and Ruane (2021) show that these productivity gaps remained large among listed firms through 2019. Our data allow us to show that these gaps are productivity gaps remain through 2018 for a much larger and representative sample of firms. We additionally document that these productivity gaps are large in the service sector, for which we have data post-2013.

There are many possible explanations for the decline in China's business dynamism, One possibility is an aging population, which may be an important factor in understanding the decline of new firm creation in the U.S. (Pugsley and Şahin, 2018) . Another possibility is that the decline in dynamism reflects in part a natural transition following one-off events such as WTO accession, which created new opportunities for private firm growth in both external and internal markets. This growth of the private sector was in part enabled by large-scale SOE reform (involving the closure, privatization or merger of more than 80 percent of SOEs between 1998 and 2007 (Hsieh and Song, 2015) which allowed for productivity-enhancing resource reallocation (**?**).

However, there remains substantial scope for SOE reform in China, with the SOE share of industrial assets remaining at almost 40% in 2019. This SOE presence could have important indirect effects on productivity if it reduces private sector dynamism. We explore this possibility by correlating measures of business dynamism with SOE intensity across provinces. We focus on two measures of dynamism: life-cycle growth of firms and the responsiveness of capital growth to the marginal product of capital. We find that in the cross-section of provinces, business dynamism tends to be weaker where SOEs account for a larger share of assets. We take this as suggestive evidence that SOE reform in China could not only boost productivity growth directly through resource reallocation, but also indirectly by stimulating business dynamism.

An extensive literature has documented how various large-scale reforms in the early 2000s spurred China's productivity growth, including entry into the WTO and reductions in external trade barriers (Brandt and Zhang, 2017), reductions in internal trade and migration barriers (Tombe and Zhu, 2019), and SOE reform (Brandt et al., 2012). Studies using rich firm-level data have also documented the importance of the private sector (Hsieh and Song, 2015), with the entry and rapid growth of young private firms the primary driver of aggregate productivity growth (Brandt et al., 2012). However, firm-level studies for the years following the 2008 financial crisis show that this dynamism had started losing steam, with lower firm productivity growth and entry during 2008-2013 (Brandt et al., 2020; Brandt and Lim, 2020). We contribute to the literature by using new data to show that this dynamism continued to lose steam until at least 2018, a period during which aggregate productivity growth slowed even further.

Our paper also relates closely to the literature on business dynamism, which has documented how business dynamism matters for aggregate productivity, and therefore economic growth. For example, Garcia-Macia et al. (2019) find that entry of new firms accounts for around a quarter of U.S. productivity growth between 1983 and 2013. Decker and others (2020) provide evidence that firm responsiveness to shocks has been declining in the U.S. and that this has contributed to slow productivity growth. Akcigit and Ates. (2019a,b) highlight that declining U.S. business dynamism reflects lower knowledge diffusion between firms. Akcigit et al. (2021) examine the role that market power and M&As play in driving business dynamism in a larger set of countries. Our findings suggest that, in some countries, a large state presence may be an additional factor to consider when studying business dynamism.

The rest of the paper is organized as follows. Section 2. describes the Orbis dataset, and shows that it is able to match broad aggregate productivity trends. Section 3. lays out six stylized facts that point to declining business dynamism. Section 4. discusses the relationship between declining dynamism and state presence. Section 5. concludes.

## 2. Orbis Data

We use firm-level data from Bureau Van Dijk's Orbis database to analyze productivity and firm dynamism trends from 2003 to 2018. Orbis has been commonly used to study firm-level productivity issues including misallocation (Gopinath et al., 2017) and market power (Díez, Fan and Villegas-Sanchez, 2021), but we are not aware of any other papers which have used Orbis to study firm dynamics in China.

There are two main benefits of using Orbis; the coverage of firms and the time horizon. The Orbis database has a broad coverage of manufacturing firms across the size distribution from 2003 to 2018, and also has coverage of service sector firms from 2013 to 2018. Because there is a minimum annual revenue threshold up to 2012, we impose a RMB 5 million revenue threshold in all years for our baseline results. The cleaned manufacturing database contains on average 221,180 firms per year for which we can observe revenues, capital and costs. We measure revenues as sales plus other operating revenues. We measure capital as either total assets or tangible fixed assets. We measure costs as costs of goods sold plus other operating costs. An important feature of the Orbis database is the coverage of firms through 2018, allowing us to compare firm dynamics in the 2000s with the 2010s. In contrast, the commonly used Chinese Industrial Survey ends in 2013. While sampling changes lead to changes in coverage over time relative to official values, aggregate manufacturing revenues from our data are 78 percent of official aggregates on average for above-scale manufacturing. Another important variable in our paper is firm age, which we construct based on the reported year of incorporation. See Appendix A for more details on the data and sampling.

Some of our results require classifying firms by ownership type. We identify SOEs in our database by combining information from Orbis' own ownership database and linking firm identifiers to Wind ownership data for listed firms (see Appendix B for further details). We identify around 3,200 SOEs every year on average in manufacturing and mining sectors, and (for the subperiod 2013-2018) 9,200 SOEs every year on average in services sectors.

### 2.1. Aggregate TFP from Orbis

We check the reliability of our data for understanding trends in China's aggregate TFP by confirming that the firm-level data also features the productivity slowdown in Figure 1a. We construct an aggregate TFP series from our firm-level data as a gross-output weighted average of industry-level TFP, based on a Cobb-Douglas industry production function. We use revenues as our measure of output, tangible fixed assets as our measure of capital, and use industry cost shares to identify labor and intermediate inputs from the sum of cost of goods sold plus non-operating costs. We deflate all variables using 2-digit industry deflators for revenues and intermediate inputs. We construct our sectoral TFP estimates at the same-level as our industry-specific deflators, thereby avoiding the possibility of conflating true productivity growth with changes in markups. See Appendix C for full details.[1]

Our measure of manufacturing TFP points to a slowdown in productivity growth post-GFC, as shown in Figure 2. Sampling changes post-2013 increase the volatility of TFP series, however it is clear that TFP growth slowed down considerable post-GFC relative to the previous decade. Understanding whether declining firm dynamism is in part responsible for this decline is a critical input for the design of policies to reverse it and achieve sustainably high long-run growth.

## 3. Declining Dynamism

We document six facts from the data that show a decline in China's business dynamism. We show that (i) the revenue share of young firms has declined, (ii) the life-cycle growth of young firms relative to older incumbents has weakened, (iii) life-cycle growth in productivity and investments in intangibles have declined, (iv) younger and smaller firms are more capital constrained than their older and larger counterparts, (v) the efficiency of capital reallocation has declined over time, and (vi) there are large and persistent productivity gaps between SOEs and private firms.

**Fact 1: The revenue and asset share of young Chinese firms has declined over time.**

[1] Note that our TFP series is not directly comparable in levels to that from the PWT, both because we focus only on manufacturing, and because our production function is in terms of gross output rather than value-added.

Figure 2: Average manufacturing TFP based on Orbis' data

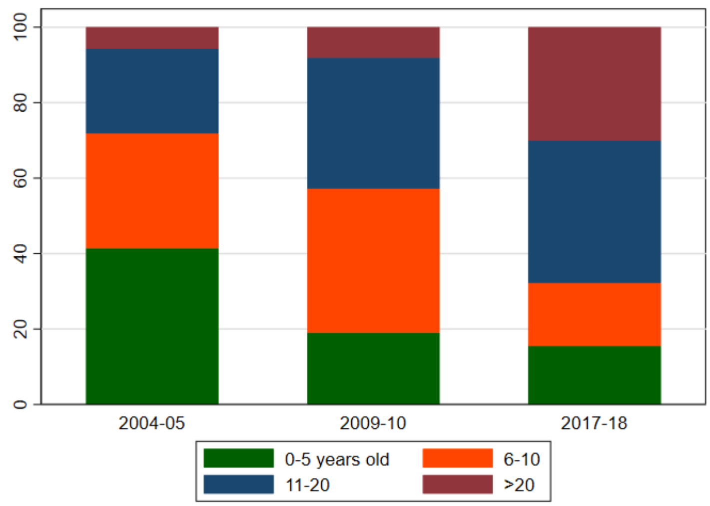

**Notes**: This figure plots aggregate TFP on a log-scale and normalized to 0 in 2003, constructed from the Orbis database. See Appendix C for details.

It is well established that entry of young firms is an important contributor to aggregate productivity growth (see e.g. Alon, Berger, Dent and Pugsley, 2018). A critical moment to quantify their importance is their share of outputs and inputs (Garcia-Macia et al., 2019). Figure 3 shows that the revenue share of young firms in China has declined dramatically over time: the share of firms under 10 years old fell from around 70 percent in 2003-04 to around 30 percent in 2017-18. We find a similar trend when we use total assets as a measure of firm size rather than revenues. We also find a similarly small revenue share for young firms using Orbis' data on service sector firms, indicating that this is a common pattern across the whole economy. One potential concern is that changes in sampling methodology would affect these distributions. Our baseline figure deals with sampling concerns by imposing the same minimum size threshold in all years, only including firms with over 5 million RMB in revenues. However, we also find a low revenue share for young firms in 2017/18 when we include all manufacturing firms in Orbis, expanding the sample from around 200,000 firms to 700,000 firms.

It is unsurprising that the revenue share of young firms was particularly high in the wake of China's WTO entry and large-scale market reforms in the early 2000s. This high revenue share is also consistent with evidence from (Brandt et al., 2012) that the entry and rapid growth of young private firms the primary driver of aggregate productivity growth in the 2000s. The enormous decline in the revenue share of young firms over the following 14 years in part reflects post-reform transition dynamics. Private firms that entered in the early 2000s were more productive than previous incumbents, and thus raised the bar for future entrants to claim a large market share. It is therefore clear that the sources of Chinese growth shifted markedly between the 2000s and 2010s, away from the entry and growth of young firms, and towards growth among incumbent firms.

A low revenue share of young firms could either reflect low productivity upon entry or weak life-cycle dynamics, i.e. weak growth with age. We consider how life-cycle growth of young firms has evolved next.

Figure 3: Revenue share of firms by age group




**Notes**: This figure shows the revenue share of firms of different age groups across years in Orbis. The sample is manufacturing firms with over RMB 5 million in revenues.

**Fact 2: Life-cycle growth of young Chinese firms has declined over time.**

Recent evidence suggests that growth over a typical firm's life-cycle (growth with age) tends to be much higher in the U.S. than in developing economies (Hsieh and Klenow, 2014), with the U.S. in particular exhibiting strong up-or-out dynamics which spur aggregate productivity growth (Haltiwanger, Jarmin and Miranda, 2013; Eslava et al., 2019).

In the absence of panel data, firms' life-cycle growth can be estimated from how the size of firms from the same cohort varies over time (Hsieh and Klenow, 2014). However, because Orbis is a panel we can keep track of individual firms as they age, similarly to Eslava et al. (2019). The long time horizon from 2013 to 2018 also means that we can evaluate how medium-run growth dynamics have changed between the 2000s and

2010s. We estimate life-cycle growth through the following regression:

$$\Delta_k y_{ist} = \alpha + \sum_{a=1}^{5} \beta_a I(\text{age group} = a) + FE_{st} + \epsilon_{ist} \tag{1}$$

where $y_{ist}$ is the $k$-year revenue growth for firm $i$ in sector $s$ in year $t$ (growth between year $t$ and $t+k$). $I(\text{age group} = a)$ are a set of dummies for five different age groups; 1-2, 3-5, 6-10, 11-15 and 16+ (omitted). $FE_{st}$ is a full set of sector year fixed effects. We set $k = 3$ in order to focus on the medium-run growth dynamics of firms and fitting better with our broad age categories. Finally, because we are interested in how firm's life-cycle growth dynamics have changed over time, we interact the age group dummies with dummies for the two time periods of interest: 2003-2010 and 2011-2018.[2]

Figure 4 shows the results. Similarly to what has been documented in other countries, we find that average firm growth decreases with age; 3-5 year old firms have 3-year growth rates around 17 percentage points higher than firms in the 16+ age group. However, more strikingly, we find that the revenue growth of firms under the age of 10 (relative to 16+) is substantially smaller from 2011-2018 than from 2003-2010. While this pattern is inverted for the youngest firms between 1 and 2 years (startups), this largely reflects noise given that there are much fewer firms in this age group. A possible concern is that the change in life-cycle growth reflects a changing size of entrants. A well known fact is that growth rates decline with firm size (Gibrat's law), and so weaker life-cycle growth may simply reflect changing size of entrants over time. However, we find that our results become more pronounced when we control for initial firm size, with even the growth rate of startups being lower in 2011-2018 than in 2003-2010.

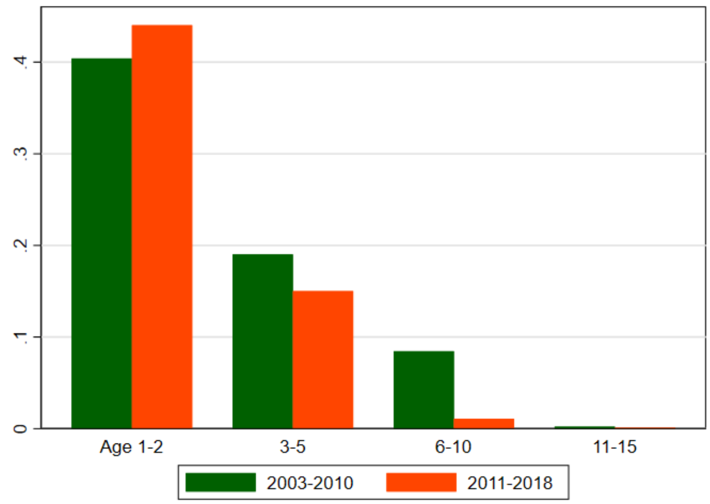
The weaker life-cycle growth of young firms in China in the 2010s suggests that young firms may be investing less in improving their productivity or product quality, or that they are facing increasing barriers to growth. We consider these possible explanations next.

**Fact 3: Productivity growth and innovation over the life-cycle has weakened.**

The flatter life-cycle growth depicted in Figure 4 could be due to (a) increasing distortions which prevent firms from growing, or (b) firms investing less in R&D, process efficiency, quality improvements, or other intangible inputs. Under standard monop-

[2] One issue is that the minimum size of firms in our sample increases to RMB 20 million in 2011 and 2012. This can introduce a selection bias when we consider revenue growth for firms who cross the 20 million threshold in these years. We resolve this by only observations in 2011 and 2012 where revenues in btoh $t$ and $t+k$ are greater than RMB 20 million.

Figure 4: 3-year growth rate of revenues




**Notes**: This figure plots the 3-year growth rate of revenues for firms of different age groups, relative to firms in the 15+ age group. Bars are plotted separately for 2003-2010 and for 2011-2018. The coefficients are obtained from a regression of 3-year growth rates against sector-year fixed effects and age group dummies. The sample is manufacturing firms with over RMB 5 million in revenues.

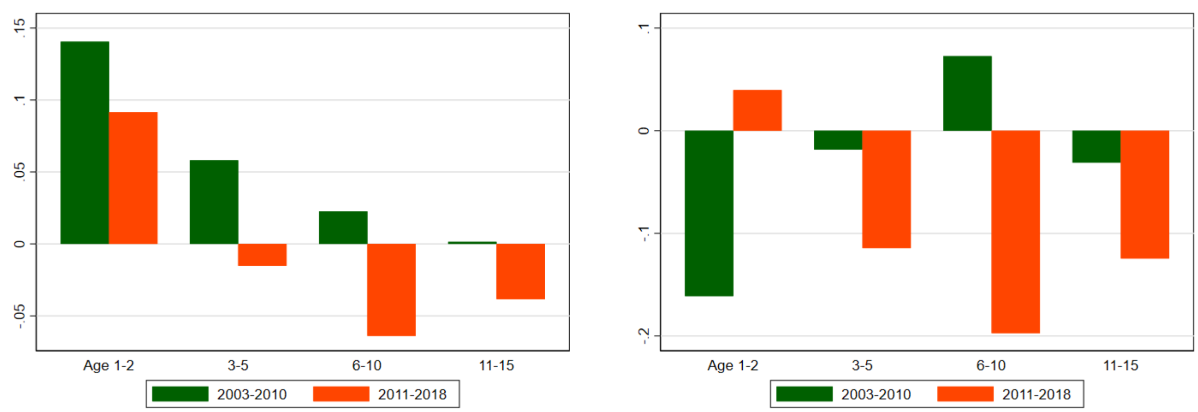
olistic competition assumptions, increasing distortions would show up as higher average revenue products (TFPR), while lower efficiency or quality would show up as lower 'quantity productivity' (TFPQ). This widely adopted TFPR vs. TFPQ notation goes back to Foster et al. (2008), and we follow the Hsieh and Klenow (2009) measurement approach as implemented in Bils, Klenow and Ruane (2021). In particular, we measure TFPR as $Q_{si}/I_{si}$ and TFPQ as $Q_{si}^{\frac{\sigma}{\sigma-1}}/I_{si}$where $Q_{si}$ is firm revenues and $I_{si}$ are firm inputs with $I_{si} = (K_{sis}^{\alpha} w L_{si}^{1-\alpha_s})^{\gamma_s} X_{si}^{1-\gamma_s}$. $\alpha_s$ and $\gamma_s$ are industry cost shares, and we set $\sigma = 4$.

We do not find evidence that TFPR varies over the life-cycle, nor that it changes between the 2000s and the 2010s. This suggests that increasing distortions alone does not explain the weakening of the life-cycle growth of young firms. We do find, on the other hand, that TFPQ of young firms relative to older firms did decline substantially. Figure 5a shows that in the 2000s, TFPQ growth was declining monotonically with age, however it becomes U-shaped in the 2010s, with 6-10 year old firms in particular experiencing lower TFPQ growth than 16+ firms. We dig further into the sources of the decline in life-cycle productivity growth by looking at the behavior of intangible investment with age, which we are able to measure for a subset of the manufacturing firms in our sample. The data on intangible fixed assets paint a similar picture, showing that young firms are investing relatively less in process efficiency and quality improvements than they had in the previous decade (Figure 5b).[3]

Why are firms investing less in productivity and quality improvements? One possibility is that the returns to such investments declined because of size-related distortions which discourage firms from making these investments. A more benign explanation is that our findings reflect outstanding innovation and productivity investments by older firms. For example, Garcia-Macia et al. (2019) find that investments by old and large incumbents account for a large share of U.S. productivity growth. However, this does not appear to be the case in China, given the very weak TFP growth from 2011-2018 shown in Figure 2. Rather, our findings indicate a concerning decrease in the dynamism of young firms in China, which could be contributing to the aggregate productivity growth slowdown.

Figure 5: 3-year growth rates of productivity and innovation

(a) Physical productivity (TFPQ) (b) Intangible fixed assets (innovation)




**Notes**: These figures plots the 3-year growth rate of TFPQ (left) and intangible fixed assets (right) for firms of different age groups, relative to firms in the 15+ age group. Bars are plotted separately for 2003-2010 and for 2011-2018. The coefficients are obtained from a regression of 3-year growth rates against sector-year fixed effects and age group dummies. The sample is manufacturing firms with over RMB 5 million in revenues.

**Fact 4: Younger / smaller firms are more capital constrained than larger / older firms.**

Differences in access to or the cost of capital will be reflected in differences in marginal products of capital across firms and result in capital misallocation. To explore how capital constraints vary across firms, we follow the standard approach in the literature and examine how the *average* product of capital (i.e. capital productivity measured as rev-

[3] These results are noisier as our sample is restricted to firms with non-missing intangible asset growth, particularly for the youngest group of firms aged 1-2.

enues / capital) varies with firm size and firm age. Under the assumption of monopolistic competition and constant returns to scale, the average product of capital equals the marginal product.

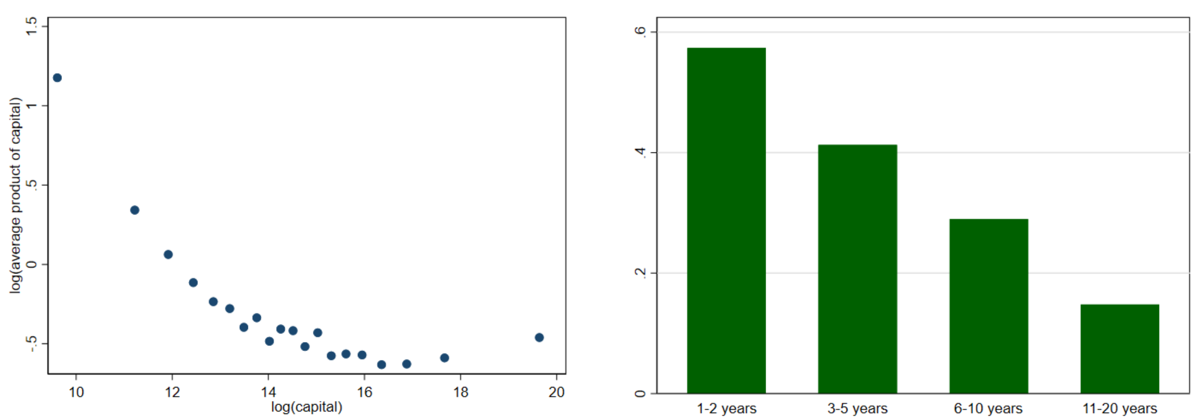
The left panel in Figure 6 shows that smaller firms tend to have much higher capital productivity than larger firms in 2017-18. Such differences in capital productivity likely reflect (at least in part) differences in the marginal products of capital across firms, suggesting that there are large potential gains from capital reallocation across firms.[4] Financial frictions are likely to be playing an important role for explaining this pattern (Bai et al., 2018), and while the literature has typically focused on the importance of such frictions in the 2000s, these patterns suggest that they are an equally important barrier to firm growth in recent years. The right panel in Figure 7 shows younger firms also have higher average products of capital than older firms. The decrease in ARPK with age is consistent with productive young firms facing financial frictions which prevent them from rapidly accumulating capital and reaching their optimal scale.

While these cross-sectional facts from the data point towards capital misallocation across firms being quantitatively important in China in recent years, we next study the dynamics of capital reallocation across firms.

Figure 6: Average revenue product of capital (ARPK) by size and age

(a) ARPK and size

(b) ARPK and age, relative to age 21+




**Notes**: The left figure shows a binned scatter plot of the log(average product of capital) against log(capital), controlling for sector-year fixed effects. The average product of capital is measured as firm revenues divided by total assets. The right figure shows a bar chart of the log(average product of capital) for firms in different age groups, relative to firms that are in the 20+ age group. The coefficients are obtained from a regression of log(ARPK) against age group dummies, controling for sector-year fixed effects. The sample is manufacturing firms in 2017-2018 with over RMB 5 million in revenues.

[4] Measurement error which varies with firm size is another possible factor.

**Fact 5: Capital reallocation to high marginal product of capital firms has declined.**

The dynamics of input reallocation across firms is an important determinant of resource misallocation and aggregate productivity. For example, adjustment costs to input reallocation can prevent the efficient reallocation of inputs towards firms whose productivity is growing and away from those whose productivity is shrinking (Asker, Collard-Wexler and De Loecker, 2014).

An important measure of reallocation is the dispersion of input growth, which captures both the dispersion in the shocks that firms are hit by and the extent to which these shocks result in inputs moving. Dispersion in input growth tends to be higher when the economy has many high-growth firms (Akcigit and Ates., 2019a,b), and so is an important metric for understanding market dynamism. We find that dispersion in total asset growth has declined over time from 0.126 in 2003-2007 to 0.083 in 2013-2018.[5]

Furthermore, we evaluate whether capital is moving towards the firms with the highest measured marginal products of capital. As before, we measure the marginal product of capital as the ratio of revenue to total assets. We obtain our estimates from the following specification:

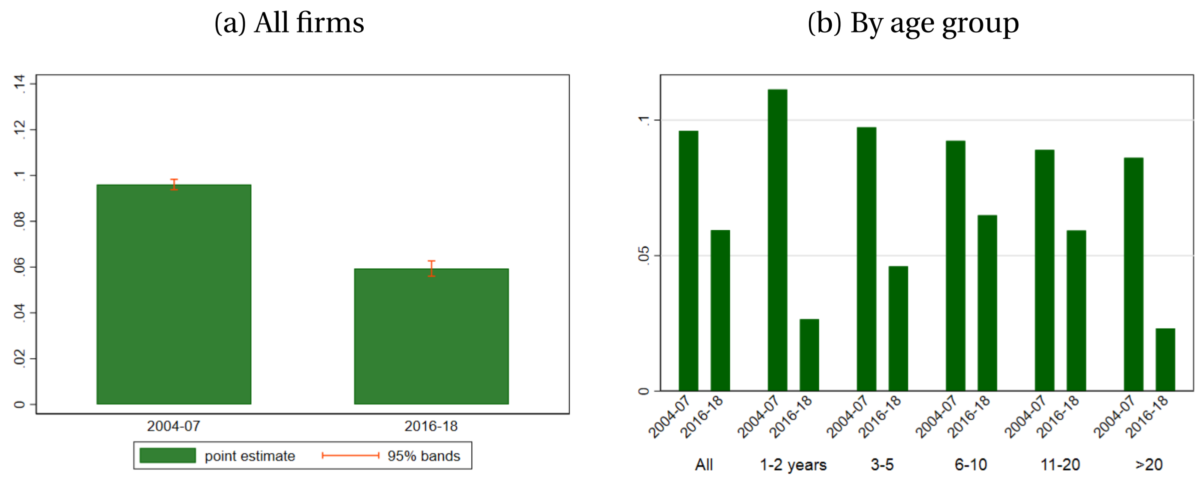
$$\Delta k_{ist} = \alpha + \beta k_{ist} + \gamma arpk_{ist} + FE_{st} + \nu_{ist} \tag{2}$$

where $\Delta k_{ist}$ is the growth rate of capital of firm $i$ in sector $s$ between year $t$ and $t+1$. $k_{ist}$ is log(capital) in year $t$ and $arpk_{ist}$ is log(ARPK) in year $t$. $FE_{st}$ is a full set of sector year fixed effects. We estimate the coefficient on log(ARPK) $\gamma$ separately across time periods and also across firm types. A higher value of $\gamma$ suggests that capital is growing more for high marginal product firms, which is suggestive evidence of more efficient capital reallocation.

We report the estimated coefficients in Figure 7. Contrasting the beginning and end of our sample period, we find that the responsiveness of capital growth to the marginal product of capital declined from 0.096 in 2004-2007 to 0.059 in 2016-2018 (Figure 7a). The decline is particularly marked among the youngest and oldest firms (Figure 7b), a feature that is consistent, for example, with older and less productive firms being better able to access finance at the expense of younger and more productive ones. This decline in responsiveness suggests that the process of capital allocation across firms, particularly from old to young firms, has weakened over time.

[5] We focus on total assets as our measure of inputs because it is reported by all firms in our database. We exclude years around the GFC both because it was an unusual shock and because of the increase in the minimum size threshold in 2011 and 2012.

Figure 7: Response of capital growth to lagged (log) average capital productivity




**Notes:** The left figure shows the coefficients (and 95% confidence intervals) obtained from firm-level regressions of capital growth against the lagged log(average product of capital) and lagged log(total assets), controlling for sector-year fixed effects. We run the regression separately for the first three years and last three years of our sample. The right figure plots the coefficients from the same regression by age group. The sample is manufacturing firms with over RMB 5 million in revenues.

**Fact 6: SOEs have persistently lower revenue and capital productivity than POEs.**

Many papers have documented large revenue productivity gaps between SOEs and private firms using data on above-scale industrial firms through 2013 (Hsieh and Klenow, 2009; Berkowitz, Ma and Nishioka, 2017; Bai et al., 2018), which are often interpreted as reflecting significant resource misallocation. These productivity gaps have also been found for the more recent period (through 2019) among listed firms and shown to be a quantitatively important of resource misallocation (Jurzyk and Ruane, 2021). However there is limited evidence about whether the earlier findings for manufacturing firms hold true for non-listed firms in recent years, or whether these productivity gaps exist in service sectors also.

Our data allow us to measure these gaps from 2003 to 2018 for a large sample of non-listed firms manufacturing sectors, as well as service sectors from 2013 to 2018. We run the following regressions to estimate the SOE productivity gaps:

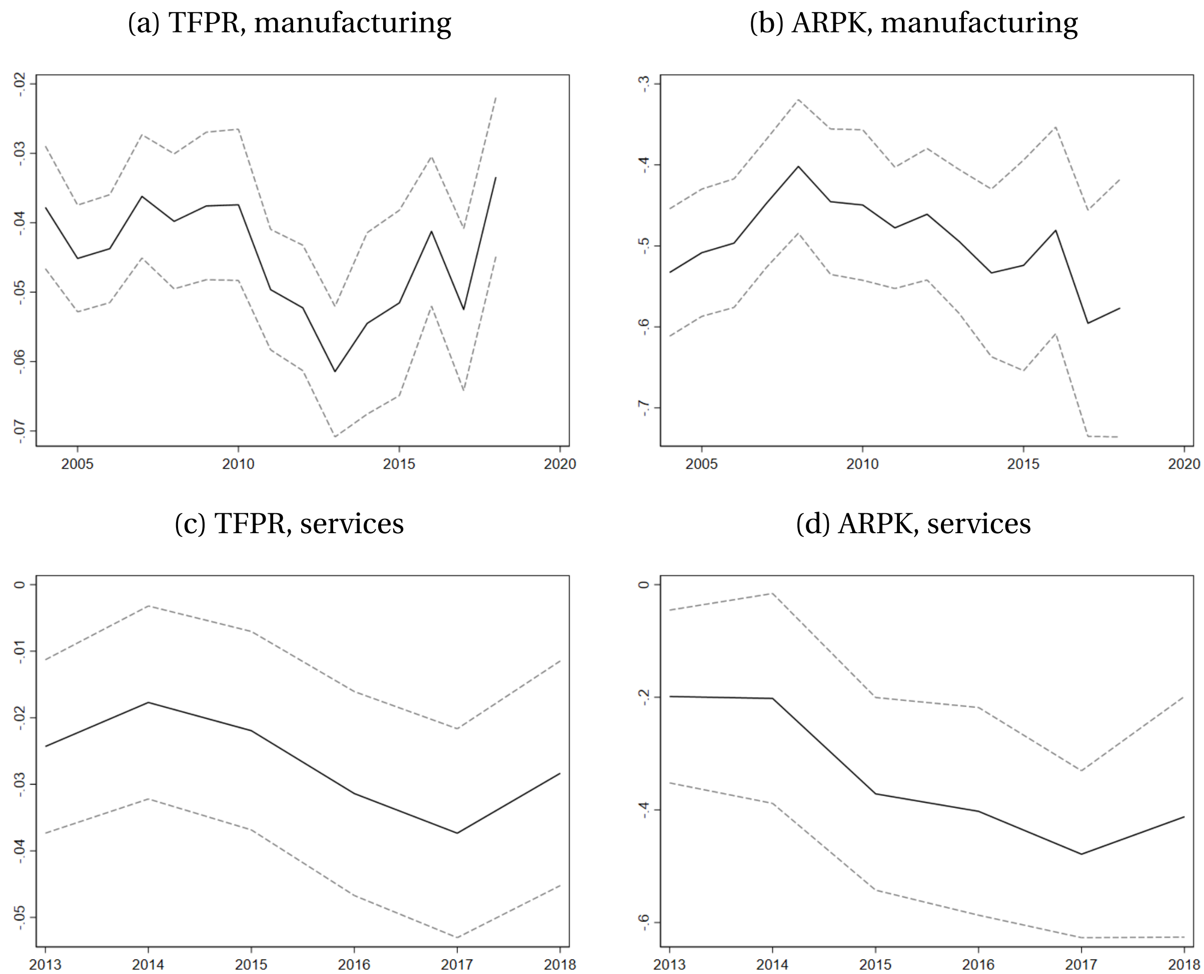
$$arp_{ist} = \alpha + \beta SOE_{ist} + FE_{st} + \nu_{ist} \tag{3}$$

where $arp_{ist}$ is either firm-level TFPR or ARPK, and $SOE_{ist}$ is a dummy variable identifying SOEs. We control for sector-year fixed effects $FE_{st}$ to ensure that the measured gaps do not reflect, e.g., the fact that SOEs tend to be present in more-established or more capital-intensive sectors. Figure 8b shows that SOEs have consistently had lower revenue productivity than private firms, with an average revenue productivity gap of around 4-5 percent.[6] As found in most of the earlier literature, these gaps are almost exclusively explained by SOEs' lower capital productivity, as shown in the top left panel figure. The gaps for services, estimated for the 2013-2018 period in which services-sector coverage becomes meaningful in Orbis, are somewhat smaller but still statistically and economically significant.

Our findings confirm that the low revenue productivity of SOEs remains a feature of the Chinese economy in more recent years. Many papers have studied how this implies that there are large gains from SOE reforms which induce a reallocation of inputs away from SOEs and towards the private sector. However, in the next section we explore a second channel through which SOE reform could improve productivity, by increasing business dynamism.

[6]Differences in the magnitude of the measured gaps vis-a-vis Jurzyk and Ruane (2021) are due to the fact that we measure productivity as the ratio of revenues to inputs, while they used value-added to inputs.

Figure 8: SOE productivity gaps




**Notes**: The figures plot the coefficients from regressions of log(TFPR) and log(ARPK) against SOE dummies and sector-year fixed effects. TFPR is revenue productivity, measured as firm revenues divided by the geometric average of assets and costs, with weights given by industry cost shares. ARPK is capital productivity, defined as revenues divided by total assets. We plot the coefficients on the SOE dummies separately for firms in manufacturing and firms in services, for which we have a smaller sample. See Appendix B for more details on how the SOE dummies are constructed.

# 4. Regional SOE Intensity and Business Dynamism

A critical puzzle is why China's business dynamism has slowed down so dramatically since the 2000s. Many factors are most likely at play, especially given such trends have been observed in other countries such as the U.S., where changing demographics and market power have played a role (Pugsley and Şahin, 2018; Akcigit and Ates., 2019b).

We focus here on one factor that seems particularly relevant for China – the role played by the state presence through state owned enterprises. There are two main reasons to consider regional SOE intensity as a factor in explaining the decline in China's business dynamism. Firstly, Brandt et al. (2020) find that regional state presence is an important factor in reducing the creation of new firms, suggesting that SOE presence may indeed reduce business dynamism. Secondly, China's growth spurt in the 2000s happened during a period of large-scale SOE reform (the SOE share of industrial assets declined from over 54 percent in 2003 to below 43 percent in 2008), while the productivity slowdown has coincided with a plateauing of the share of SOE among industrial firms, with SOEs still accounting for 39 percent of assets in 2019 despite substantially lower capital productivity. It is therefore natural to investigate whether state presence in China is associated with lower private sector dynamism. We consider two of our measures of business dynamism: the life-cycle growth of young firms and the responsiveness of capital growth to the marginal product of capital.

## 4.1. Life-Cycle Growth and SOE Intensity

We use our data on manufacturing firms to explore how the life-cycle growth of private firms varies with both sector-level and province-level SOE intensity. We construct SOE intensity as the asset share of SOEs identified in our Orbis database (see Appendix B for details).[7] Our measure of life-cycle dynamism in a sector or region follows our previously described approach; we construct the 3-year average growth rates of young firms (age $< 5$) relative to old firms (16+) in each sector- and province-year, and regress these against initial SOE intensity. We run the following regression at the province-year level:

$$lc_{pt} = \alpha + \beta SOEI_{pt} + FE_p + FE_t + \nu_{pt} \tag{4}$$

where $lc_{pt}$ is our measure of life-cycle growth (revenues, assets, TFPQ and intangibles), $SOEI_{pt}$ is SOE intensity, and $FE_p$ and $FE_t$ are province and year fixed effects respectively. The year fixed effects control for common time trends in life-cycle dynamism and SOE intensity, which is important given that we have previously documented that at the aggregate level life-cycle dynamism has fallen while SOE intensity has plateaued. The province fixed effects control for any time-invariant province characteristics. The coefficient $\beta$ is therefore identified by relative changes in province-level SOE intensity and life-cycle dynamism.

We find that young firms operating in provinces with higher SOE intensity tend to

[7] Data on employment is very limited in Orbis, while assets are reported for all firms.

have weaker revenue growth, capital growth, and TFPQ growth. These results, shown in Table 1 are economically significant although only statistically significant for revenue and asset growth. The last column in Table 1 also reports the association between intangible asset growth and SOE intensity. While it also has a negative sign, the coefficient is very imprecisely estimated. The results suggest that being in a province with 10 percentage point higher SOE share of assets reduces 3-year revenue and input growth by 3.5 percent for young firms, relative to an average 3-year growth rate of 17.5 percent. We also run Equation 4 at the industry-year level rather than province-year level but do not find any association between life-cycle growth and SOE intensity at the industry-level.

Taken together, these results suggest that some of the negative spillover effects of high SOE intensity to private firms may be local rather than sectoral. Local SOE intensity is therefore not only associated with less entry of new firms (Brandt et al., 2020) but also with weaker life-cycle growth. One interpretation of this is that it may reflect the political economy problems discussed in (Brandt et al., 2020). For example, young firms may invest less in productivity improvements or market expansion because they may face local regulatory barriers, which are put in place out of the concern that business dynamism could threaten the position of local SOEs through product market competition and competition for local factors of production. More research is required however to identify the precise mechanisms through which local SOE intensity affects the dynamism of entry and young firm growth.

Table 1: Province-level young firm life-cycle growth vs. provincial SOE intensity

| VARIABLES | (1)<br>3-year revenue growth | (2)<br>3-year asset growth | (3)<br>3-year TFPQ growth | (4)<br>3-year intangibles' growth |
|---|---|---|---|---|
| State presence | -0.00349** | -0.00291** | -0.00120 | -0.00503 |
| | (0.00147) | (0.00136) | (0.000867) | (0.0110) |
| Constant | 0.271*** | 0.233*** | 0.0945*** | 0.0540 |
| | (0.0485) | (0.0448) | (0.0286) | (0.372) |
| Observations | 362 | 363 | 362 | 210 |
| R-squared | 0.268 | 0.196 | 0.254 | 0.233 |
| Age | 1-5 | 1-5 | 1-5 | 1-5 |
| Years | All | All | All | All |
| Year FE | YES | YES | YES | YES |
| Province FE | YES | YES | YES | YES |

**Notes:** Table 1 reports results from province-year level regressions of the relative growth of young vs. old firms (in revenues, assets, TFPQ and intangibles) against province-year level measures of state presence. Young firms are those between the ages of 1 and 5, while older firms are those whose age is 16+. We include province and year fixed effects in all regressions.

### 4.2. Capital Reallocation and SOE Intensity

We also use the richness of our data to explore how the responsiveness of capital to capital productivity among private firms varies with local SOE intensity. Again, we construct SOE intensity as the asset share of SOEs identified in our database and we divide provinces into high and low SOE intensity. We extend Equation 2 to interact capital responsiveness with a dummy for high province-level intensity. In addition, we include province fixed effects to control for time-invariant province-level characteristics. As before, we estimate separate elasticities for each period: 2003-2007 and 2014-2018. We do not find a significant link from 2003-2007 between regional SOE intensity and capital responsiveness, see Table 2 column (1). However, in the 2014-2018 period, we find that provinces with high SOE intensity have significantly lower capital responsiveness. This is concerning as it suggests a worsening allocation of capital to firms with high capital productivity, in particular in provinces with high SOE intensity.

A potential explanation for this finding is that the efficiency of the local banking system for capital allocation is worse in regions where most banks can lend (or are incentivized to lend) to SOEs. This is suggestive evidence that high SOE intensity is not only problematic because the assets owned by SOEs could be better allocated, but also because they result in a worse allocation of resources among private firms, lowering aggregate productivity further.

Taking the results from this section together, the evidence is suggestive of SOE intensity being potentially an important driver of declining business dynamism. The evidence presented bears direct links to young firms' declining life-cycle growth (Facts 2 and 3), and the worsening of capital reallocation over time (Facts 4 and 5). Worsening reallocation among private firms is an additional source of misallocation to that evident from productivity gaps between SOEs and private firms (Fact 6). Given that younger and smaller firms have higher capital productivity (Fact 3), the declining reallocation ability of the economy may both reflect the effects of financial frictions and potentially risk amplifying them. Altogether, worsened prospects for younger firms will likely lead to a continued decline in their share of economic activity (Fact 1) and contribution to economic growth.

## 5. Conclusion

After impressive growth in the 2000s, China's productivity has more recently stagnated. We use firm-level data to analyze productivity and firm dynamism trends from 2003 to 2018. We construct a bottom-up estimate of manufacturing productivity from our

Table 2: Province-level capital responsiveness vs. provincial SOE intensity

| VARIABLES | (1)<br>1-year Capital growth | (2)<br>1-year Capital growth |
|---|---|---|
| log(Average Product of Capital) | 0.114*** | 0.0766*** |
| | (0.000923) | (0.00161) |
| High State Presence | -0.000944 | 0.00703 |
| | (0.00359) | (0.00520) |
| log(ARPK) x High State Presence | 0.00171 | -0.0325*** |
| | (0.00188) | (0.00395) |
| Constant | 0.0709*** | 0.0637*** |
| | (0.000936) | (0.00101) |
| Observations | 601,764 | 186,697 |
| R-squared | 0.060 | 0.046 |
| Years | 2003-2007 | 2014-2018 |
| Sector-Year FE | YES | YES |
| Province FE | YES | YES |

**Notes:** Table 2 reports results from firm-year level regressions of capital growth against log(ARPK), a dummy for provinces with high state presence and the interaction between log(ARPK) and high state presence. We run the regression separately for the first and last 4 years of our sample.

data and confirm the productivity growth slowdown. We then document six facts that show a decline in China's business dynamism. We show that (i) the revenue share of young firms has declined, (ii) the life-cycle growth of young firms relative to older incumbents has weakened, (iii) this is related lower physical productivity and innovation, (iv) younger and smaller firms are more capital constrained than their older and larger counterparts, (v) the responsiveness of capital growth to firms' marginal products of capital has weakened, and (vi) there are large and persistent productivity gaps between SOEs and private firms. In the cross-section of provinces, we find that where SOEs account for a larger share of assets, business dynamism tends to be weaker. The findings underscore the need for China to undertake pro-market reforms to boost productivity growth. In particular, SOE reform could boost productivity growth both directly through resource reallocation and indirectly by stimulating business dynamism.

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# A Data Appendix

The main dataset we use in the paper is from Bureau Van Dijk's Orbis database. The data has extensive coverage of the Chinese manufacturing sector from 2003 to 2018. Similarly to the commonly used Chinese Industrial Survey, from 2003 to 2010, the data is collected for firms with more than 5 million RMB in revenues. In 2011 and 2012, the database only has information for firms with revenues over a 20 million RMB threshold. From 2013 to 2018, there is no minimum revenue threshold. In order to preserve comparability of our sample over time, we restrict our attention to firms with at least 5 million RMB in revenues in all years, and check robustness to setting this threshold to 20 million RMB in all years.

The main capital variables we use are tangible fixed assets, fixed assets and total assets. Total assets are reported by all firms in all years, while tangible fixed assets and fixed assets are missing in some years. For the years in which these are missing, we impute them using industry shares and the firm's reported total assets.[8] We construct costs as cost of goods solds + other operating costs. These include both labor costs and material inputs. Because employment and labor costs are not commonly reported in Orbis, we don't separate materials from labor costs. We measure revenues as total operating revenues, which includes sales and other revenues. We clean the data in standard ways, dropping firms with missing or zero assets, revenues or costs. We also drop plants where revenues, assets or costs increase or decrease by a factor of 20 or more from year to year. Finally, we trim the 0.5% tails of revenues/costs, revenues/assets and assets/costs. The final number of observations in each year are reported in Table 3, along with and average revenues, costs and capital.

# B State Ownership Data

We classify firms' ownership between private and state-owned by combining information two sources, WIND and Orbis. For listed firms, we use WIND data that classify firms each year into private or state-owned. For unlisted firms, we resort to Orbis' historical ownership databases. Specifically, we classify as state-owned those firms that in Orbis show up as having a Global Ultimate Owner controlling at least 50 percent of the company that for which the entity type is "S" (i.e. the state).

For the analysis that correlates business dynamism with state presence at the sector/province level, we use the last-observed POE/SOE classification for the specific firm

[8] We impute tangible fixed assets from fixed assets in 2003, and fixed assets from tangible fixed assets in 2010. We impute both fixed assets and tangible fixed assets from total assets in 2014, 2017 and 2018.

Table 3: Province-level capital responsiveness vs. provincial SOE intensity

| | Observations | Revenues | Costs | Total Assets | Tangible Fixed Assets |
|---|---|---|---|---|---|
| 2003 | 86,968 | 91,636,403 | 85,481,774 | 94,817,986 | 36,034,866 |
| 2004 | 161,234 | 73,647,919 | 69,086,726 | 69,417,834 | 26,456,472 |
| 2005 | 180,741 | 92,110,839 | 86,920,457 | 79,579,964 | 30,092,239 |
| 2006 | 265,105 | 101,337,358 | 94,970,617 | 82,154,171 | 29,952,293 |
| 2007 | 303,623 | 116,731,065 | 107,981,800 | 92,800,197 | 32,772,664 |
| 2008 | 353,580 | 111,435,921 | 104,431,020 | 87,078,285 | 30,141,470 |
| 2009 | 294,682 | 132,614,342 | 123,542,275 | 108,783,969 | 36,732,682 |
| 2010 | 262,169 | 153,797,953 | 142,712,045 | 125,190,272 | 40,524,759 |
| 2011 | 242,957 | 276,088,841 | 256,496,768 | 213,095,978 | 71,524,902 |
| 2012 | 235,888 | 292,644,457 | 273,609,596 | 230,397,440 | 73,899,523 |
| 2013 | 250,795 | 29,5314,973 | 276,183,723 | 239,986,516 | 77,116,929 |
| 2014 | 241,776 | 225,927,394 | 214,976,571 | 253,124,775 | 75,962,412 |
| 2015 | 98,698 | 425,288,257 | 412,465,565 | 545,848,812 | 161,837,954 |
| 2016 | 125,465 | 434,359,175 | 410,411,028 | 592,013,264 | 167,105,593 |
| 2017 | 155,087 | 519,030,692 | 499,327,685 | 724,920,665 | 184,086,506 |
| 2018 | 280,115 | 329,358,590 | 321,326,740 | 548,890,078 | 137,220,768 |

Notes: This table reports the number of observations in the cleaned Orbis manufacturing database in each year, along with average revenues, costs, total assets and tangible fixed assets.

Figure 9: Aggregate state presence: CEIC vs. Orbis-WIND estimates

(a) SOE assets / total assets (b) SOE revenues / total revenues


ID. For those firms were we observe the classification at least twice, 1.16 percent show a transition from POE to SOE, and 0.42 percent show a transition from SOE to POE. Transitions thus appear to be overall relatively rare, suggesting that using 'last-observed' SOE status should not lead to large measurement issues.

Figure 9 compares the time series of aggregate SOE assets (Figure 9a) and SOE revenues (Figure 9b) in percent of totals as derived from Orbis-WIND, with the corresponding aggregates published by NBS and compiled by CEIC. In doing this comparison, we restrict attention to those sectors for which CEIC has data, namely NACE 2-digits going from 5 to 36 (mining, manufacturing, and utilities). Our bottom-up estimates broadly match the official percentages in levels, and show the decline of the early 2000s. Since around the GFC, however, it is worth noting that our bottom-up estimates show a slight upward trend not present in the official data.

In our analyses in the main text, however, we mainly exploit the cross-sectional variation in state presence in Section 4.. Figure 10 shows that, in the cross-section, our bottom-up estimates of state presence tend to be highly correlated with those that can be obtained from CEIC data. As a reference, Figure 11 zooms into the 2018 comparison. While in less than a handful of cases our measure disagrees with CEIC data (machinery repair, water supply), by and large it appears to accurately gauge the extent of state presence.

Figure 10: State presence by assets and revenues: cross-sectional (across sectors) correlations between CEIC and bottom-up Orbis-WIND estimates, by year

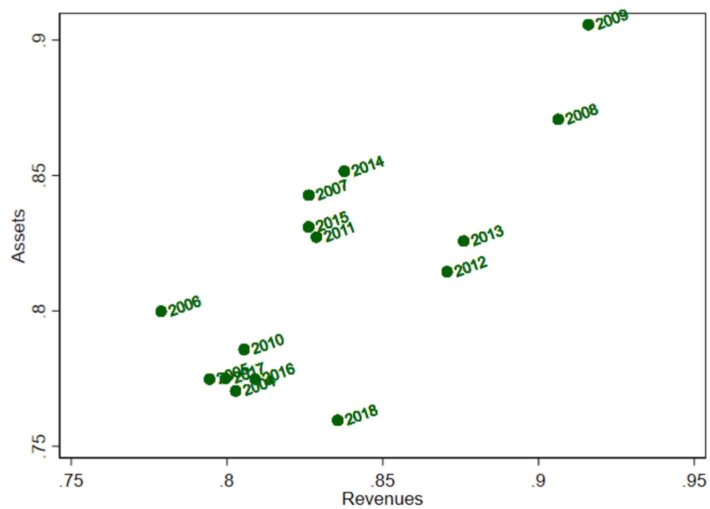
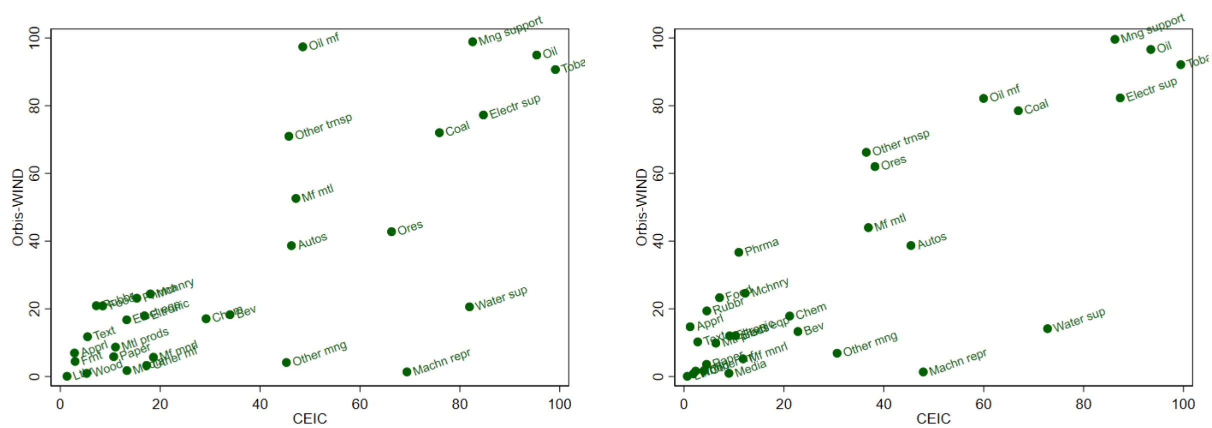



Figure 11: State presence by assets and revenues in 2018 for different sectors

(a) Assets

(b) Revenues



# C Constructing Sectoral TFP Measures

We start by positing a sectoral production function

$$Q_{jt} = A_{jt}(K_{jt}^{\alpha_s} L_{jt}^{1-\alpha_j})^{\gamma_j} X_{jt}^{1-\gamma_j},$$

where $Q$ denotes gross output, $K$ is capital, $L$ is labor inputs, $X$ is intermediate inputs, and $A$ is sectoral TFP. $\alpha_s$ is the capital share (of value-added) and $\gamma_s$ is the capital and labor share of gross output. As is customary, the idea is to construct sectoral TFP as a residual (no capitalization indicates variables are in logs):

$$a_{jt} = q_{jt} - \gamma_j(\alpha_j k_{jt} + (1-\alpha_j) l_{jt}) - (1-\gamma_j) x_{jt}. \tag{5}$$

We define these production functions at the 2-digit (i.e. "Division") level of the NACE Rev. 2 classification. Next we construct TFP at the sector $s$ level (e.g. manufacturing) by aggregating our industry TFP measures using each industry's gross output share:

$$a_{st} = \sum_{j \in s} \frac{P_{jt} Q_{jt}}{P_{st} Q_{st}} a_{sjt}.$$

The remainder of this appendix describes the data used to construct all the variables in equation (5). In constructing the estimates we use extensively WIOD's global input-output data (Timmer, Dietzenbacher, Los, Stehrer and de Vries, 2015). Orbis uses the NACE Rev. 2 industry classification. WIOD follows the ISIC Rev. 4 classification. Wherever WIOD data are used, the mapping in Table 4 is used.[9]

*Nominal variables.* Nominal gross output is measured as Operating revenue, and capital as Tangible fixed assets. Ideally one would measure the nominal wage bill using Cost of employees, and nominal spending in intermediate inputs using material costs. Given that these are missing for many firms in the sample, we use instead Cost of goods sold plus Operating expenses to measure the sum of the nominal wage bill and nominal spending in intermediates. We impute each component using WIOD's Socio Economic Accounts data for compensation of employees (COMP) and intermediate-input spending (II), using the average for 2003-2014.

*Gross-output deflators.* For most WIOD sectors a corresponding PPI index is available

[9] WIOD's data contain a total of 56 sectors. There are no firms in sectors 55 (Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use) and 56 (Activities of extraterritorial organizations and bodies) in Orbis. These sectors are omitted from the analysis.

from NBS (retrieved from CEIC). This is not the case for some services sectors. As a result, for those services sectors we use the GDP deflator for the closest-matching sector (retrieved from Haver). Given that these are services, and hence less-tradable sectors, sectoral GDP deflators should closely follow the overall producer-price movements for these sectors. The mapping from WIOD sectors to price indices is shown in Figure 5.

*Intermediate-input deflators.* The intermediate-input deflator of a sector $s$ is calculated as the weighted average of the gross-output deflators of all sectors, where the weights are given by sector $s$'s 2004-2014 purchases from each sector. The sectoral purchase data are from WIOD.

*Capital deflator.* Capital is deflated using the NBS Fixed Asset Investment price index (retrieved from CEIC).

*Wage deflators.* Wage deflators are from NBS. The mapping from NBS sectoral wages to WIOD sectors is shown in Table 6.

*Production elasticities.* To construct industry-specific production elasticities $\alpha_{jt}$ and $\gamma_{jt}$, we first assume a rental rate of capital of 0.2 (Bils et al., 2021). Production elasticities are then readily calculated as the capital share of value added and the capital-cum-labor share of gross output, over the entire 2004-2016 sample. That is,

$$\begin{aligned}\alpha_{jt} &= \alpha_j = \frac{R\overline{K}_j}{R\overline{K}_j + \overline{wL}_j},\\ \gamma_{jt} &= \gamma_j = \frac{R\overline{K}_j + \overline{wL}_j}{R\overline{K}_j + \overline{wL}_j + \overline{P^x X}_j},\end{aligned}$$

where $R = 0.2$ and bars over variables denote average values.

Table 4: NACE Rev. 2-WIOD correspondence.

| NACE | WIOD | WIOD sector name |
|---|---|---|
| 1 | 1 | Crop and animal production, hunting and related service activities |
| 2 | 2 | Forestry and logging |
| 3 | 3 | Fishing and aquaculture |
| 5 | 4 | Mining and quarrying |

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**Table 4 – continued from previous page**

| NACE | WIOD | WIOD sector name |
|---|---|---|
| 6 | 4 | Mining and quarrying |
| 7 | 4 | Mining and quarrying |
| 8 | 4 | Mining and quarrying |
| 9 | 4 | Mining and quarrying |
| 10 | 5 | Manufacture of food products, beverages and tobacco products |
| 11 | 5 | Manufacture of food products, beverages and tobacco products |
| 12 | 5 | Manufacture of food products, beverages and tobacco products |
| 13 | 6 | Manufacture of textiles, wearing apparel and leather products |
| 14 | 6 | Manufacture of textiles, wearing apparel and leather products |
| 15 | 6 | Manufacture of textiles, wearing apparel and leather products |
| 16 | 7 | Manufacture of wood and cork, except furniture; |
| 17 | 8 | Manufacture of paper and paper products |
| 18 | 9 | Printing and reproduction of recorded media |
| 19 | 10 | Manufacture of coke and refined petroleum products |
| 20 | 11 | Manufacture of chemicals and chemical products |
| 21 | 12 | Manufacture of basic pharmaceutical products |
| 22 | 13 | Manufacture of rubber and plastic products |
| 23 | 14 | Manufacture of other non-metallic mineral products |
| 24 | 15 | Manufacture of basic metals |
| 25 | 16 | Manufacture of fabricated metal products, exc. machinery & equipment |
| 26 | 17 | Manufacture of computer, electronic and optical products |
| 27 | 18 | Manufacture of electrical equipment |
| 28 | 19 | Manufacture of machinery and equipment n.e.c. |
| 29 | 20 | Manufacture of motor vehicles, trailers and semi-trailers |
| 30 | 21 | Manufacture of other transport equipment |

Continued on next page

**Table 4 – continued from previous page**

| NACE | WIOD | WIOD sector name |
|---|---|---|
| 31 | 22 | Manufacture of furniture; other manufacturing |
| 32 | 22 | Manufacture of furniture; other manufacturing |
| 33 | 23 | Repair and installation of machinery and equipment |
| 35 | 24 | Electricity, gas, steam and air conditioning supply |
| 36 | 25 | Water collection, treatment and supply |
| 37 | 26 | Sewerage; waste collection, etc. |
| 38 | 26 | Sewerage; waste collection, etc. |
| 39 | 26 | Sewerage; waste collection, etc. |
| 41 | 27 | Construction |
| 42 | 27 | Construction |
| 43 | 27 | Construction |
| 45 | 28 | Wholesale and retail trade and repair of motor vehicles |
| 46 | 29 | Wholesale trade, except of motor vehicles and motorcycles |
| 47 | 30 | Retail trade, except of motor vehicles and motorcycles |
| 49 | 31 | Land transport and transport via pipelines |
| 50 | 32 | Water transport |
| 51 | 33 | Air transport |
| 52 | 34 | Warehousing and support activities for transportation |
| 53 | 35 | Postal and courier activities |
| 55 | 36 | Accommodation and food service activities |
| 56 | 36 | Accommodation and food service activities |
| 58 | 37 | Publishing activities |
| 59 | 38 | Motion picture, video and television programme production, etc. |
| 60 | 38 | Motion picture, video and television programme production, etc. |
| 61 | 39 | Telecommunications |

Continued on next page

**Table 4 – continued from previous page**

| NACE | WIOD | WIOD sector name |
|---|---|---|
| 62 | 40 | Computer programming, consultancy and related activities |
| 63 | 40 | Computer programming, consultancy and related activities |
| 64 | 41 | Financial service activities, except insurance and pension funding |
| 65 | 42 | Insurance, reinsurance and pension funding |
| 66 | 43 | Activities auxiliary to financial services and insurance activities |
| 68 | 44 | Real estate activities |
| 69 | 45 | Legal and accounting activities; etc. |
| 70 | 45 | Legal and accounting activities; etc. |
| 71 | 46 | Architectural and engineering activities; technical testing and analysis |
| 72 | 47 | Scientific research and development |
| 73 | 48 | Advertising and market research |
| 74 | 49 | Other professional, scientific and technical activities; etc. |
| 75 | 49 | Other professional, scientific and technical activities; etc. |
| 77 | 50 | Administrative and support service activities |
| 78 | 50 | Administrative and support service activities |
| 79 | 50 | Administrative and support service activities |
| 80 | 50 | Administrative and support service activities |
| 81 | 50 | Administrative and support service activities |
| 82 | 50 | Administrative and support service activities |
| 84 | 51 | Public administration and defence; compulsory social security |
| 85 | 52 | Education |
| 86 | 53 | Human health and social work activities |
| 87 | 53 | Human health and social work activities |
| 88 | 53 | Human health and social work activities |
| 90 | 54 | Other service activities |

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**Table 4 – continued from previous page**

| NACE | WIOD | WIOD sector name |
|---|---|---|
| 91 | 54 | Other service activities |
| 92 | 54 | Other service activities |
| 93 | 54 | Other service activities |
| 94 | 54 | Other service activities |
| 95 | 54 | Other service activities |
| 96 | 54 | Other service activities |

Table 5: Sectoral gross output price indices.

| WIOD sector | Price index | Source |
|---|---|---|
| 1 | PPI: Agricultural & Sideline Food | CEIC |
| 2 | PPI: Forestry Product | CEIC |
| 3 | PPI: Fishery Product | CEIC |
| 4 | PPI: Mining and Quarrying | CEIC |
| 5 | PPI: Food | CEIC |
| 6 | PPI: Textile | CEIC |
| 7 | PPI: Wood Processing, etc. | CEIC |
| 8 | PPI: Mfg Good: Paper Making | CEIC |
| 9 | PPI: Printing & Record Medium Reproduction | CEIC |
| 10 | PPI: Petroleum, Coking & Nuclear Fuel | CEIC |
| 11 | PPI: Chemical Material & Product | CEIC |
| 12 | PPI: Pharmaceutical | CEIC |
| 13 | PPI: Rubber & Plastic Product | CEIC |
| 14 | PPI: Non Metallic Mineral Product | CEIC |
| 15 | PPI: Metallurgical | CEIC |

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**Table 5 – continued from previous page**

| WIOD sector | Price index | Source |
|---|---|---|
| 16 | PPI: Fabricated Metal Product | CEIC |
| 17 | PPI: Computer, Communication & Other Elect. Eq. | CEIC |
| 18 | PPI: Electrical Machinery & Equipment | CEIC |
| 19 | PPI: Electrical Machinery & Equipment | CEIC |
| 20 | PPI: Automobile | CEIC |
| 21 | PPI: Rail, Ship, Aircraft, Spacecraft & Other Eq. | CEIC |
| 22 | PPI: Furniture | CEIC |
| 23 | PPI: Fabricated Metal Product, Machine & Eq. Repair | CEIC |
| 24 | PPI: Electricity, Heat Production & Supply | CEIC |
| 25 | PPI: Water Production & Supply | CEIC |
| 26 | PPI: Comprehensive Utilization of Resource Waste | CEIC |
| 27 | GDP deflator: Construction | Haver |
| 28 | GDP deflator: Wholesale and Retail Trade | Haver |
| 29 | GDP deflator: Wholesale and Retail Trade | Haver |
| 30 | GDP deflator: Wholesale and Retail Trade | Haver |
| 31 | GDP deflator: Transportation, Post and Telecom. | Haver |
| 32 | GDP deflator: Transportation, Post and Telecom. | Haver |
| 33 | GDP deflator: Transportation, Post and Telecom. | Haver |
| 34 | GDP deflator: Transportation, Post and Telecom. | Haver |
| 35 | GDP deflator: Transportation, Post and Telecom. | Haver |
| 36 | GDP deflator: Hotels and Catering | Haver |
| 37 | GDP deflator: Other | Haver |
| 38 | GDP deflator: Other | Haver |
| 39 | GDP deflator: Transportation, Post and Telecom. | Haver |
| 40 | GDP deflator: Other | Haver |

Continued on next page

**Table 5 – continued from previous page**

| WIOD sector | Price index | Source |
|---|---|---|
| 41 | GDP deflator: Financial Intermediation | Haver |
| 42 | GDP deflator: Financial Intermediation | Haver |
| 43 | GDP deflator: Financial Intermediation | Haver |
| 44 | GDP deflator: Real Estate | Haver |
| 45 | GDP deflator: Other | Haver |
| 46 | GDP deflator: Other | Haver |
| 47 | GDP deflator: Other | Haver |
| 48 | GDP deflator: Other | Haver |
| 49 | GDP deflator: Other | Haver |
| 50 | GDP deflator: Other | Haver |
| 51 | GDP deflator: Other | Haver |
| 52 | GDP deflator: Other | Haver |
| 53 | GDP deflator: Other | Haver |
| 54 | GDP deflator: Other | Haver |

Table 6: NBS wages-WIOD mapping.

| WIOD sector | NBS sectoral wage |
|---|---|
| 1 | Agriculture, Forestry, Animal Husbandry and Fishery |
| 2 | Agriculture, Forestry, Animal Husbandry and Fishery |
| 3 | Agriculture, Forestry, Animal Husbandry and Fishery |
| 4 | Mining |
| 5 | Manufacturing |
| 6 | Manufacturing |
| 7 | Manufacturing |

Continued on next page

Table 6 – continued from previous page

| WIOD sector | NBS sectoral wage |
|---|---|
| 8 | Manufacturing |
| 9 | Manufacturing |
| 10 | Manufacturing |
| 11 | Manufacturing |
| 12 | Manufacturing |
| 13 | Manufacturing |
| 14 | Manufacturing |
| 15 | Manufacturing |
| 16 | Manufacturing |
| 17 | Manufacturing |
| 18 | Manufacturing |
| 19 | Manufacturing |
| 20 | Manufacturing |
| 21 | Manufacturing |
| 22 | Manufacturing |
| 23 | Manufacturing |
| 24 | Production and Distribution of Electricity, Gas and Water |
| 25 | Production and Distribution of Electricity, Gas and Water |
| 26 | Production and Distribution of Electricity, Gas and Water |
| 27 | Construction |
| 28 | Wholesale and Retail Trade |
| 29 | Wholesale and Retail Trade |
| 30 | Wholesale and Retail Trade |
| 31 | Transport, Storage and Post |
| 32 | Transport, Storage and Post |

Continued on next page

**Table 6 – continued from previous page**

| WIOD sector | NBS sectoral wage |
|---|---|
| 33 | Transport, Storage and Post |
| 34 | Transport, Storage and Post |
| 35 | Transport, Storage and Post |
| 36 | Hotels and Catering Services |
| 37 | Information Transmission, Computer Service and Software |
| 38 | Information Transmission, Computer Service and Software |
| 39 | Information Transmission, Computer Service and Software |
| 40 | Information Transmission, Computer Service and Software |
| 41 | Financial Intermediation |
| 42 | Financial Intermediation |
| 43 | Financial Intermediation |
| 44 | Real Estate |
| 45 | Leasing and Business Services |
| 46 | Leasing and Business Services |
| 47 | Scientific Research, Technical Services, and Geological Prospecting |
| 48 | All |
| 49 | All |
| 50 | All |
| 51 | Public Management and Social Organization |
| 52 | Education |
| 53 | Health, Social Securities and Social Welfare |
| 54 | All |

PUBLICATIONS

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