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Misallocation and Productivity: The Case of Vietnamese Manufacturing[*]

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Abstract: *This paper attempts to measure the effect of resource misallocation on aggregate manufacturing total factor productivity (TFP), focusing on Vietnamese manufacturing firms for the period 2000–2009. One of the major findings of this paper is that there would have been substantial improvement in aggregate TFP in Viet Nam in the absence of distortions. The results imply that potential productivity gains from removing distortions are large in Vietnamese manufacturing. We also find that smaller firms tend to face advantageous distortions, while larger firms tend to face disadvantageous ones. Moreover, the efficient size distribution is more dispersed than the actual size distribution. These results together suggest that Vietnamese policies may constrain the largest and most efficient producers and coddle its small and least efficient ones.*

Key words: Misallocation; Total factor productivity; Viet Nam

JEL classification: O47; F14; D2

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1. Introduction

Differences in per capita income across countries result mainly from differences in total factor productivity (TFP).[1] Therefore, clarifying the underlying causes of low productivity in developing countries is one of the central concerns in various fields of economics such as development economics, international economics, and macroeconomics. Given the fact that production efficiency is heterogeneous across firms, some recent studies on this issue argue that aggregate TFP depends not only on the TFP of individual firms but also on the allocation of resources across firms.[2] In other words, low productivity in developing countries can be attributable to the misallocation of resources across heterogeneous firms.

How do we measure the misallocation of resources? One way to answer this question is to focus on distortions that reflect the difference between the actual and efficient outcomes. Such distortions are called ‘wedges’ in the literature. A seminal paper is Hsieh and Klenow (2009), which estimates wedges from data on value added and factor inputs for manufacturing establishments in China, India, and the United States. They found that the distortions were much larger in China and India than in the United States. Moreover, as mentioned above, Hsieh and Klenow (2009) found that the removal of distortions has a significant effect on aggregate TFP in China and India. Following Hsieh and Klenow (2009), several studies have provided a similar picture: large TFP gains could be expected from the removal of distortions.[3]

Along this line of literature, this paper extends the analysis of Hsieh and Klenow (2009) to Vietnamese manufacturing between 2000 and 2009 and asks the following four questions:

i. To what extent are resources misallocated in Viet Nam?
ii. How large would the productivity gains have been in the absence of distortions?
iii. Are the distortions related to firm size?
iv. What would the distribution of firm size have been in the absence of distortions?

[1] ‘Large differences in output per worker between rich and poor countries have been attributed, in no small part, to differences in total factor productivity’ (Hsieh and Klenow, 2009, p.1403); ‘cross-country income differences mostly result from differences in total factor productivity’ (Waugh, 2010, p. 2095). McMillan and Rodrik (2011) also argued for the importance of resource reallocation in enhancing productivity growth in developing countries.
[2] See Restuccia and Rogerson (2013) and Hopenhayn (2014) for a survey.
[3] See, for example, Camacho and Conover (2010) for the case of Colombia; Busso et al. (2012) for Latin America; Bellone and Mallen-Pisano (2013) for France; Hosono and Takizawa (2013) for Japan; de Vries (2014) for Brazil; Dheera-Aumpon (2014) for Thailand; Bach (2014) for Viet Nam; and Calligaris (2015) for Italy.

Answering these questions have important implications for the potential growth, because reallocation would lead to productivity gains that would accelerate potential growth in transition towards the improved inter-firm resource allocation.

Our study is closely related to Bach (2014), which also examined resource misallocation in Viet Nam using firm-level data. His study addressed the first two questions but did not compare resource misallocation in Viet Nam with misallocation in other Asian countries. Moreover, his study did not address the last two questions. From a policy perspective, the last two questions are important because many countries give preferential treatment to small and medium-sized enterprises (SMEs). Indeed, size-dependent policies, which limit the size of firms, could be an important source of misallocation (Restuccia and Rogerson, 2013). In answering the four questions above, this paper goes one step further by providing a deeper understanding of the potential productivity gains from removing distortions in Viet Nam.[4]

The rest of this paper is organised as follows. In Section 2, we describe the methodology of Hsieh and Klenow (2009). Section 3 describes the Vietnamese firm-level data used in our study. Section 4 presents the results. Concluding remarks and policy implications are presented in Section 5.

2. Measurement of Misallocation

Hsieh and Klenow (2009) formulated an analytical framework to estimate misallocation. Although some studies such as Bartelsman et al. (2013) developed an alternative framework, this paper employs Hsieh and Klenow’s framework for the following two reasons. First, their framework is tractable in the sense that it is simple and its data requirements are minimal. This is a significant advantage in estimating misallocation in Viet Nam because of the limited data available, as we will discuss in the next section. Second, the framework allows us to decompose the source of misallocation into distortions in output markets and those in capital markets. Such decompositions are useful if the distortions come from different sources. The Hsieh and Klenow (2009) methodology is summarised below.

Assume that a representative firm produces a single final good Y in a perfectly competitive final goods market. The firm produces Y, using the output Y_s of S manufacturing

[4] Another important difference between his study and our study is that his study did not control for the skill differences of workers across firms in measuring quantity-based TFP (hereafter, TFPQ) and revenue-based TFP (hereafter, TFPR).

industries, with the following Cobb–Douglas production technology:

$$Y = \prod_{s=1}^{S} Y_s^{\theta_s}, \text{where} \sum_{s=1}^{S} \theta_s = 1, \tag{1}$$

and θ_s is the output share of each industry s.

Each industry produces output, Y_s, using M_s differentiated goods produced by individual firm i with a constant elasticity of substitution technology ($s = 1, \dots, S$). Output in industry s is then given by:[5]

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad \sigma > 1, \tag{2}$$

where σ is the elasticity of substitution between varieties and Y_{si} is the output of the differentiated good produced by firm i in industry s, using capital and labour, based on the following Cobb–Douglas technology:

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}, \tag{3}$$

where A_{si}, K_{si}, and L_{si} denote productivity, capital, and labour of firm i in industry s, respectively; α_s represents the capital share, which is different across industries but the same across firms within an industry.

To assess the extent of misallocation, Hsieh and Klenow (2009) followed Foster et al. (2008) in making a distinction between physical productivity, denoted by TFPQ, and revenue productivity, denoted by TFPR:

$$TFPQ_{si} \triangleq A_{si} = \frac{Y_{si}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}} \tag{4}$$

and

$$TFPR_{si} \triangleq P_{si} A_{si} = \frac{P_{si} Y_{si}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}}, \tag{5}$$

respectively, where P_{si} represents the firm-specific output price.

In addition to firm heterogeneity in terms of productivity (as in Melitz, 2003), firms potentially face different output and capital distortions. More specifically, Hsieh and Klenow (2009) incorporated two types of firm-level wedges into this framework. One raises the marginal product of capital and labour by the same proportion, which is denoted by τ_{Ysi}. The

[5] We suppress the time subscript to avoid heavy notation, although we utilise firm-level panel data in the empirical analysis.

other increases the marginal product of capital relative to labour, which is denoted by τ_{Ksi}. These wedges are given from the firm's viewpoint, and we do not make any assumptions about what generates them.[6]

An example of such distortions is subsidised credit. If two firms have identical technologies but one of the firms can borrow at a lower interest rate (and the other firm can borrow at a higher interest rate from the financial market), the marginal product of capital of the firm that can access the subsidised credit will be lower than that of the other firm. This results in the misallocation of capital because one firm enjoys a lower interest rate even though the two firms have the same technologies. In other words, in Hsieh and Klenow (2009)'s framework, the differences in factor prices mean the existence of distortions.

With these wedges, the expected profits of the firm are written as:[7]

$$\pi_{si} = (1 - \tau_{Ysi}) P_{si} Y_{si} - w L_{si} - (1 + \tau_{Ksi}) R K_{si}, \tag{6}$$

where w and R denote the common wages and rental costs facing all firms, respectively. Firms maximise their profits under the following constraint:

$$Y_{si} = Y_s \left(\frac{P_s}{P_{si}}\right)^{\sigma}, \tag{7}$$

where

$$P_s \equiv \left(\sum_{i=1}^{M_s} P_{si}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}. \tag{8}$$

In the presence of distortions, firms will produce a different quantity compared with what they would produce without these wedges (i.e. the efficient case).

Solving the profit maximisation problem under a monopolistic competition framework and the equilibrium allocation of resources across industries, we have:

$$P_{si} = \frac{\sigma}{\sigma - 1} \left(\frac{R}{\alpha_s}\right)^{\alpha_s} \left(\frac{w}{1 - \alpha_s}\right)^{1-\alpha_s} A_{si}^{-1} \frac{(1 + \tau_{Ksi})^{\alpha_s}}{1 - \tau_{Ysi}}, \tag{9}$$

[6] Distortions can be generated by various factors such as trade policies and credit market imperfections. In our companion paper (Ha and Kiyota, 2015), we examined the determinants of distortions in Vietnamese manufacturing. Leon-Ledesma and Christopoulos (2016) examined the effects of access to finance obstacles on misallocation. Using the firm-level data covering about 45 countries, they found that access to finance obstacles and private credit increase the dispersion of distortions. However, they also found that the financial variables explain a small part of the dispersion of factor market and size distributions.

[7] Distortions to output and to capital relative to labour are an observationally equivalent characterisation of those to the absolute levels of capital and labour. For more details, see Hsieh and Klenow (2009, Appendix III)

$$1-\tau_{Ysi}=\frac{\sigma}{\sigma-1}\frac{wL_{si}}{(1-\alpha_s)P_{si}Y_{si}}, \tag{10}$$

$$1+\tau_{Ksi}=\frac{\alpha_s}{1-\alpha_s}\frac{wL_{si}}{RK_{si}}. \tag{11}$$

From equation (9), we have:

$$TFPR_{si}=\xi_s\frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}, \tag{12}$$

where

$$\xi_s=\frac{\sigma}{\sigma-1}\left(\frac{R}{\alpha_s}\right)^{\alpha_s}\left(\frac{w}{1-\alpha_s}\right)^{1-\alpha_s}. \tag{13}$$

Noting that ξ_s is different across industries but constant within an industry, equation (12) implies:

$$TFPR_{si}\propto\frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}. \tag{14}$$

This equation means that the large deviation of firm TFPR from ξ_s is a sign that the firm faces large distortions.

Denote industry TFP as TFP_s. Define industry TFP as a weighted geometric average of firm i's $TFPQ_{si}$:

$$TFP_s\triangleq\left[\sum_{i=1}^{M_s}\left(TFPQ_{si}\frac{\overline{TFPR}_s}{TFPR_{si}}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}, \tag{15}$$

where $\overline{TFPR}_s$ is the geometric average of the average marginal revenue product of labour and capital in industry s:

$$\overline{TFPR}_s\triangleq\frac{\sigma}{\sigma-1}\left[\frac{R}{\alpha_s\sum_{i=1}^{M_s}\frac{1-\tau_{Ysi}}{1+\tau_{Ksi}}\frac{P_{si}Y_{si}}{P_sY_s}}\right]^{\alpha_s}\left[\frac{w}{(1-\alpha_s)\sum_{i=1}^{M_s}(1-\tau_{Ysi})\frac{P_{si}Y_{si}}{P_sY_s}}\right]^{1-\alpha_s}. \tag{16}$$

There are two remarks regarding equation (15). First, the higher the dispersion in TFPR, the lower the industry TFP will be. Hsieh and Klenow (2013) showed that when TFPQ and TFPR are jointly log-normally distributed and when there is only variation in $\log(1-\tau_{Ysi})$, aggregate TFP can be expressed as follows:[8]

[8] A similar property is obtained even when there is variation in $\log(1+\tau_{Ksi})$, although the equation becomes more complicated. For more details, see Hsieh and Klenow (2013).

$$\log\mathrm{TFP}_s = \frac{1}{\sigma-1}\left[\log M_s + \log E\left(TFPQ_{si}^{\sigma-1}\right)\right] - \frac{\sigma}{2} var(\log TFPR_{si}). \tag{17}$$

This equation suggests that industry TFP will decline if the elasticity of substitution σ and/or TFPR dispersion increase.

Second, TFPR will be equalised across firms within industry s if τ_{Ksi} and τ_{Ysi} are equalised. For example, from equation (12), $TFPR_{si} = \xi_s \ \forall i$ if $\tau_{Ksi} = \tau_{Ysi} = 0$. This in turn implies that $TFPR_{si} = \xi_s = \overline{TFPR}_s \ \forall i$.[9] Denote industry TFP without any distortions as $\overline{TFPQ}_s$. From equation (15), we can obtain:

$$\overline{TFPQ}_s \triangleq \bar{A}_s = \left(\sum_{i=1}^{M_s} A_{si}^{\sigma-1}\right)^{\frac{1}{\sigma-1}}, \tag{18}$$

which is called ‘efficient’ industry TFP.

Note that in order to obtain ‘efficient’ TFP, one needs information on firm-level TFPQ (i.e. A_{si}). One problem is the limited availability of firm-level price data, P_{si}, which are not available in many countries including Viet Nam.[10] Hsieh and Klenow (2009) rewrote equation (4) as:

$$TFPQ_{si} = A_{si} = \kappa_s \frac{(P_{si}Y_{si})^{\frac{\sigma}{\sigma-1}}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}}, \text{where } \kappa_s = w^{1-\alpha_s} \frac{(P_s Y_s)^{-\frac{1}{\sigma-1}}}{P_s}. \tag{19}$$

Noting that κ_s is a scaling constant by industry and does not affect the relative differences between firms within industry s, it can be normalised to unity (i.e. $\kappa_s = 1$). This manipulation enables us to estimate TFPQ without firm-level price data. Note that from equations (5) and (19), $TFPQ_{si} > TFPR_{si}$ if $\kappa_s = 1$ and $P_{si}Y_{si} \geq 1$. Therefore, in the Hsieh and Klenow (2009) framework the dispersion of TFPQ tends to be larger than that of TFPR.

[9] Note that even when TFPR is equalised across firms, TFPQ can be different across firms because more productive firms charge lower prices [see equation (9)]. In other words, if $A_{si} > A_{sj}$ and $P_{si} < P_{sj}$, $P_{si}A_{si}$ could be equal to $P_{sj}A_{sj}$ for $i \neq j$.

[10] There are a few countries in which firm-level (or plant-level) price data are available. For example, Eslava et al. (2004) utilised plant-level price data for Colombia to estimate plant-level TFPQ.

3. Data

3.1. Source

This paper utilises firm-level data from the *Annual Survey on Enterprises* collected by the General Statistics Office (GSO) of Viet Nam.[11] The survey was conducted for the first time in 2000 and then annually thereafter to provide researchers and policymakers with comprehensive information on Vietnamese firms. These data cover registered firms operating in all industries, including agriculture, industry and construction, and services.

The survey covers all state-owned enterprises and foreign-owned firms without any firm size threshold. However, as for domestic private firms, those with fewer than 10 workers are chosen by random sampling.[12] Household business activities are also not covered in this survey.[13] The survey information includes the type of ownership, assets and liabilities, number of employees, sales, capital stock, the industry that the firm belongs to, and obligations to the government (for example, taxes) from January to December of that year.

The data have some disadvantages. Some of the input data, such as materials, are only available for some years. Information on working hours and capital utilisation rates is also unavailable. Firms' year of establishment and export status are not available every year. This paper uses firms with information on inputs, outputs, and cost shares. There are some re-entry firms that disappeared and then reappeared later, which are omitted from our analysis. Some firms changed industry and/or ownership during the sample period.[14] We drop firms with fewer than 10 employees, regardless of their ownership, to avoid the effects of the random sampling.

[11] We use the same data used in Ha and Kiyota (2014). This section is based on Section 3 of Ha and Kiyota (2014). Note also that the use of firm-level data is more consistent with the theory than the use of plant-level data. This is because, as Nishimura et al. (2005) pointed out, resource allocation within a firm is determined by managerial decisions. Moreover, research and development or headquarter activities are typically classified as service activities, which are not covered in the manufacturing survey.

[12] This threshold was used in surveys before 2010. From 2010, different regions set different firm size thresholds.

[13] The survey covered 62.2 percent of total employment in manufacturing in 2009. The data on total employment in manufacturing are obtained from the GSO online database on population and employment at http://www.gso.gov.vn

[14] If a firm has switched industry, the industry to which the firm belonged for the majority of the surveyed years is regarded as that firm's industry. If a firm belonged to more than one industry for equal amounts of time, we assign the industry code of the industry that the firm belonged to most recently.

3.2. Variables and parameters

The main variables that we use are the two-digit Viet Nam Standard Industry Classification (VSIC) industry code, ownership type, value added, employment, total labour costs, and capital stock. Following Hsieh and Klenow (2009), we use wage bills instead of the number of workers to capture the potential differences in employee quality.[15] Capital stock is measured as total fixed assets recorded at the end of each year. Both wage bills and capital stock are deflated by the manufacturing GDP deflator.[16]

To compute dispersion, we follow other research in setting the key parameters σ and R as follows. We assume that the elasticity of substitution σ equals 3 and R is 10 percent, comprising a 5 percent depreciation rate and a 5 percent interest rate. We also follow Hsieh and Klenow (2009) to set α_s equal to one minus the labour share in the corresponding industry in the United States. Under Hsieh and Klenow's framework, the output elasticities of capital and labour (i.e. α_s and $1-\alpha_s$) do not embed distortions. Given the assumption that the United States economy is less distorted than the Vietnamese economy, the use of United States shares can be justified.

The United States labour share is obtained from the NBER-CES Manufacturing Industry Database, which is a joint product of the National Bureau of Economic Research and the United States Census Bureau's Center for Economic Studies.[17] Industry classifications are based on the North American Industry Classification System (NAICS) version 1997. Based on the data, we first match the NAICS code with the four-digit VSIC code using concordance tables between NAICS, International Standard Industry Classification revision 3, and VSIC. We then aggregate total payroll and total value added by two-digit VSIC sectors. To compute the labour share, we take the ratio of total payroll over total value added by sector. Because total payroll in the database does not include fringe benefits and employer's contribution to social security, this labour share only reflects two-thirds of the aggregate labour share in the whole manufacturing sector. Therefore, we follow Hsieh and Klenow (2009) to inflate the labour shares by 3/2 to obtain United States labour elasticities.

As firms' output prices are not available, we have obtained TFPQ by raising nominal output to the power of $\sigma/(\sigma-1)$, assuming that normal demand relationships hold. If a

[15] The use of wage bills as a measure of labour input implies that $w=1$. See Camacho and Conover (2010, p. 10).

[16] As Aw et al. (2001) pointed out, it is preferable to utilise the investment goods price deflator rather than the manufacturing GDP deflator to obtain the real capital stock. However, as Ha and Kiyota (2014) discussed, the investment goods price deflator is not available for our data set.

[17] Data can be downloaded from the NBER's website at http://www.nber.org/nberces/

firm's real output is high, one would expect its price to be low so that consumers demand more output. Following Ziebarth (2013), the dispersion of TFP is defined as the deviation of the log of TFP from its industry mean: $\log(TFPR_{si}/\overline{TFPR}_s)$ and $\log\left(TFPQ_{si} \cdot M_s^{\frac{1}{\sigma-1}}/\overline{TFPQ}_s\right)$, where $\overline{TFPR}_s$ and $\overline{TFPQ}_s$ are from equations (16) and (18), respectively.[18] We trim 2 percent of firm productivity and distortions by removing values below the 1st percentile and above the 99th percentile from the distribution of $\log(TFPR_{si}/\overline{TFPR}_s)$ and $\log\left(TFPQ_{si} \cdot M_s^{\frac{1}{\sigma-1}}/\overline{TFPQ}_s\right)$. Then, we recalculate $\overline{TFPR}_s$, $\overline{TFPQ}_s$ and $\overline{TFP}_s$. As robustness checks, Section 5 examines whether the results are sensitive to the values of σ, α_s, and the threshold level of trimming.

4. Results

4.1. To what extent are resources misallocated in Viet Nam?

This section addresses the first question: To what extent are resources misallocated in Viet Nam? To answer this question, we compare the dispersions of TFP in Viet Nam with those in China, India, Japan, Thailand, and the United States. The dispersions of TFPR are reported in Table 1, while those of TFPQ are reported in Table 2. Both tables present standard deviations, differences between the 90th and 10th percentiles, differences between the 75th and 25th percentiles, and average per capita GDP during the sample period.[19] Figures for China, India, and the United States are directly retrieved from Hsieh and Klenow (2009); for Japan from Hosono and Takizawa (2013); and for Thailand from Dheera-Aumpon (2014).

[18] Note that some of the effects of the changes in prices are controlled for by taking the ratio.

[19] Noting that both TFPR and TFPQ are divided by their industry means, these statistics can be interpreted as the coefficients of variation.

Table 1: Dispersion of TFPR in China, India, Japan, Thailand, the United States, and Viet Nam

	Viet Nam 2000–2009	Thailand 2006	China 1998–2005	India 1987–1994	Japan 1981–2008	United States 1977–1997
S.D.	0.79	0.85	0.68	0.68	0.55	0.45
75–25	0.97	1.04	0.89	0.80	0.70	0.47
90–10	2.00	2.09	1.72	1.66	1.40	1.08
GDP per capita	685	2,813	1,304	400	31,101	30,533

Notes: Figures for Thailand are directly retrieved from Dheera-Aumpon (2014, Table 3); for China from Hsieh and Klenow (2009, Table 2, arithmetic averages); for Japan from Hosono and Takizawa (2013). TFPR is calculated from equation (5) and then scaled by the geometric mean of $TFPR_{si}$ across all firms in an industry s. Industries are weighted by value added shares. For more details, see the main text. GDP per capita is the annual average over each sample period (constant 2005 United States dollars).
Source: Hsieh and Klenow (2009), Hosono and Takizawa (2013), Dheera-Aumpon (2014), and authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam. Per capita GDP is obtained from World Bank (2014).

Table 2: Dispersion of TFPQ in China, India, Japan, Thailand, the United States, and Viet Nam

	Viet Nam 2000–2009	Thailand 2006	China 1998–2005	India 1987–1994	Japan 1981–2008	United States 1977–1997
S.D.	1.42	1.59	1.00	1.19	0.98	0.83
75–25	2.01	2.18	1.34	1.56	1.27	1.16
90–10	3.70	4.12	2.57	3.03	2.48	2.15

Notes: Figures for Thailand are directly retrieved from Dheera-Aumpon (2014, Table 2); for China, India, and the United States from Hsieh and Klenow (2009, Table 1, arithmetic averages); for Japan from Hosono and Takizawa (2013, Table 1). TFPQ is calculated from equation (19) and then scaled by the geometric mean of $TFPQ_{si}$ across all firms in an industry s. Industries are weighted by value added shares. For more details, see the main text.
Sources: Hsieh and Klenow (2009), Hosono and Takizawa (2013), Dheera-Aumpon (2014), and authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

These tables indicate that the standard deviation of TFPR for Viet Nam is 0.79, which is comparable to those for China (0.68), India (0.68), and Thailand (0.85), and is larger than those for Japan (0.55) and the United States (0.45). Similar patterns are also confirmed for the differences between the 75th and 25th percentiles and those between the 90th and 10th percentiles.[20] Although more careful examination is needed in the form of a direct comparison, the results suggest that distortions in developing countries, including Viet Nam, tend to be large relative to those in developed countries.

[20] The difference between the 75th and 25th percentile firms is 0.97, which corresponds to a TFP ratio of $e^{0.97} = 2.63$. Similarly, the difference between the 90th and 10th percentile firms is 2.00, which corresponds to a TFP ratio of $e^{2.00} = 7.39$. These figures are much larger than those of the United States. For more details, see Syverson (2011).

4.2. How large would the productivity gains be without distortions?

This section addresses the second question of this paper: How large would the productivity gains have been in the absence of distortions? To answer this question, we estimate TFP gains when the marginal products of labour and capital are equalised across firms within each industry. For each industry, the gains are computed as the ratio of actual TFP obtained from equation (15) to the 'efficient' TFP obtained from equation (18). We then aggregate the gains across industries using industry value added shares as the weights. In particular, we compute:

$$
\begin{aligned}
\frac{Y}{Y^*} \quad &\triangleq \quad \prod_{s=1}^{S}\left(\frac{Y_s}{Y_s^*}\right)^{\theta_s} = \prod_{s=1}^{S}\left(\frac{TFP_s}{\overline{\overline{TFPQ}}_s}\right)^{\theta_s} \\
&= \prod_{s=1}^{S}\left\{\frac{1}{\overline{\overline{TFPQ}}_s}\left[\sum_{i=1}^{M_s}\left(TFPQ_{si}\frac{\overline{TFPR}_s}{TFPR_{si}}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}\right\}^{\theta_s} \\
&= \prod_{s=1}^{S}\left[\sum_{i=1}^{M_s}\left(\frac{A_{si}}{\bar{A}_s}\frac{\overline{TFPR}_s}{TFPR_{si}}\right)^{\sigma-1}\right]^{\frac{\theta_s}{\sigma-1}},
\end{aligned}
\tag{20}
$$

where Y^* is the 'efficient' output that corresponds to the 'efficient' TFP and θ_s is the value added share of industry s ($\sum_s \theta_s = 1$). The first equality (i.e. $Y_s/Y_s^* = TFP_s/\overline{\overline{TFPQ}}_s$) is obtained when K_s and L_s are given. As the total amount of inputs is fixed, the output gains come solely from the reallocation of resources in the absence of distortions.

Table 3 presents the TFP gains from equalising TFPR across firms within each industry. The gains are measured relative to the TFP gains in the United States in 1997.[21] To report the percentage TFP gains in Viet Nam relative to those in the United States, we take the ratio of Y^*/Y to the United States equivalent in 1997, subtract 1, and multiply by 100. If Viet Nam hypothetically moves to 'United States efficiency,' substantial gains are expected: 30.7 percent. The gains are smaller than those for China (39.2 percent), India (46.9 percent), and Thailand (73.4 percent), but larger than those for Japan (3.0 percent).

One may be concerned that the dispersion of TFPR is larger (Table 1), whereas the gains are smaller (Table 3) in Viet Nam than in China and India. Noting that the gains are computed from the inverse of equation (20) (i.e. $(Y^*/Y - 1) \times 100$), Y^*/Y will be small if $A_{si}/\bar{A}_s$ and/or $\overline{TFPR}_s/TFPR_{si}$ become large. The results suggest that, on average, $A_{si}/\bar{A}_s$ is larger in Viet Nam than in China and India. Similarly, we find large TFP gains for Thailand,

[21] Hsieh and Klenow (2009) called this comparison a conservative analysis because the United States gains are largest in 1997.

which is possibly attributed to a small $A_{si}/\bar{A}_s$ for Thailand.[22] Although these are hypothetical exercises and thus should not be taken literally, the results suggest that substantial productivity gains are expected in Viet Nam by the kind of reallocation considered here.

Table 3: TFP Gains from Equalising TFPR Relative to 1997 United States Gains

	Viet Nam 2000–2009	Thailand 2006	China 1998–2005	India 1987–1994	Japan 1981–2008
%	30.7	73.4	39.3	46.9	3.0

Notes: The data for Thailand are calculated from Dheera-Aumpon (2014, Table 4). The data for China, India, and the United States are arithmetic averages of Hsieh and Klenow (2009, Table 6). The data for Japan are calculated from Hosono and Takizawa (2013, Table 2).
Sources: Hsieh and Klenow (2009), Hosono and Takizawa (2013), Dheera-Aumpon (2014), and authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

4.3. Are the distortions related to firm size?

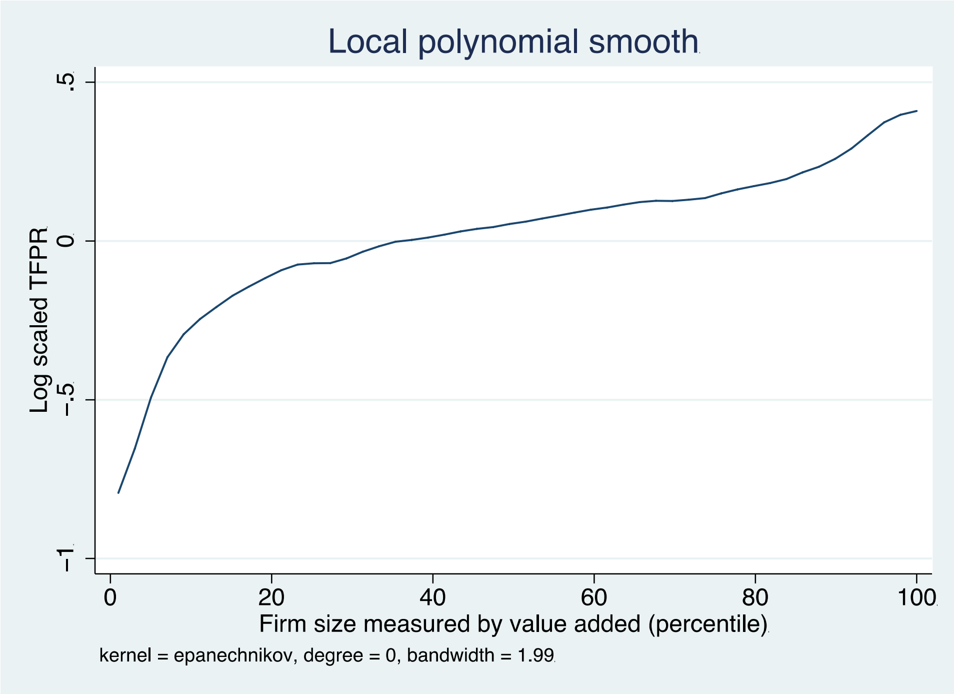
This section examines whether the distortions are related to firm size. This question has important policy implications because, for example, many countries give preferential treatment to SMEs. If SMEs tend to face larger disadvantageous distortions, preferential treatment to SMEs can be justified. Following Hsieh and Klenow (2009) and Ziebarth (2013), we examine the relationship between firm size and TFPR.

Figure 1 presents the relationship between firm size percentile as measured by value added and scaled TFPR relative to a given industry. Figure 1 indicates that TFPR is strongly increasing in percentiles of firm size. Noting that TFPR is proportional to the distortions (equation 14), this result implies that smaller firms tend to face advantageous distortions, whereas larger firms tend to face disadvantageous ones. This result is similar to that in India (Hsieh and Klenow, 2009, Figure 6) and the United States in the 19th century (Ziebarth, 2013, Figure 3).

Interestingly, this correlation with firm size is different for the distortions in output and the distortions in capital markets. Figure 2 presents the relationship between the distortions in output markets and firm size (in terms of value added). Figure 2 indicates that the distortions in output markets are strongly decreasing in percentiles of firm size. Noting that the distortions in output markets are measured by $(1 - \tau_Y)$, this result is similar to that in TFPR: smaller firms tend to face advantageous distortions, whereas larger firms tend to face disadvantageous ones.

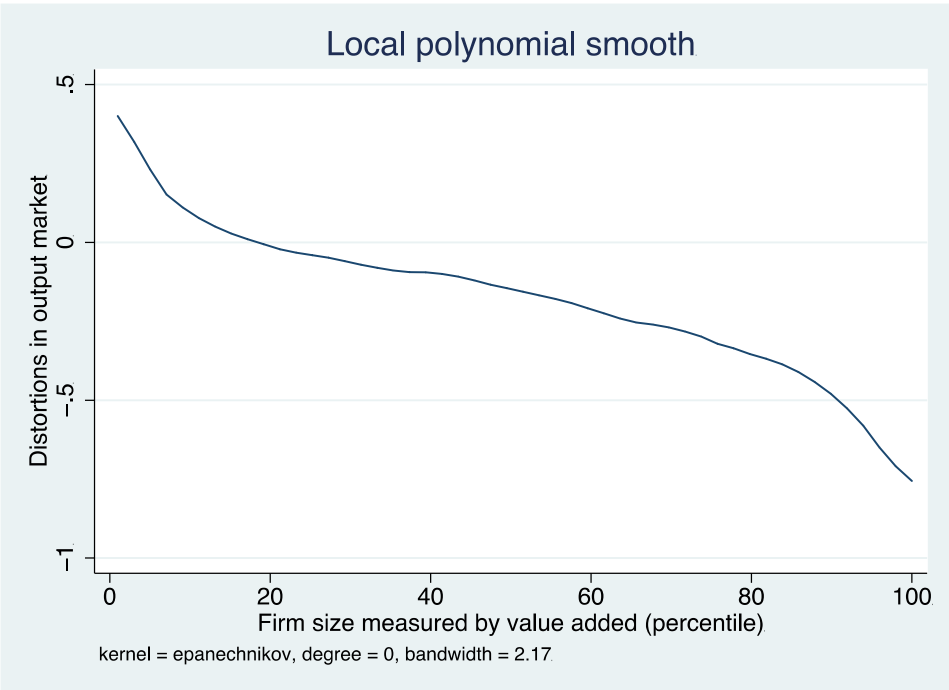
[22] Indeed, Figure 1 in Dheera-Aumpon (2014) suggests that the distribution of TFPQ in Thailand moves to the left and its mean takes a negative value. Although it is not clear why the distribution moves to the left, this may be a reason why the large TFP gains are expected in Thailand.

Figure 1: TFPR and Size



Note: This figure presents the relationship between scaled TFPR relative to a given industry and size percentile as measured by value added.
Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

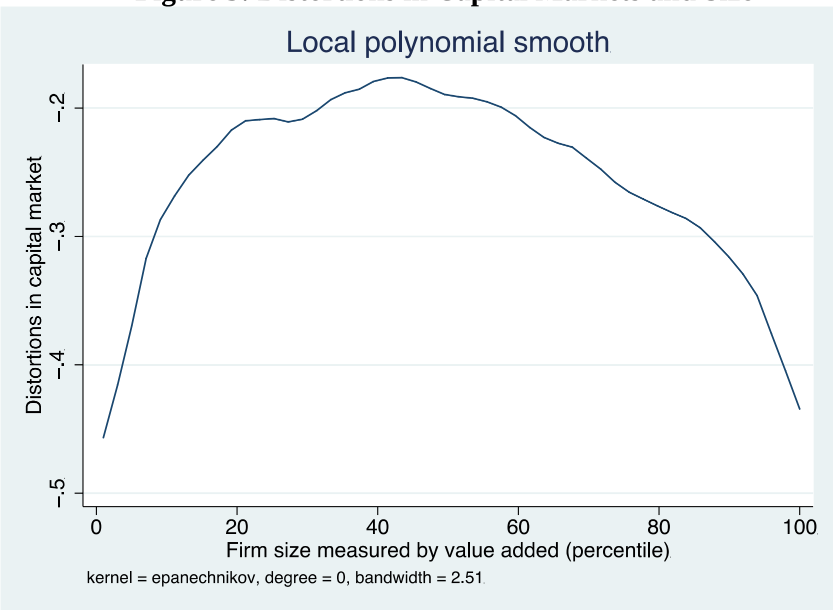
Figure 2: Distortions in Output Markets and Size



Note: This figure presents the relationship between scaled $1 - \tau_Y$ relative to a given industry and size percentile as measured by value added.
Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

Figure 3 presents the relationship between the distortions in capital markets and firm size. In contrast to the distortions in output markets, Figure 3 presents an inverse U-shaped relationship. Noting that the distortions in capital markets are measured by $(1 + \tau_K)$, this result suggests that both small and large firms tend to face advantageous distortions. In contrast, middle-sized firms tend to face disadvantageous distortions. This pattern is different from those of TFPR and distortions in output markets. This may be because small firms are treated preferentially, whereas large firms can diversify their capital procurement.

Figure 3: Distortions in Capital Markets and Size

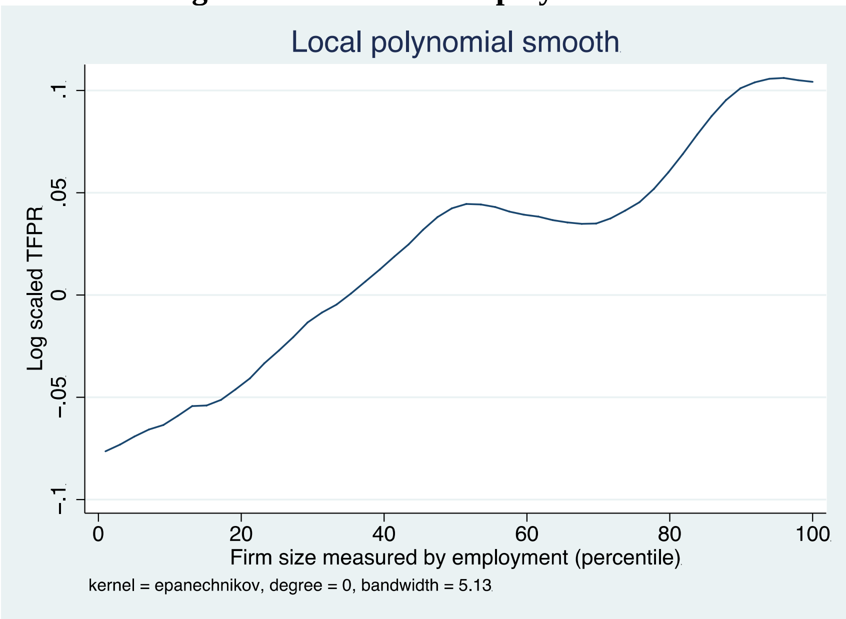


Note: This figure presents the relationship between scaled $1 + \tau_K$ relative to a given industry and size percentile as measured by value added.
Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

It is also interesting to note that the result for TFPR mainly reflects that of distortions in output markets. This result implies that the distortions in output markets have stronger effects on TFPR than those in capital markets. This result is consistent with the result of Midrigan and Xu (2014) which showed that financial frictions, measured by borrowing constraints, had relatively small impacts on productivity.

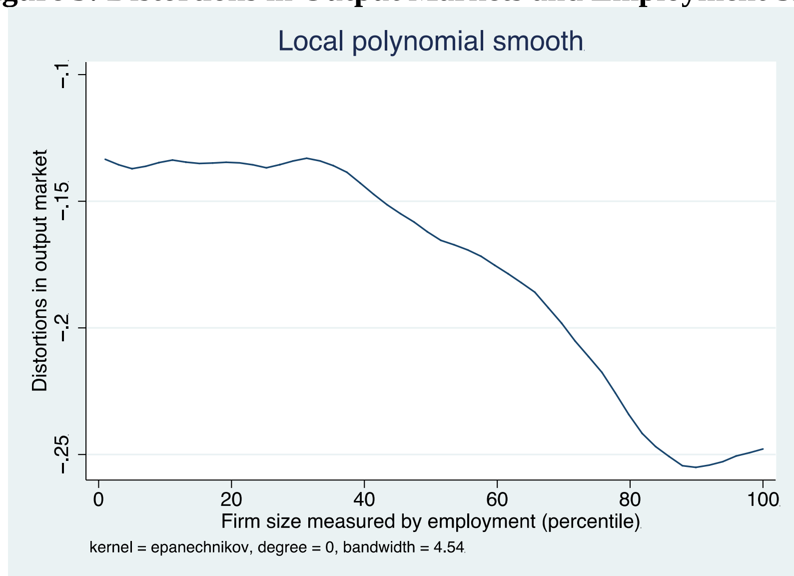
One may be concerned that our measurement of firm size, following Hsieh and Klenow (2009), is based on value added rather than employment. However, in reality, SMEs are defined by the number of employees, not by the size of their value added, in many countries. To address this concern, we examine the relationship between distortions and firm size measured by employment. The results are presented in Figures 4, 5, and 6. The results are presented in Figures 4, 5, and 6. The results are different from, but qualitatively similar to, those measured by value added: TFPR is increasing in percentiles of firm employment size, the distortions in output markets are decreasing, and the distortions in capital markets are inverse U-shaped except for the top 20 percentiles. Noting that the results for TFPR mainly reflect the distortions in output markets, we can conclude that our main messages remain unchanged even when firm size is measured by employment.

Figure 4: TFPR and Employment Size



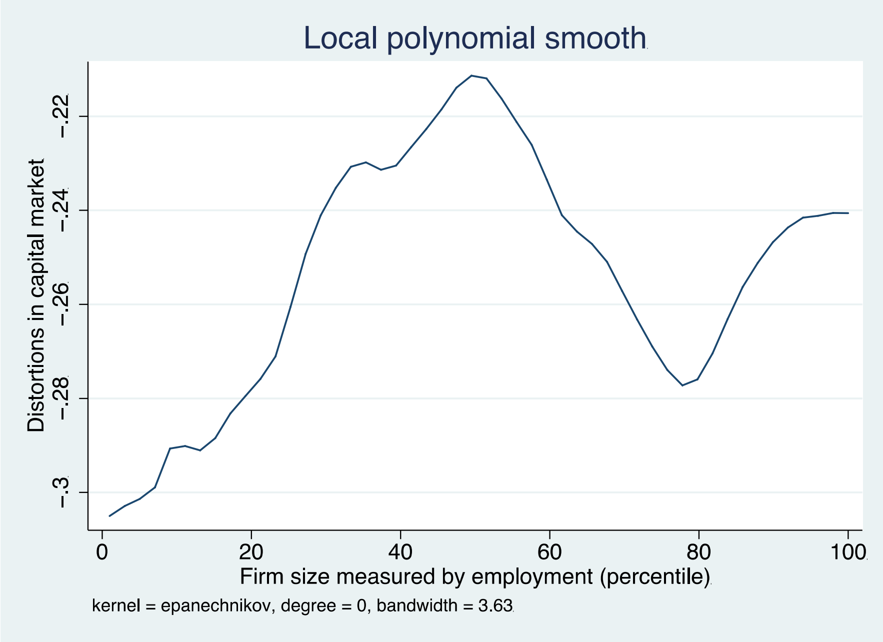
Note: This figure presents the relationship between scaled TFPR relative to a given industry and size percentile as measured by employment.
Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

Figure 5: Distortions in Output Markets and Employment Size



Note: This figure presents the relationship between scaled $1 + \tau_Y$ relative to a given industry and size percentile as measured by employment.
Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

Figure 6: Distortions in Capital Markets and Employment Size



Note: This figure presents the relationship between scaled $1+\tau_K$ relative to a given industry and size percentile as measured by employment.
Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

4.4. What would the distribution of firm size have been in the absence of distortions?

The model also has an implication for the distribution of firm size. Equation (7) is rewritten as:

$$P_{si}Y_{si} = Y_{si}^{\frac{\sigma-1}{\sigma}} P_s Y_s^{\frac{1}{\sigma}}. \tag{21}$$

From equations (7) and (9), we have:

$$Y_{si} = \left[\frac{\sigma-1}{\sigma}\left(\frac{\alpha_s}{R}\right)^{\alpha_s}\left(\frac{1-\alpha_s}{w}\right)^{1-\alpha_s}\right]^{\sigma} P_s^{\sigma} Y_s \left[\frac{A_{si}(1-\tau_{Ysi})}{(1+\tau_{Ksi})^{\alpha_s}}\right]^{\sigma}. \tag{22}$$

Similar to equation (14), from equations (21) and (22), we have:

$$P_{si}Y_{si} \propto \left[\frac{A_{si}(1-\tau_{Ysi})}{(1+\tau_{Ksi})^{\alpha_s}}\right]^{\sigma-1}. \tag{23}$$

Equation (23) suggests that without distortions, more (less) productive firms tend to be larger (smaller). When A_{si} and $1-\tau_{Ysi}$ are correlated negatively, more productive firms tend to be smaller than the efficient size. Similarly, if A_{si} and $1+\tau_{Ksi}$ are correlated positively, less productive firms tend to be larger than the efficient size. Both cases result in smaller size dispersion. This in turn implies that when distortions are large, the efficient size distribution is more dispersed than the actual size distribution.

To examine this implication, we compare the actual firm size distribution with the efficient firm size distribution. The size is measured as the value added of the firms, following Hsieh and Klenow (2009). Let $P^*_{si}Y^*_{si}$ be the efficient firm size. The efficient sizes relative to actual sizes are:

$$\frac{P^*_{si}Y^*_{si}}{P_{si}Y_{si}} = \frac{Y^*}{Y}\left(\frac{Y_s}{Y^*_s}\right)^{\sigma-1}\left[\frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}\right]^{\sigma-1}, \quad (24)$$

where the efficient firm size is obtained when τ_{Ksi} and τ_{Ysi} are equalised within industry s; Y^*/Y and Y_s/Y^*_s are obtained from equation (20), respectively.[23] We compute the actual and efficient sizes from this equation, by year, and then take averages over the period.

Table 4 and Figure 7 present the results. In Table 4, the rows are the actual firm size quartiles with equal numbers of firms. The columns are the bins of efficient firm size relative to actual firm size. We classify firms into four bins. For example, 0%–50% means that the firm size would be less than half of the actual firm size if all distortions are removed. Similarly, 200+% means that the firm size would be more than double without distortions. The entries are the shares of firms (averaged over the period). The rows sum to 25 percent, and the rows and columns together to 100 percent.

Examining Table 4, we highlight two results. First, although average output rises substantially (as we confirmed in Section 4.2), many firms of all sizes would shrink. Second, the largest quartile indicates the largest expansion among the firm sizes (8.7 percent). This result means that initially large firms are less likely to shrink and more likely to expand. This finding is also confirmed from Figure 7.

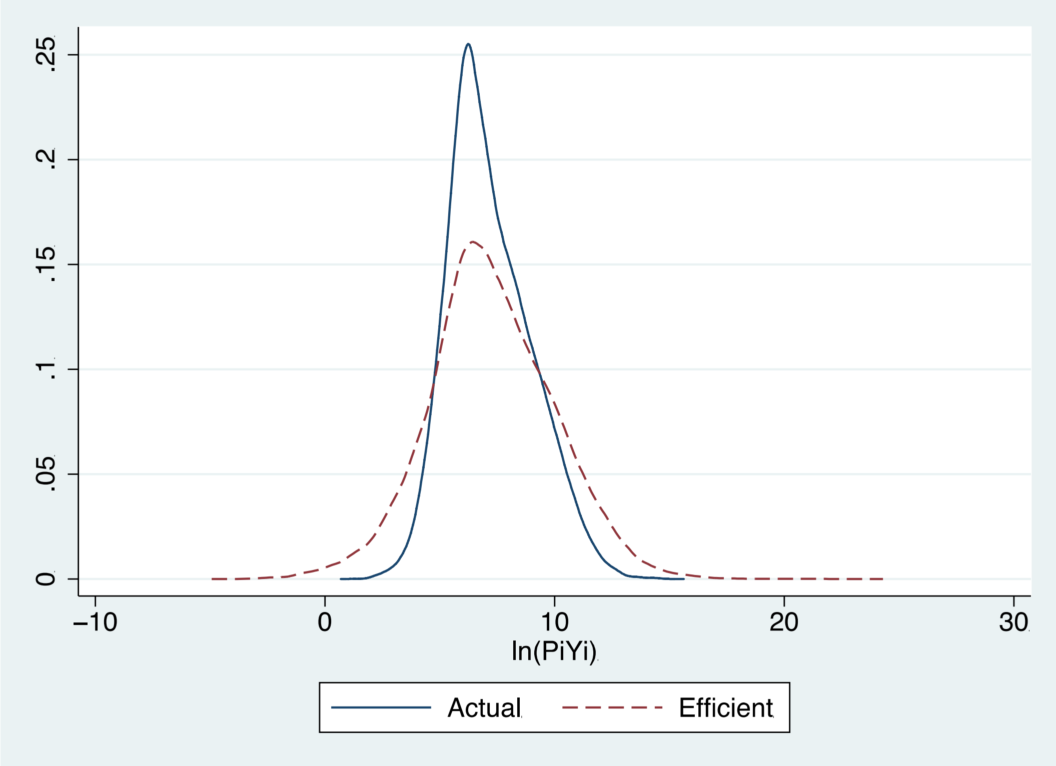
Table 4: Actual Size vs. Efficient Size

	Efficient firm size relative to actual firm size				
2000–2009 (average)	0%–50%	50%–100%	100%–200%	200%+	Total
Actual firm size					
Top size quartile	5.1	5.5	5.7	8.7	25.0
2nd quartile	8.0	5.6	4.6	6.8	25.0
3rd quartile	9.1	6.3	4.4	5.2	25.0
Bottom quartile	13.7	5.1	3.0	3.1	25.0
Total	36.0	22.4	17.6	23.9	100.0

Notes: The rows are the actual firm size quartiles with equal numbers of firms. The columns are the bins of efficient firm size relative to actual firm size. We classify firms into four bins, by the value added of firms. For example, 0%–50% means that the firm size would be less than half of the actual firm size if all distortions were removed. Similarly, 200+% means that the firm size would be more than double without distortions. The entries are the shares of firms (averaged over the period).
Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

[23] For the derivation of equation (24), see the Appendix.

Figure 7: Distribution of Firm Size



Note: The solid line indicates the actual size distribution, whereas the dashed line indicates the efficient size distribution.
Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

As the model suggests, the efficient size distribution is more dispersed than the actual size distribution. This result is consistent with the finding of the previous section. Like the case of India (Banerjee and Duflo, 2005, p.507), Viet Nam's policies may constrain its large and most efficient producers and coddle its small and least efficient ones. Indeed, Vietnamese SMEs are supported by various policies such as government supporting funds (Tran et al., 2008, pp. 347–359). These results for Viet Nam are similar to those for China, India, and the United States in Hsieh and Klenow (2009).[24]

4.5. Robustness check: different parameter values

One may be concerned that our analysis is sensitive to the choice of parameter values and sample selection because our results are based on specific parameter values such as $\sigma = 3$. To address this concern, we reconduct all the analyses using different parameter values.

[24] Indeed, the Vietnamese government had launched various schemes to improve the performance of SMEs, such as establishing credit funds and providing worker training (Tran et al., 2008, pp. 347–359). However, unlike India, where size-related policies are explicitly imposed by law, such policies in Viet Nam are only guidelines. We cannot identify from the data which individual firm is eligible for support or has received any form of support. It is thus difficult for us to conduct an analysis similar to Hsieh and Klenow (2009, Part VI).

Because it is tedious to examine all the results, this section examines i) how sensitive the estimated TFPR and TFP gains (reported in Section 4.2 and in Table 3) are to the choice of parameter values and sample selection, and ii) the correlation between alternative and baseline TFPR. In this robustness check, we report absolute TFP gains rather than relative TFP gains (to the United States) because we only change the parameter values in Viet Nam (not in the United States).

We first examine whether the results are sensitive to the value of the elasticity of substitution: σ. In the baseline analysis, following Hsieh and Klenow (2009), we set $\sigma = 3$. This implies that the markup is 1.5 ($= 3/(3-1)$). As a robustness check, we set $\sigma = 2$ and $\sigma = 6$, and the corresponding markups are 2 ($= 2/(2-1)$) and 1.2 ($= 6/(6-1)$), respectively. The second and third columns in Table 5 present the results. The TFP gains are somewhat sensitive to the value of the elasticity of substitution. The TFP gains are 65.3 percent when $\sigma = 2$ and 161.9 percent when $\sigma = 6$, while the baseline TFP gains are 86.8 percent.[25]

Nevertheless, the estimated TFPR is qualitatively similar to the baseline results. Table 5 also reports the correlation with baseline TFPR, which is 0.997 when $\sigma = 2$ and 0.994 when $\sigma = 6$. These high correlations suggest that the results are quantitatively different from, but qualitatively similar to, the baseline results.[26] The standard deviation of lnTFPR is 0.78 when $\sigma = 2$ and 0.79 when $\sigma = 6$, both of which are similar to that of the baseline model (0.79).

[25] This result is consistent with equation (17), which implies that the TFP gains will be large if the elasticity of substitution is large.

[26] It may also be important to allow the elasticities to vary across industries. Although Broda et al. (2006) estimated the elasticity of substitution for various countries, Viet Nam is not covered in their analysis. We thus leave this exercise for future research.

Table 5: Robustness Check: TFP Gains from Equalising TFPR Relative to 1997 United States Gains

	(1) Baseline	(2) Robustness Check 1	(3) Robustness Check 2	(4) Robustness Check 3	(5) Robustness Check 4	(6) Robustness Check 5	(7) Robustness Check 6	(8) Robustness Check 7
Elasticity: σ	$\sigma = 3$	$\sigma = 2$	$\sigma = 6$	$\sigma = 3$	$\sigma = 3$	$\sigma = 3$	$\sigma = 3$	$\sigma = 3$
Technology: α	United States	United States	United States	1/3	Viet Nam	Firm-specific	United States	United States
Trim	1%	1%	1%	1%	1%	1%	2%	2%
N	100,601	100,601	100,612	100,848	100,832	100,947	97,263	10,186
sd(TFPR)	0.79	0.78	0.79	0.64	0.64	0.61	0.71	0.68
TFP gains (%)	86.8	65.3	161.9	70.1	68.0	40.0	75.7	64.5
Correlation with baseline TFPR	1.000	0.997	0.994	0.927	0.889	0.794	0.995	0.948
Panel structure	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Balanced Panel

Note: The baseline is obtained from Table 3.

Source: Authors' calculations, based on the *Annual Survey of Enterprises* by the GSO of Viet Nam.

We also examine the sensitivity of the results to the value of the technology parameter (i.e. capital share α_s). We examine two different technologies. One is $\alpha_s = 1/3$ as in Ziebarth (2013) and the other is the Vietnamese cost share, which is defined as the industry-year average capital share of the sample firms. The results are presented in the fourth and fifth columns in Table 5. The TFP gains are 70.1 percent when $\alpha_s = 1/3$ and 68.0 percent when we assume Vietnamese technology. The correlation with the baseline TFPR is 0.927 when $\alpha_s = 1/3$ and 0.889 when we assume Vietnamese technology. The standard deviation of lnTFPR is 0.64 for both cases. Similar to the value of the elasticity of substitution, the results are quantitatively different from, but qualitatively similar to, the baseline results.

One may also be concerned that the technology parameter α_s is heterogeneous across firms even within industries. To address this concern, we use the firm-level capital share so that the capital share can vary across firms.[27] The results are presented in the sixth column in Table 5, and are similar to the baseline results, although the TFP gains are somewhat sensitive to the technology parameters. The TFP gains are 40.0 percent. The correlation with the baseline TFPR is 0.794. The standard deviation of lnTFPR is 0.61. These results together suggest that our main messages remain unchanged even when we use different values for the technology parameter.

Another concern may be that the data are not precise, and thus Vietnamese firm-level data are subject to measurement error problems. Although we cannot rule out arbitrary measurement error, we can try to gauge whether our results are attributable to some specific forms of measurement error. We focus on two forms of measurement error. First, serious measurement error, possibly because of reporting error, tends to appear as outliers. We trimmed 2 percent from the tails (below the 2nd percentile and above the 98th percentile), instead of 1 percent as in the baseline analysis, and examined how sensitive the results are to the trim values. The seventh column reports the results. The TFP gains are 75.7 percent. The correlation with the baseline TFPR remains high at 0.995. The standard deviation of lnTFPR (0.71) is slightly lower than that of the baseline model (0.79).

We also estimate the TFP gains for firms that survived throughout the sample period (i.e. balanced panel). This exercise enables us to control for the effects of firm entry and exit. The eighth column presents the results. This exercise reduces the sample size substantially

[27] Note that ξ_s can vary across firms if the capital share is different across firms (see equation (12)). In other words, TFPR will not necessarily be proportional to the capital and output wedges. We thus present the results for reference only. Note also that, from equation (11), if the technology parameter is heterogeneous across firms (i.e. α_s ($= RK_{si}/P_{si}Y_{si}$), distortions appear only in τ_{Ysi} because τ_{Ksi} will be zero.

(N = 10,186). Nonetheless, the estimated TFP gains are large and the correlation with baseline TFP is high: 64.5 percent and 0.948, respectively. The standard deviation of lnTFPR is 0.68, which is comparable to that of the baseline model. The results suggest that about three-quarters (=64.5%/86.8%) of TFP gains come from the incumbent firms, while the rest of the gains come from entrants and exiters. We can thus conclude that the results from the balanced panel are qualitatively similar to the baseline results.

In sum, the magnitude of the TFP gains are somewhat sensitive to the choice of the values of parameters σ and α. Nonetheless, our main messages remain unchanged even if we use different parameter values or we employ different sample selection criteria: potential TFP gains from removing distortions are large in Vietnamese manufacturing.

5. Concluding Remarks

This paper employed the Hsieh and Klenow (2009) framework to investigate misallocation and productivity linkages in Vietnamese manufacturing during the period 2000–2009 using firm-level data. Our study has four major findings. First, misallocation in Viet Nam is comparable to that in China, India, and Thailand. This result is consistent with the common knowledge that resources in developing countries are not efficiently allocated.

Second, there would be substantial improvement in TFP if no distortions existed. If Viet Nam hypothetically moved to ‘United States efficiency,’ its TFP would be boosted by 30.7 percent. Third, smaller firms tend to face advantageous distortions, whereas larger firms tend to face disadvantageous ones. Finally, the efficient distribution of firm size is more dispersed than the actual size distribution. This result implies that Viet Nam’s policies may constrain its large and most efficient producers and coddle its small and least efficient ones.

These findings have policy implications. The first finding suggests that, similar to other developing countries, resource misallocation, which is caused by the distortions, seems to be an important issue in Viet Nam. The second finding states that potential productivity gains from removing distortions are large in Vietnamese manufacturing. The result implies that reallocation would lead to productivity gains that would accelerate potential growth in transition towards the improved inter-firm resource allocation. The last two findings together imply that Viet Nam’s policies may constrain its large and most efficient producers and coddle its small and least efficient ones. These results together suggest that policymakers need to focus more on the allocation of resources. An important question, therefore, is whether or not the resources are allocated to productive firms.

Appendix. Derivation of Equation (24)

From equations (7), (8), and (9), actual firm size is written as:

$$\begin{aligned} P_{si}Y_{si} &= P_s^{\sigma} Y_s P_{si}^{1-\sigma} \\ &= P_s Y_s \left(\frac{P_{si}}{P_s}\right)^{1-\sigma} \\ &= \theta_s Y \left[\frac{(1+\tau_{Ksi})^{\alpha_s}}{A_{si}(1-\tau_{Ysi})}\right]^{1-\sigma} \Bigg/ \sum_j \left[\frac{\left(1+\tau_{Ksj}\right)^{\alpha_s}}{A_{sj}\left(1-\tau_{Ysj}\right)}\right]^{1-\sigma}. \end{aligned} \tag{A-1}$$

Efficient firm size is obtained when τ_{Ksi} and τ_{Ysi} are equalised within industry s (e.g. $\tau_{Ksi} = \tau_{Ks}$ and $\tau_{Ysi} = \tau_{Ys}$). From equation (A-1), the efficient firm size is written as:

$$P_{si}^{*}Y_{si}^{*} = \theta_s Y^{*} \frac{A_{si}^{\sigma-1}}{\sum_j A_{sj}^{\sigma-1}}. \tag{A-2}$$

From equations (A-1) and (A-2), we have:

$$\frac{P_{si}^{*}Y_{si}^{*}}{P_{si}Y_{si}} = \frac{Y^{*}}{Y}\left(\frac{Y_s}{Y_s^{*}}\right)^{\sigma-1}\left[\frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}\right]^{\sigma-1}. \blacksquare \tag{A-3}$$

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