Misallocation and Productivity: The Case of Vietnamese Manufacturing

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This paper attempts to measure the effect of resource misallocation on aggregate manufacturing total factor productivity, focusing on Vietnamese manufacturing firms during the period 2000–2009. One of the major findings of this paper is that there would have been substantial improvement in aggregate total factor productivity in Viet Nam in the absence of distortions. The results imply that potential productivity gains from removing distortions in Vietnamese manufacturing are large. 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 suggest that Viet Nam's policies may constrain its largest and most efficient producers, and coddle its smallest and least efficient ones.

Keywords: misallocation, total factor productivity, Viet Nam
JEL codes: D22, F14, O47

I. Introduction

Differences in per capita income across economies result mainly from differences in total factor productivity (TFP).[1] Therefore, clarifying the underlying causes of low productivity in developing economies 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

[1]"Large differences in output per worker between rich and poor economies have been attributed, in no small part, to differences in total factor productivity" (Hsieh and Klenow 2009, p. 1403); "[C]ross-economy 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 economies.

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 economies can be attributed 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. The seminal work of Hsieh and Klenow (2009) estimates wedges from data on value added and factor inputs for manufacturing establishments in the People's Republic of China (PRC), India, and the United States (US). They found that the distortions were much larger in the PRC and India than in the US. Hsieh and Klenow (2009) also found that the removal of distortions has a significant effect on aggregate TFP in the PRC 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]

This paper extends the analysis of Hsieh and Klenow (2009) to Vietnamese manufacturing between 2000 and 2009 and asks the following 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?

Answering these questions has important implications for potential growth because reallocation would lead to productivity gains that can accelerate potential growth through improved interfirm resource allocation.

Our study is closely related to Bach (2014), who also examined resource misallocation in Viet Nam using firm-level data. His study addressed the first two questions above but did not compare resource misallocation in Viet Nam with misallocation in other Asian economies. Nor did his study address the last two questions. From a policy perspective, the last two questions are important because many economies give preferential treatment to small and medium-sized enterprises (SMEs). Indeed, size-dependent policies, which limit the size of firms, could be an

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[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, Madrigal, and Pages–Serra (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.

important source of misallocation (Restuccia and Rogerson 2013). In answering the four questions, 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 organized as follows. In section II, we describe the methodology of Hsieh and Klenow (2009). Section III describes the Vietnamese firm-level data used in our study. Section IV presents the results. Concluding remarks and policy implications are presented in section V.

II. Measurement of Misallocation

Hsieh and Klenow (2009) formulated an analytical framework to estimate misallocation. Although some studies such as Bartelsman, Haltiwanger, and Scarpetta (2013) developed an alternative framework, this paper employs Hsieh and Klenow's framework for the following reasons. First, their framework is tractable in the sense that it is simple and its data requirements are minimal. This provides a significant advantage in estimating misallocation in Viet Nam because of the limited data availability, 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 summarized 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 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 ($s = 1, \ldots, S$). Output in industry s is then given by:[5]

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

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[4]Another important difference between Bach (2014) and our study is that his study did not control for the skill differences of workers across firms in measuring quantity-based TFP and revenue-based TFP.

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

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 labor, 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 the productivity, capital, and labor of firm i in industry s, respectively; and 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, Haltiwanger, and Syverson (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 (see, for example, 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 labor by the same proportion, which is denoted by τ_{Ysi}. The other increases the marginal product of capital relative to labor, 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 subsidized credit. If two firms have identical technologies but one of the firms can borrow from the financial market at a lower interest rate (and the other firm can borrow at a higher interest rate), the marginal product of capital of the firm that can access the subsidized 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.

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[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. León–Ledesma and Christopoulos (2016) examined the effects of access to finance obstacles on misallocation. Using firm-level data covering 45 economies, 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.

In other words, in the framework of Hsieh and Klenow (2009), the differences in factor prices mean the existence of distortions.

With these wedges, the expected profits of the firm are written as follows:[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 maximize 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 (the efficient case).

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

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

$$1 - \tau_{Ysi} = \frac{\sigma}{\sigma - 1} \frac{w L_{si}}{(1 - \alpha_s) P_{si} Y_{si}}, \quad \text{and} \tag{10}$$

$$1 + \tau_{Ksi} = \frac{\alpha_s}{1 - \alpha_s} \frac{w L_{si}}{R K_{si}} \tag{11}$$

From equation (9), we have:

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

where

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

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

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

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

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

If we denote industry TFP as TFP_s and define industry TFP as a weighted geometric average of firm i's $TFPQ_{si}$, we have

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

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

$$\overline{TFPR_s} \triangleq \frac{\sigma}{\sigma - 1} \left[\frac{R}{\alpha_s \sum_{i=1}^{M_s} \frac{1-\tau_{Ysi}}{1+\tau_{Ksi}} \frac{P_{si}Y_{si}}{P_s Y_s}} \right]^{\alpha_s} \left[\frac{w}{(1 - \alpha_s) \sum_{i=1}^{M_s} (1 - \tau_{Ysi}) \frac{P_{si}Y_{si}}{P_s Y_s}} \right]^{1-\alpha_s} \qquad (16)$$

There are two points of clarification 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]

$$\log TFP_s = \frac{1}{\sigma - 1} \left[\log M_s + \log E \left(TFPQ_{si}^{\sigma-1} \right) \right] - \frac{\sigma}{2} var \left(\log TFPR_{si} \right) \qquad (17)$$

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

Second, TFPR will be equalized across firms within industry s if τ_{Ksi} and τ_{Ysi} are equalized. For example, from equation (12), $TFPR_{si} = \xi_s \forall i$ if $\tau_{Ksi} = \tau_{Ysi} = 0$. This implies that $TFPR_{si} = \xi_s = \overline{TFPR_s} \forall i$.[9] Denoting industry TFP without any

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[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).

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

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.

      In order to obtain "efficient" TFP, one needs information on firm-level TFPQ (A_{si}). One problem is the limited availability of firm-level price data, P_{si}, which are not available for many economies, including Viet Nam.[10] Hsieh and Klenow (2009) rewrote equation (4) as

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

      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 normalized to unity ($\kappa_s = 1$). 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.

III. Data

A. Source

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

      The survey covers all state-owned enterprises and foreign-owned firms without any firm size threshold. However, for domestic private firms, those with fewer than 10 workers are chosen by random sampling.[12] Household business

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[10]There are some economies for which firm-level (or plant-level) price data are available. For example, Eslava et al. (2004) utilized plant-level price data for Colombia to estimate plant-level TFPQ.

[11]We use the same data as Ha and Kiyota (2014); this section is based on section III of their study. 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, Nakajima, and Kiyota (2005) point out, resource allocation within a firm is determined by managerial decisions. Moreover, research and development and headquarters 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.

activities are not covered in this survey.[13] The survey information includes type of ownership, assets and liabilities, number of employees, sales, capital stock, industry that the firm belongs to, and obligations to the government (e.g., taxes) from January to December of that year.

The data have some disadvantages. Some of the input data, such as materials, are not available for all years. Information on working hours and capital utilization 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. Reentry firms, which are those that disappeared from the data and then reappeared later, 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.

B.   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 labor 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 gross domestic product (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%, comprising a 5% depreciation rate and a 5% interest rate. We also follow Hsieh and Klenow (2009) to set α_s equal to 1 minus the labor share in the corresponding industry in the US. Under Hsieh and Klenow's framework, the output elasticities of capital and labor (α_s and $1 - \alpha_s$) do not embed distortions. Given the assumption that the US economy is less distorted than the Vietnamese economy, the use of US shares can be justified.

The US labor share is obtained from the NBER–CES Manufacturing Industry Database, which is a joint product of the National Bureau of Economic Research and the US Census Bureau's Center for Economic Studies.[17] Industry classifications

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[13]The survey covered 62.2% of total employment in manufacturing in 2009. The data on total employment in manufacturing were obtained from the General Statistics Office online database on population and employment.

[14]If a firm has switched industries, the industry to which the firm belonged for the majority of the surveyed years is regarded as the 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.

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

[16]As Aw, Chen, and Roberts (2001) pointed out, it is preferable to utilize 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 National Bureau of Economic Research's website at http://www.nber.org /nberces/

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 labor 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 labor share only reflects two-thirds of the aggregate labor share in the whole manufacturing sector. Therefore, we follow Hsieh and Klenow (2009) to inflate the labor shares by 1.5 to obtain US labor 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 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 $\log(TFPQ_{si} M_s^{\frac{1}{\sigma-1}}/\overline{TFPQ_s})$, where $\overline{TFPR_s}$ and $\overline{TFPQ_s}$ are from equations (16) and (18), respectively.[18] We trim 2% of firm productivity and distortions by removing values below the first percentile and above the 99th percentile from the distribution of $\log(TFPR_{si}/\overline{TFPR_s})$ and $\log(TFPQ_{si} M_s^{\frac{1}{\sigma-1}}/\overline{TFPQ_s})$. Then, we recalculate $\overline{TFPR_s}$, $\overline{TFPQ_s}$, and $\overline{TFP_s}$. For robustness checks, section V examines whether the results are sensitive to the values of σ, α_s, and the threshold level of trimming.

IV. Results

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

This section addresses the first question of the paper: 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 the PRC, India, Japan, Thailand, and the US. 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 the PRC, India, and the US are from Hsieh and Klenow (2009); for Japan, from Hosono and Takizawa (2013); and for Thailand, from Dheera–Aumpon (2014).

These tables indicate that the standard deviation of TFPR for Viet Nam is 0.79, which is comparable to the standard deviations for the PRC (0.68), India (0.68),

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[18]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 Revenue-Based Total Factor Productivity**

	Viet Nam 2000–2009	Thailand 2006	People's Republic of China 1998–2005	India 1987–1994	Japan 1981–2008	United States 1977–1997
SD	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

GDP = gross domestic product, SD = standard deviation, TFPR = revenue-based total factor productivity.
Notes: Data for Thailand are from Dheera–Aumpon (2014, Table 3). Data for the People's Republic of China are arithmetic averages from Hsieh and Klenow (2009, Table 2). Data for Japan are from Hosono and Takizawa (2013). TFPR is calculated from equation (5) and then scaled by the geometric mean of TFPR across all firms in an industry *s*. Industries are weighted by value-added shares. GDP per capita is the annual average over each sample period in constant 2005 US dollars.
Sources: Hsieh, C.-T., and P. J. Klenow. 2009. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics* 124 (4): 1403–48; Hosono, K., and M. Takizawa. 2013. Misallocation and the Dynamics of Establishment. *Financial Review* 112 (1): 180–209 (in Japanese); Dheera–Aumpon, S. 2014. Misallocation and Manufacturing TFP in Thailand. *Asia-Pacific Economic Literature* 28 (2): 63–76; and authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5; per capita GDP data obtained from World Bank. 2014. *World Development Indicators*. Washington, DC.

Table 2. **Dispersion of Quantity-Based Total Factor Productivity**

	Viet Nam 2000–2009	Thailand 2006	People's Republic of China 1998–2005	India 1987–1994	Japan 1981–2008	United States 1977–1997
SD	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

SD = standard deviation, TFPQ = quantity-based total factor productivity.
Notes: Data for Thailand are from Dheera–Aumpon (2014, Table 2). Data for the People's Republic of China, India, and the United States are arithmetic averages from Hsieh and Klenow (2009, Table 1). Data for Japan are from Hosono and Takizawa (2013). TFPQ is calculated from equation (19) and then scaled by the geometric mean of TFPQ across all firms in an industry *s*. Industries are weighted by value-added shares.
Sources: Hsieh, C.-T., and P. J. Klenow. 2009. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics* 124 (4): 1403–48; Hosono, K., and M. Takizawa. 2013. Misallocation and the Dynamics of Establishment. *Financial Review* 112 (1): 180–209 (in Japanese); Dheera–Aumpon, S. 2014. Misallocation and Manufacturing TFP in Thailand. *Asia-Pacific Economic Literature* 28 (2): 63–76; and authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

and Thailand (0.85), and is larger than the standard deviations for Japan (0.55) and the US (0.45). Similar patterns were also confirmed for the differences between the 75th and 25th percentiles, and between the 90th and 10th percentiles.[20] Although more careful examination is needed in the form of a direct comparison, the results

[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, which corresponds to a TFP ratio of $e^{2.00} = 7.39$. These figures are much larger than those for the US. For more details, see Syverson (2011).

suggest that distortions in developing economies, including Viet Nam, tend to be large relative to those in developed economies.

B.   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 labor and capital are equalized 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

$$
\frac{Y}{Y^*} \stackrel{\Delta}{=} \prod_{s=1}^{S} \left(\frac{Y_s}{Y_s^*} \right)^{\theta_s} = \prod_{s=1}^{S} \left(\frac{TFP_s}{\overline{TFPQ_s}} \right)^{\theta_s}
$$

$$
= \prod_{s=1}^{S} \left\{ \frac{1}{\overline{TFPQ_s}} \left[\sum_{i=1}^{M_s} \left(TFPQ_{si} \frac{\overline{TFPR_s}}{TFPR_{si}} \right)^{\sigma-1} \right]^{\frac{1}{\sigma-1}} \right\}^{\theta_s}
$$

$$
= \prod_{s=1}^{S} \left[\sum_{i=1}^{M_s} \left(\frac{A_{si}}{\overline{A}_s} \frac{\overline{TFPR_s}}{TFPR_{si}} \right)^{\sigma-1} \right]^{\frac{\theta_s}{\sigma-1}} \tag{20}
$$

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 ($Y_s/Y_s^* = TFP_s/\overline{TFPQ_s}$) 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 equalizing TFPR across firms within each industry. The gains are measured relative to the TFP gains in the US in 1997.[21] To report TFP percentage gains in Viet Nam relative to those in the US, we take the ratio of Y^*/Y to the US equivalent in 1997, subtract 1, and multiply by 100. If Viet Nam hypothetically moves to "US efficiency," substantial gains (30.7%) are expected. The gains are smaller than those for the PRC (39.2%), India (46.9%), and Thailand (73.4%), but larger than those for Japan (3%).

One may be concerned that the dispersion of TFPR is larger (Table 1), while the gains are smaller in Viet Nam than in either the PRC or India (Table 3). Noting that the gains are computed from the inverse of equation (20), ($Y^*/Y - 1) \times 100$),

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

Table 3. **Total Factor Productivity Gains from Equalizing Revenue-Based Total Factor Productivity Relative to 1997 Gains in the United States**

	Viet Nam 2000–2009	Thailand 2006	People's Republic of 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 the People's Republic of China, India, and the United States are arithmetic averages from Hsieh and Klenow (2009, Table 6). The data for Japan are calculated from Hosono and Takizawa (2013, Table 2).
Sources: Hsieh, C.-T., and P. J. Klenow. 2009. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics* 124 (4): 1403–48; Hosono, K., and M. Takizawa. 2013. Misallocation and the Dynamics of Establishment. *Financial Review* 112 (1): 180–209 (in Japanese); Dheera–Aumpon, S. 2014. Misallocation and Manufacturing TFP in Thailand. *Asia-Pacific Economic Literature* 28 (2): 63–76; and authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

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 either the PRC or India. Similarly, we find large TFP gains for Thailand, 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.

### C. 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 economies 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 increasing as firm size increases. Noting that TFPR is proportional to the distortions (equation 14), this result implies that smaller firms tend to face advantageous distortions, while larger firms tend to face disadvantageous ones. This result is similar to that found for India (Hsieh and Klenow 2009, Figure 6) and for the US 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).

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[22] 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 large TFP gains are expected in Thailand.

Figure 1. **Revenue-Based Total Factor Productivity and Size**
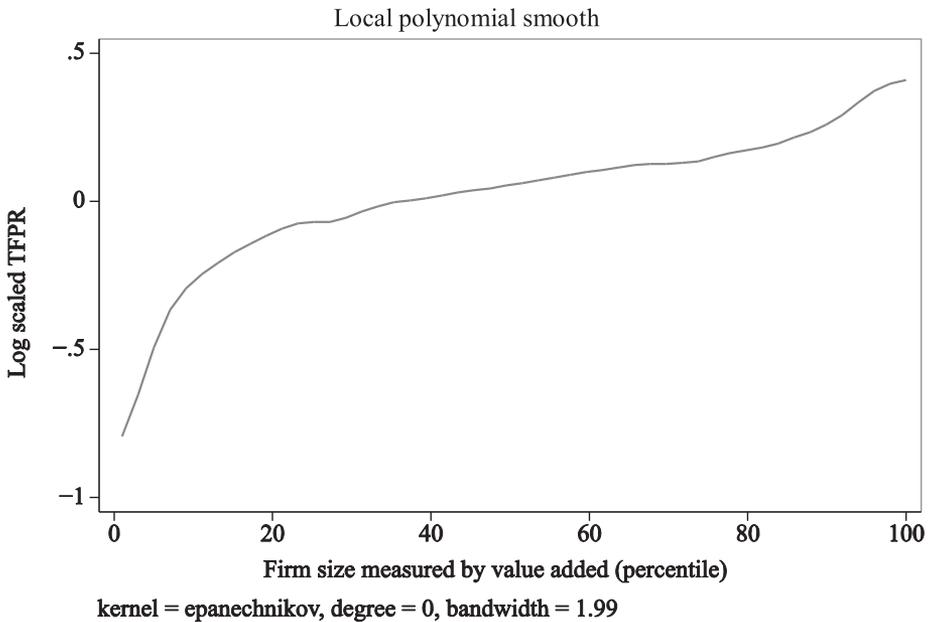
Local polynomial smooth

kernel = epanechnikov, degree = 0, bandwidth = 1.99
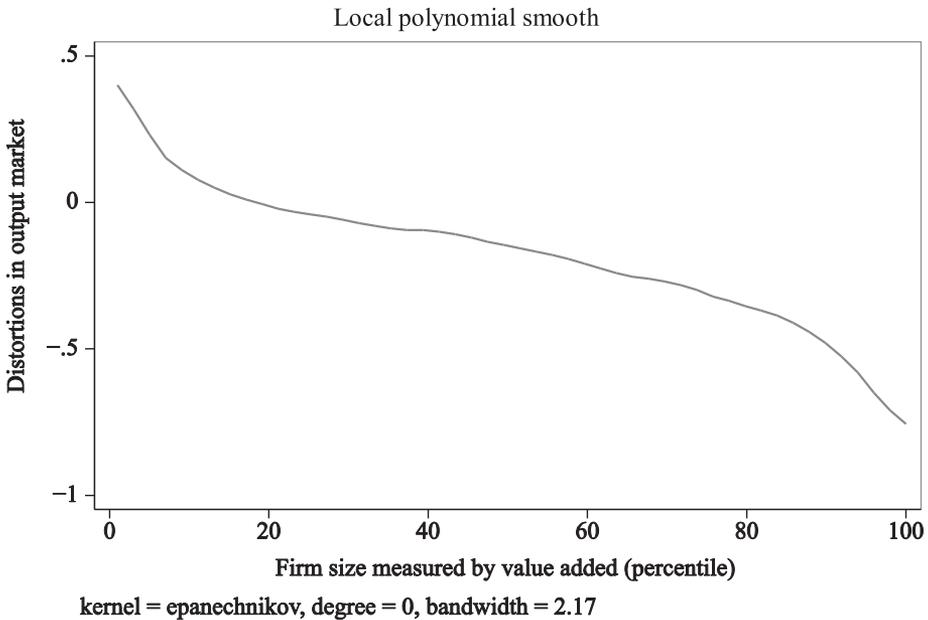
TFPR = revenue-based total factor productivity.
Note: This figure presents the relationship between scaled TFPR relative to a given industry and size percentile as measured by value added.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

Figure 2 indicates that the distortions in output markets decrease as firm size increases. 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, while larger firms tend to face disadvantageous ones.

Figure 3 presents the relationship between the distortions in capital markets and firm size. In contrast to the distortions in output markets, Figure 3 shows 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, while large firms can diversify their capital procurement.

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 findings of Midrigan and Xu (2014), who showed that financial frictions, measured by borrowing constraints, had relatively small impacts on productivity.

Figure 2. **Distortions in Output Markets and Size**

Local polynomial smooth

kernel = epanechnikov, degree = 0, bandwidth = 2.17

Note: This figure presents the relationship between scaled $1 - \tau_Y$ relative to a given industry and size percentile as measured by value added.
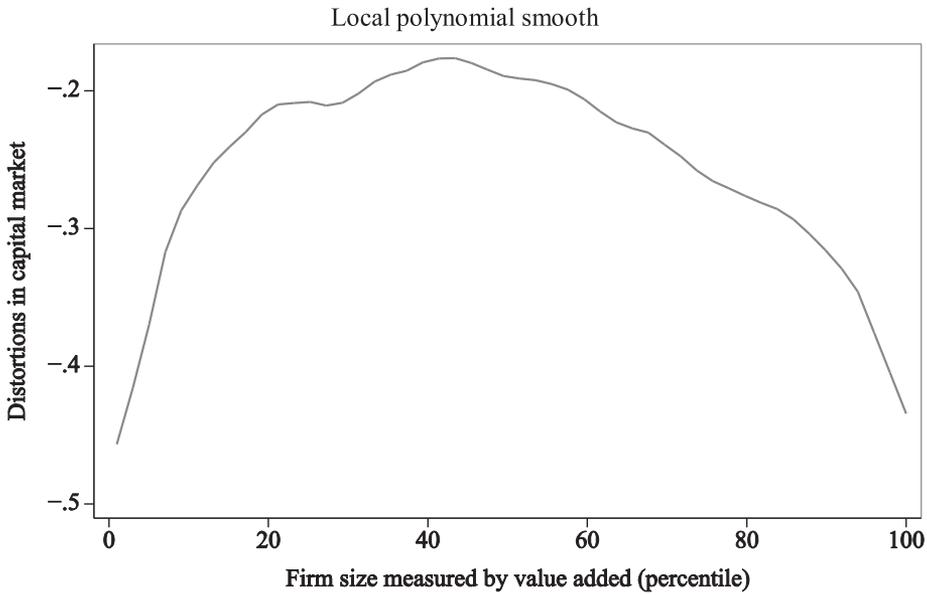Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

One may be concerned that our measurement of firm size, following Hsieh and Klenow (2009), is based on value added rather than employment. In many economies, SMEs are defined by the number of employees rather than by the size of their value added. To address this concern, we examine the relationship between distortions and firm size as measured by employment. The results are presented in Figures 4, 5, and 6. The results are different from—but qualitatively similar to—those when firm size is measured by value added: as firm size (in terms of employment) increases, TFPR is increasing, the distortions in output markets are decreasing, and the distortions in capital markets show an inverse U-shaped relationship except for the top quintile of firms. 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.

D.   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

Figure 3. **Distortions in Capital Markets and Size**

Local polynomial smooth

kernel = epanechnikov, degree = 0, bandwidth = 2.51

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 Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

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

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

Figure 4. **Revenue-Based Total Factor Productivity and Employment Size**

Local polynomial smooth
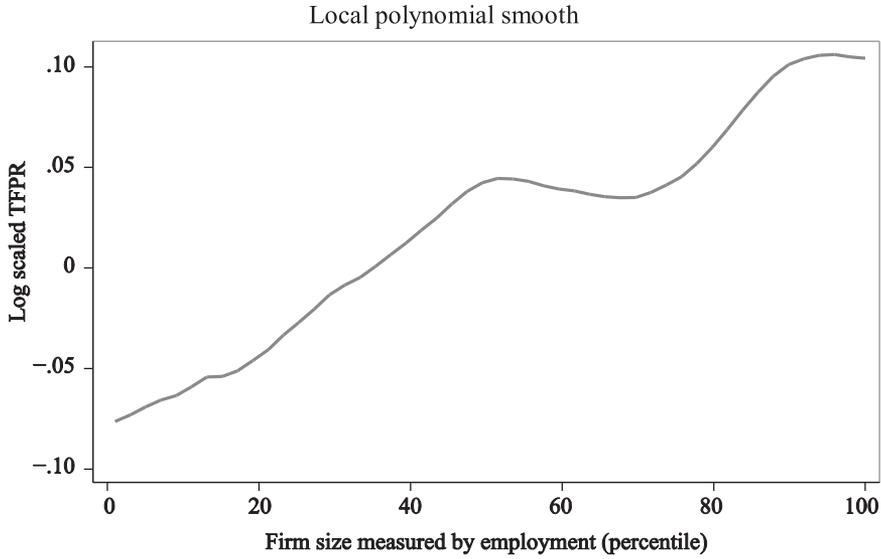
kernel = epanechnikov, degree = 0, bandwidth = 2.51

TFPR = revenue-based total factor productivity.
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 Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

efficient size. Both cases result in smaller size dispersion. This 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

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

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

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

Figure 5. **Distortions in Output Markets and Employment Size**

Local polynomial smooth
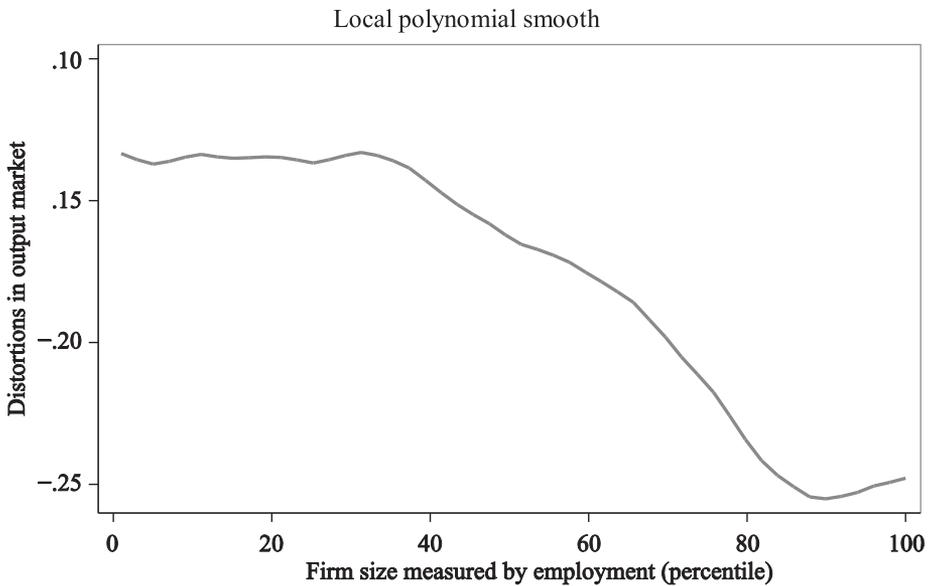
kernel = epanechnikov, degree = 0, bandwidth = 4.54

Note: This figure presents the relationship between scaled $1 + \tau_Y$ relative to a given industry and size percentile as measured by employment.
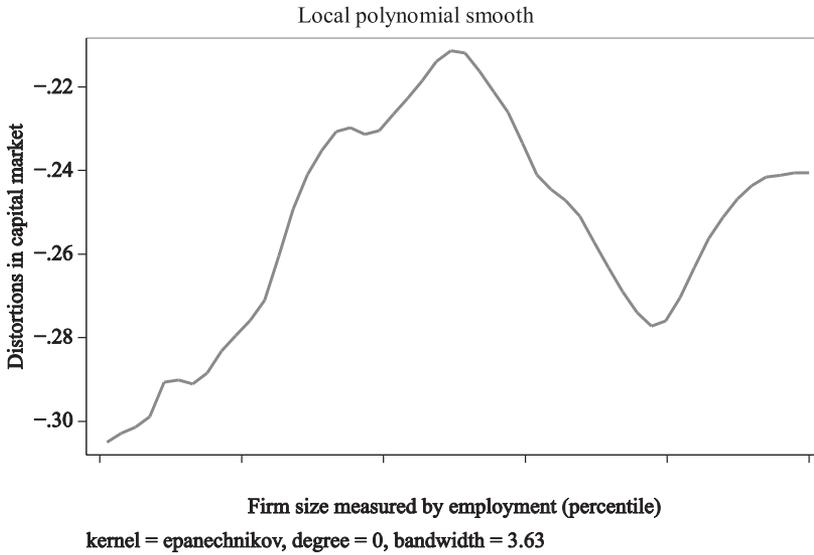Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

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%; the rows and columns together sum to 100%.

Examining Table 4, we highlight two results. First, although average output rises substantially (as we confirmed in section IV), many firms of all sizes would shrink without distortions. Second, the largest quartile indicates the largest expansion among all firm sizes (8.7%). This result means that large firms are less likely to shrink and more likely to expand. This finding is also confirmed by Figure 7.

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 largest and most efficient producers and coddle its smallest and least efficient ones. Indeed, Vietnamese SMEs are supported by various policies such as government-supported financing (Tran, Le, and Nguyen 2008, pp. 347–59).

Figure 6. **Distortions in Capital Markets and Employment Size**

Local polynomial smooth

kernel = epanechnikov, degree = 0, bandwidth = 3.63

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 Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

Table 4. **Actual Size versus Efficient Size**

| 2000–2009 (average)	Efficient firm size relative to actual firm size				Total
	0%–50%	**50%–100%**	**100%–200%**	**200%+**	**Total**
Actual firm size					
Top quartile	5.1	5.5	5.7	8.7	25.0
Second quartile	8.0	5.6	4.6	6.8	25.0
Third 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 Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

These results for Viet Nam are similar to those of the PRC, India, and the US in Hsieh and Klenow (2009).[24]

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[24]The Government of Viet Nam has launched various schemes to improve the performance of SMEs, including credit funds and worker trainings (Tran, Le, and Nguyen 2008, pp. 347–59). 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 firms are eligible for support or have received any form of support. It is thus difficult for us to conduct an analysis similar to that of Hsieh and Klenow (2009).

Figure 7. **Distribution of Firm Size**
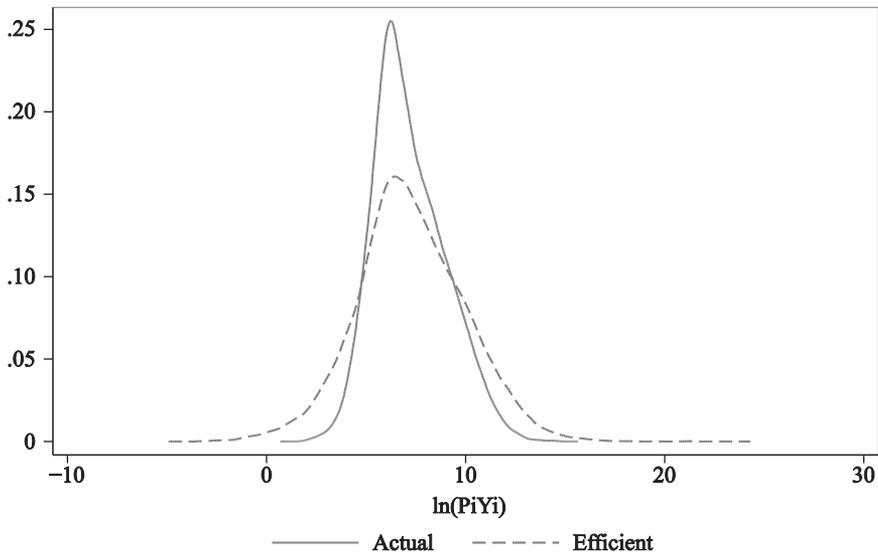
Note: The solid line indicates the actual size distribution, while the dashed line indicates the efficient size distribution.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

E.   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. Because it is tedious to examine all the results, this section examines (i) how sensitive the estimated TFPR and TFP gains (reported in section IV 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 US) because we only change the parameter values in Viet Nam (not in the US).

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% when $\sigma = 2$ and 161.9% when $\sigma = 6$, while the baseline TFP gains are 86.8%.[25]

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

Table 5. Robustness Check: Total Factor Productivity Gains from Equalizing Revenue-Based Total Factor Productivity Relative to 1997 Gains in the United States

	(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

SD = standard deviation, TFP = total factor productivity, TFPR = revenue-based total factor productivity.
Note: The baseline is obtained from Table 3.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid =479&idmid=5

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).

We also examine the sensitivity of the results to the value of the technology parameter (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% when $\alpha_s = 1/3$ and 68% 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%. 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% from the tails (below the second percentile and above the 98th percentile), instead of 1% 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%. 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).

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

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

We also estimate the TFP gains for firms that survived throughout the sample period (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 ($N = 10,186$). Nonetheless, the estimated TFP gains are large and the correlation with baseline TFP is high: 64.5% 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 of TFP gains come from the incumbent firms, while the rest of the gains come from firms entering and exiting the market. 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 employ different sample selection criteria: the potential TFP gains from removing distortions in Vietnamese manufacturing are large.

V. 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 the PRC, India, and Thailand. This result is consistent with the common knowledge that resources in developing economies are not efficiently allocated.

Second, there would be substantial improvement in TFP if no distortions existed. If Viet Nam hypothetically moved to "US efficiency," its TFP would be boosted by 30.7%. Third, smaller firms tend to face advantageous distortions, while 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 smallest and least efficient ones.

These findings have policy implications. The first finding suggests that, similar to other developing economies, resource misallocation caused by the distortions seems to be an important issue in Viet Nam. The second finding states that the potential productivity gains from removing distortions in Vietnamese manufacturing are large. The result implies that reallocation would lead to productivity gains that can accelerate potential growth through improved interfirm resource allocation. The last two findings together imply that Viet Nam's policies, as stated earlier, may constrain its largest and most efficient producers and coddle its smallest and least efficient ones. This suggests that policy makers need to focus

more attention on the allocation of resources. An important question, therefore, is whether or not resources are being allocated to productive firms.

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Appendix. Derivation of Equation (24)

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

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

Efficient firm size is obtained when τ_{Ksi} and τ_{Ysi} are equalized 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

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