Misallocation and Productivity Dispersion with Locally Segmented Markets

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Abstract

This paper studies the relationship between misallocation of production inputs and productivity dispersion in an industry with locally segmented markets. I show that revenue productivity dispersion is not a sign of misallocation if it comes from firms operating in different markets. Any reallocation across firms operating in different markets increases a consumer's utility in one market but decreases the utility of consumers living in other markets. Therefore, any reallocation of resources across markets represents a movement along a Pareto efficient frontier. I quantify the extent to which revenue productivity dispersion across markets can over-estimate misallocation using Korean ready-mixed concrete industry data. I show that dispersion in revenue productivity substantially over-estimates the size of misallocation.

JEL Codes: O47, O40, D24, L61

Keywords: misallocation; industry vs. market; market segmentation; ready-mixed concrete

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1 Introduction

Aggregate productivity is a function of both the within-firm technology level and between-firm resource allocation. Following the seminal work of Hsieh and Klenow (2009), various papers have provided quantitative evidence of between-firm resource misallocation and its sources.[1] A standard measure of misallocation is between-firm dispersion in revenue productivity.[2] Hsieh and Klenow (2009) show that under CES demand and constant returns to scale technology, dispersion in revenue productivity is a sufficient statistic for measuring misallocation. However, there are ample reasons why dispersion in revenue productivity might not be a sign of misallocation. These include unobserved heterogeneity in production technology (Gollin and Udry (2021)), adjustment costs (Asker et al. (2014)), measurement error (Bils et al. (2021)), and model mis-specification (Haltiwanger et al. (2018)).

This paper adds another explanation by studying an industry with locally segmented markets. Most existing papers in the literature assume that one can aggregate firms' outputs using a single aggregator that comes from a representative consumer's preferences. However, this cannot be the case when we look at an industry with locally segmented markets, because different markets serve different consumers. That is, the difference between industry and market has been largely ignored in the literature.

I argue that revenue productivity dispersion is not a sign of misallocation if it comes from firms operating in different markets. The intuition is that any reallocation across firms operating in different markets increases consumers' utility in one market but decreases the utility of consumers living in other markets. Therefore, any reallocation of resources across markets represents a movement along a Pareto efficient frontier, as long as there is no within-market misallocation. I formally show this with a simple model by extending Hsieh and Klenow (2009) to allow multiple consumers.

Based on the theoretical result, I quantify the extent to which revenue productivity

[1] See Hopenhayn (2014) and Restuccia and Rogerson (2017) for recent progress in the literature.

[2] See Bartelsman et al. (2013) for an alternative Olley-Pakes covariance measure.

dispersion across markets can over-estimate misallocation using Korean ready-mixed concrete industry data.[3] The variance of revenue productivity decreases, on average, 14.2% if we control for year-market fixed effects. More importantly, I compare the misallocation measure from Hsieh and Klenow (2009) and aggregated versions of similarly constructed market-level misallocation measures. I show that the Hsieh and Klenow misallocation measure is significantly higher than the unweighted and revenue-weighted average of market-level misallocation measures.

The main message of this paper is to show that dispersion in revenue productivity is likely to over-estimate misallocation if an industry is actually a group of markets. This implication is particularly interesting compared to other efficient sources of revenue productivity dispersion proposed in the literature. The misallocation literature has mainly emerged to explain aggregate productivity differences across developed and developing countries. To study cross-country differences, what matters is not the level of misallocation per se but the gap of misallocation between countries. It is not easy to explain why unobserved heterogeneity in production technology, adjustment costs, measurement error, and model mis-specification would be more prevalent in one country than in others.

However, there is clear evidence that market integration is low in developing countries due to incomplete transportation infrastructure.[4] In this sense, market segmentation is much more prevalent to developing countries, so we are likely to over-estimate the magnitude of misallocation especially for developing countries.

A closely related paper that shares the same spirit is Gupta (2020). He shows that there is assortative matching between richer consumers and high markup firms that produce high-quality products. In that case, markup dispersion across firms arises because their products target different consumers, so that such dispersion may not be a source of misallocation.

[3] A ready-mixed concrete industry is well-known for geographical market segmentation due to its product characteristics (Syverson (2004))

[4] See Gupta (2020) for relevant papers and evidence.

Compared to this work, the contributions of this paper are (1) to show *formally* why distortions across firms targeting different consumers may not be a source of misallocation and (2) to apply this intuition to an industry with a homogeneous but locationally differentiated product.

The rest of the paper proceeds as follows. I sketch a simple model of monopolistic competition with homogeneous firms operating in different markets to show why dispersion in revenue productivity may arise even in the absence of misallocation. I then quantify how much revenue productivity dispersion declines if we control for variation across segmented markets, using data for the ready-mixed concrete industry in Korea. I lay out the model in Section 2. In Section 3, I introduce the data and empirical framework. In Section 4, I show the quantitative results. I conclude in Section 5.

2 Model

I introduce a simple one-period model to illustrate that dispersion in revenue productivity in an industry is not necessarily a sign of misallocation if it comes from dispersion across segmented markets. The model extends Hsieh and Klenow (2009) by allowing multiple consumers in an industry. The economy consists of one industry and two (local) markets, A and B. In each market, there is a representative consumer and many firms.[5] I assume monopolistic competition among firms.

[5] Another natural interpretation of a representative consumer would be a final good producer that combines intermediate inputs.

2.1 Consumers

A representative consumer in a market $i \in \{A, B\}$ has standard constant elasticity of substitution (CES) preferences with the common substitution parameter σ,

$$U_i = [\sum_{j=1}^{n} c_{ij}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where c_{ij} is consumption of product j in market i. The number of products (or firms) in both markets is given as n. Both consumers have a labor endowment $\bar{L}$ and own firms operating in each market. A consumer i has α_i share of all firms in A and B, where $\alpha_A + \alpha_B = 1$. There is lump-sum transfer T_i to consumers arising from market distortions, which we will discuss later when presenting the firm's problem. I assume that consumers supply their labor inelastically and to both markets.

The budget constraint of a consumer i is

$$\sum_{j=1}^{n} p_{ij} c_{ij} \leq w\bar{L} + \alpha_i(\Pi_1 + \Pi_2) + T_i, \tag{2}$$

where p_{ij} is the price of product j in market i, w is the wage, and Π_i is the total profit from the firms operating in market i.

Consumers maximize (1) subject to (2). The resulting first-order condition generates a standard demand function for product j in market i,

$$\frac{p_{ij}}{p_i} = (\frac{c_{ij}}{c_i})^{-\frac{1}{\sigma}}, \tag{3}$$

where $c_i = [\sum_{j=1}^{n} c_{ij}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$ and $p_i = [\sum_{j=1}^{n} p_{ij}^{1-\sigma}]^{\frac{1}{1-\sigma}}$.

2.2 Firms

Firms in the economy produce differentiated goods with a constant return to scale (CRS) technology using only labor. I assume productivity is homogeneous for simplicity. Firm j in market i produces output y_{ij} as

$$y_{ij} = Al_{ij}, \tag{4}$$

where A is the common productivity and l_{ij} is labor input.

I represent any market-specific wedges that distort marginal products of labor in a reduced-form way as a market-specific output distortion τ_i. Some examples of τ_i include heterogeneous markups over different markets and heterogeneous tax systems across local governments.[6]

A firm maximizes profit subject to demand system (3) and production function (4),

$$\begin{aligned} max_{\{p_{ij}\}} \pi_{ij} &= (1-\tau_i)p_{ij}y_{ij} - wl_{ij} \\ &s.t.\ \ (3)\ \ \text{and}\ \ (4) \end{aligned}$$

where $c_{ij} = y_{ij}$.[7] Profit maximization yields the standard first-order condition that the firm's output price is a fixed markup over its marginal cost:

$$p_{ij} = \frac{\sigma}{\sigma - 1} \frac{w}{(1-\tau_i)A}. \tag{5}$$

Revenue productivity $TFPR$ is defined as revenue divided by labor input, i.e., $TFPR_{ij} = \frac{p_{ij}y_{ij}}{l_{ij}} = p_{ij}A$. By combining this definition with equation (5),

$$TFPR_{ij} = \frac{\sigma}{\sigma - 1} \frac{w}{1-\tau_i}. \tag{6}$$

We can easily see that there is no revenue productivity dispersion within a market in this

[6]Differences in local competition would translate into markup dispersion across markets in an industry. See Hottman (2019).

[7]The lump-sum transfer T_i in the consumer's problem arises from the distortion τ_i, i.e., $T_i = \sum_{j=1}^{n} \tau_i p_{ij} y_{ij}$.

model, but there potentially is dispersion *across* markets. According to Hsieh and Klenow (2009), any revenue productivity dispersion in an industry is a sign of misallocation due to distortions. To see if this is the case for an industry with segmented markets, we need to check whether the decentralized equilibrium is Pareto efficient.

Since firms in a market are homogeneous, the equilibrium production and hired labor will be the same for all firms in a market. Therefore, the only thing that we need to check is whether a social planner would also want to equalize labor inputs across firms operating in the same market.

2.3 Social Planner

A social planner solves the following (reduced form) problem.[8]

$$max_{\{l_{ij}\}}\, U_A = A[\sum_{j=1}^{n} l_{Aj}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$$

$$s.t.$$

$$U_B = A[\sum_{j=1}^{n} l_{Bj}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \geq \bar{u}_B$$

$$\sum_{i\in\{A,B\}} \sum_{j=1}^{n} l_{ij} = 2\bar{L}.$$

I denote the Lagrange multipliers of the first and second constraints as λ and μ, respectively. The first-order conditions imply

$$A(\sum_{j=1}^{n} l_{Aj}^{\frac{\sigma-1}{\sigma}})^{\frac{1}{\sigma-1}} = \mu l_{Aj}^{\frac{1}{\sigma}} \quad (7)$$

$$A\lambda(\sum_{j=1}^{n} l_{Bj}^{\frac{\sigma-1}{\sigma}})^{\frac{1}{\sigma-1}} = \mu l_{Bj}^{\frac{1}{\sigma}}. \quad (8)$$

Equations (7) and (8) imply that l_{ij} is the same for all firms operating in the same market, i.e., $l_{Aj} = l_A$ and $l_{Bj} = l_B$, $\forall j$.

[8] The original social planner's problem is in Appendix.

Therefore, for a given $\bar{u}_B$, the social planner can always replicate the allocations in a decentralized equilibrium. In other words, the decentralized equilibrium is always Pareto efficient in an industry with segmented markets if the distortions vary only across markets.

The main message of this simple model is that dispersion in revenue productivity does not necessarily imply misallocation in an industry with segmented markets. Therefore, the model highlights that we may *over-estimate* the extent of misallocation if we regard revenue productivity dispersion across markets as a sign of misallocation.

2.4 Discussion

One might wonder whether the previous theoretical result depends on some of the strong assumptions of the model. In this subsection, I discuss if (1) inelastic labor supply and one factor production and (2) nontradability of goods are important assumptions in deriving the above theoretical result.

2.4.1 Inelastic Labor Supply and Single Factor Production

Assuming there is only one factor of production, which is supplied inelasticlly, and which is used in a linear production technology may seem to be critical in driving the result that there is no resource misallocation in the baseline model. Under these assumptions, the total labor supply is not affected by the level of the distortions, and labor reallocation across firms operating in different markets is just splitting the fixed pie into different pieces. In other words, labor reallocation across markets cannot lead to Pareto improvement, under the model's assumptions.

If we relax the assumption of inelastic labor supply, the decentralized equilibrium would not be socially optimal. However, it is important to think deeply about the nature of the social inefficiency. The model assumes monopolistic competition and exogenous taxes, which are deviations from an economy in which the First Welfare Theorem would apply. Fixed markups from monopolistic competition and exogenous taxes reduce firms' labor demand.

In turn, this leads to lower equilibrium labor inputs, and thus lower equilibrium outputs compared to the social planner's allocation. In sum, the inefficiency comes out of smaller *total* labor input than in the social planner problem. Even if we assume that there is no cross-market dispersion in the tax rate, i.e., $\tau_A = \tau_B$, a decentralized equilibrium is not socially optimal if we assume elastic labor supply.

However, the misallocation problem as presented in the existing literature does not come from inefficiency in total factor supply. According to Restuccia and Rogerson (2017), the misallocation problem is defined as "... we are interested in situations in which the allocation of a *given* amount of capital and labor across heterogeneous producers is distorted." Therefore, I discuss briefly if we would observe distortions in labor allocation for a given total labor supply in an extended model with elastic labor supply and production with both labor and capital. The details of the extended model are in the Appendix. The notation is the same as in the baseline model.

A consumer's utility in the extended model is defined by standard CES preferences with elastic labor supply where, σ is the substitution parameter across goods and η governs the elasticity of labor supply,

$$U_i = [\sum_{j=1}^{n} c_{ij}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} - \frac{1}{1+\frac{1}{\eta}} h_i^{1+\frac{1}{\eta}}, \tag{9}$$

where h_i is labor supply of household i. In equilibrium, $c_{ij} = y_{ij} = Ak_{ij}^{\theta} l_{ij}^{1-\theta} = A(\frac{k_{ij}}{l_{ij}})^{\theta} l_{ij}$ hold.

Several things should be noted from the decentralized equilibrium in the extended model in the Appendix. First, from (22), $\frac{k_{ij}}{l_{ij}}$ is constant for all i and j. Second, from (18), the equilibrium labor supply for both consumer A and B are the same, i.e,. $h_A = h_B$. Lastly, the equilibrium labor and capital inputs for each firm l_{ij} and k_{ij} are the same for each firm operating in the same market i. Considering the three results, I denote (1) $A(\frac{k_{ij}}{l_{ij}})^{\theta}$ as a constant C; (2) the common labor supply as h^{eq}; and (3) the common labor and capital inputs as L_i and K_i, respectively.[9]

Plugging these terms into (9) leads to the following (reduced form) utility function:

$$U_i = C^{\frac{\sigma}{\sigma-1}} L_i - \frac{1}{1+\frac{1}{\eta}} (h^{eq})^{1+\frac{1}{\eta}}. \tag{10}$$

By the labor market clearing condition, $n(L_A + L_B) = 2h^{eq}$. Therefore, if we do not consider inefficiency arising from the labor supply margin, following the definition of the misallocation problem in Restuccia and Rogerson (2017), any reallocation of labor inputs across markets increases one consumer's utility while decreasing the other consumer's utility. Formally speaking, for a given level of h^{eq}, an increase in L_A increases consumer A's utility while it decreases consumer B's utility. In sum, cross-market dispersion in the distortion does not lead misallocation as it is commonly defined even when we allow elastic labor supply and production using both capital and labor.

As a short side note, it might be reasonable to assume exogenous supply of capital and labor in the context of the ready-mixed concrete industry, which I study below. Demand for ready-mixed concrete mostly comes from the local construction sector. However, construction firms do not supply capital and labor to ready-mixed concrete plants. Therefore, assuming endogenous labor and capital supply in the context of ready-mixed concrete may be unnecessary.

2.4.2 Nontradable Goods

Another assumption made in the model is that all goods are nontradable. Unlike inelastic labor supply, the previous results are sensitive to the assumption that products are nontradable. However, assuming nontradability is necessary to study misallocation in an industry with locally segmented markets. If we can trade goods across regions, then it is hard to say

[9] According to the extended social planner's problem in the Appendix, a social planner would also want to equalize the labor supply of consumers A and B, i.e., $h_A = h_B$.

that firms in different regions belong to separate markets. As long as firms compete with each other by selling products to the same set of consumers, we have to say that they are operating in the *same* market. Therefore, nontradability of goods is an essential assumption to study misallocation in an industry with locally segmented markets.

3 Empirical Analysis

This section demonstrates empirically how much dispersion in revenue productivity can be attributed to pure within-market variation in a specific industry with locally segmented markets, specifically the ready-mixed concrete industry in Korea.

3.1 Data

The main source of data is the public version of the Korean Mining and Manufacturing Survey (KMMS) from 2007 to 2018. The data covers all mining and manufacturing establishments with at least 10 employees. The empirical analysis centers on the ready-mixed concrete industry (Industry Code: 23322), which is a leading example of an industry with locally segmented markets. Since producers have to deliver ready-mixed concrete before it hardens, markets have to be localized.[10] I use five variables to estimate revenue productivity for each establishment: revenue, labor compensation, the number of employees, fixed assets, and materials spending. I exclude the years 2010 and 2015 since the data in those years does not have information about fixed assets, which is an essential variable to estimate TFPR.

3.2 Market Definition

One of the key tasks is defining markets. According to anecdotal evidence quoted in Syverson (2004), "stated maximum ideal delivery distances (for concrete) were between 30- and 45-minutes drive from the plant." Under this principle, I define markets based on the *-Si* / *-Gun*

[10]See Syverson (2008) for the details of the ready-mixed concrete industry.

administrative classification in Korea. A *-Si* or *-Gun* is smaller than a county in the United States. However, since there is no within-*Si* highway in most cases, I argue that driving time within a *-Si* would be similar to that for a U.S. county. A notable exception is *Seoul*, which has a well-constructed highway system to adjacent cities. Therefore, I define *Seoul* and its adjacent cities as one market.

3.3 Empirical Framework

3.3.1 TFPR Estimation and Decomposition

A key variable of interest is the revenue productivity of establishments. Under a standard Cobb-Douglas production function, a log of revenue productivity (TFPR) of an establishment is computed as the log of its revenue minus a weighted sum of its logged labor input, capital stock, and materials spending as follows:

$$log(TFPR_{it}) := log(P_{it}A_{it}) = r_{it} - \alpha_{lt}l_{it} - \alpha_{kt}k_{it} - \alpha_{mt}m_{it}, \tag{11}$$

where the coefficients α_j are the input elasticities of input $j \in \{l, k, m\}$. Information about the coefficients α_j is essential to compute TFPR. I use the existing estimates for these coefficients from the Korea Industrial Productivity Database (KIP DB).[11] I obtain capital, labor, and material shares for non-metal minerals manufacturing from KIP DB. Although a CRS production function is not a trivial assumption, CRS is not rejected in the ready-mixed concrete industry data in the U.S. (Syverson (2004)).

Given estimated TFPR, I statistically extract a pure within-market component by esti-

[11]KIP DB assumes CRS production function and estimate α_l and α_m using labor and material shares from National Account. They estimate α_k by subtracting the estimates for labor and material spending from 1.

mating year-market fixed effects.

$$log(TFPR_{imt}) = \mu_{mt} + \epsilon_{imt}, \tag{12}$$

where $TFPR_{imt}$ is TFPR of firm i in market m in year t, μ_{mt} is a year-market fixed effect, and ϵ_{imt} is a residual term.

The main purpose of this empirical exercise is to show *quantitatively* how much dispersion in TFPR in an industry with locally segmented markets is reduced if we control for cross-market TFPR variation. I estimate $Var(log(TFPR_{imt}))$ and $Var(\epsilon_{imt})$ using the sample variance of estimated TFPR and the sample variance of estimated residuals from equation (12). The point of this exercise is to quantify the gap between $Var(log(TFPR_{imt}))$ and $Var(\epsilon_{imt})$.

3.3.2 Misallocation

As we are looking at an industry with locally segmented markets, it is hard to define a single misallocation index unless we assume a specific *social welfare function*. This is because multiple consumers are consuming in different markets, and we need to aggregate their utilities to create a single welfare index. As well-known, there is no unique correct way of defining a social welfare function. Therefore, misallocation measures should be calculated for each market, where we can define a representative consumer.

I am going to compare an industry-level misallocation measure from Hsieh and Klenow (2009) with market-level misallocation measures. I aggregate the market-level misallocation measures across markets by taking unweighted and revenue-weighted means, as there is no single correct aggregator.

Under CES demand and CRS technology, Hsieh and Klenow (2009) derive the following industry-level misallocation measure:

$$\mathcal{M}_t = 1 - [\sum_{i=1}^{n_t} (\frac{A_{it}}{\bar{A}_t} \frac{\overline{TFPR}_t}{TFPR_{it}})^{\sigma-1}]^{\frac{1}{\sigma-1}}, \tag{13}$$

where A_{it} and $TFPR_{it}$ are physical productivity (TFPQ) and the revenue productivity of a firm i in year t, and $\bar{A}_t = (\sum_{i=1}^{n_t} A_{it}^{\sigma-1})^{\frac{1}{\sigma-1}}$. I assume that there is only output distortion, so $TFPR_{it}$ fully captures underlying distortions. Under this assumption, $\frac{\overline{TFPR}_t}{TFPR_{it}} = \frac{1/TFPR_{it}}{\sum_i (1/TFPR_{it}) \frac{R_{it}}{\sum_i R_{it}}}$, where R_{it} is the revenue of firm i in year t and $\overline{TFPR}_t$ is the harmonic mean of $TFPR_{it}$, weighted by revenue share.[12]

Similarly, I calculate the misallocation measure for each market.

$$\mathcal{M}_{mt} = 1 - [\sum_{i \in m} (\frac{A_{it}}{\bar{A}_{mt}} \frac{\overline{TFPR}_{mt}}{TFPR_{it}})^{\sigma-1}]^{\frac{1}{\sigma-1}}, \tag{14}$$

where m is a market and $\frac{\overline{TFPR}_{mt}}{TFPR_{it}} = \frac{1/TFPR_{it}}{\sum_{i \in m} (1/TFPR_{it}) \frac{R_{it}}{\sum_{i \in m} R_{it}}}$. I then aggregate $\mathcal{M}_{mt}$ to the industry level using unweighted and revenue-weighted averages.

Since there is no information about physical output in KMMS, I estimate TFPQ using the method in Hsieh and Klenow (2009).

$$A_{it} = \frac{R_{it}^{\frac{\sigma}{\sigma-1}}}{K_{it}^{\alpha_k} L_{it}^{\alpha_l} M_{it}^{\alpha_m}}, \tag{15}$$

where K_{it}, L_{it}, and M_{it} are the capital, labor, and material inputs. Haltiwanger et al. (2018) point out that the Hsieh-Klenow TFPQ measure has a low correlation with TFPQ measures that are directly computed from physical outputs. However, the focus of this paper is not

[12] If there is no distortion, the equilibrium aggregate productivity is derived as $\bar{A}_t = (\sum_{i=1}^{n_t} A_{it}^{\sigma-1})^{\frac{1}{\sigma-1}}$. In other words, $\bar{A}_t$ is the aggregate productivity in the social planner's allocation. In this case, there is no TFPR dispersion. However, there is TFPR dispersion if there are distortions. In this case, the equilibrium aggregate productivity is *derived* as $[\sum_{i=1}^{n_t} (A_{it} \frac{\overline{TFPR}_t}{TFPR_{it}})^{\sigma-1}]^{\frac{1}{\sigma-1}}$. Therefore, misallocation index is defined as equation (13).

estimating TFPQ per se. Rather, it is to show how much estimated misallocation can be biased if we do not distinguish between industry and market for a *given* TFPQ distribution. As in Hsieh and Klenow (2009), I set $\sigma = 3$.

4 Results

4.1 Summary Statistics

Table 1 shows information about the markets for ready-mixed concrete in Korea and about revenue productivity dispersion. The average number of active markets over the period 2007-2018 in KMMS is 90.5. As there are no establishments for some geographic markets in some periods, the number of (active) markets varies over time. The average number of establishments in a market per year is around 5. The number is smaller than the average number of plants (15.0) reported for the U.S. in Syverson (2004). This implies that the markets in this paper might be more narrowly defined compared to the Bureau of Economic Analysis's component economic areas (CEA) used in Syverson (2004). I calculate the output-weighted average of log-TFPR for each market-year and then take the unweighted average of the market-year level average values, which results in an estimated average TFPR of 1.34.

The fourth and fifth rows of Table 1 report a notable fact. First, I calculate the within-market standard deviation of TFPR for each year. The unweighted average of these within-market standard deviations is 0.26, as shown in the fourth row. Next, I calculate the standard deviation of the aforementioned output-weighted average TFPR measures across markets, which is 0.23, as shown in the fifth row. Comparing these two numbers implies that across-market revenue productivity dispersion is sizable relative to within-market dispersion, suggesting that a considerable amount of revenue productivity dispersion may be consistent with efficiency, when seen through the lens of the model presented in Section 2.

[Table 1: Insert here]

4.2 TFPR Decomposition

Figure 1 shows alternative measures of dispersion in TFPR over time. The solid line and the gray dashed line represent estimated $Var(log(TFPR_{imt}))$ and $Var(\epsilon_{imt})$, respectively. On average, the variance of residual TFPR is around 14.2% smaller than the original TFPR variance.

[Figure 1: Insert here]

4.3 Misallocation

Figure 2 reports the extent of misallocation in the ready-mixed concrete industry for each year. The solid line is the Hsieh and Klenow industry-wide misallocation measure $\mathcal{M}_t$ in equation (13). The gray dashed line and the dashed dot line are unweighted- and revenue-weighted-means of the market-level misallocation measure $\mathcal{M}_{mt}$ in equation (14), that is, $\mathcal{M}_t^{UnWeighted} = \frac{1}{M_t}\sum_m \mathcal{M}_{mt}$ and $\mathcal{M}_t^{RevWeighted} = \sum_m \frac{\sum_{i\in m} R_{it}}{\sum_m \sum_{i\in m R_{it}}}\mathcal{M}_{mt}$, where M_t is the number of active markets in year t.

[Figure 2: Insert here]

We observe that misallocation as measured through industry-wide TFPR dispersion is higher than the two market-based misallocation indices. As argued above, however, there is no single correct aggregator of market-level misallocation, because the correct measure depends on how we construct the social welfare function. The point of this exercise to sound a caution that the standard Hsieh-Klenow misallocation measure might over-estimate the extent of misallocation in an industry when the industry consists of multiple markets.

5 Conclusion

I study the misallocation of production inputs in an industry with locally segmented markets. I argue that dispersion in revenue productivity is not always evidence of misallocation in terms of Pareto efficiency. If there is dispersion in distortions across markets, there is no misallocation, as an equilibrium allocation of resources across markets moves along the Pareto frontier. I quantify how much revenue productivity dispersion in the Korean concrete industry occurs within and across markets to show the potential magnitude of bias in measuring misallocation.

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6 Tables

# of markets	90.5
# of estab.	4.87
Output-weighted average log-TFPR	1.34
Within-market SD of log-TFPR	0.26
Across-market SD of log-TFPR	0.23

Table 1: Summary Statistics

7 Figures

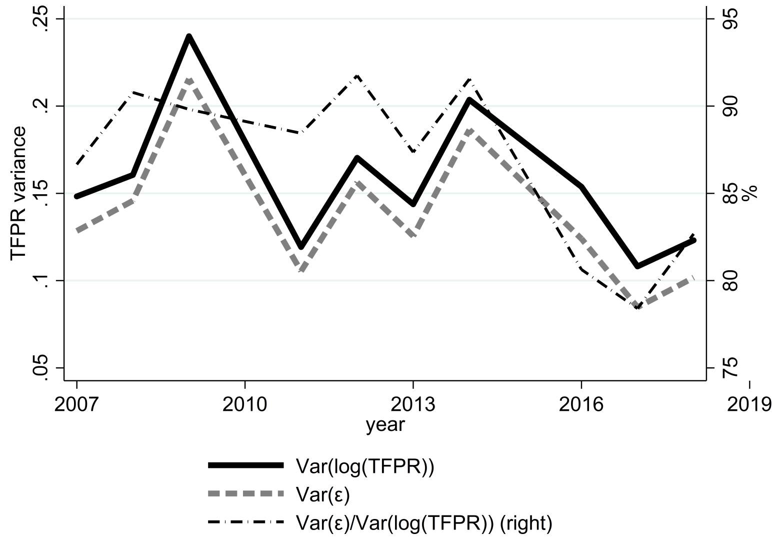

Figure 1: TFPR dispersion

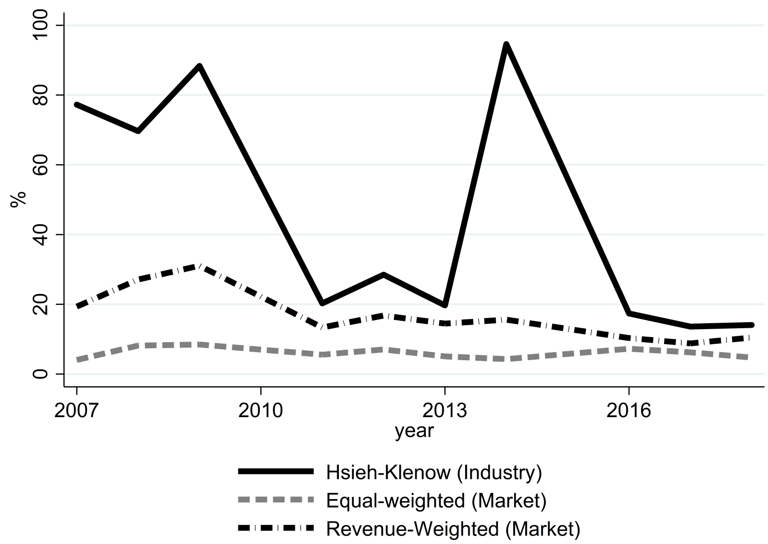

Figure 2: Misallocation

8 Appendix

8.1 The Original Social Planner's Problem

A social planner wants to solve the following problem:

$$max_{\{l_{ij}\}}\; U_A = [\sum_{j=1}^{n} c_{Aj}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$$

$$s.t.$$

$$U_B = [\sum_{j=1}^{n} c_{Bj}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \geq \bar{u}_B$$

$$\sum_{i\in\{A,B\}} \sum_{j=1}^{n} l_{ij} = 2\bar{L}, \quad c_{ij} = y_{ij}, \quad y_{ij} = Al_{ij}.$$

8.2 The Extended Model with Elastic Labor Supply and Production with Capital and Labor

Most of the assumptions are the same with the baseline model. I extend it by adding an endogenous labor supply and production with both capital and labor. All of the unexplained notations are the same with the one in the baseline model.

8.2.1 A Decentralized Economy

<u>Consumers</u>

A representative consumer in a market $i \in \{A, B\}$ has standard CES preference with the substitution parameter σ and the labor elasticity parameter η,

$$U_i = [\sum_{j=1}^{n} c_{ij}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} - \frac{1}{1+\frac{1}{\eta}} h_i^{1+\frac{1}{\eta}}, \tag{16}$$

where c_{ij} is consumption of product j in market i and h_i is labor supply of a consumer i. As in the baseline model, I assume that consumers supply their labor to both markets. I assume that a s_i share of total exogenous capital $\bar{K}$ is owned by a consumer i.

The budget constraint of a consumer i is

$$\sum_{j=1}^{n} p_{ij}c_{ij} \leq wh_i + r(s_i\bar{K}) + \alpha_i(\Pi_1 + \Pi_2) + T_i, \tag{17}$$

Consumers maximize (16) subject to (17). The resulting first-order condition with respect to consumption generates a standard demand function (3).

Labor supply is determined by equalization of marginal disutility of labor supply and wage.

$$w = h_i^{\frac{1}{\eta}} \tag{18}$$

Therefore, $h_A = h_B$ in equilibrium. Let denote the common equilibrium labor supply as h^{eq}, i.e., $h_A = h_B = h^{eq}$.

Firms

Firms in the economy produce differentiated goods with a CRS technology using both capital and labor. Firm j in market i produces output y_{ij} as

$$y_{ij} = Ak_{ij}^{\theta}l_{ij}^{1-\theta}, \tag{19}$$

where A is the common productivity, k_{ij} is capital input, l_{ij} is labor input, and θ is elasticity of output with respect to capital.

A firm maximizes profit subject to demand system (3) and production function (19),

$$\begin{aligned} max_{\{k_{ij},l_{ij}\}}\pi_{ij} = (1-\tau_i)p_{ij}y_{ij} - rk_{ij} - wl_{ij} \\ s.t. \ \ (3) \ \ \text{and} \ \ (19) \end{aligned}$$

where $c_{ij} = y_{ij}$. Profit maximization yields the standard first-order conditions:

$$r = \frac{\sigma - 1}{\sigma}(1 - \tau_i)p_{ij}A\theta k_{ij}^{\theta-1}l_{ij}^{1-\theta} \tag{20}$$

$$w = \frac{\sigma - 1}{\sigma}(1 - \tau_i)p_{ij}A(1 - \theta)k_{ij}^{\theta}l_{ij}^{-\theta} \tag{21}$$

By combining (20) and (21), we derive the following relationship between factor inputs

$$\frac{k_{ij}}{l_{ij}} = \frac{\theta}{1 - \theta}\frac{w}{r}, \quad \forall i, j. \tag{22}$$

In addition, we can easily see that y_{ij}, l_{ij} and k_{ij} are the same for the firms in market i.

Market Clearing

Goods, capital, and labor markets are cleared.

$$c_{ij} = y_{ij} \tag{23}$$

$$\sum_i \sum_j k_{ij} = \bar{K} \tag{24}$$

$$\sum_i \sum_j l_{ij} = h_A + h_B = 2h^{eq} \tag{25}$$

8.2.2 Social Planner

A social planner solves the following problem:

$$max_{\{l_{ij},k_{ij},h_A,h_B\}}\ U_A = [\sum_{j=1}^{n} c_{Aj}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} - \frac{1}{1+\frac{1}{\eta}}h_A^{1+\frac{1}{\eta}}$$

$$s.t.$$

$$U_B = [\sum_{j=1}^{n} c_{Bj}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} - \frac{1}{1+\frac{1}{\eta}}h_B^{1+\frac{1}{\eta}} \geq \bar{u}_B$$

$$\sum_{i\in\{A,B\}}\sum_{j=1}^{n} k_{ij} = \bar{K}, \quad \sum_{i\in\{A,B\}}\sum_{j=1}^{n} l_{ij} = h_A + h_B, \quad c_{ij} = y_{ij}, \quad y_{ij} = Ak_{ij}^{\theta}l_{ij}^{1-\theta}.$$

By solving the problem, it is easy to see that

$$h_A = h_B, \tag{26}$$

$$\frac{k_{Aj}}{l_{Aj}} = \frac{k_{Bj}}{l_{Bj}}, \quad \forall j \tag{27}$$

$$l_{ij} \text{ and } k_{ij} \text{ are constant for firms in the same market } i. \tag{28}$$