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Agglomeration Economies, Productivity, and Quality Upgrading

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Abstract

Empirical studies on agglomeration have focused on the identification of its productivity-enhancement effects. A reduction in marginal costs due to agglomeration economies increases the operating profit of firms, which enables them to employ more inputs to produce higher-quality products. This study examines such effects of agglomeration on product quality by using plant-product-level data for Japanese manufacturing. Empirical findings confirm that product quality increases with the market size of regions, suggesting that agglomeration-inducing polices are effective for increasing firms' profits by improving both productivity and product quality. Stated differently, our results indicate that the benefits of agglomeration on profits are underestimated in previous studies by ignoring its contribution to quality upgrading.

Keywords: Agglomeration, Japanese manufacturing, Product quality, Total factor productivity

JEL classification: D24, L15, R11

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1. Introduction

Agglomeration and its influences on regional economy have been extensively examined in urban economic literature (Ciccone and Hall 1996, Henderson 1986, Henderson 2003). For instance, Rice et al. (2006) demonstrate that most of the urban-rural income gaps can be explained by the difference in productivity between the two regions. Empirical studies have identified agglomeration economies (an externality arising from spatial concentration of economic activities) as a key determinant of regional productivity gaps (e.g., Combes et al. 2012). More precisely, productivity of firms in a region increases by 3–8% when the market size is doubled (World Bank 2009). In addition to such empirical evidence, studies on the micro-foundations of agglomeration economies have been accumulated recently (Duranton and Puga 2004).

Compared to considerable research attention on market size and the regional economy, the literature has not fully explored the role of the market structure in the context of agglomeration economies. However, this does not imply that its role is negligible. For example, it is well known that when firms face a downward sloping demand curve, namely, if they have some market power, their profit maximizing prices are inversely related to their productivity (Foster et al. 2008). This implies that the agglomeration's impacts on firms' profits will be partially offset because prices in cities are reduced by agglomeration economies.[2]

[2] A negative relationship between agglomeration and product prices may also arise because of transport costs. As transport costs can be saved in agglomerated regions, prices of manufacturing goods tend to be low there, according to the New Economic Geography literature (e.g., Krugman 1991). Empirically, Handbury and Weinstein (2015) conclude that the price level for food products falls with the market size in the United States.

Product quality constitutes an important factor of consumer demand for vertically differentiated products. Product quality, defined as a demand sifter, raises consumers' willingness to pay for the goods; to upgrade quality, firms are required to employ more inputs in the production process (Picard and Okubo 2012, Shaked and Sutton 1987). Since agglomeration economies raise the marginal product of inputs, firms in cities would optimally increase factor inputs to improve the quality of their products. Indeed, several articles have also addressed the role of the market size in quality upgrading. Picard (2015) develops a theoretical model in which he shows that the larger a region is, the higher the quality of goods produced by firms in that region. This is because a larger market size allows them to incur higher fixed costs necessary for quality upgrading. Empirical results in Hummels and Klenow (2005) indicate that larger countries tend to export higher-quality goods. Berry and Waldfogel (2010) confirm that product quality in the newspaper and restaurant industries is positively related to the regional market size. Yet, little attention has been paid to whether agglomeration economies improve product quality, or how quality upgrading alters the agglomeration's impacts on the firms' profits.

Our contribution is, therefore, to demonstrate theoretically and empirically the role of product quality in the context of agglomeration economies. The results of this study are summarized as follows: Agglomeration economies, modeled as Hicks-neutral technical change in the production function, reduce marginal costs of production in cities. A reduction in marginal costs increases operating profits of firms, which allows them to employ more inputs to upgrade the quality of their products. This finding motivates us to empirically explore the relationship between the regional market size and quality upgrading. In doing so, we follow Khandelwal (2010) to estimate the quality of products for each plant by employing plant-product-level data for Japanese manufacturing. By regressing the estimated product quality on variables that measure the regional market size, we find statistically significant evidence that agglomeration of economic activities in a region enhances the product quality of plants in that region.

This study provides important implications for competitiveness of firms. The production of high-quality goods is often considered as a source of competitiveness of firms, and as a precondition for economic development in the globalization era (Amiti and Khandelwal 2013). For example, for locating in the skill-intensive segments of an internationally fragmented production process, firms in developed countries are required to provide high-quality intermediated goods (Timmer et al. 2014). Japanese firms are no exception: within global value chains, they have steadily increased the share of exports of intermediate inputs (IMF 2015). To be competitive as suppliers of such goods, they are required to keep upgrading the quality of their products. Our results suggest that agglomeration-inducing policies are effective for this purpose: firms in urban areas allocate the benefits of agglomeration economies between productivity enhancement and quality upgrading.

To predict the effectiveness of agglomeration-inducing policies, previous studies have often examined the agglomeration's impacts on total factor productivity (TFP). However, if quality upgrading involves the increased use of inputs, TFP underestimates the benefits of agglomeration economies by ignoring their contribution to quality upgrading. To put it differently, the use of TFP as the base for the selection of targets for agglomeration subsidies can bias the (local) governments' decisions: industries that put the highest priority on quality upgrading may not be able to receive subsidies because the agglomeration's impacts measured by TFP will not be very high for them. Another contribution of this study is, therefore, to highlight the importance of considering the agglomeration's impacts on product quality when developing agglomeration-inducing policies.

The remainder of the paper is organized as follows: Section 2 discusses the economic role of product quality and the estimation methods, Section 3 outlines the conceptual and empirical framework, Section 4 enumerates our data sources and analytic variables, Section 5 presents empirical results, and Section 6 concludes with a summary of results and policy implications.

2. Product Quality and its Estimation

Understanding the economic role of product quality has attracted significant research attention in the literature on industrial organization and international trade. For instance, recent studies in empirical international trade try to incorporate product quality using product-level or plant-product-level data. As discussed in the introduction, product quality is economically defined as a demand sifter, which raises consumers' willingness to pay for a commodity. In other words, if one product is of higher quality than another, demand for the former is greater than the latter, even if the two products have the same price.

The level of product quality is optimally chosen by firms by altering marginal or fixed costs, or both (Shaked and Sutton 1987). Antoniades (2015) discusses that R&D investment (high fixed costs) is necessary to promote innovation for quality upgrading (see also Picard 2015). In contrast, Kugler and Verhoogen (2012) show that high-quality (high marginal-cost) inputs are required to produce high-quality products. The assumption on the link between product quality and marginal cost can be found in other studies, such as Baldwin and Harrigan (2011), Fan et al. (2015), and Hallak and Sivadasan (2013).

Indeed, we can observe marginal cost-quality trade-offs in various sites of production. First, Crozet et al. (2011) argue that the quality of French wine depends on the quality of the grapes, which are the primary intermediate goods. Farmers producing high-quality grapes avoid over-cropping to maintain the flavor, and therefore grapes from such vineyards with a high reputation tend to have higher prices. Furthermore, champagne wine needs more time for its lees to acquire more complexity in its taste. Second, Lexus, the luxury car brand from Toyota, is produced in highly sophisticated and computerized manufacturing plants (Kageyama 2007). Because quality requirements for the welding process, body panel fit tolerances, and painting are more stringent for Lexus than for other Toyota vehicles, only veteran technical workers are engaged in those processes. The third example is that of a handmade leather bag, Birkin, by Hermès, which is known as a symbol of wealth because of its high price and the fact that it is used by celebrities. According to Calgary Herald (2010), Birkin bags use leathers from various tanners and are hand-sewn, buffed, painted, and polished by expert artisans. These examples clearly demonstrate that improving product quality requires not only higher fixed costs but also higher variable costs.

Because quality upgrading accompanies additional variable costs, early studies such as Schott (2004) and Hallak (2006) employ unit value as a proxy for quality. Unit value can be easily obtained from trade data, but is not necessarily consistent with the definition of product quality. For example, even if products are supplied at an identical price (unit value), those with fashionable design or high functionality tend to have a larger market share because they are considered to be of better quality. Moreover, because unit value reflects the cost structure, it is possible that high-quality products have lower prices than low-quality counterparts. For example, Chinese smartphone company Xiaomi's current share in the smartphone market exceeds that of Apple and Samsung in China. This is not only because it offers products with low prices, primarily due to low wages and mass production, but also because its products are competitive in terms of design and functionality among Chinese consumers. To sum up, their competitiveness is not accurately reflected in a unit-value-based quality measure.

An ideal measure of product quality, therefore, should overcome such shortcomings of unit price. Khandelwal (2010) follows Berry (1994) to develop an alternative approach to measure product quality, based on the logit demand functions. Their approach is unique as it takes into account the differences in the market share between products. Among products with identical price, the highest quality is assigned to the one with the highest market share. Khandelwal (2010) applies the above method to U.S. trade data to estimate product quality by source countries for hundreds of manufacturing products. Using the same quality estimates, Amiti and Khandelwal (2013) examine if trade liberalization stimulates quality upgrading of manufacturing products.[3] In this study, we incorporate agglomeration economies into Khandelwal's (2010) framework to see how agglomeration of economic activities affects the firms' choice of quality and productivity.

3. Conceptual and Empirical Framework

3.1. Effects of Agglomeration on Product Quality

Consider the market with a monopolistic competition for product group *j* of industry *k*, which consists of plants producing product *i*, $i = 1, ..., I_j$. Consumer *n*'s utility for product *i* is defined as follows:

(1) $$V_{ni} = \lambda_i - \alpha p_i + \varepsilon_{ni},$$

where λ_i and p_i denote quality and price of product *i*, respectively. $\alpha > 0$ is a parameter,

[3] Other examples include Smeets et al. (2014) and Bernini et al. (2013). Smeets et al. (2014) investigate the relationship between product quality and foreign outsourcing in Danish apparel industry. Bernini et al. (2013) explore the effects of firm-level financial structure on the quality level of French exports.

measuring the utility loss due to an income fall. A random variable, ε_{ni}, represents consumer *n*'s specific preference for product *i*, implying that products are horizontally differentiated within product group *j* (Khandelwal 2010). Suppose ε_{ni} follows a type I distribution; then, the market share of product *i* within product group *j* is given by the following equation:

(2) $$s_i = \frac{\exp\left(\lambda_i - \alpha p_i\right)}{\sum_{l=1}^{I_j} \exp\left(\lambda_l - \alpha p_l\right)}.$$

Next, consider the supply side of the market. Following Fan et al. (2015), we assume that to engage in the production of differentiated goods, firms must undertake R&D investment, which uniquely determines the quality level of the product (λ_i). The amount of investment, or fixed cost of production, is:

(3) $$FC_i = \lambda_i^{\gamma} f,$$

where *f* is the amount of R&D investment necessary to develop a product of quality one ($\lambda_i = 1$), and a parameter $\gamma > 0$ indicates that developing a higher-quality product requires a greater investment. For a given λ_i, the production function is defined by the following equation (Fan et al. 2015):

(4) $$y_i = A\left(G_r\right)\lambda_i^{-\beta} g(\mathbf{x}),$$

where $\mathbf{x}$ is a vector of conventional inputs and $g(.)$ is linearly homogeneous in $\mathbf{x}$. A parameter $\beta > 0$ shows the extent (in percentage) to which output decreases when firms improve product quality by one percent, while holding inputs constant. In other words, Equation (4) implies that the production of higher-quality products requires more inputs.

Lastly, $A(.)$ represents agglomeration economies in region *r*, which increases with the market size (G_r) of that region, namely $\partial A / \partial G_r > 0$ (Henderson 2003). Provided Equation (4), the marginal costs of production are expressed in the following equation:

(5) $$MC_i = \frac{\lambda_i^{\beta} c(\mathbf{w})}{A(G_r)},$$

where $\mathbf{w}$ is a vector of input prices and $c(.)$ is unit costs to produce a product of quality one.

Given marginal and fixed costs, each firm, facing a demand curve in Equation (2), maximizes its profits with respect to price and quality:

(6) $$\max_{p_i,\lambda_i} \Pi_i \equiv s_i M \left(p_i - MC_i \right) - FC_i ,$$

where *M* denotes the total demand for the product group. First-order conditions for profit maximization are given as:

(7) $$p_i - \frac{1}{\alpha} - MC_i = 0 ,$$

(8) $$s_i M \left(p_i - MC_i - \frac{\partial MC_i}{\partial \lambda_i} \right) - \gamma \lambda_i^{\gamma - 1} f = 0 .$$

Second-order condition is satisfied as long as the following condition holds:

(9) $$B \equiv A^2 \left[(\beta - 1)(\beta MC_i s_i M)^2 + \beta\gamma(\beta + \gamma - 2) s_i M FC_i MC_i + (\gamma - \lambda_i - 1)(\gamma FC_i)^2 \right] > 0 .$$

Sufficient condition for Equation (9) is $\beta > 1$ and $\gamma > \lambda_i + 1$, indicating that production and R&D are characterized by diminishing returns to scale in quality (see Equations 3 and 4).

Equation (7) indicates that the price of a product is determined by the marginal costs and the utility loss due to an income fall (α). Because marginal costs are a function of product quality, the optimal product quality is implicitly determined by Equations (7) and (8). By applying the implicit function theorem to these equations, the effects of agglomeration, namely market size, on product quality and price are, respectively, derived as:

$$(10) \qquad \frac{\partial \ln \lambda_i}{\partial \ln G_r} = \frac{A^2 MC_i s_i M \left[\beta^2 MC_i s_i M + \gamma(\beta+\gamma) FC_i \right]}{B} \frac{\partial \ln A}{\partial \ln G_r},$$

$$(11) \qquad \frac{\partial \ln p_i}{\partial \ln G_r} = -\frac{MC_i}{p_i}\left(\frac{\partial \ln A}{\partial \ln G} - \beta \frac{\partial \ln \lambda_i}{\partial \ln G_r} \right).$$

In addition, the following equation can be obtained from Equations (2), (10), and (11):

$$(12) \qquad \frac{\partial \ln s_i}{\partial \ln G_r} = \frac{\lambda_i A^2 MC_i s_i M \left[\beta(\beta-1) MC_i s_i M + \gamma(\beta+\gamma-1) FC_i \right]}{B} \frac{\partial \ln A}{\partial \ln G_r}.$$

Equation (12) is positive as long as a sufficient condition for Equation (9) ($\beta > 1$ and $\gamma > \lambda_i + 1$) holds.

Because $\partial A / \partial G_r > 0$ from the definition of agglomeration economies, Equation (10) is positive, implying that product quality improves with the size of the market. As shown in Equation (5), an increase in product quality accompanies a rise in marginal costs, but to a lesser extent in large markets than in small ones because of agglomeration economies. Hence, the third term in the parenthesis of Equation (8) declines with the market size, indicating that firms in large regions must increase the quality level of their products so that Equation (8) holds. Equation (11) shows that there are two channels through which agglomeration economies affect the price of the product. The first term in parenthesis indicates that holding product quality constant, an improvement in productivity in a large region reduces marginal costs, and therefore reduces the prices of products in that region. The second term in parenthesis shows that quality upgrading increases the product price by the same extent as it increases marginal costs. The net impacts of agglomeration economies on price are ambiguous from Equation (11). Lastly, Equation (12) indicates that regardless of the agglomeration's impacts on prices, the market share is larger for firms in agglomerated regions than for those in less agglomerated regions. The above results can be summarized in the following proposition:

Proposition. *Suppose quality upgrading involves the increased use of inputs. If agglomeration economies are modeled as a Hicks-neutral technical change in the production function, then the following result holds: The larger the size of a market, the higher the product quality and the larger the market shares of firms in that region.*

This proposition will be empirically tested in the following section. However, there are, of course, other channels through which agglomeration improves product quality. For example, prices of high-quality material might be lower in urban areas where intermediate goods producers agglomerate (Fujita et al. 1999), which enables urban firms to produce higher-quality products than rural firms. Consequently, it should be noted that without explicitly specifying the spillover channel, the estimation results in the following section show the overall effects of agglomeration on product quality (Combes et al. 2008).

3.2. Effects of Agglomeration on Profits

We next consider the impacts of agglomeration on firms' profits. By differentiating firms' profits with respect to market size, we have:

(13) $$\frac{\partial \ln \Pi_i}{\partial \ln G_r} = \frac{\gamma}{\frac{\gamma - \lambda_i}{\alpha MC_i} + \beta} \frac{\partial \ln A}{\partial \ln G_r}.$$

Equation (13) indicates that agglomeration economies (*A*) increase firms' profits. The product quality augments the effects since the denominator declines with λ_i. This finding highlights the effectiveness of agglomeration-inducing policies; these policies can increase profits directly and indirectly through quality upgrading.

Quality upgrading also has important implications for the measurement of benefits of agglomeration economies. In general, TFP in the literature is obtained as the residual between revenue deflated by the industry price index (P_k) and the weighted sum of inputs in the production function:

(14) $$\ln TFP_i \equiv \ln \frac{R_i}{P_k} - \ln g(\mathbf{x}).$$

Note that revenue is the product of output and price of the product:

(15) $$R_i \equiv p_i y_i.$$

By substituting Equation (15) into (14) and by using Equation (4), TFP can be rewritten as:

(16) $$\ln TFP_i = \ln A - \beta \ln \lambda_i + \ln p_i - \ln P_k.$$

According to Equation (16), TFP constitutes agglomeration economies, product quality, price of the product, and the industry price index.

By differentiating Equation (16) with respect to the market size, the following equation can be derived:[4]

(17) $$\frac{\partial \ln TFP_i}{\partial \ln G_r} = \left(1 - \frac{MC_i}{p_i}\right)\left(\frac{\partial \ln A}{\partial \ln G_r} - \beta \frac{\partial \ln \lambda_i}{\partial \ln G_r}\right).$$

The first parenthesis represents the Lerner index: the higher market power a firm has, the greater will be the improvement in TFP due to market size. The second parenthesis is the difference between an increase in agglomeration economies and the increased use of inputs for quality upgrading, both due to an increase in market size. Equation (17) explicitly indicates that firms allocate the benefits of agglomeration economies ($\partial \ln A / \partial \ln G_r$) between productivity enhancement ($\partial \ln TFP_i / \partial \ln G_r$) and quality upgrading ($\partial \ln \lambda_i / \partial \ln G_r$).[5] Hence, when regressing TFP on the market size (*G*) without controlling the product quality (λ_i), the parameter estimate on market size does not represent the impacts of market size on agglomeration economies (*A*). Instead, it is biased downward due to the increased use of inputs for quality upgrading.

As shown in Equation (13), agglomeration economies determine firms' profits. Although TFP has been widely employed in the literature to quantitatively evaluate the impacts

[4] The derivative of the industry price index with respect to market size is assumed to be zero. As the industry price index is aggregated at the national level, it is not likely that an infinitesimal change in market size of a single region will significantly affect the industry price index.

[5] Strictly speaking, the effects of agglomeration on product quality are also reflected in TFP through a rise in prices (Equation 11). However, the argument that TFP underestimates the benefits of agglomeration economies is valid as long as quality upgrading involves an increase in factor inputs.

of agglomeration on firms' profitability, the interpretation should be cautious as TFP may underestimate the benefits of agglomeration economies by ignoring quality upgrading as long as quality upgrading involves the increased use of inputs.[6]

3.3. Estimation of Product Quality

Following Khandelwal (2010) and Amiti and Khandelwal (2013), our empirical framework starts from defining consumer *n*'s utility as a function of price, product quality, and consumer *n*'s specific preference for the product (Equation 1). If we assume that each individual chooses to consume one unit of product *i* that has the highest utility within a product group, the market share of product *i* is given by Equation (2). To make the model empirically tractable, consumers are allowed not to select any product from among alternatives but purchase an outside product; the utility of consuming an outside product is normalized to zero ($\lambda_{ot} - \alpha p_{ot} = 0$). Then, Berry (1994) shows that the log difference between the market shares of product *i* and that of an outside product can be expressed as:

$$\ln s_{it} - \ln s_{ot} = \lambda_{it} - \alpha p_{it}, \quad (18)$$

where *t* denotes the year and s_{ot} is the market share of an outside product in year *t*.

Detailed product characteristics such as the sugar content of cereals and the fuel efficiency of automobiles can be used as proxies for product quality (e.g., Berry et al. 1995,

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[6] We cannot directly examine the impacts of quality upgrading on TFP as suggested in Equations (16) and (17) because estimation of plant-product level TFP is not possible. Our sample includes many multi-product plants but we do not know how much factor inputs are used for individual products.

Nevo 2001). However, in our case, such product characteristics are not available. Instead of using proxies, following Khandelwal (2010), we assume that the product quality λ_{it} can be expressed as the sum of three factors: year fixed effects (δ_t), plant-product fixed effects (δ_i), and product-year fixed effects (δ_{it}).[7] Year fixed effects are supposed to capture time-specific macro-economic shocks on product quality. By contrast, plant-product fixed effects measure the time-invariant product quality. Stated differently, they are supposed to reflect the plant-specific ability to produce high-quality products. Lastly, product-year fixed effects—deviations from average quality—are treated as the residual. Then, Equation (18) can be rewritten as follows:

(19) $$\ln s_{it} - \ln s_{ot} = -\alpha p_{it} + \varphi \ln size_{it-1} + \delta_t + \delta_i + \delta_{it}.$$

Equation (19) is individually estimated for each product group but, econometrically, there are three issues that need to be addressed when estimating Equation (19). First, as will be discussed in Section 4, our definition of products is based on a 6-digit level of the product classification. If products were classified at a finer level, the market share of each product would be an aggregation of more finely classified "hidden" varieties within the product.[8] Stated differently, the more hidden varieties a firm produces within the same product group, the larger will be the market share of that firm. Following Khandelwal (2010), we control the potential number of hidden varieties by the lagged plant size ($size_{it-1}$) in Equation (19).

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[7] As plant is a unit of analysis in our empirical studies, *i* refers to plant-product and not firm-product.
[8] For example, apparel producers offer a variety of products with different colors or different sizes for an identical price within each product group.

Second, the amount of consumption of the outside product is not known in our dataset.[9] However, we can consider the market share of the outside product as another component of year fixed effects because it takes the same value for every product within the same product group by definition. Accordingly, the equation to be estimated can be rearranged as follows:

(19′) $\ln s_{it} = -\alpha p_{it} + \varphi \ln size_{it-1} + \xi_t + \delta_i + \delta_{it}$,

where $\xi_t \equiv \ln s_{ot} + \delta_t$. Lastly, as prices and market shares are simultaneously determined in the market, appropriate instruments are needed to consistently estimate the price parameter in Equation (19′). Two instruments are used in this study: annual gas prices by prefecture and the average price of products (excluding the price of plant-product *i*) belonging to the same product group. The identifying assumption is that distribution costs (gas prices) and the average price of products represent the cost structure of plant-product *i* in year *t* to some extent, and therefore can explain its price (p_{it}). However, distribution costs or common shocks to prices of other products in year *t* have negligible impacts on plant *i*'s decision on the product's quality level in the same year (δ_{it}) if we control for plant-product and year fixed effects on quality (Nevo 2001, Khandelwal 2010).

3.4. Identification of Agglomeration Economies

Once we obtain the parameter estimates in Equation (19′), the product quality can be estimated

[9] Imported products are often used as the outside product in previous studies. However, we cannot obtain the value of imports for each product because the concordance table between the product classification in the Census of Manufactures and that in trade statistics is not available.

for each plant-product and year as follows:

(20) $\hat{\lambda}_{it} = \hat{\delta}_i + \hat{\delta}_{it} = \ln s_{it} + \hat{\alpha} p_{it} - \hat{\varphi} \ln size_{it-1} - \hat{\xi}_t$.

Year fixed effects (ξ_t) are deducted in Equation (20) because they reflect not only time-specific shocks on product quality but also the market share of the outside product. Given the product quality estimates, we can evaluate the impacts of agglomeration on product quality from the following equation:

(21) $\hat{\lambda}_{it} = \kappa_0 + \kappa_1 \ln G_{rt} + \theta_i + \mu_{it}$.

A statistically significant positive sign on market size (G_{rt}) indicates that agglomeration economies enhance product quality.

Plant-product fixed effects (θ_i) are included in Equation (21) to control for unobserved plant heterogeneity (Henderson 2003, Martin et al. 2011). The product quality might be high in cities not because of agglomeration economies but due to spatial sorting of plants producing high-quality products into cities (Picard and Okubo 2012). In addition, the parameter on market size can be spurious due to the simultaneity bias caused by the correlation between the market size of a region and unobserved economic shocks on the quality of plant-product *i* in the region (μ_{it}) (Combes and Gobillon 2015, Martin et al. 2011). We apply the GMM estimation to the first difference of Equation (21) to correct for the simultaneity bias:

(22) $\Delta\hat{\lambda}_{it} = \kappa_1 \Delta \ln G_{rt} + \Delta\mu_{it}$.

We instrument first-differenced explanatory variables in Equation (22) by their level at year

$t-2$. Suppose market size converges over time to a certain level. Then, the first difference in the log of market size should be negatively correlated with the level of that variable at year $t-2$; however, the exclusion restriction remains valid as long as market size at year $t-2$ does not affect the change in unobserved shocks between $t-1$ and t (Martin et al. 2011).

4. Data and Variables

The *Census of Manufactures*, published by Japan's Ministry of Economy, Trade and Industry (METI), is the primary data source in this study. Its microdata are available only for plants that have four or more employees.[10] A unique identification number is assigned for each plant and each product, which allows the construction of a panel of individual plant-product from 1994 to 2007.[11] The product classification is frequently revised; however, revisions within this period are relatively minor. Hence, products from different years can be easily matched with each other by using the concordance table. Our key variables—value of shipment and quantity—are available at the 6-digit level of the product classification.[12] However, we exclude miscellaneous products such as "miscellaneous telecommunication equipment" from the sample because METI does not ask plants to report the quantity of those products.[13] In addition, following Khandelwal (2010), we restrict our sample to differentiated products—classified based

[10] All establishments in the manufacturing sector are covered in a census in calendar years ending in 0, 3, 5, and 8. By contrast, only establishments with four or more employees are covered in other years.

[11] The plant identification number is revised every five years. Thus, we use the concordance table provided by the RIETI to construct a panel of plant-product-level data.

[12] The first four digits of the product codes mostly correspond to the 4-digit International Standard Industrial Classification.

[13] For example, among 1,842 product groups, quantity shipped is reported for 765 groups in 2007.

on Rauch (1999)'s (conservative) product classification—as the variations in product quality are zero by definition for homogeneous goods. After the elimination of product groups with a small number of observations, 380 product groups remain in the sample.

With regard to regional variables, the *Census of Manufactures* provides information about plant location at two administrative levels: prefecture and municipality. We use each of the 47 prefectures as a geographical unit (region) because the latter unit is too small to capture agglomeration. Workers commute and firms transact with suppliers and customers beyond the border of municipalities. However, prefecture is also an administrative geographical unit and does not necessarily coincide with the economic boundary of regions. An official geographical unit similar to the metropolitan statistical area (MSA) in the United States is not available in Japan; however, Asahi-Shimbun (2007), a newspaper company, defines original metropolitan areas in which municipalities are grouped into 110 metropolitan areas according to commuting patterns. The results obtained from using prefecture as a geographical unit will be compared with those based on metropolitan areas to check the robustness of the results. The annual gas prices by prefecture, annual prefectural population, and annual municipal population are, respectively, obtained from *Retail Price Survey*, *Population Estimates*, and *Basic Resident Registration* published by the Ministry of Internal Affairs and Communications (MIC).

Variables are constructed as follows. The market share of plant-product i (s_{it}) is the ratio of quantity of product i shipped to the sum of quantity of products shipped, which belong to the same 6-digit product group. The price of the product (p_{it}) is measured by dividing the value of shipment by quantity shipped. Observations belonging to the top and bottom 1% of the price distribution for each product group are dropped from the sample to exclude outliers. Lastly, the number of employees at year $t-1$ is used as a proxy for the lagged plant size ($size_{it-1}$).

As for agglomeration economies, previous studies consider two types of externalities: localization and urbanization economies (e.g., Combes et al. 2008, Martin et al. 2011). Localization (urbanization) economies are productivity-enhancing externalities that arise from the spatial concentration of firms in the same (any) industry. Following Martin et al. (2011), localization economies (LOC_{it}) are measured as one plus the total number of employees in other plants in the same industry and region as plant i.[14] Urbanization economies (MP_{rt}) are measured by regional population (Henderson 1986). We construct the measure of urbanization economies by employing the idea of market potential to take into account the discussion that administrative regions do not necessarily coincide with the economic boundary of regions. Market potential is an indicator of the proximity to intermediate and final goods markets and producers, which is originally introduced in Harris (1954) and extensively discussed in the New Economic Geography literature (Fujita et al. 1999). In most of the empirical studies (e.g., da Mata 2007), it is defined as the weighted sum of population in a region and its neighboring

[14] The definition of industry is based on the 3-digit industrial classification. As the data on employment used for the production of individual products is not available for multi-product plants, plants' industrial classification is determined by their major products in the year concerned.

regions using the inverse of transport costs as weights:

$$(23) \qquad MP_{rt} = \sum_c \frac{Pop_{ct}}{\tau_{rct}},$$

where Pop_{ct} denotes population in region *c* in year *t*. τ_{rct} represents the transport costs from region *r* to *c* in year *t* and is defined as:

$$(24) \qquad \tau_{crt} = p^g_{ct} d_{cr},$$

where p^g_{ct} is gas prices in region *c* in year *t* and d_{cr} is the great circle distance between regions *c* and *r*.[15] The intraregional distance is given by $2/3\sqrt{Area_r/\pi}$, where $Area_r$ denotes the area of region *r*. Summary statistics of variables are reported in Table 1.

5. Estimation Results

The results from estimating Equation (19′) for each product group are summarized in Table 2. Overall, our data fit well with the postulated logit demand model. Of the 380 product groups, price coefficients are negative and significant for 335 groups. From among these, the regression model satisfies the over-identification test, and has low first-stage *F*-statistic *p*-values for 289 groups. The third row shows that the average and the median of the coefficients of the plant size are positive, suggesting that the market share increases to some extent due to hidden varieties. Lastly, the median of own price elasticity is -0.596, which is very close to that of -

[15] Gas prices exhibited large fluctuations (from 87 to 146 yen per liter) during the sample period. If average gas mileage does not vary much across years, Equation (24) measures the average cost of fuel consumption to transport goods between the two regions.

0.58 in Khandelwal (2010).[16]

Given the parameter estimates in Table 2, the quality for each plant-product is obtained according to Equation (20), and is used to estimate Equation (22). Note that the plant-product fixed effects disappear when taking the first difference in product quality in Equation (22) and only residuals, namely, variations in product quality in the short run, remain in the estimation. Thus, the estimation results of Equation (22) explain the agglomeration's impacts on quality upgrading in the short run. In order to observe the contribution of such short-run variations to overall variations in product quality, we carry out a variance decomposition in Table 3.[17] Most of the variation in product quality is explained by that in the plant-product fixed effects, but the contribution of residuals is not negligible.

The estimation results of Equation (22) are presented in Table 4.[18] The parameters on market potential (urbanization economies) are significantly positive for any specification, implying that a proximity to intermediate and final goods markets and producers is key to improving product quality. In both cases (prefectures and metropolitan areas), GMM estimates of coefficients on market potential are greater than OLS estimates. Plants facing negative shocks on the quality of their products have to employ more inputs for quality upgrading than those facing positive shocks, and thus need to increase the demand for production factors,

[16] Own-price elasticity is low because parameters are estimated using variation within plant-product over time (Khandelwal 2010).

[17] Since the average product quality from different product groups cannot be compared directly, the average of standard deviation obtained for each product group is presented in the table.

[18] Instruments are LOC_{rt-2}, MP_{rt-2}, and population in region r in year $t-2$.

including hiring of additional workers. Consequently, our GMM estimates could be deemed correct for such negative correlation between shocks on product quality and population.

Before we evaluate the agglomeration's impacts on product quality quantitatively, a comment on the interpretation of parameter estimates is in order. Although not explicitly considered in Section 2.1, there might exist a case that agglomeration economies reduce the fixed costs (FC_i) necessary for quality upgrading (Equation 3). For example, knowledge spillovers in cities may improve the performance of R&D projects. Thus, a positive relationship between product quality and market size, as observed in Table 4, might be a result of lowered fixed costs due to agglomeration economies. However, considering a significant time lag between R&D investment and the production of upgraded products, it is not likely that plants instantaneously adjust product quality to contemporaneous shocks on market potential by altering their level of R&D investment. Alternatively, if fixed costs for quality upgrading do not show significant variations in the short run, they will be captured by plant-product fixed effects (θ_i) in Equation (21). As a result, a positive sign on the market potential in Equation (22) should indicate that quality upgrading is realized through a reduction in marginal costs due to agglomeration economies.

The economic interpretation of parameter estimates in Table 4 is obtained by considering how much the product quality improves when the market size is doubled, and to what extent it contributes to variations in product quality in Table 3. When the market potential is doubled, the product quality increases by 0.241, or by 0.178, depending on the specification of the geographical unit. Hence, the agglomeration's impacts on quality upgrading are considerably large; 47.7% (= 0.241 / 0.505) or 35.2% (= 0.178 / 0.505) of the variations in product quality in the short run are explained by agglomeration economies.

Since variations in product quality are mostly determined by plant-product fixed effects (Table 3), identifying their local determinants is also important. Following Martin et al. (2011), plant-product fixed effects are regressed on the average of $\ln LOC_{it}$ and $\ln MP_{rt}$ across years, for each plant-product. The estimation results are presented in Table 5. Contrary to the short-run's case in Table 4, localization economies significantly improve product quality in either of the specifications of the geographical units. As discussed above, if plant-product fixed effects reflect fixed costs for quality upgrading, the results suggest that spatial concentration of plants in the same industry improves the efficiency of R&D projects and lowers the fixed costs necessary for quality upgrading. Alternatively, for products mainly consumed within a local market, the size of the local market, namely, $\ln LOC_{it}$ and $\ln MP_{rt}$, determines the maximum level of fixed costs each plant in that market can afford (Picard 2015). Therefore, the results may indicate that urban plants producing locally consumed products can afford greater fixed costs than rural plants can. At the end, because the estimation model does not explain any causality between plant-product fixed effects and the market size, the results may support the sorting hypothesis by Picard and Okubo (2012) that plants producing high-quality products prefer to locate in regions with a large market.

Following this, Equation (22) is estimated separately for small and large plants in Table 6.[19] Since small plants are more dependent on local economic conditions than their larger counterparts, the former are more likely to benefit from agglomeration economies than the latter (Acs et al. 1994, Martin et al. 2011). This argument should hold even if product quality is used as the dependent variable. Indeed, coefficients on market potential are positive and significant only if Equation (22) is estimated for small plants in Table 6. Furthermore, the magnitude of those coefficients is nearly or more than doubled when compared with Table 4. Coefficients on localization economies (LOC_{rt}) are unexpectedly negative and significant in the estimation for large plants, implying that spatial concentration of firms in the same industry worsens the quality of products of the large plants. This might be due to high congestion costs, outweighing agglomeration benefits for large plants in large regions.

Lastly, Table 7 presents the results of estimation using the market share as the dependent variable. Coefficients on market potential are positive and significant in either specification of the geographical unit, indicating that the larger the market potential in a region is, the bigger is the market share of plants in that region. Consequently, empirical results that both the product quality and the market share increase with market size are supportive of the proposition in Section 2.1.

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[19] A plant is considered large if the average employment of the plant during the estimation period exceeds its median.

6. Summary and Conclusions

Agglomeration economies are the key determinant of regional economic performance, and therefore have attracted great attention in academic and policy circles. It is generally agreed that doubling the market size enhances the productivity of firms by 3–8%. However, the effects of agglomeration on product quality have not been well examined in the literature. Since product quality constitutes one of the important factors characterizing consumer demand, identifying effective policies for quality upgrading will help improve firms' competitiveness.

This study demonstrates theoretically and empirically how agglomeration of economic activities affects the firms' choice of product quality. To be consistent with the definition of product quality, we extend Berry (1994) and Khandelwal's (2010) logit demand framework to include the firms' decision on product quality. The theoretical analysis indicates that productivity improvement due to agglomeration economies allows firms to employ more inputs to enhance the quality of their products. The empirical analysis confirms the quality-enhancing effects of agglomeration by using plant-product-level data for Japanese manufacturing.

The results of this study demonstrate the effectiveness of agglomeration-inducing policies for quality upgrading. To be more precise, firms allocate the benefits of agglomeration economies between productivity enhancement and quality upgrading. We have shown that TFP underestimates the benefits of agglomeration economies by ignoring their contribution to quality upgrading. As a result, the local governments' choice of targets for agglomeration subsidies may be biased toward industries where quality upgrading is not the main concern, as long as the decision is based on how much the TFP of the firms in the targeted industry improves. The agglomeration's impacts on product quality should be considered in order to implement ideal agglomeration-inducing policies, favoring firms that balance quality upgrading and productivity improvement to maximize their overall competitiveness.

References

Acs, Z., Audretsch, D., and M. Feldman. (1994). “R&D spillovers and recipient firm size.” *Review of Economics and Statistics*. 76: 336-340.

Amiti, M. and A. Khandelwal. (2013). “Import competition and quality upgrading.” *Review of Economics and Statistics*. 95: 476–490.

Antoniades, A. (2015). “Heterogeneous firms, quality, and trade.” *Journal of International Economics*. 95: 263–273.

Asahi-Shimbun. (2007). *Minryoku 2007*. Tokyo: Asahi-shimbun.

Baldwin, R. and J. Harrigan. (2011). “Zeros, quality and space: Trade theory and trade evidence.” *American Economic Journal: Microeconomics*, 3: 60–88.

Bernini, M., Guillou, S., and F. Bellone. (2013). “Firm’s leverage and export quality: Evidence from France.” *GREDEG Working Paper*, No.2013-29. Nice, France: Gredeg-Skema.

Berry, S. (1994). “Estimating discrete-choice models of product differentiation.” *RAND Journal of Economics*. 25: 242–262.

Berry, S., Levinsohn, J., and A. Pakes. (1995). “Automobile prices in market equilibrium.” *Econometrica*. 63: 841–890.

Berry, S. and J. Waldfogel. (2011). “Product quality and market size.” *Journal of Industrial Economics*. 58: 1–31.

Calgary Herald. (2010). “Box up the Birkin Hermes craftsman stitches up lavish leather goods in

Calgary." *The Calgary Herald*. 16 October 2010.

Ciccone, A. and R. Hall. (1996). "Productivity and the density of economic activity." *American Economic Review*. 86: 54–70.

Combes, P.P., Duranton, G., and L. Gobillon. (2008). "Spatial wage disparities: Sorting matters!" *Journal of Urban Economics*. 63: 723–742.

Combes, P.P., Duranton, G., Gobillon, L., Puga, D., and S. Roux. (2012). "The productivity advantages of large cities: Distinguishing agglomeration from firm selection." *Econometrica*. 80: 2543–2594.

Combes, P.P. and L. Gobillon. (2015). "The Empirics of agglomeration economies" in G. Duranton, J.V. Henderson, and W. Strange, eds., *Handbook of Regional and Urban Economics Volume 5A*. Amsterdam: Elsevier.

Combes, P.P., Mayer, T., and J.F. Thisse. (2008) *Economic Geography*. Princeton: Princeton University Press.

Crozet, M., Head, K., and T. Mayer. (2012). "Quality sorting and trade: Firm-level evidence for French wine" *Review of Economic Studies*. 79: 609–644.

da Mata, D., Deichmann, U., Henderson, J.V., Lall, S., and H. Wang. (2007). "Determinants of city growth in Brazil." *Journal of Urban Economics*. 62: 252–272.

Duranton, G. and D. Puga. (2004) "Micro-foundations of urban agglomeration economies." in J.V. Henderson and J.F. Thisse, eds., *Handbook of Regional and Urban Economics*

Volume 4. Amsterdam: Elsevier.

Fan, H., Li, Y., and S. Yeaple. (2015). “Trade liberalization, quality, and export prices.” *Review of Economics and Statistics*. 97: 1033–1051.

Foster, L., Haltiwanger, J., and C. Syverson. (2008). “Reallocation, firm turnover, and efficiency: Selection on productivity or profitability?” *American Economic Review*. 98: 394–425.

Fujita, M., Krugman, P., and A.J. Venables. (1999). *The Spatial Economy: Cities, Regions, and International Trade*. Cambridge, MA: MIT Press.

Hallak, J.C. (2006). “Product quality and the direction of trade.” *Journal of International Economics*. 68: 238–265.

Hallak, J.C. and J. Sivadasan. (2013). “Product and process productivity: Implications for quality choice and conditional exporter premia,” *Journal of International Economics*, 91: 53–67.

Handbury, J. and D. Weinstein. (2015). “Goods prices and availability in cities.” *Review of Economic Studies*. 82: 258–296.

Harris, C. (1954). “The market as a factor in the localization of industry in the United States.” *Annals of the Association of American Geographers*. 44: 315–348.

Henderson, J.V. (1986). “Urbanization in a developing country: City size and population composition.” *Journal of Development Economics*. 22: 269–293.

Henderson, J.V. (2003). “Marshall’s scale economies.” *Journal of Urban Economics*. 53: 1–28.

Hummels, D. and P. Klenow. (2005). “The variety and quality of a nation’s exports.” *American Economic Review*. 95: 704–723.

International Monetary Fund (IMF). (2015) *World Economic Outlook*. Washington, DC: IMF.

Kageyama, Y. (2007). “At Lexus ‘dojo’ plant workers train on virtues to keep up quality, build elite team.” *Associated Press*. 13 October 2007.

Khandelwal, A. (2010). “The long and short (of) quality ladders.” *Review of Economic Studies*. 77: 1450–1476.

Krugman, P. (1991). “Increasing Returns and Economic Geography.” *Journal of Political Economy*. 99: 483–499.

Kugler, M. and E. Verhoogen. (2012). “Prices, plant size, and product quality.” *Review of Economic Studies*. 79: 307–339.

Martin, P., Mayer, T., F. Mayneris. (2011). “Spatial concentration and plant-level productivity in France.” *Journal of Urban Economics*. 69: 182–195.

Nevo, A. (2001). “Measuring market power in the ready-to-eat cereal industry.” *Econometrica*. 69: 307–342.

Picard, P.M. (2015). “Trade, economic geography and the choice of product quality.” *Regional Science and Urban Economics*. 54: 18–27.

Picard, P.M. and T. Okubo. (2012). “Firms' locations under demand heterogeneity.” *Regional Science and Urban Economics*. 42: 961–974.

Rauch, J. (1999). "Network versus markets in International trade." *Journal of International Economics*. 48: 7–35.

Rice, P., Venables, A.J., and E. Patacchini. (2006). "Spatial determinants of productivity: Analysis for the regions of Great Britain." *Regional Science and Urban Economics*. 36: 727–752.

Schott, P. (2004). "Across-product versus within-product specialization in international trade." *Quarterly Journal of Economics*. 119: 647–678.

Shaked, A. and J. Sutton. (1987). "Product differentiation and industrial structure." *Journal of Industrial Economics*. 36: 131–146.

Smeets, V., Traiberman, S., and F. Warzynski. (2014). "Offshoring and the shortening of the quality ladder: Evidence from Danish apparel." *ERIA Discussion Paper*, No. 2014-12. Jakarta, Indonesia: ERIA.

Timmer, M., Erumban, A., Los, B., Stehrer, R., and G. de Vries. (2014). "Slicing up global value chains." *Journal of Economic Perspectives*. 28: 99–118.

World Bank. (2009). *World Development Report 2009: Reshaping Economic Geography*. Washington, DC: The World Bank.

Table 1: Summary Statistics

Variable	Unit	Mean	Std. dev.
Price	Yen	217.26	8,795.66
Market share	Index, 0-1	0.01	0.03
Plant size	Person	63.88	372.78
# Employees in the same industry and prefecture	Person	2,772.03	8,924.63
Market potential (prefecture)	Number	5,557.14	3,328.48
# Employees in the same industry and metropolitan area	Person	1,828.23	8,113.67
Market potential (metropolitan area)	Number	4,531.53	2,275.64

Source: METI, Census of Manufactures, various years
MIC, Retail Price Survey, various years
MIC, Population Estimates, various years
MIC, Basic Resident Registration, various years

Table 2: Parameter Estimates of Demand Functions

Statistic	Mean	Median	10th percentile	90 percentile
Price coefficient	-0.426	-0.018	-1.001	-0.000
Price coefficient, *p*-value	0.049	0.000	0.000	0.146
Coefficient on plant size	0.403	0.439	-0.015	0.779
Own price elasticity	-0.567	-0.596	-0.944	-0.187
Over-identification restrictions, *p*-value	0.456	0.437	0.055	0.874
First stage *F*-stat, *p*-value	0.001	0.000	0.000	0.000
Observations per estimation	1874	499	164	3080
Total estimations		380		
Total observations		712,265		

Note: Equation (19′) is individually estimated for 380 product groups. Each row of the table except for the own price elasticity presents summary statistics of the estimation results for each product group. Own price elasticity is obtained for each observation by multiplying price coefficient by the price of plant-product. Standard errors clustered at the plant level are used to obtain *p*-values.

Table 3: Variance Decomposition of Product Quality

	Std. dev.	Correlation with product quality
Product quality	1.662	1.000
Plant-product fixed effects	1.575	0.994
Residuals	0.505	0.430

Note: Table shows the average of standard deviation obtained for each product group.

Table 4: Parameter Estimates of the Product Quality Model

Variable	(1)	(2)	(3)	(4)
Δln*LOC*	0.010***	-0.011	0.001	-0.093*
	(0.003)	(0.064)	(0.003)	(0.053)
Δln*MP*	0.035***	0.241***	0.034***	0.178***
	(0.009)	(0.071)	(0.009)	(0.055)
Geographical unit	Prefecture		Metropolitan area	
Estimator	OLS	GMM	OLS	GMM
F-stat, *p*-value	0.00		0.00	
R-squared	0.00		0.00	
Hansen's J statistic, *p*-value		0.63		0.55
First-stage *F*-stat, *p*-value, *LOC*		0.00		0.00
First-stage *F*-stat, *p*-value, *MP*		0.00		0.00
Observations	593,027	489,758	593,027	489,758

Notes: * and *** indicate statistical significance at 10 percent and 1 percent, respectively. Dependent variable is the first difference in product quality. Values in parenthesis are standard errors clustered at the plant-product level.

Table 5: Parameter Estimates of the Plant-Product Fixed Effects Model

Variable	(1)	(2)
Average ln*LOC*	0.078***	0.062***
	(0.016)	(0.013)
Average ln*MP*	-0.004	-0.050
	(0.035)	(0.062)
Geographical unit	Prefecture	Metropolitan area
F-stat, *p*-value	0.00	0.00
R-squared	0.60	0.60
Observations	94,431	94,431

Note: *** indicates statistical significance at 1 percent. Dependent variable is plant-product fixed effects on product quality. Product fixed effects are included in both estimations. Values in parenthesis are standard errors clustered at the product level.

Table 6: Parameter Estimates of the Product Quality Model by Plant Size

Variable	(1)	(2)	(3)	(4)
Δln*LOC*	0.175*	-0.139*	0.055	-0.189***
	(0.101)	(0.084)	(0.086)	(0.069)
Δln*MP*	0.430***	0.029	0.389***	-0.060
	(0.085)	(0.109)	(0.066)	(0.083)
Geographical unit	Prefecture		Metropolitan area	
Plant size	Small	Large	Small	Large
Hansen's J statistic, *p*-value	0.84	0.05	0.58	0.26
First-stage *F*-stat, *p*-value, *LOC*	0.00	0.00	0.00	0.00
First-stage *F*-stat, *p*-value, *MP*	0.00	0.00	0.00	0.00
Observations	211,127	278,631	211,127	278,631

Notes: * and *** indicate statistical significance at 10 percent and 1 percent, respectively. Dependent variable is the first difference in product quality. Values in parenthesis are standard errors clustered at the plant-product level.

Table 7: Parameter Estimates of the Market Share Model

Variable	(1)	(2)
Δln*LOC*	-0.057	-0.141**
	(0.074)	(0.061)
Δln*MP*	0.223***	0.148**
	(0.080)	(0.062)
Geographical unit	Prefecture	Metropolitan area
Hansen's J statistic, *p*-value	0.10	0.15
First-stage *F*-stat, *p*-value, *LOC*	0.00	0.00
First-stage *F*-stat, *p*-value, *MP*	0.00	0.00
Observations	489,758	489,758

Notes: ** and *** indicate statistical significance at 5 percent and 1 percent, respectively. Dependent variable is the first difference in the market share. Values in parenthesis are standard errors clustered at the plant-product level.