Misallocation in Vietnam: A Structural Analysis Across Industries and Ownership Structures

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Abstract

In this paper, I use a comprehensive firm-level dataset and develop a structural general equilibrium model featuring three layers of economic organization: firms, ownership structures (state-owned, non-state, and foreign-invested), and industries to quantify resource misallocation in Vietnam over the 2011-2020 period. I also decompose the effect of distortions in each structural layer to aggregate productivity. The findings reveal significant allocative inefficiencies within the Vietnamese economy, that intensify over time. Distortions in the capital market have a weaker impact on aggregate productivity than those in the labor market—a pattern that persists across various aggregation levels. Counterfactual exercises show that distortions among firms within industry-ownership groups and across industries are the primary drivers of inefficiency. In contrast, distortions across ownership structures within industries have a minor effect on aggregate productivity and exhibit a modest declining trend, largely due to reductions in labor distortions.

JEL classification: O11, O53, D24.

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1 Introduction

Differences in living standards across countries have long been a major concern in macroeconomics. Over the past few decades, significant progress has been made in understanding the factors driving these cross-country disparities. Earlier studies by Klenow and Rodriguez-Clare (1997), Prescott (1998), and Hall and Jones (1999), have indicated that a substantial portion of the variation in income per capita can be explained by differences in Total Factor Productivity (TFP) between economies. Further investigations into the sources of TFP disparities, notably by Restuccia and Rogerson (2008) and Hsieh and Klenow (2009) have emphasized that allocative inefficiency across producers is a key factor contributing to lower TFP in developing countries compared to developed ones.

In this paper, I exploit a rich firm-level dataset and develop a static general equilibrium model to assess the extent of allocative inefficiency in Vietnam over the period 2011 to 2020. The Vietnamese economy represents an interesting case due to its remarkable growth following the reforms in the late 1980s, yet it still faces a substantial gap in living standards compared to developed countries. Between 1990 and 2020, Vietnam achieved an impressive annual average GDP per capita growth rate of approximately 5.4%. Despite this robust growth, Vietnam remains classified as a lower-middle-income country, with a GDP per capita of $3.6 thousand in 2020, about one-twentieth that of the United States.[1] This study investigates the role of resource allocation efficiency and its evolution in shaping the aggregate productivity of the Vietnamese economy.

Following the economic reforms in the late 1980s, the Vietnamese government began allowing the establishment of diverse ownership structures alongside state-owned enterprises (SOEs), including private firms and foreign-invested enterprises. To promote market liberalization and prevent discrimination between SOEs and other ownership types, the government simultaneously reduced the number of SOEs, encouraged the development of private firms, and welcomed foreign-invested enterprises. Consequently, over the past few decades, the economy has witnessed a gradual decline in the number of SOEs,

[1] Calculation based on the data available at: https://databank.worldbank.org/source/world-development-indicators

accompanied by a significant increase in other ownership types. However, despite this transition to a more liberal economic framework, remnants of the pre-reform centralized economy persist, with SOEs maintaining certain privileges over other firms. For example, SOEs have preferential access to substantial investment sources, including the State budget and the official development assistance (ODA). Additionally, the dominance of state-owned banks (where the State holds controlling shares) in the financial market may afford SOEs advantages in accessing credit over other firms. Given this context, this study also investigates the effects of distortions between ownership structures on the economy. Further details regarding the landscape of firm ownership in Vietnam are provided in the next section.

To quantitatively evaluate the extent of misallocation in Vietnam, I develop a theoretical framework based on a three-layer static general equilibrium model. These three layers comprise firms, ownership structures, and industries. Assuming aggregate production inputs are fixed, the model allows for the identification of the optimal resource allocation within the economy. The difference between actual aggregate productivity and the optimal productivity suggested by the theoretical framework is used to measure the cost of misallocation. Moreover, by incorporating the three structural layers, the model enables counterfactual experiments to decompose the contributions of distortions across firms, ownership structures, and industries to the overall degree of misallocation.

Several key findings emerged from this study. Firstly, Vietnam faced substantial challenges in efficiently allocating resources, a problem that became more pronounced during the 2011–2020 period. My theoretical framework suggested that under optimal resource allocation, aggregate TFP in Vietnam would have been 3.01 times higher in 2011, 3.35 times higher in 2016, and 3.74 times higher in 2020. In terms of factor-specific distortions, misallocation in the capital market had a weaker impact on aggregate productivity than distortions in the labor market. This pattern was consistently observed across different aggregation levels. Furthermore, among the three structural layers, misallocation between firms within industry–ownership groups and misallocation between industries were the main sources of inefficiency. In contrast, distortions between ownership structures

within industries played only a minor role, and their contribution to overall misallocation declined over time. This decline was driven by reductions in labor market distortions, whereas capital misallocation slightly increased over the same period.

This study is part of the broader literature on misallocation, which encompasses various dimensions such as industries, regions, ownership structures, and input market distortions. Among recent research, Adamopoulos, Brandt, et al. (2022), Chen, Restuccia, et al. (2022), Adamopoulos and Restuccia (2020), and Adamopoulos and Restuccia (2014) have investigated the frictions affecting aggregate agricultural TFP, while Cirera et al. (2020), Bento and Restuccia (2017), Hsieh and Klenow (2014) have focused on misallocation in manufacturing industries. Regarding production input distortions, Chen, Habib, et al. (2023), David and Venkateswaran (2019), and Midrigan and Xu (2014) have analyzed financial frictions in the capital market. Meanwhile, Alpysbayeva and Vanormelingen (2022), Ngai et al. (2019), and Tombe and Zhu (2019) examine the effect the labor market distortions on aggregate TFP. In another dimension, several researchers, including Bussolo et al. (2019), Brandt, Jiang, et al. (2022), Hsieh and Song (2015) and Brandt, Tombe, et al. (2013) have investigated the effect of distortions between ownership types on the economy.[2]

In the context of Vietnam, with a focus on agriculture, Ayerst et al. (2020) studied input market constraints and found substantial misallocation across farms, which increased during the 2006-2016 period. On another aspect, K. Le (2020) investigated the impact of the Rice Land Designation Policy and found that removing the land use restrictions could increase agricultural productivity by approximately 40%. In the manufacturing sector, Doan and Kiyota (2015), P. T. T. Nguyen and M. K. Nguyen (2020) examined misallocation across manufacturing firms, indicating significant improvements in aggregate manufacturing TFP associated with the absence of distortions. Furthermore, Zhou (2015), Bach (2019), and P. Le (2022) explored the connection between misallocation and firm ownership policy in Vietnam. Zhou (2015) developed a firm dynamic model with collateral constraints, following the approach of Midrigan and Xu (2014), indicating

[2]See Restuccia and Rogerson (2013), Hopenhayn (2014), and Restuccia and Rogerson (2017) for a more comprehensive review of literature on misallocation

that private firms experience more severe financial barriers compared to SOEs, and that, conditional on a level of financial development, the extent of misallocation tends to rise as the financial constraints diverge between these two types of ownership. Meanwhile, Bach (2019) applied the methodology of Hsieh and Klenow (2009) and found that reallocating resources efficiently in the manufacturing sector could boost output growth between 142% to 226% over the 2000-2008 period. The author also noted that the marginal effect of credit attainment on capital distortion significantly differs across ownership types. More recently, P. Le (2022) developed the model based on the work of David and Venkateswaran (2019) to quantify the effect of ownership policy on misallocation, finding that removing distortions could increase aggregate manufacturing TFP by 110%. Additionally, among adjustment cost, uncertainty, and policy distortion, the last factor accounts for over 80% of capital misallocation. D. Nguyen (2025) investigated the reforms in increasing openness to foreign firms and indicated that reducing distortions toward foreign firms can lead to a growth in aggregate productivity of 40%.

This paper differs from prior research on misallocation in Vietnam by focusing on a measurement of overall allocative inefficiency across the entire economy rather than being limited to specific economic areas or industries. This study is related in context to the work of Brandt, Tombe, et al. (2013), who examined market distortions across regions and ownership sectors in China using sector-level data. However, in this paper, I leverage a more detailed micro dataset at the firm level to investigate more deeply structural distortions at different aggregation levels. Additionally, my three-layer model enables the decomposition of contributions of distortions between industries, among ownership structures, and across firms to the overall extent of misallocation through counterfactual experiments. In summary, this study contributes to the existing literature in two ways. First, I provide a comprehensive diagnostic analysis of misallocation within the entire economy of Vietnam rather than focusing on specific industries or economic sectors. Second, I develop a three-structural-layer framework to further investigate and quantify the contribution of each layer to the overall level of misallocation in Vietnam.

The rest of this paper proceeds as follows. The next section provides a brief back-

ground on the context of firm ownership in Vietnam. Section 3 introduces a theoretical framework for measuring misallocation and Section 4 describes the data used in the analysis. Subsequently, Section 5 discusses the main findings and the counterfactual experimental results. Finally, Section 6 concludes the paper. The algebraic derivations for equations presented in this paper are provided in Appendix A.

2 Firm Ownership Structure in Vietnam

The landscape of firm ownership in Vietnam has undergone a transformative journey reflecting the economy's evolution and liberalization. Before the economic reforms of the late 1980s, the country operated under a centralized economy characterized by a single form of firm ownership: state-owned enterprises (SOEs). These government-managed enterprises held a dominant position in the economy. In 1986, Vietnam initiated an economic transformation by shifting from a centrally planned economy to a market-oriented socialist system. These reforms marked a watershed moment in the economy's structure by allowing the establishment of private enterprises. Subsequently, in 1988, Vietnam took another major step toward economic liberalization by welcoming foreign investment. This move facilitated the attraction of foreign capital, leading to diversification in firm ownership through the emergence of foreign-invested firms. Today, the Vietnamese government recognizes three primary ownership categories: state-owned enterprises, where the State either fully owns or holds dominant shares in firms; foreign-invested firms (FDIs), which receive capital from abroad; and non-state firms, encompassing other domestic private enterprises.

Following the economic reforms, the government maintained its recognition of SOEs as a pivotal force in the economy while simultaneously encouraging the development of private firms, fostering a more diverse business environment. To further enhance market liberalization and prevent discrimination between SOEs and other ownership types, the government initiated the equitization of SOEs. This process began with experiments equitizing small SOEs in 1992 by transforming them into joint-stock companies and sell-

ing the firms' shares to public investors. Subsequently, the government mandated the equitization of SOEs in non-strategic industries in 1998. This equitization process has continued to the present day. Moreover, in alignment with globalization trends, Vietnam embarked on a journey to attract foreign investment, particularly after joining the World Trade Organization (WTO) in 2007. As a result of these dynamic changes, the number of SOEs has gradually decreased, while there has been a sharp increase in the prevalence of other ownership types.

Figure 1 displays the distribution of firms, capital, labor, and revenue across ownership structures in 2020. Notably, the non-state enterprises emerge as the dominant group in terms of firm population, whereas the other types represent small shares, specifically, less than 3% for foreign-invested firms and less than 0.5% for state-owned firms. It is noteworthy that, compared to their modest share of firms, the state-owned firms command a substantial share of capital, while the FDI firms account for a significant portion of the labor force. One possible explanation for this observation is the preferential access of SOEs to major sources of investment, such as the state budget and ODA, and advantages in the financial market dominated by the state-owned banks. Meanwhile, foreign-invested firms may leverage the low labor costs in the local market.

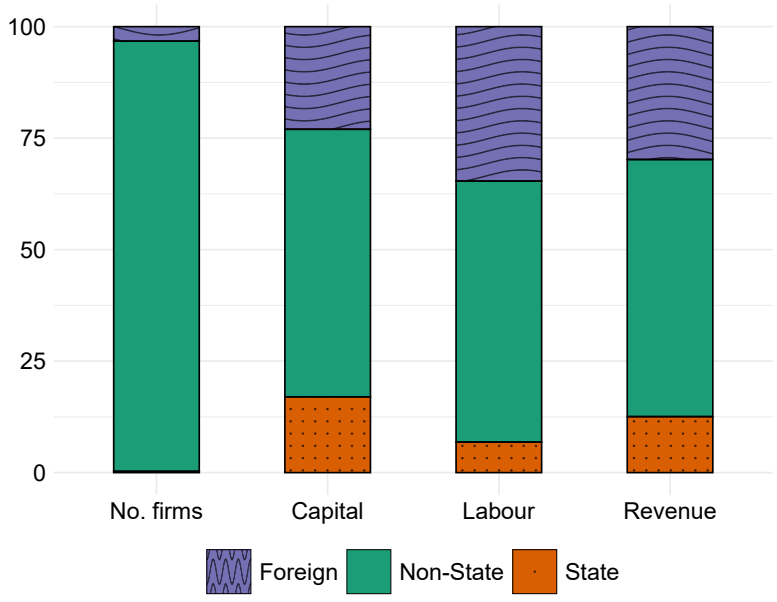


Figure 1: Shares by ownership structures

Additionally, considering the efficiency of production factor utilization, Figure 2 il-

lustrates the average revenue per unit of input across ownership structures. Among the three ownership types, on average, SOEs have the lowest revenue per unit of capital while FDI firms exhibit the smallest revenue per worker. Figures 1 and 2 together suggest a potential source of misallocation across ownership structures, where a small proportion of the firm population occupies a high share of inputs but does not utilize them effectively. Despite these observations, the following analysis will quantify and indicate that misallocation across ownership structures contributes only a minor part to the overall extent of misallocation in Vietnam. The primary drivers are distortions across firms and industries.

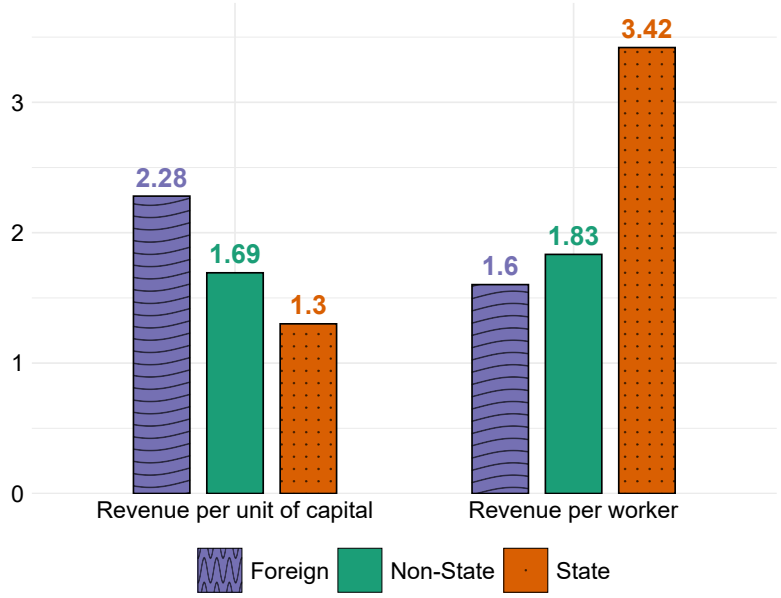


Figure 2: Average revenue per unit of input factor

3 Framework for Quantifying Misallocation

In this study, I construct a three-layer static general equilibrium model to capture the allocation of resources across industries, ownership structures and firms. I consider an economy comprised of a set of m industries, indexed by i. Within each industry, there are three distinct ownership types, indexed by s, namely state-owned, non-State and foreign-invested. Each industry-ownership group is formulized by firms, indexed by j, which produce differentiated products. The following assumptions are proposed:

Firstly, firms operate under a constant return to scale Cobb-Douglas production function with identical input elasticities.[3]

$$Y_{isj} = A_{isj} K_{isj}^{\alpha} L_{isj}^{1-\alpha} \tag{A.1}$$

where $\alpha \in (0, 1)$ and Y_{isj}, A_{isj}, K_{isj}, and L_{isj} denote output, TFP, capital and labor, respectively, for firm j with ownership type s in industry i.

Secondly, the production function for each industry-ownership group is specified as a constant elasticity of substitution (CES) aggregation of the outputs produced by firms within the group:

$$Y_{is} = \left(\sum_{j} Y_{isj}^{1-\phi} \right)^{\frac{1}{1-\phi}} \tag{A.2}$$

where $\frac{1}{\phi}$ is the elasticity of substitution between the differentiated products of firms within the group, Y_{isj}.

Additionally, it is worth noting that to avoid all resources being allocated to the most productive establishment, I also assume that products are imperfect substitutes across firms within each industry-ownership group. In other words, the substitution parameter satisfies $\phi > 0$.

The output at the industry level is defined as:

$$Y_i = \prod_{s} Y_{is}^{\theta_{is}} \tag{A.3}$$

where θ_{is} denotes the output share of ownership group s in industry i, and $\sum_{s} \theta_{is} = 1$, $\forall i$.

The final aggregate output of the economy is constructed by combining industry

[3]The assumption of homogeneous input elasticities across firms is a simplification originally adopted to enable analytical tractability for efficient allocation. While the model can be extended to allow for heterogeneous factor elasticities across industries without losing closed-form solutions, such an extension requires consistent estimates of production elasticities across broad industry groups (at one-digit International Standard Industrial Code (ISIC) level). Further discussion on the parameter choice is presented in Section 5.1.

outputs through a Cobb-Douglas function:

$$Y = \prod_i Y_i^{\omega_i} \tag{A.4}$$

where ω_i represents the output share of industry i, and $\sum_i \omega_i = 1$.

Finally, the allocation of aggregate capital and labor across firms, ownership structures, and industries is described by the following constraints:

$$\sum_i \sum_s \sum_j K_{isj} = K; \quad K \text{ given} \tag{A.5}$$

$$\sum_i \sum_s \sum_j L_{isj} = L; \quad L \text{ given} \tag{A.6}$$

Holding the aggregate capital K and labor L fixed enables the model to investigate the efficiency of their allocation among industries, ownership structures, and firms independently of any changes in the total quantity of these inputs.

3.1 Efficient allocation

Efficient allocation corresponds to the solution of the following social planner's problem:

$$\max_{\{K_{isj}, L_{isj}\}} Y$$

subject to (A.1), (A.2), (A.3), (A.4), (A.5) and (A.6).

In other words, for a given amount of aggregate factors K and L, the efficient allocation is a set of factor allocations, $\{K^*_{isj}, L^*_{isj}\}_{i,s,j}$, such that:

i) $\sum_i \sum_s \sum_j K^*_{isj} = K$.

ii) $\sum_i \sum_s \sum_j L^*_{isj} = L$.

iii) The aggregate output Y is maximized.

The efficient allocation is characterized as:

$$X^*_{isj} = \underbrace{\left(\frac{A_{isj}^{\frac{1-\phi}{\phi}}}{\sum_j A_{isj}^{\frac{1-\phi}{\phi}}} \right)}_{\frac{X^*_{isj}}{X^*_{is}}} \underbrace{\theta_{is}}_{\frac{X^*_{is}}{X^*_i}} \underbrace{\omega_i}_{\frac{X^*_i}{X}} X \tag{SP-01}$$

where $X \in \{K, L\}$.

Under efficient allocation, the optimal TFPs at industry-ownership, industry, and aggregate levels are given by:

$$A^*_{is} = \left(\sum_j A_{isj}^{\frac{1-\phi}{\phi}} \right)^{\frac{\phi}{1-\phi}} \tag{SP-02}$$

$$A^*_i = \prod_s (\theta_{is} A^*_{is})^{\theta_{is}} \tag{SP-03}$$

$$A^* = \prod_i (\omega_i A^*_i)^{\omega_i} \tag{SP-04}$$

The associated outputs are given by:

$$Y^*_{isj} = A_{isj} {K^*_{isj}}^{\alpha} {L^*_{isj}}^{1-\alpha} \tag{SP-05}$$

$$Y^*_{is} = A^*_{is} {K^*_{is}}^{\alpha} {L^*_{is}}^{1-\alpha} \tag{SP-06}$$

$$Y^*_i = A^*_i K^{*\alpha}_i {L^*_i}^{1-\alpha} \tag{SP-07}$$

$$Y^* = A^* K^{\alpha} L^{1-\alpha} \tag{SP-08}$$

The analytical solution highlights a fundamental principle of efficient allocation: producers with higher productivity should be allocated greater shares of resources, ensuring optimal utilization of productive capacity.

All detailed algebraic derivations of the equations presented in this paper are provided in Appendix A.

3.2 Allocation in a competitive market with distortions

In the competitive market environment, I assume that firms face different capital and labor wedges. While there are other alternative ways to introduce distortions, this paper focuses on capital and labor wedges to investigate their respective contributions to overall misallocation.

3.2.1 The problem at the firm level

Firms maximize their profit by choosing the amount of capital and labor:

$$\begin{aligned} &\max_{\{K_{isj},L_{isj}\}} P_{isj}Y_{isj} - \tau_{K,isj}rK_{isj} - \tau_{L,isj}wL_{isj} \quad \text{subject to (A.1)} \\ \equiv &\max_{\{K_{isj},L_{isj}\}} P_{isj}A_{isj}K_{isj}^{\alpha}L_{isj}^{1-\alpha} - \tau_{K,isj}rK_{isj} - \tau_{L,isj}wL_{isj} \end{aligned}$$

Here, $\tau_{K,isj}$ and $\tau_{L,isj}$ represent capital and labor wedges respectively faced by firm j with ownership type s in industry i. For instance, a firm with credit restrictions would face higher τ_K than one with easy access to cheap capital, while firms receiving employment subsidies would exhibit a lower τ_L than those without such support. In the absence of distortions, $\tau_{K,isj} = \tau_{L,isj} = 1,\ \forall i, s, j$.

From the first-order conditions, the wedges satisfy:

$$\tau_{K,isj} = \left(\frac{\alpha}{r}\right)\left(\frac{P_{isj}Y_{isj}}{K_{isj}}\right) \tag{1}$$

$$\tau_{L,isj} = \left(\frac{1-\alpha}{w}\right)\left(\frac{P_{isj}Y_{isj}}{L_{isj}}\right) \tag{2}$$

3.2.2 The problem at the industry-ownership level

At the industry-ownership level, the profit maximization problem is:

$$\begin{aligned} &\max_{\{Y_{isj}\}} P_{is}Y_{is} - \sum_j P_{isj}Y_{isj} \quad \text{subject to (A.2)} \\ \equiv &\max_{\{Y_{isj}\}} P_{is}\left(\sum_j Y_{isj}^{1-\phi}\right)^{\frac{1}{1-\phi}} - \sum_j P_{isj}Y_{isj} \end{aligned}$$

The associated first-order conditions imply:

$$\frac{P_{isj}}{P_{is}} = \left(\frac{Y_{isj}}{Y_{is}}\right)^{-\phi}, \forall i, s, j \tag{3}$$

From equation (3) and assumption (A.2), it follows that:

$$P_{is} = \left(\sum_j P_{isj}^{\frac{\phi-1}{\phi}}\right)^{\frac{\phi}{\phi-1}} \tag{4}$$

3.2.3 The problem at the industry level

At the industry level, the profit maximization problem is:

$$\begin{aligned} &\max_{\{Y_{is}\}} P_i Y_i - \sum_s P_{is} Y_{is} \quad \text{subject to (A.3)} \\ \equiv &\max_{\{Y_{is}\}} P_i \left(\prod_s Y_{is}^{\theta_{is}}\right) - \sum_s P_{is} Y_{is} \end{aligned}$$

The first-order conditions imply

$$\frac{P_{is}}{P_i} = \theta_{is} \left(\frac{Y_{is}}{Y_i}\right)^{-1} \tag{5}$$

From equation (5) and assumption (A.3), it follows that:

$$P_i = \prod_s \left(\frac{P_{is}}{\theta_{is}}\right)^{\theta_{is}} \tag{6}$$

3.2.4 The problem at the economy-wide level

At the economy-wide level, the final good producer's profit maximization problem is:

$$\begin{aligned} &\max_{\{Y_i\}} PY - \sum_i P_i Y_i \quad \text{subject to (A.4)} \\ \equiv &\max_{\{Y_i\}} P \left(\prod_i Y_i^{\omega_i}\right) - \sum_i P_i Y_i \end{aligned}$$

The first-order conditions imply:

$$\frac{P_i}{P} = \omega_i \left(\frac{Y_i}{Y} \right)^{-1} \tag{7}$$

Similarly, from equation (7) and assumption (A.4), it follows that:

$$P = \prod_i \left(\frac{P_i}{\omega_i} \right)^{\omega_i} \tag{8}$$

It is important to note that at all aggregation levels, this model does not incorporate output wedges across firms within each industry-ownership group, among ownership types within industries, or across industries in the economy. This assumption stems from the lack of observed price data, which are necessary for identification of such wedges. Nevertheless, distortions remain present at each aggregation level through firm-specific wedges in capital and labor inputs.

3.2.5 Competitive equilibrium

Definition:

For given sets of wedges $\{\tau_{K,isj}, \tau_{L,isj}\}_{i,s,j}$ and firms' productivities $\{A_{isj}\}_{i,s,j}$ the competitive equilibrium consists of sets of prices $\{P_{isj}, P_{is}, P_i, P\}_{i,s,j}$, outputs $\{Y_{isj}, Y_{is}, Y_i, Y\}_{i,s,j}$, and factor allocations $\{K_{isj}, L_{isj}\}_{i,s,j}$ such that assumptions (A.1) to (A.6) and equations (1) to (8) hold. Here, the sets of prices and outputs correspond, respectively, to the firm level, industry-ownership level, industry level, and aggregate economy-wide level.

Competitive equilibrium characterization:

The competitive equilibrium allocation is characterized as:

$$X_{isj} = \underbrace{\left(\frac{\overline{A_{isj}}^{\frac{1-\phi}{\phi}} \tau_{X,isj}^{-1}}{\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}} \tau_{X,isj}^{-1}} \right)}_{\frac{X_{isj}}{X_{is}}} \underbrace{\left(\frac{\theta_{is} \tau_{X,is}^{-1}}{\sum_s \theta_{is} \tau_{X,is}^{-1}} \right)}_{\frac{X_{is}}{X_i}} \underbrace{\left(\frac{\omega_i \tau_{X,i}^{-1}}{\sum_i \omega_i \tau_{X,i}^{-1}} \right)}_{\frac{X_i}{X}} X \tag{CE-01}$$

where $X \in \{K, L\}$ and the distorted TFPs and wedges at different aggregation levels

are defined as:

$$\overline{A_{isj}} \equiv \frac{A_{isj}}{\tau_{K,isj}^{\alpha}\tau_{L,isj}^{1-\alpha}} \qquad \text{(CE-02)}$$

$$\overline{A_{is}} \equiv \left(\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}}\right)^{\frac{\phi}{1-\phi}} \qquad \text{(CE-03)}; \quad \tau_{X,is} \equiv \frac{\overline{A_{is}}^{\frac{1-\phi}{\phi}}}{\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}}\tau_{X,isj}^{-1}} \qquad \text{(CE-04)}$$

$$\overline{A_i} \equiv \prod_s \left(\theta_{is}\overline{A_{is}}\right)^{\theta_{is}} \qquad \text{(CE-05)}; \quad \tau_{X,i} \equiv \frac{1}{\sum_s \theta_{is}\tau_{X,is}^{-1}} \qquad \text{(CE-06)}$$

$$\overline{A} \equiv \prod_i \left(\omega_i\overline{A_i}\right)^{\omega_i} \qquad \text{(CE-07)}; \quad \tau_X \equiv \frac{1}{\sum_i \omega_i\tau_{X,i}^{-1}} \qquad \text{(CE-08)}$$

Consistent with the note in the previous section, although the model does not explicitly introduce output wedges at any aggregation levels, distortion at each level (i.e., $\tau_{X,is}$, $\tau_{X,i}$, and τ_X) still arise through the firm-specific wedges, $\tau_{X,isj}$.

At the equilibrium, output at each aggregation level is given by:

$$Y_{isj} = \underbrace{\overline{A_{isj}}\tau_{K,isj}^{\alpha}\tau_{L,isj}^{1-\alpha}}_{A_{isj}} K_{isj}^{\alpha}L_{isj}^{1-\alpha} \qquad \text{(CE-09)}$$

$$Y_{is} = \underbrace{\overline{A_{is}}\tau_{K,is}^{\alpha}\tau_{L,is}^{1-\alpha}}_{A_{is}} K_{is}^{\alpha}L_{is}^{1-\alpha} \qquad \text{(CE-10)}$$

$$Y_{i} = \underbrace{\overline{A_{i}}\tau_{K,i}^{\alpha}\tau_{L,i}^{1-\alpha}}_{A_{i}} K_{i}^{\alpha}L_{i}^{1-\alpha} \qquad \text{(CE-11)}$$

$$Y = \underbrace{\overline{A}\tau_{K}^{\alpha}\tau_{L}^{1-\alpha}}_{A} K^{\alpha}L^{1-\alpha} \qquad \text{(CE-12)}$$

In summary, these characterizations reveal several key points. Firstly, the competitive equilibrium allocations depend not only on firms' TFPs but also on capital and labor wedges. Without distortions ($\tau_{K,isj} = \tau_{L,isj} = 1,\ \forall i, s, j$) the competitive equilibrium allocations coincide with the planner's efficient allocations, suggesting that more productive establishments should receive greater resources. Secondly, the aggregate TFPs (i.e., A_{is}, A_i, A) are determined by factor market wedges. Finally, any proportional changes common to all wedges do not affect equilibrium allocations or aggregate TFPs, which is

a useful property for identifying capital and labor wedges from observed data. Details on wedge identification are provided in Section 4.

3.3 Misallocation identification and measurement

This section demonstrates how to identify signals of misallocation and measure its extent using the preceding framework.

3.3.1 Signs of misallocation

Given the framework presented in previous sections, misallocation can be diagnosed by considering the following criteria:

i) Dispersion in revenue-based total factor productivity (TFPR) across firms,

ii) Deviation of observed actual factor allocations from those predicted under the efficient allocation (equivalently, the competitive equilibrium without distortions).

Evidence supporting either criterion indicates potential resource misallocation within the economy. Firstly, a firm's TFPR is defined as $TFPR_{isj} \equiv P_{isj}A_{isj}$ where A_{isj} is the firm's physical TFP and P_{isj} is the output price. At the equilibrium, it can be shown that a firm's TFPR is equal to the geometric average of its marginal revenue products of capital and labor:

$$TFPR_{isj} = P_{isj}A_{isj} = \left(\frac{P_{isj}Y_{isj}}{K_{isj}}\right)^{\alpha} \left(\frac{P_{isj}Y_{isj}}{L_{isj}}\right)^{1-\alpha}$$

According to the first-order conditions presented in Equations (1) and (2), with the absence of distortions (i.e., $\tau_{K,isj} = \tau_{L,isj} = 1,\ \forall i, s, j$) the marginal revenue products of capital and labor are equalized across all firms, ownership structures, and industries, resulting in the equalization of firms' TFPR in the economy. Thus, variance in observed TFPR values would suggest the presence of inefficiencies in input markets.

Secondly, equation (SP-02) implies that, under the efficient allocations, a firm's optimal input level is proportional to its productivity raised to the power $\frac{1-\phi}{\phi}$ ($X_{isj} \propto A_{isj}^{\frac{1-\phi}{\phi}}$,

where $X \in \{K, L\}$). Taking logarithms, the theoretical slope of efficient factor allocation with respect to TFP is $\frac{1-\phi}{\phi}$. Therefore, departures of actual allocation from this predicted slope constitute further evidence of allocative inefficiencies.

3.3.2 Misallocation measurement

The previous section identified potential signs of misallocation; however, these indicators do not provide an aggregate quantitative measure of the extent of resource misallocation. A common metric in the literature is the counterfactual increase in aggregate output achievable through efficient resource reallocation. In this study, assuming fixed aggregate capital and labor inputs, this output increase corresponds to the gain in TFP at the economy-wide level. Hence, the cost of misallocation can be quantified as the potential aggregate TFP gain, calculated by comparing the efficient TFP (or equivalently, the competitive TFP absent distortions) and the actual TFP associated with the observed factor allocation.

The potential aggregate TFP gain is defined as $G = \left(\frac{A^*}{A} - 1\right)$, where $A = \frac{Y}{K^\alpha L^{1-\alpha}}$ is the actual TFP, with the aggregate output, Y computed based on the production function assumptions (A.1) to (A.4). Additionally, TFP gains can be computed at lower aggregation levels to quantify improvements achievable from efficient reallocation within these groups. For instance, the metrics $G_i = \left(\frac{A_i^*}{A_i} - 1\right)$ and $G_{is} = \left(\frac{A_{is}^*}{A_{is}} - 1\right)$ represent potential gains at the industry and industry-ownership levels, respectively.

4 Data and Sample Overview

This section provides an overview of the dataset and key variable definitions used to analyze the allocative efficiency of the economy. It also illustrates the procedure for constructing the final sample for quantitative analysis and provides a brief description of the sample.

4.1 Data and key variables

This study utilizes a universal firm-level dataset, the Vietnam Enterprise Survey (VES), which has been conducted annually by the General Statistics Office of Vietnam since 2000. This study focuses on the period from 2011 to 2020, using repeated cross-sectional data in 2011, 2016 and 2020. These years correspond to census year and, due to the regulation in Vietnam, all registered firms are required to complete the survey. Hence, the data from these census years provide representative coverage of the firm population in Vietnam.

The VES dataset contains rich information on firm demographics, operational performance, energy consumption, and financial statements including assets and liabilities. This study primarily utilizes data on firms' revenue, fixed assets, and employment.

The key firm-level variables used in this paper are identified as follows:

Real output - Y_{isj}: A common challenge in the literature with firm-level data is that output is often reported in nominal form as revenue ($P_{isj}Y_{isj}$), without accompanying price information (P_{isj}), making direct measurement of real output (Y_{isj}) difficult. Following Hsieh and Klenow (2009), I derive firms' real output by raising revenue to the power $\frac{1}{1-\phi}$:

$$Y_{isj} = (P_{isj}Y_{isj})^{\frac{1}{1-\phi}}$$

Applying profit maximization conditions in Section 2, the following relation holds:

$$Y_{isj} = \left(\frac{(P_{is}Y_{is})^{\frac{\phi}{\phi-1}}}{P_{is}} \right) (P_{isj}Y_{isj})^{\frac{1}{1-\phi}}$$

This equation implies that estimating physical output from nominal revenue following above method preserves relative output within each industry-ownership group and, consequently, does not affect the aggregate output gain or, equivalently, the aggregate TFP gain.

Capital - K_{isj}: Capital input is proxied by firms' fixed assets, defined as the average book value of fixed assets reported at the beginning and end of the reporting year.

Labor - L_{isj}: Labor input is measured as the average number of employees reported

at the beginning and end of the reporting year.

Production factor wedges - $\tau_{K,isj}, \tau_{L,isj}$: As previously discussed in Section 3.2.5, a key characteristic of the model is that uniform proportional adjustments in production factor wedges across firms, ownership structures and industries do not affect the equilibrium allocation and the aggregate TFP. From the first-order condition associated with firms' profit maximization problem, Equations (1) and (2), input wedges can be estimated as the average revenue per unit of capital and labor respectively: $\tau_{K,isj} = \frac{P_{isj}Y_{isj}}{K_{isj}}$ and $\tau_{L,isj} = \frac{P_{isj}Y_{isj}}{L_{isj}}$, and this estimation does not affect the measurement of misallocation.

Physical TFP - A_{isj}: Physical TFP is computed as the residual from the specified production function using the measured input and output variables described above.

4.2 Sample construction

The sample for analysis consists of firms with active operating status and positive values of output, capital and labor. To eliminate potential outliers, I followed Hsieh and Klenow (2009) in trimming the data based on $\log\left(\frac{A_{isj}}{A_{is}}\right)$ and $\log\left(\frac{TFPR_{isj}}{TFPR_{is}}\right)$. Specifically, firms are grouped by industry-ownership pairs and the lower and upper 2.5% tails of the distributions within each group are trimmed.

Regarding ownership classification, state-owned firms are those in which the State either owns the entire enterprise or holds a majority stake (over 50%). Foreign-invested firms are establishments with any foreign capital participation, while non-state firms include all other domestic private enterprises.

Industries are classified according to the one-digit International Standard Industrial Classification (ISIC). The final sample for each year covers 14 one-digit ISIC industries. The industries excluded from the sample consist of: D - Electricity, gas, steam and air conditioning supply; O - Public administration and defence, compulsory social security; P - Education; Q - Human health and social work activities; S - Other services activities; T - Activities of households as employers, undifferentiated goods- and services-producing activities of households for own use; and U - activities of extraterritorial organizations and bodies. The last industry is not covered in the VES data, while the others are excluded

either due to unavailability of data for all three years or having fewer than five firms in the respective industry-sector group.

The final samples in 2011, 2016, and 2020 comprise approximately 158,000; 172,000; and 226,000 observations, respectively, spanning broad economic sectors including agriculture, manufacturing, and services. On average, the sample size accounts for approximately 92% of all active firms reported in the survey each year.

5 Quantitative Results

In this section, the framework outlined in Section 3, together with the data described in Section 4, is used to provide quantitative evidence of potential misallocation in Vietnam and to estimate the extent of allocative inefficiency present in the economy.

5.1 Parameter choice

The parameters in the theoretical model include $\boldsymbol{\alpha}, \boldsymbol{\phi}, \boldsymbol{\theta_{is}}, \boldsymbol{\omega_i}$. Following Hsieh and Klenow (2009), I use the U.S. labor share of $\frac{2}{3}$, implying $\alpha = \frac{1}{3}$. The reason for adopting the U.S. technology parameters, rather than deriving them directly from Vietnamese data, is that observable factor shares in Vietnam may be substantially distorted. To the extent that this is a technological parameter, the U.S. values are taken as representative of a less distorted technological environment.

In addition, I set $\phi = \frac{1}{3}$,corresponding to an elasticity of substitution of 3, as in Hsieh and Klenow (2009). While this value is relatively low compared to estimates in the international trade and industrial organization literature (see, e.g., Fontagné et al. (2018)), it is commonly used in the misallocation literature to conservatively estimate the extent of allocative inefficiency. A higher elasticity (or equivalently a lower ϕ) would imply a greater potential TFP gain from efficient resource reallocation.

Regarding θ_{is} and ω_i, Equations (5) and (7) yield $\theta_{is} = \frac{P_{is}Y_{is}}{P_iY_i}$ for all i, s and $\omega_i = \frac{P_iY_i}{PY}$ for all i. These parameters are calibrated to capture the average revenue share of each ownership structure within industries and of each industry within the overall economy

over the study period, respectively.

5.2 Productivity and the actual allocations

Figure 3 illustrates changes in both firm-level physical and productivity distributions over the 2011-2020 period. The left panel shows the density of physical productivity (TFPQ) while the right describes that of revenue productivity (TFPR). In both panels, there is a slight rightward shift of the distributions, suggesting an overall improvement in the productivity of firms in Vietnam during this period. While the distribution of TFPR looks more concentrated at the middle than that of TFPQ, it still signals the presence of misallocation. As discussed earlier in Section 3.3.1, the TFPR should be equalized across firms in all industries and ownership structures in a non-distorted economy.

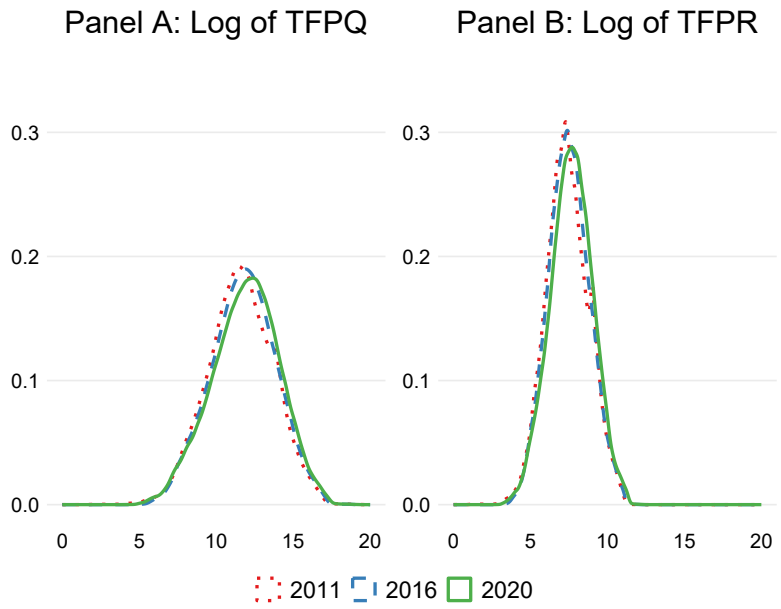


Figure 3: Productivity distributions.
Note: The firms' productivities are in logarithmic transformation, with the minimum value normalized to 1 across all three years.

Figure 4 provides additional information on the dispersion of firms' productivities. The left panel illustrates TFPQ dispersion, while the right panel show TFPR dispersion. The variation statistics of TFPQ and TFPR share several common patterns, including a slight decrease followed by a gradual increase in both the 99th-to-1st percentile ratio and the standard deviation, along with relative stability in the 90th-to-10th and 75th-to-25th percentile ratios. These characteristics suggest that the evolution of dispersion for both

TFPQ and TFPR has been modest and primarily driven by changes in the extreme tails of the distribution. Moreover, the dispersion statistics for TFPR provide further evidence of misallocation across firms in Vietnam.

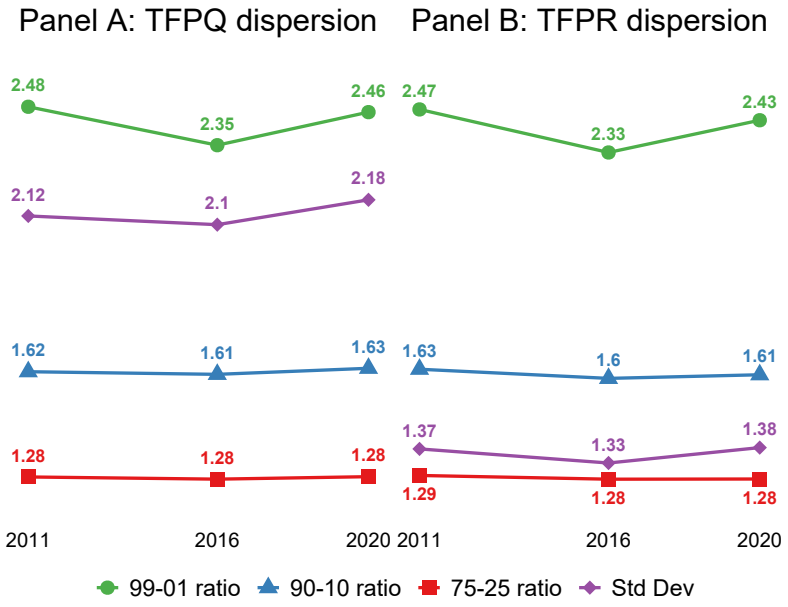


Figure 4: Firm productivity dispersion.
Note: "99-01 ratio" represents the fraction between the 99th percentile and 1st percentile of the distribution. Similar explanations apply to the "90-10 ratio" and "75-25 ratio". "Std Dev" stands for standard deviation,

Furthermore, the relationship between the actual allocation of production factors and firm-level TFPQ also serves as a key diagnostic indicator of potential misallocation.

Figure 5 and 6 show the correlation between firms' allocated capital and labor and their physical productivity, clustered by ownership structure. The red solid line in each panel represents the ideal linear slope suggested under the efficient allocation. As described in Section 3.3.1, this slope is $\frac{1-\phi}{\phi}$, which equals 2 when $\phi = \frac{1}{3}$. In other words, under optimal resource allocation, firms with 1% higher productivity would receive 2% more resources. Meanwhile, the other dashed line in each panel, colored by ownership structure, represents the fitted line from a linear regression of actual firm inputs on TFPQ. Although these fitted lines have positive slopes, the observed allocation exhibits weaker elasticities between production factors and firms' TFPQ compared to those implied by efficient allocation. The flatter slopes of the fitted lines relative to the red lines confirm a significant deviation of the actual allocation from the efficient benchmark. This dis-

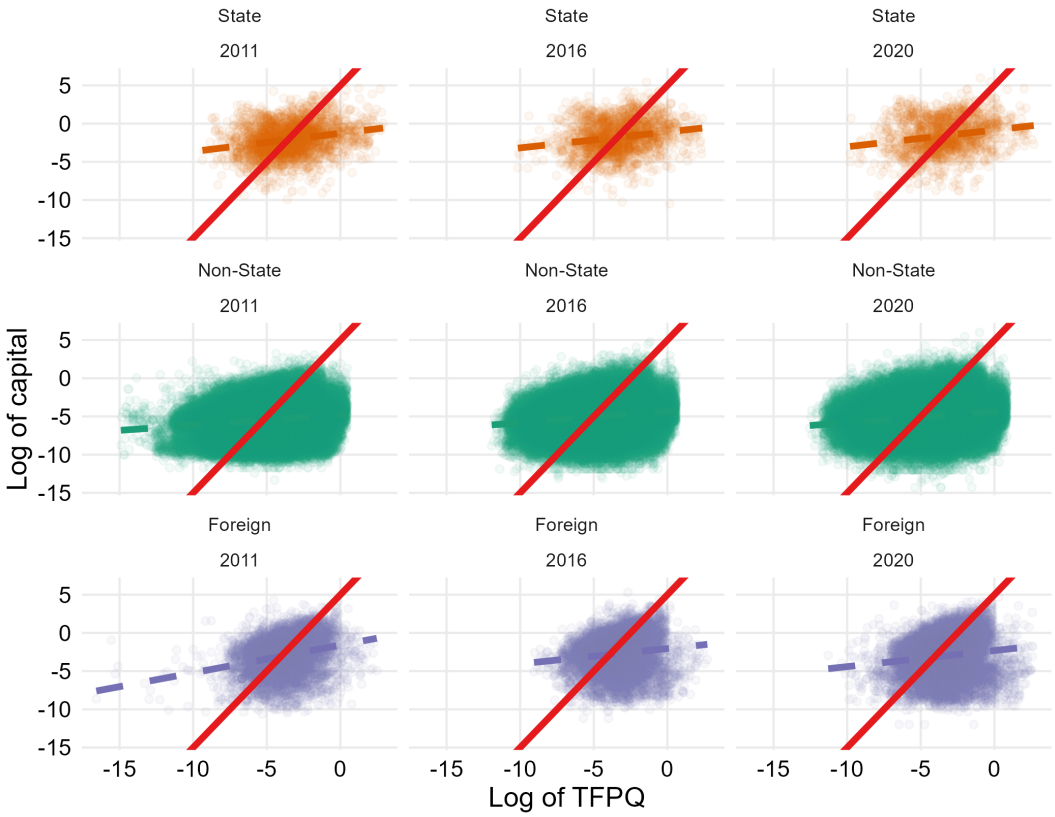


Figure 5: Capital against TFPQ across ownership structures.

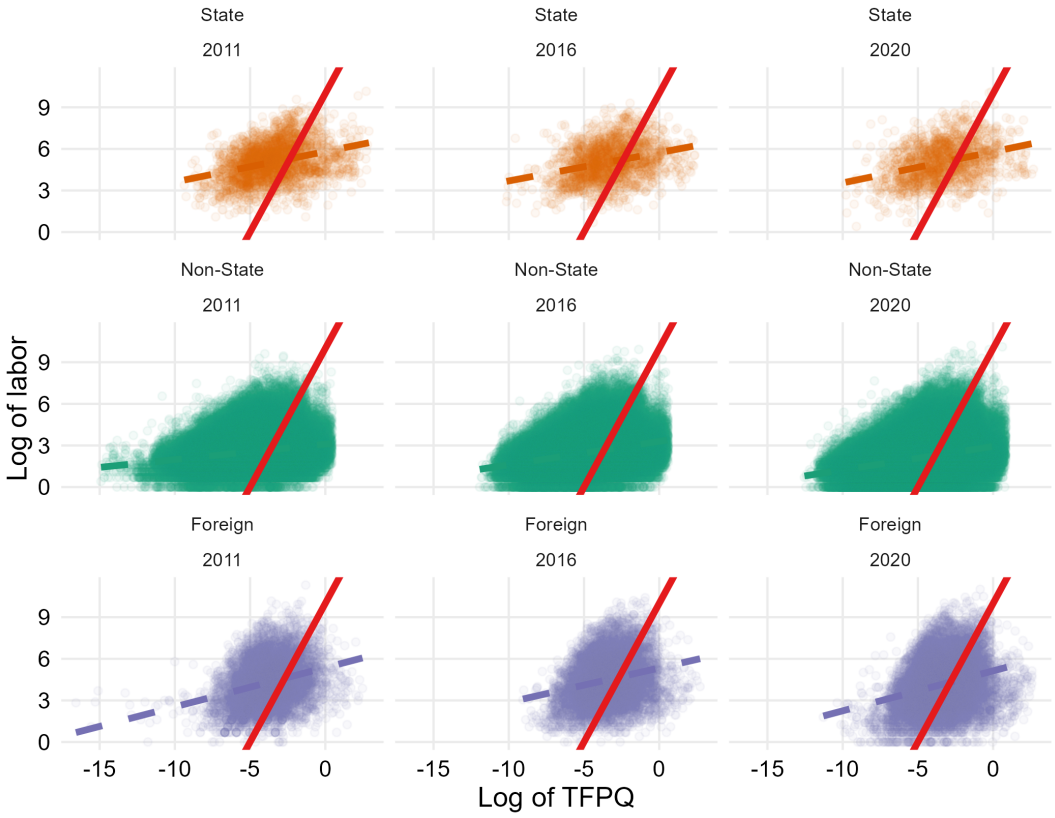


Figure 6: Labor against TFPQ across ownership structures.

crepancy suggests that the economy faces substantial challenges in allocating resources efficiently. Additionally, it is noteworthy that the slopes of the regression lines appear stable over time, indicating that the efficiency of resource allocation within the Vietnamese economy has not improved over the period.

5.3 Productivity gains from eliminating distortions

This section presents the TFP gain estimations from eliminating distortions in input factor markets at various aggregation levels. As noted in Section 3.3.2, the aggregate TFP gain is calculated as $\left(\frac{TFP_e}{TFP_a} - 1\right)$, where TFP_e is the TFP at equilibrium with all input wedges eliminated, and TFP_a is actual TFP. Table 1 reports the TFP gains under three scenarios: removing both capital and labor wedges (i.e., $\tau_{K,isj} = \tau_{L,isj} = 1,\ \forall i, s, j$) or removing only capital wedges (i.e., $\tau_{K,isj} = 1$), or removing only labor wedges (i.e., $\tau_{L,isj} = 1,\ \forall i, s, j$).

	2011	**2016**	**2020**
AGGREGATE TFP GAIN			
From removing capital and labor wedges	3.01	3.35	3.74
From removing capital wedges	0.65	0.88	1.05
From removing labor wedges	1.28	1.38	1.59
AVERAGE INDUSTRY-LEVEL TFP GAIN			
From removing capital and labor wedges	2.83	3.26	3.76
From removing capital wedges	0.84	1.02	1.19
From removing labor wedges	1.12	1.14	1.40
AVERAGE INDUSTRY-OWNERSHIP-LEVEL TFP GAIN			
From removing capital and labor wedges	2.14	2.37	2.84
From removing capital wedges	0.91	0.88	1.09
From removing labor wedges	0.90	0.92	1.16

Table 1: TFP gains from removing wedges at different aggregation levels

The top panel of Table 1 shows the potential economy-wide TFP gains. Removing distortions in both input factor markets leads to significant improvements in aggregate TFP: 3.01 times in 2011, rising to 3.35 times in 2016 and to 3.74 times in 2020. Removing capital wedges alone results in increases in aggregate TFP of 65%, 88%, and 105% for those years, while eliminating labor wedges yields relatively larger gains of 1.29, 1.38, and 1.59 times, respectively. These results highlight two key points: (1) misallocation

in Vietnam is substantial and has worsened over 2011–2020; (2) distortions in labor and capital markets have intensified, with labor distortions having a stronger impact on aggregate TFP.

The middle panel of Table 1 presents average TFP gains at the industry level, while the bottom panel reports the average gains at the industry-ownership level in the absence of distortion. Both panels confirm the upward trend in the extent of misallocation in the economy and across input markets. The results also reveals the relatively weaker impact of capital wedges compared to labor wedges. Interestingly, the disparity between effects of capital and labor distortions increase at higher aggregation levels.

5.4 Decomposition of the aggregate TFP gain

The previous section describes the aggregate TFP gain from removing input factor distortions and a rise in average TFP gains at different aggregation levels. However, these measurements do not reveal the contribution of distortions across firms, ownership structures and industries to overall misallocation. This section analyzes the impact on the aggregate TFP of three different sources: distortions between industries, between ownership structures within industries and across firms within industry-ownership groups. The analysis is carried out through a series of counterfactual experiments using the theoretical framework introduced in Section 3. The counterfactual exercises are as follows:

- Within each industry:
  - Eliminating both capital and labor wedges across firms within each industry by equalizing firm-level wedges to the industry-level values, i.e., $\tau_{K,isj} = \tau_{K,i}, \tau_{L,isj} = \tau_{L,i}$ for all i, s, j. Here, $\tau_{K,i}$ and $\tau_{L,i}$ are calculated from the original data as described in Equation (CE-06).
  - Eliminating only capital wedges across firms within each industry, i.e., $\tau_{K,isj} = \tau_{K,i}$.
  - Eliminating only labor wedges across firms within each industry, i.e., $\tau_{L,isj} = \tau_{L,i}$.

- Within each industry-ownership group:
  - Eliminating both capital and labor wedges across firms within each industry-ownership group by equalizing firm-level wedges to the industry-ownership-level values, i.e., $\tau_{K,isj} = \tau_{K,is}, \tau_{L,isj} = \tau_{L,is}$ for all i, s, j. Here, $\tau_{K,is}$ and $\tau_{L,is}$ are calculated from the original data as described in Equation (CE-04).
  - Eliminating only capital wedges across firms within each industry-ownership group, i.e., $\tau_{K,isj} = \tau_{K,is}$.
  - Eliminating only labor wedges across firms within each industry-ownership group, i.e., $\tau_{L,isj} = \tau_{L,is}$.

There are several approaches in the literature for equalizing input factor wedges across firms within a group such as using the mean, median, minimum or maximum values. In these counterfactual exercises, the chosen method ensures that the factor wedges at higher levels of aggregation match those calculated from the original data, thereby isolating the within-group effect. The aggregate TFP gains are then computed as the ratios of counterfactual TFP to the actual TFP calculated from the original data minus one, i.e., $\left(\frac{TFP_{cf}}{TFP_{act}} - 1\right)$. The results of these exercises are reported in Table 2.

AGGREGATE TFP GAIN	**2011**	**2016**	**2020**
From experiment at industry-level			
Equalizing all wedges	2.01	2.31	2.63
Equalizing capital wedges	0.49	0.69	0.83
Equalizing labor wedges	0.91	1.03	1.22
From experiment at industry-ownership-level			
Equalizing all wedges	1.83	2.16	2.46
Equalizing capital wedges	0.47	0.66	0.80
Equalizing labor wedges	0.81	0.96	1.16

Table 2: The aggregate TFP gains from counterfactual experiments

The results in Table 2 indicate that the aggregate TFP gains from equalizing input market distortions within-industry and within-industry-ownership levels have increased over time. In addition, the impact of capital wedges on economy-wide TFP is less pronounced than that of labor wedges, both at the industry and industry-ownership levels.

The findings from counterfactual experiments, in conjunction with the insights from Table 1, underscore a consistent upward trajectory in the overall magnitude of misallocation as well as distortions within each factor market. Moreover, the results highlight a relatively weaker effect of capital market distortions compared to those in the labor market in Vietnam over 2011-2020 period. Importantly, these patterns hold consistently across different degrees of aggregation, including the economy-wide, industry, and industry-ownership levels.

To decompose the impact of different sources of misallocation on the aggregate TFP, let G, G_{wi}, G_{wis} denote the aggregate TFP gains from the original analysis, from the elimination of within-industry distortions and from the equalization of within-industry-ownership distortions, respectively. The TFP gain resulting from removing between-industry distortion can be derived as $G_{bi} = G - G_{wi}$. Similarly, the cost of misallocation between ownership structures within industries is defined as $G_{bs} = G_{wi} - G_{wis}$.

Table 3 report the results of misallocation decomposition in terms of both levels and percentages. The results reveal that the distortions between firms within industry-ownership group have constituted a major source of misallocation in Vietnam, accounting for 60-65% of the overall magnitude. These distortions have consistently increased over the 2011-2020 period, both in terms of the compounded effects of input factor distortions and the separate impacts of capital and labor distortions.

In addition, distortions between industries have been the second-largest contributor, accounting on average for over 30% of aggregate allocative inefficiency. While The overall misallocation and capital distortion across industries increased over the period, the labor distortions remained relatively stable. However, relative to aggregate misallocation, the proportions of distortions between industries have decreased in both input markets as well as in their compounded impacts.

Regarding the distortions between ownership structures within industries, the results suggest two key findings. First, this type of distortion had a minor effect on the aggregate TFP and exhibited a slight decrease in the contribution to the overall level of misallocation. Secondly, the decline is mainly driven by the reduction in labor distortion

DECOMPOSITION OF MISALLOCATION	2011	2016	2020
Between industries			
Overall misallocation	1.00 (33.21%)	1.04 (30.93%)	1.12 (29.78%)
Capital misallocation	0.17 (25.33%)	0.20 (22.34%)	0.22 (21.28%)
Labor misallocation	0.38 (29.41%)	0.36 (25.77%)	0.37 (23.03%)
Between ownership structures within industry			
Overall misallocation	0.18 (6.08%)	0.15 (4.56%)	0.16 (4.36%)
Capital misallocation	0.02 (2.30%)	0.02 (2.85%)	0.03 (2.83%)
Labor misallocation	0.10 (7.59%)	0.06 (4.64%)	0.07 (4.13%)
Between firms within industry-ownership group			
Overall misallocation	1.83 (60.71%)	2.16 (64.51%)	2.46 (65.83%)
Capital misallocation	0.47 (72.37%)	0.66 (74.81%)	0.80 (75.89%)
Labor misallocation	0.81 (63.01%)	0.96 (69.58%)	1.16 (72.84%)

Table 3: Decomposition of overall misallocation based on different sources.
Note: The percentages are presented in brackets under the level values and each proportion is calculated as the ratio of the value to associated aggregate number reported in the top panel of Table 1. In other words, the sum of each type of misallocation across three panels in Table 3 equals to the corresponding one in Table 1. For example, overall misallocation between industries account for 33.21% (1.00/3.01) of the aggregate misallocation while capital distortions across industries account for 25.33% (0.17/0.65) of the aggregate capital distortions.

as between-ownership capital distortions slightly increased over the time frame.

Moreover, regarding factor market distortions, the results suggest that although capital misallocation has a weaker impact on the aggregate TFP, it worsened over the period, a trend consistently observed across difference aggregation levels. The labor market distortions also increased over the time frame. However, the increase was primarily driven by the labor misallocation across firms, while labor distortions across ownership structures and industries were relatively stable.

6 Conclusions

In conclusion, this study has investigated the extent of production input misallocation between industries, across ownership structures and among firms in the Vietnamese economy over the period from 2011 to 2020. Despite significant growth in GDP per capita during this time, the findings of this study suggest that Vietnam continued to face substantial challenges in efficiently allocating resources. In particular, the results indicate that the economy could achieve a significant improvement in aggregate TFP through reallocating resources more efficiently. In addition, the severity of misallocation in the country appears to have increased from 2011 to 2020. Regarding different types of resource misallocation, capital distortions have weaker impact on the economy than labor distortions. This pattern is consistently observed across different aggregation levels, including between industries, within industries across ownership structures and among firms in the same industry-ownership group.

The results from counterfactual exercises reveal that distortions across firms within industry-ownership group are the key contributor, accounting for over 60% of the overall magnitude of misallocation. Interestingly, the between-industry distortions account for over 30% of the overall extent of misallocation, which may reflect the effects of Vietnam's structural transformation strategy during this period. In Resolution 10/NQ-CP, dated April 24, 2012, outlining the implementation of the socio-economic development strategy for the 2011-2020 period, the Government of Vietnam laid out 15 critical tasks. Two

key objectives among these are: i) prioritizing the development of supporting industries, processing industries, information technology industries, biological industries, and environmental industries; ii) promoting the growth of service industries with a high level of technology. These priorities could potentially impact resource allocation across industries in two ways. First, some of the mentioned industries might not operate as efficiently as expected but still receive a disproportionate share of resources compared to more efficient ones. Second, even within efficient industries, the transition of capital and labor may not be uniform, preventing them from reaching their optimal output levels. For example, high-tech industries often require a highly skilled workforce, which may not always be readily available. Consequently, firms in these industries might find themselves in a situation where they have sufficient capital but insufficient labor to optimize production. This, to some extent, aligns with the finding that capital distortions have a weaker effect on the overall level of misallocation than labor distortions.

Regarding the distortions across different types of ownership, the findings indicated that this source of misallocation has had a minimal impact on the aggregate TFP, and has exhibited a decreasing trend in both magnitude and proportion. This reduction was mainly driven by the decrease in labor misallocation across ownership structures, while the capital distortion slightly increased. The findings suggest that barriers to labor mobility between ownership structures within industries may have become less restrictive. Whereas, the continued dominance of State-owned banks in the financial system could contribute to persistent inefficiencies in the capital market.

Last but not least, it is important to acknowledge limitations in this study, which could be addressed in future research. First, assumption (A.1) imposes a hypothesis of a homogeneous elasticity of the production across establishments in the economy. This simplifying assumption was originally made to facilitate analytical solutions for efficient allocation. While a closed-form solution can still be achieved by relaxing the assumption to allow heterogeneous factor elasticity across industries, doing so requires consistent estimation of production elasticity across broad industries (one-digit ISIC) in a less distorted economy such as the U.S. To the best of my knowledge, such data are

currently unavailable. In addition, relying on cross-sectional data limits the study's ability to clarify the contribution of adjustment costs to the measured misallocation. Utilizing panel data would be beneficial to isolate the extent of allocative inefficiency. Despite these limitations, this study provides a comprehensive overview of resource misallocation across industries, ownership structures, and firms in Vietnam over the 2011–2020 period.

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A Algebraic Derivations

A.1 Social Planner's problem

The social planner's problem is:

$$\max_{\{K_{isj},L_{isj}\}} Y$$

subject to (A.1), (A.2), (A.3), (A.4), (A.5) and (A.6) in the paper.

We can find the solution for the Social Planner's problem by employing the stage backward method to consecutively address the following problems:

$$\max_{\{K_{isj},L_{isj}\}} Y_{is} \tag{P1}$$

$$\text{subject to: } (\text{A.1}), (\text{A.2})$$

$$\sum_j K_{isj} = K_{is}, \ K_{is} \text{ given}$$

$$\sum_j L_{isj} = L_{is}, \ L_{is} \text{ given}$$

$$\max_{\{K_{is},L_{is}\}} Y_i \tag{P2}$$

$$\text{subject to: } (\text{A.1}), (\text{A.2}), (\text{A.3})$$

$$\sum_s K_{is} = K_i, \ K_i \text{ given}$$

$$\sum_s L_{is} = L_i, \ L_i \text{ given}$$

$$\max_{\{K_i,L_i\}} Y \tag{P3}$$

$$\text{subject to: } (\text{A.1}), (\text{A.2}), (\text{A.3}), (\text{A.4})$$

$$\sum_i K_{is} = K, \ K \text{ given}$$

$$\sum_i L_{is} = L, \ L \text{ given}$$

A.1.1 Characterization of (P1)

Problem (P1) is equivalent to:

$$\max_{\{K_{isj},L_{isj}\}} \quad \left[\sum_j \left(A_{isj}K_{isj}^{\alpha}L_{isj}^{1-\alpha}\right)^{1-\phi}\right]^{\frac{1}{1-\phi}}$$

subject to:

$$\sum_j K_{isj} = K_{is}, \;\; K_{is} \text{ given}$$

$$\sum_j L_{isj} = L_{is}, \;\; L_{is} \text{ given}$$

The standard first-order conditions are as follows:

$$\alpha Y_{is}^{\phi} Y_{isj}^{-\phi} \frac{Y_{isj}}{K_{isj}} = \lambda_{K_{is}} \quad \forall j \tag{P1-01}$$

$$(1-\alpha)\, Y_{is}^{\phi} Y_{isj}^{-\phi} \frac{Y_{isj}}{L_{isj}} = \lambda_{L_{is}} \quad \forall j \tag{P1-02}$$

where $\lambda_{K_{is}}$ and $\lambda_{L_{is}}$ are the Lagrangian multipliers.

From (P1-01) and (P1-02) we have:

$$\frac{K_{isj}}{L_{isj}} = \frac{\alpha}{1-\alpha}\frac{\lambda_{L_{is}}}{\lambda_{K_{is}}} \quad \forall j \tag{P1-03}$$

From (P1-01), we have:

$$K_{isj} = Y_{is}^{\phi} Y_{isj}^{1-\phi} \frac{\alpha}{\lambda_{K_{is}}} \quad \forall j \tag{P1-04}$$

which implies:

$$\begin{aligned}
K_{is} &= \sum_j K_{isj} \\
&= \sum_j Y_{is}^{\phi} Y_{isj}^{1-\phi} \frac{\alpha}{\lambda_{K_{is}}} \\
&= Y_{is}^{\phi} \frac{\alpha}{\lambda_{K_{is}}} \left(\sum_j Y_{isj}^{1-\phi} \right) \\
&= Y_{is}^{\phi} \frac{\alpha}{\lambda_{K_{is}}} Y_{is}^{1-\phi} \quad \text{as from (A.2) } Y_{is} = \left(\sum_j Y_{isj}^{1-\phi} \right)^{\frac{1}{1-\phi}} \\
&= \frac{\alpha}{\lambda_{K_{is}}} Y_{is} \qquad \text{(P1-05)}
\end{aligned}$$

Taking the ratio of (P1-04) and (P1-05) we have:

$$\frac{K_{isj}}{K_{is}} = \frac{Y_{isj}^{1-\phi}}{Y_{is}^{1-\phi}} \quad \forall j \qquad \text{(P1-06)}$$

From equation (P1-06) and assumptions (A.1),(A.2), we have:

$$\begin{aligned}
\frac{K_{isj}}{K_{is}} = \frac{Y_{isj}^{1-\phi}}{Y_{is}^{1-\phi}} &= \frac{\left[A_{isj} K_{isj}^{\alpha} L_{isj}^{1-\alpha} \right]^{1-\phi}}{\sum_j Y_{isj}^{1-\phi}} \\
&= \frac{\left[A_{isj} K_{isj} \left(\frac{L_{isj}}{K_{isj}} \right)^{1-\alpha} \right]^{1-\phi}}{\sum_j \left[A_{isj} K_{isj} \left(\frac{L_{isj}}{K_{isj}} \right)^{1-\alpha} \right]^{1-\phi}} \\
&= \frac{\left(A_{isj} K_{isj} \right)^{1-\phi}}{\sum_j \left(A_{isj} K_{isj} \right)^{1-\phi}} \quad \text{as from (P1-03) } \frac{K_{isj}}{L_{isj}} = \frac{\alpha}{1-\alpha} \frac{\lambda_{L_{is}}}{\lambda_{K_{is}}} \quad \forall j
\end{aligned}$$

The equation above implies that $\forall j$:

$$
\begin{aligned}
A_{isj}^{1-\phi} K_{is} &= K_{isj}^{\phi} \left[\sum_j \left(A_{isj} K_{isj} \right)^{1-\phi} \right] \\
\iff A_{isj}^{1-\phi} K_{is} &= K_{isj}^{\phi} \left[\sum_j \left(A_{isj} K_{is} \frac{K_{isj}}{K_{is}} \right)^{1-\phi} \right] \\
\iff A_{isj}^{1-\phi} K_{is}^{\phi} &= K_{isj}^{\phi} \left[\sum_j \left(A_{isj} \frac{K_{isj}}{K_{is}} \right)^{1-\phi} \right] \\
\iff A_{isj}^{\frac{1-\phi}{\phi}} K_{is} &= K_{isj} \left[\sum_j \left(A_{isj} \frac{K_{isj}}{K_{is}} \right)^{1-\phi} \right]^{\frac{1}{\phi}} \\
\iff \frac{K_{isj}}{K_{is}} &= \frac{A_{isj}^{\frac{1-\phi}{\phi}}}{\left[\sum_j \left(A_{isj} \frac{K_{isj}}{K_{is}} \right)^{1-\phi} \right]^{\frac{1}{\phi}}}
\end{aligned}
\tag{P1-07}
$$

From (P1-07) we have:

$$
\sum_j \frac{A_{isj}^{\frac{1-\phi}{\phi}}}{\left[\sum_j \left(A_{isj} \frac{K_{isj}}{K_{is}} \right)^{1-\phi} \right]^{\frac{1}{\phi}}} = \sum_j \frac{K_{isj}}{K_{is}} = 1
$$

which implies:

$$
\sum_j A_{isj}^{\frac{1-\phi}{\phi}} = \left[\sum_j \left(A_{isj} \frac{K_{isj}}{K_{is}} \right)^{1-\phi} \right]^{\frac{1}{\phi}} \tag{P1-08}
$$

From equations (P1-07) and (P1-08), we have:

$$
\frac{K_{isj}}{K_{is}} = \frac{A_{isj}^{\frac{1-\phi}{\phi}}}{\sum_j A_{isj}^{\frac{1-\phi}{\phi}}} \tag{P1-09}
$$

Similarly, from equation (P1-02) we can derive:

$$
\frac{L_{isj}}{L_{is}} = \frac{Y_{isj}^{1-\phi}}{Y_{is}^{1-\phi}} \quad \forall j
$$

Thus, the optimal allocation of (P1) is characterized by:

$$\frac{K^*_{isj}}{K_{is}} = \frac{L^*_{isj}}{L_{is}} = \frac{A_{isj}^{\frac{1-\phi}{\phi}}}{\sum_j A_{isj}^{\frac{1-\phi}{\phi}}} \tag{P1-10}$$

The optimal aggregate industry-sector output is:

$$\begin{aligned}
Y^*_{is} &= \left(\sum_j {Y^*_{isj}}^{1-\phi}\right)^{\frac{1}{1-\phi}} \\
&= \left[\sum_j \left(A_{isj}K^*_{isj}\left(\frac{L^*_{isj}}{K^*_{isj}}\right)^{1-\alpha}\right)^{1-\phi}\right]^{\frac{1}{1-\phi}} \\
&= \left[\sum_j \left(A_{isj}K^*_{isj}\right)^{1-\phi}\right]^{\frac{1}{1-\phi}} \left(\frac{L_{is}}{K_{is}}\right)^{1-\alpha} \text{ as } \frac{K^*_{isj}}{K_{is}} = \frac{L^*_{isj}}{L_{is}} \implies \frac{L^*_{isj}}{K^*_{isj}} = \frac{L_{is}}{K_{is}}, \forall j \\
&= \left[\sum_j \left(A_{isj}\frac{K^*_{isj}}{K_{is}}\right)^{1-\phi}\right]^{\frac{1}{1-\phi}} K_{is}\left(\frac{L_{is}}{K_{is}}\right)^{1-\alpha} \\
&= \left(\sum_j A_{isj}^{\frac{1-\phi}{\phi}}\right)^{\frac{\phi}{1-\phi}} K_{is}\left(\frac{L_{is}}{K_{is}}\right)^{1-\alpha} \text{ as } \sum_j A_{isj}^{\frac{1-\phi}{\phi}} = \left[\sum_j \left(A_{isj}\frac{K_{isj}}{K_{is}}\right)^{1-\phi}\right]^{\frac{1}{\phi}} \\
&= A^*_{is}K^{\alpha}_{is}L^{1-\alpha}_{is} \quad \text{where } A^*_{is} = \left(\sum_j A_{isj}^{\frac{1-\phi}{\phi}}\right)^{\frac{\phi}{1-\phi}}
\end{aligned} \tag{P1-11}$$

A.1.2 Characterization of (P2)

Given the solution of problem (P1), we found that the optimal output is in a Cobb-Douglas form of capital and labor at the industry-ownership structure level. Thus, Problem (P2) is equivalent to:

$$\max_{\{K_{is},L_{is}\}} \quad \prod_s \left(A_{is}K_{is}^{\alpha}L_{is}^{1-\alpha}\right)^{\theta_{is}}$$

subject to:

$$\sum_s K_{is} = K_i, \ \ K_i \text{ given}$$

$$\sum_s L_{is} = L_i, \ \ L_i \text{ given}$$

With a similar method of solving Problem 1, the solution of (P2) is characterized by the following equations:

$$\frac{K_{is}^*}{K_i} = \frac{L_{is}^*}{L_i} = \theta_{is} \tag{P2-01}$$

$$Y_i^* = A_i^* K_i^{\alpha} L_i^{1-\alpha} \text{ where } A_i^* = \prod_s (\theta_{is}A_{is})^{\theta_{is}} \tag{P2-02}$$

A.1.3 Characterization of (P3)

Similarly, given the functional form of optimal output at the industry level, Problem (P3) is equivalent to:

$$\max_{\{K_i,L_i\}} \quad \prod_i \left(A_i K_i^{\alpha} L_i^{1-\alpha}\right)^{\omega_i}$$

subject to:

$$\sum_i K_i = K, \ \ K \text{ given}$$

$$\sum_i L_i = L, \ \ L \text{ given}$$

Similar to (P2), we can derive the solution for (P3) as follows:

$$\frac{K_i^*}{K} = \frac{L_i^*}{L} = \omega_i \tag{P3-01}$$

$$Y^* = A^* K^\alpha L^{1-\alpha} \quad \text{where } A^* = \prod_i (\omega_i A_i)^{\omega_i} \tag{P3-02}$$

A.1.4 Characterization of the Social Planner's problem

From the characteristics of (P1), (P2), (P3) above, the solution for Social Planner's problem, in other words, the efficient allocation is characterized as:

$$X_{isj}^* = \underbrace{\left(\frac{A_{isj}^{\frac{1-\phi}{\phi}}}{\sum_j A_{isj}^{\frac{1-\phi}{\phi}}} \right)}_{\frac{X_{isj}^*}{X_{is}^*}} \underbrace{\theta_{is}}_{\frac{X_{is}^*}{X_i^*}} \underbrace{\omega_i}_{\frac{X_i^*}{X}} X$$

where $X \in \{K, L\}$ and

$$A_{is}^* = \left(\sum_j A_{isj}^{\frac{1-\phi}{\phi}} \right)^{\frac{\phi}{1-\phi}}$$

$$A_i^* = \prod_s (\theta_{is} A_{is})^{\theta_{is}}$$

$$A^* = \prod_i (\omega_i A_i)^{\omega_i}$$

The outputs of firms and other aggregation levels under the efficient allocation are:

$$Y_{isj}^* = A_{isj} {K_{isj}^*}^\alpha {L_{isj}^*}^{1-\alpha}$$

$$Y_{is}^* = A_{is}^* {K_{is}^*}^\alpha {L_{is}^*}^{1-\alpha}$$

$$Y_i^* = A_i^* K_i^{*\alpha} L_i^{*1-\alpha}$$

$$Y^* = A^* K^\alpha L^{1-\alpha}$$

The expressions above are identical to equations (SP-01)-(SP-08) in the main text.

A.2 Competitive equilibrium with distortions

From equations (1) and (2) from the main text, we have:

$$\frac{K_{isj}}{L_{isj}} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{w}{r}\right)\left(\frac{\tau_{L,isj}}{\tau_{K,isj}}\right) \tag{9}$$

Substitute the equation above to equation (1), we can derive:

$$P_{isj} = A_{ijs}^{-1}\tau_{K,isj}^{\alpha}\tau_{L,isj}^{1-\alpha}\left(\frac{r}{\alpha}\right)^{\alpha}\left(\frac{w}{1-\alpha}\right)^{1-\alpha} \tag{10}$$

Let's define: $C_p \equiv \left(\frac{r}{\alpha}\right)^{\alpha}\left(\frac{w}{1-\alpha}\right)^{1-\alpha}$ and $\overline{A_{isj}}$ as presented in (CE-02), equation (10) becomes:

$$P_{isj} = \overline{A_{isj}}^{-1} C_p \tag{11}$$

From equations (11) and (4), we have:

$$\begin{aligned} P_{is} &= \left(\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}}\right)^{\frac{\phi}{\phi-1}} C_p \\ &= \overline{A_{is}}^{-1} C_p \quad \text{where } \overline{A_{is}} \text{ is defined as in (CE-03)} \end{aligned} \tag{12}$$

From the assumption of firms' production function in (A.1) and equation (9), we have:

$$\begin{aligned} Y_{isj} &= A_{isj}K_{isj}\left(\frac{\alpha}{1-\alpha}\frac{w}{r}\frac{\tau_{L,isj}}{\tau_{K,isj}}\right)^{\alpha-1} \\ &= \overline{A_{isj}}K_{isj}\tau_{K,isj}C_k \quad \text{where } C_k \equiv \left(\frac{\alpha}{1-\alpha}\frac{w}{r}\right)^{\alpha-1} \end{aligned} \tag{13}$$

Substitute equation (13) into (A.2) we have:

$$\begin{aligned} Y_{is} &= \left[\sum_j \left(\overline{A_{isj}} K_{isj} \tau_{K,isj} C_k\right)^{1-\phi}\right]^{\frac{1}{1-\phi}} \\ &= \left[\sum_j \left(\overline{A_{isj}} \tau_{K,isj} \frac{K_{isj}}{K_{is}}\right)^{1-\phi}\right]^{\frac{1}{1-\phi}} K_{is} C_k \\ &= D_{k,is} K_{is} C_k \quad \text{here } D_{k,is} \equiv \left[\sum_j \left(\overline{A_{isj}} \tau_{K,isj} \frac{K_{isj}}{K_{is}}\right)^{1-\phi}\right]^{\frac{1}{1-\phi}} \end{aligned} \tag{14}$$

Substitute equations (13) and (14) into equation (3), we have:

$$\frac{P_{isj}}{P_{is}} = \left(\frac{\overline{A_{isj}} K_{isj} \tau_{K,isj} C_k}{D_{k,is} K_{is} C_k}\right)^{-\phi} = \left(\frac{\overline{A_{isj}} \tau_{K,isj}}{D_{k,is}} \frac{K_{isj}}{K_{is}}\right)^{-\phi} \tag{15}$$

In addition, from equations (11) and (12), we have:

$$\frac{P_{isj}}{P_{is}} = \frac{\overline{A_{isj}}^{-1} C_p}{\overline{A_{is}}^{-1} C_p} = \left(\frac{\overline{A_{isj}}}{\overline{A_{is}}}\right)^{-1} \tag{16}$$

Equations (15) and (16) imply:

$$\begin{aligned} & \left(\frac{\overline{A_{isj}}}{\overline{A_{is}}}\right)^{-1} = \left(\frac{\overline{A_{isj}} \tau_{K,isj}}{D_{k,is}} \frac{K_{isj}}{K_{is}}\right)^{-\phi} \\ \iff & \left(\frac{K_{isj}}{K_{is}}\right)^{\phi} = \left(\frac{\overline{A_{isj}} \tau_{K,isj}}{D_{k,is}}\right)^{-\phi} \left(\frac{\overline{A_{isj}}}{\overline{A_{is}}}\right) \\ \iff & \frac{K_{isj}}{K_{is}} = D_{k,is} \overline{A_{is}}^{-\frac{1}{\phi}} \overline{A_{isj}}^{\frac{1-\phi}{\phi}} \tau_{K,isj}^{-1} \end{aligned} \tag{17}$$

Equation (17) implies:

$$\begin{aligned}
\sum_j \frac{K_{isj}}{K_{is}} &= \sum_j D_{k,is}\overline{A_{is}}^{-\frac{1}{\phi}}\overline{A_{isj}}^{\frac{1-\phi}{\phi}}\tau_{K,isj}^{-1} \\
\iff \quad 1 &= D_{k,is}\overline{A_{is}}^{-\frac{1}{\phi}}\left(\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}}\tau_{K,isj}^{-1}\right) \\
\iff \quad D_{k,is} &= \frac{\overline{A_{is}}^{\frac{1}{\phi}}}{\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}}\tau_{K,isj}^{-1}} \\
&= \overline{A_{is}}\frac{\overline{A_{is}}^{\frac{1-\phi}{\phi}}}{\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}}\tau_{K,isj}^{-1}} \\
&= \overline{A_{is}}\tau_{K,is} \quad \text{here } \tau_{K,is} \text{ is defined as in (CE-04)}
\end{aligned} \tag{18}$$

Substitute equation (18) into (14) and (17), we have:

$$Y_{is} = \overline{A_{is}}\tau_{K,is}K_{is}C_k \tag{19}$$

$$\frac{K_{isj}}{K_{is}} = \frac{\overline{A_{isj}}^{\frac{1-\phi}{\phi}}\tau_{K,isj}^{-1}}{\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}}\tau_{K,isj}^{-1}} \tag{20}$$

Similarly, from equation (12) and (6), we can derive:

$$P_i = \overline{A_i}^{-1}C_p \quad \text{, where } \overline{A_i} \text{ is defined as in (CE-05)} \tag{21}$$

Following the same procedure as shown in equations (14) to (18), we arrive:

$$Y_i = \overline{A_i}\tau_{K,i}K_iC_k \tag{22}$$

$$\frac{K_{is}}{K_i} = \frac{\theta_{is}\tau_{K,is}^{-1}}{\sum_s \theta_{is}\tau_{K,is}^{-1}} \tag{23}$$

where $\tau_{K,i}$ is defined as in (CE-06) in the main text.

Following the same process, at the aggregate level, we have:

$$Y = \overline{A}\tau_K K C_k \tag{24}$$

$$\frac{K_i}{K} = \frac{\omega_i \tau_{K,i}^{-1}}{\sum_i \omega_i \tau_{K,i}^{-1}} \tag{25}$$

where $\overline{A}$ and τ_K are defined as in equations (CE-07) and (CE-08) respectively.

From equations (20),(23) and (25), the competitive equilibrium allocation of capital is characterized by:

$$K_{isj} = \underbrace{\left(\frac{\overline{A_{isj}}^{\frac{1-\phi}{\phi}} \tau_{K,isj}^{-1}}{\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}} \tau_{K,isj}^{-1}} \right)}_{\frac{K_{isj}}{K_{is}}} \underbrace{\left(\frac{\theta_{is} \tau_{K,is}^{-1}}{\sum_s \theta_{is} \tau_{K,is}^{-1}} \right)}_{\frac{K_{is}}{K_i}} \underbrace{\left(\frac{\omega_i \tau_{K,i}^{-1}}{\sum_i \omega_i \tau_{K,i}^{-1}} \right)}_{\frac{K_i}{K}} K \tag{26}$$

Using the same method, we can derive the competitive equilibrium allocation of labor as follows:

$$L_{isj} = \underbrace{\left(\frac{\overline{A_{isj}}^{\frac{1-\phi}{\phi}} \tau_{L,isj}^{-1}}{\sum_j \overline{A_{isj}}^{\frac{1-\phi}{\phi}} \tau_{L,isj}^{-1}} \right)}_{\frac{L_{isj}}{L_{is}}} \underbrace{\left(\frac{\theta_{is} \tau_{L,is}^{-1}}{\sum_s \theta_{is} \tau_{L,is}^{-1}} \right)}_{\frac{L_{is}}{L_i}} \underbrace{\left(\frac{\omega_i \tau_{L,i}^{-1}}{\sum_i \omega_i \tau_{L,i}^{-1}} \right)}_{\frac{L_i}{L}} L \tag{27}$$

where $\overline{A_{isj}}, \overline{A_{is}}, \overline{A_i}, \tau_{L,is}, \tau_{L,i}$ are defined as in equations (CE-02) to (CE-06).

Here, equations (26) and (27) are similar to (CE-01) in the main text.

Moreover, while solving for the equilibrium allocation of labor, we can derive the following:

$$Y_{isj} = \overline{A_{isj}} L_{isj} \tau_{L,isj} C_L \tag{28}$$

$$Y_{is} = \overline{A_{is}} L_{is} \tau_{L,is} C_L \tag{29}$$

$$Y_i = \overline{A_i} L_i \tau_{L,i} C_L \tag{30}$$

$$Y = \overline{A} L \tau_L C_L \tag{31}$$

where $\overline{A}$ and τ_L are defined as in equations (CE-07) to (CE-08) respectively and $C_L \equiv$

$\left(\frac{\alpha}{1-\alpha}\frac{w}{r}\right)^{\alpha}$.

Since $C_k^{\alpha} C_l^{1-alpha} = 1$, from equations (13), (19), (22), (24) and equations from (28) to (31), we can derive the following:

$$
\begin{aligned}
Y_{isj} &= \underbrace{\overline{A_{isj}}\tau_{K,isj}^{\alpha}\tau_{L,isj}^{1-\alpha}}_{A_{isj}} K_{isj}^{\alpha} L_{isj}^{1-\alpha} \\
Y_{is} &= \underbrace{\overline{A_{is}}\tau_{K,is}^{\alpha}\tau_{L,is}^{1-\alpha}}_{A_{is}} K_{is}^{\alpha} L_{is}^{1-\alpha} \\
Y_{i} &= \underbrace{\overline{A_{i}}\tau_{K,i}^{\alpha}\tau_{L,i}^{1-\alpha}}_{A_{i}} K_{i}^{\alpha} L_{i}^{1-\alpha} \\
Y &= \underbrace{\overline{A}\tau_{K}^{\alpha}\tau_{L}^{1-\alpha}}_{A} K^{\alpha} L^{1-\alpha}
\end{aligned}
$$

The equations above are identical to equations (CE-09) to (CE-12).

A.3 The derivation to estimate firms' real output

The first order condition of industry-ownership-sector representative producer's problem in equation (3) implies:

$$
\begin{aligned}
P_{isj} Y_{isj}^{\phi} &= P_{is} Y_{is}^{\phi} \\
\iff P_{isj} Y_{isj} Y_{isj}^{\phi-1} &= P_{is}^{\phi} Y_{is}^{\phi} P_{is}^{1-\phi} \\
\iff Y_{isj}^{\phi-1} &= \left(\frac{P_{is}^{\phi} Y_{is}^{\phi}}{P_{is}^{\phi-1}}\right) (P_{isj} Y_{isj})^{-1} \\
\iff Y_{isj} &= \left[\frac{(P_{is} Y_{is})^{\frac{\phi}{\phi-1}}}{P_{is}}\right] (P_{isj} Y_{isj})^{\frac{1}{1-\phi}}
\end{aligned}
$$

The equation above implies that setting $\frac{(P_{is}Y_{is})^{\frac{\phi}{\phi-1}}}{P_{is}} = 1$ would not affect relative outputs across firms within the industry-ownership-sector pair and hence the TFPs gains under efficient allocations. Thus, we can estimate firms' real output from their observed revenue, i.e., $Y_{isj} = (P_{isj} Y_{isj})^{\frac{1}{1-\phi}}$.