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Regional heterogeneity
in intra-national and international trade

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Abstract

We present a two-country two-region model, specifically with two regions in each country. Each region consists of two types of labor; skilled labor is required to set up a firm, and unskilled labor is used as marginal input for production. Trade cost accrues both intra-nationally and internationally. International trade cost may are assumed to be different across regions. We examine our model in the medium-term, during a period in which the share of the labor force in each region remains constant. Our model can generate heterogeneity among regional exports in terms of export price and volume and also produces a region-based gravity model. We also find a home market effect at the regional level. Moreover, we are able to show the relative magnitude of the home market effect among home regions, in terms of a change in the export share. We empirically test our theoretical propositions with an application to the export dataset of Japanese regions. Our empirical results provide strong evidence in support of both a region-based home-market effect and a relative home-market effect.

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1. Introduction

In classical or in (new) new trade models, we assume *heterogeneity* in several features of the economy; namely, factors of production, the productivity of industries, and products within an industry.   In a Heckscher-Ohlin type model, factors of production include at least two different factors.   In a Recardian-type model, industries are different in terms of their productivity.   In Krugman-type model, consumers' preferences for variety support differentiated products within an industry.   Moreover, Melitz (2003) adds another dimension of heterogeneity in terms of the productivity of firms.   Of course, furthermore, any trade model consists of at least two different countries.   However, with only a few exceptions, trade models do not seriously address geographical features within a country, although cousin models of trade theory in New Economic Geography focus on domestic regions.

It is natural that regional heterogeneity exists within a country. Regional heterogeneity emerges from differences in climate, landscape, and endowments of natural resources. However, heterogeneity can also arise as result from economic activities. When an industry agglomerates in one location, this location may become attractive for another industry that has a close relationship with this agglomerated industry. In such a case, agglomeration itself makes this location very unique in comparison to other regions. For example, automobile makers from the US, Europe, and Japan agglomerate in Shanghai. Consequently, the city has also attracted component suppliers from all over the world. Initially, it might be that automobile makers had an incentive to locate themselves closer to a bigger market to save on transportation costs. Some firms may still decide to remain in the home country but choose to produce in a domestic region with a geographical advantage to foreign markets over other domestic regions.

What is appealing to us with regard to international trade is that exports of regional structures within a country must be affected by their relationship with foreign trading partners. In this paper, we examine the regional heterogeneity that arises from the relationship between domestic regions and foreign countries.

While most international trade studies do not consider regional heterogeneity within a country, Krugman and Elizondo (1996) and Behrens et al. (2007) are a few exceptions. Krugman and Elizondo (1996) consider three-region models for one foreign and two domestic regions. However, the two domestic regions are homogeneous and symmetric in the sense that the international transportation cost is set equal for both

domestic regions[1]. Behrens et al. (2007) considers a four-region model with two foreign and two domestic regions. Even in Behrens et al. (2007), however, regions within a country are symmetric in terms of international trade costs. In this paper, we present a trade model in which two heterogeneous regions exist within a country, extending the model of Behrens et al. (2007).

In this paper, we introduce a two-country model in which each country consists of two regions. The economy has two sectors; a homogeneous good sector under constant returns to scale and a differentiated goods sector under increasing returns to scale. Regions within a country differ in terms of population and international trade costs.

As discussed above, there are international trade models in which a country consists of multiple regions. However, in those papers, international trade costs between the foreign country and each region are assumed to be the same. Symmetric international trade costs among domestic regions also restrict the same effect of the foreign country on each domestic region. Imposing region-specific international trade costs in this paper allows us to describe the heterogeneity in each region that arises from growth in a foreign country.

Regarding the shipment of differentiated goods, there are both international transportation costs and intra-national transportation costs in this model. International transportation costs are the costs that accrue when goods are shipped between countries. Intra-national transportation costs are the costs that accrue when goods are traded between regions within a country. We call the former *trade costs* and the latter just simply *transportation costs*. In our model, we assume that trade costs are region-specific and that any transportation costs are always lower that any trade costs.

Imposing *regional heterogeneity by assumption* with regard to trade costs allows us to derive some *regional heterogeneity as result* for exports of each region within a country. First, the prices of varieties produced in each region depend on the spatial distributions of the firms not only in one's own country but also in the other country. Second, prices' dependence on the spatial distribution of firms in foreign country also makes demand dependent on the spatial distribution of firms in a foreign country. Third, the exports from regions in a country featuring relatively less skilled labor decrease as the population of skilled laborers in the foreign country increases. Finally, the export share of a region that is further from the foreign country is an

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[1] Krugman and Elizondo (1996) show that *symmetric* reduction in international trade cost makes production in a single agglomerated region spread to both domestic regions.

increasing function of the population of the foreign country.

Our model potentially allows both types of workers to move freely within a country in a long run. However, we intentionally analyze only medium-term equilibria in which both types of workers are restricted from moving across regions. More specifically, we assume that the share of workers in each region remains constant. This assumption is integrated into our model to reflect that the share of the labor force is relatively stable over a long period of time. Figure 1 presents the share of the labor force in selected European countries over 27 years. There are some fluctuations for some countries, but the shares are relatively stable. For example, Turkey experienced the most dramatic increase among the sample countries; the share increased from 0.075 in 1980 to 0.102 in 2006. For the first ten years, however, there was only a 13% increase from 0.075 in 1980 to 0.085 in 1989. Thus, our second critical point of heterogeneity in regions is the assumption that the labor force share remains different over the period of our equilibrium analysis. Figure 2 shows that the population share of states in the US has also remained relatively stable over the last 27 years. We could possibly argue that population shares in European countries and among the US states are already at a long-run equilibrium. However, this argument would not preclude our assumptions' holding in the medium-term.

The structure of the rest of the paper is as follows. The next section introduces the two-region two-country model with regional heterogeneity in international trade costs and the labor share. In section 3, we show that the regional version of the home market effect also holds in our model. We further examine the effect of relative change in the labor force in two countries on the export share. It is shown that the relative magnitude of the home market effect among regions matters. Then, section 4 empirically examines predictions of the theoretical model with applications to Japanese regional export data. We find strong support for the home market effect and the export share predictions. The last section discusses the possible extensions of our approach and concludes.

2. The model

The economy consists of two countries, labeled i (or j) $= H, F$. Each country has two regions labeled r (or s). The regions in H are called 1 and 2, and those in F are called 3 and 4. There are two factors of production: skilled and unskilled labor. We assume that the mass of skilled workers can be different for two countries even when there is no difference in the mass of unskilled workers between the two countries. We denote the mass of skilled labor in country i as L_i and each region

has the same mass of unskilled workers: $A/2$. In addition, we assume that the two countries have access to the same technology.

Each individual works and consumes in the region in which she lives. Unskilled workers are assumed to be perfectly immobile, as are skilled workers. In most studies, skilled workers are assumed to be mobile between regions but immobile between countries. Imposing skilled worker immobility in this study is interpreted as ensuring that we analyze medium-term equilibrium. The share of skilled workers living in region 1 is denoted by $\lambda_H \in [0,1]$, and that of skilled workers living in region 3 is represented by $\lambda_F \in [0,1]$.

Preference

Each consumer is endowed with one unit of labor, which she supplies inelastically. She has a quasi-linear preference regarding a homogeneous good and a differentiated consumption good. We choose the homogeneous good as numeraire. The sub-utility over the total mass of N of varieties of the differentiated good is quadratic, as in Ottaviano et al. (2002). An individual consumer solves the following problem:

$$\max_{q(v), \forall \in [0,N]} \quad \alpha \int_0^N q(v)dv - \frac{\beta-\gamma}{2}\int_0^N [q(v)]^2 dv - \frac{\gamma}{2}\left[\int_0^N q(v)dv\right]^2 + q_0, \tag{1}$$

$$s.t. \int_0^N p(v)q(v)dv + q_0 = y + \bar{q}_0,$$

where $\alpha > 0$, $\beta > \gamma > 0$ are parameters; $p(v)$ is the price of variety v and y is the consumer's income, which depends on her skilled/unskilled status. In this expression, α measures the intensity of preference for the differentiated good with respect to the numeraire. The condition $\beta > \gamma$ means that workers have a preference for variety. We assume that each worker has, in addition to her wage, sufficiently large endowments $\bar{q}_0$ of the numeraire.

Solving this optimization problem for consumers, we find the demand function as follows:

$$q_{rs}(v) = a - (b+cN)p_{rs}(v) + cP_s, \tag{2}$$

where $q_{rs}(v)$ is the demand for variety v produced in region r and consumed in region s, whereas $p_{rs}(v)$ is the price of variety v produced in region r and consumed in region s. In addition,

$$\alpha \equiv \frac{\alpha}{\beta+(N-1)\gamma}, \quad b \equiv \frac{1}{\beta+(N-1)\gamma}, \quad c \equiv \frac{\gamma}{(\beta-\gamma)[\beta+(N-1)\gamma]},$$

are positive bundles of parameters. If Λ_{rs} denotes the set of varieties produced in

region r and consumed in region s, the price index in region s is as follows:

$$P_s \equiv \int_{\Lambda_{1s}} p_{1s}(v)dv + \int_{\Lambda_{2s}} p_{2s}(v)dv + \int_{\Lambda_{3s}} p_{3s}(v)dv + \int_{\Lambda_{4s}} p_{4s}(v)dv. \quad (3)$$

Production

There are two sectors in the economy. One sector produces the homogeneous good under perfect competition using unskilled labor as the only input with constant returns to scale technology. The unit input requirement is set to one. In the other sector, monopolistically competitive firms produce a continuum of varieties of the horizontally differentiated good using both types of labor under increasing returns to scale technology. We assume that the firms can differentiate their products at no cost. Therefore, one firm produces only one variety. Thus, the number of firms is equal to the number of varieties.

Each firm in a monopolistically competitive sector incurs fixed costs of $\phi(>0)$ units of skilled labor, whereas its marginal labor requirement is normalized to zero without loss of generality. When $n_r (r=1,\cdots 4)$ stands for the number of firms in each region, from skilled labor market-clearing conditions in each region for any distribution of skilled workers, λ_i are given by the following forms:

$$n_1 = \frac{\lambda_H L_H}{\phi}, \quad n_2 = \frac{(1-\lambda_H)L_H}{\phi}, \quad n_3 = \frac{\lambda_F L_F}{\phi}, \quad n_4 = \frac{(1-\lambda_F)L_F}{\phi}. \quad (4)$$

Moreover, when $n_i (i=H,F)$ and N denote the number of varieties in each country and that of the economy, respectively, these are represented as follows:

$$n_H = n_1 + n_2 = \frac{L_H}{\phi}, \quad n_F = n_3 + n_4 = \frac{L_F}{\phi}, \quad N = n_H + n_F = \frac{L}{\phi}. \quad (5)$$

While N can vary when the population increases, in our paper, N is assumed to be fixed for mathematical simplicity. This means that L is also fixed.

With respect to transportation technology, the shipping of a good incurs a cost. First of all, the shipping of the homogeneous good is assumed to be costless. Because a homogeneous good can be shipped without cost and this good is chosen as the numeraire, the wage of unskilled labor is equal to one in all regions in equilibrium.

Next, regarding transportation technology for the differentiated good, both interregional and international forms of transportation are costly. In addition, international trade costs are region-specific. As for interregional transportation costs within a country, the shipping of a differentiated good between regions 1(3) and 2(4) incurs $\tau_H(\tau_F)$ in terms of the numeraire. Henceforth, we refer to the interregional transportation costs as *transportation costs*.

Finally, regarding international trade, all regions do not necessarily have equal access to a region in the other country. The international trade costs between region r and s, are denoted by τ_{rs} $(r \neq s)$ in terms of the numeraire. Moreover, symmetricity in trade cost is assumed for any pair of two regions; i.e., $\tau_{rs} = \tau_{sr}$. In short, trade costs are represented as follows:

$$
\tau_{rs} = \begin{cases} \tau_{13}, & r,s = 1,3, \quad r \neq s, \\ \tau_{14}, & r,s = 1,4, \quad r \neq s, \\ \tau_{23}, & r,s = 2,3, \quad r \neq s, \\ \tau_{24}, & r,s = 2,4, \quad r \neq s, \end{cases} \tag{6}
$$

Henceforth, we refer to the international transportation costs as *trade costs*. If we assume that trade cost increases monotonically in distance, geographical distance can be used as a proxy for trade cost in the later analysis. In the following, we assume that one of the regions in each country has a relative advantage in terms of geographical proximity over both regions in the foreign country. Specifically, we assume that the distance between region 2 and region 3 is the minimum distance between two countries. Figure 3 depicts our assumptions regarding the geography of regions in this section.

We focus on the case in which transportation costs τ_i and trade costs τ_{rs} are sufficiently low that interregional and international bilateral trades occur. We will show the conditions under which both international and intra-national trade between any two regions at the equilibrium prices occur.

Product and labor market

We make three crucial assumptions: the product market is segmented, the labor market is local, and entry and exit are free.

Under these assumptions, the profit of the firm in region 1 is as follows.

$$
\pi_1 = q_{11}\left(\frac{A}{2} + \lambda_H L_H\right)p_{11} + q_{12}\left(\frac{A}{2} + (1 - \lambda_H)L_H\right)(p_{12} - \tau_H)
$$
$$
+ q_{13}\left(\frac{A}{2} + \lambda_F L_F\right)(p_{13} - \tau_{13}) + q_{14}\left(\frac{A}{2} + (1 - \lambda_F)L_F\right)(p_{14} - \tau_{14}) - w_1 \frac{L_H}{n_H}. \tag{7}
$$

The firm in region 1 maximizes this profit with respect to prices p_{11}, p_{12}, p_{13} and p_{14} separately.

The market outcome

Solving the optimization problem for producers that produce differentiated good yields the profit-maximizing price as a function of the price aggregate. These are as follows:

Intraregional prices:

$$p_{11}(P_1) = \frac{a + cP_1}{2(b + cN)}, \tag{8}$$

Interregional prices:

$$p_{12}(P_2) = \frac{a + cP_2}{2(b + cN)} + \frac{\tau_H}{2} = p_{22} + \frac{\tau_H}{2}, \tag{9}$$

International prices:

$$p_{1r}(P_r) = \frac{a + cP_r}{2(b + cN)} + \frac{\tau_{1r}}{2} = p_{rr} + \frac{\tau_{1r}}{2}, \quad r = 3,4. \tag{10}$$

Note that the prices in one region depend on the price aggregate in this region, which is determined by the price set there by all firms. Because there is a continuum of firms, each firm is negligible and chooses its optimal price, taking aggregate market conditions as given. At the same time, these aggregate market conditions must be consistent with firms' optimal pricing decisions. Therefore, the (Nash) equilibrium price aggregate P_1^* must satisfy the following condition:

$$P_1^* = n_1 p_{11}^*(P_1^*) + n_2 p_{21}^*(P_1^*) + n_3 p_{31}^*(P_1^*) + n_4 p_{41}^*(P_1^*). \tag{11}$$

Similar conditions hold for the other regions. Using the profit-maximizing prices leads to P_1^*:

$$P_1^* = \frac{aN + (b + cN)[(n_H - n_1)\tau_H + n_3\tau_{13} + n_4\tau_{14}]}{2b + cN}. \tag{12}$$

Substituting this equation into the profit-maximizing prices, we find the equilibrium prices,

$$p_{11}^* = \frac{2a + c[(n_H - n_1)\tau_H + n_3\tau_{13} + n_4\tau_{14}]}{2(2b + cN)}, \tag{13}$$

$$p_{12}^* = p_{22}^* + \frac{\tau_H}{2}, \tag{14}$$

and

$$p_{1r}^* = p_{rr}^* + \frac{\tau_{1r}}{2}, \quad r = 3,4. \tag{15}$$

Note that each of equilibrium prices decreases with the number of firms located in the

corresponding region. In addition, prices increase with transportation and trade costs. These two effects are referred to as the *pro-competitive effect* in Behrens et al. (2007). The novel feature of our paper is that prices depend on the distribution of firms in the other country. This is because we assume that trade costs are region-specific.

Substituting these equilibrium prices into the demand and using the price aggregate, the equilibrium consumption level can be derived as follows:

Intra-regional demands:

$$q_{11}^* = a - bp_{11}^* + \frac{c}{2}(n_H - n_1)\tau_H + \frac{c}{2}n_3\tau_{13} + \frac{c}{2}n_4\tau_{14}, \tag{16}$$

Interregional demands:

$$q_{12}^* = q_{22}^* - (b + cN)\frac{\tau_H}{2}, \tag{17}$$

International demands:

$$q_{1r}^* = q_{rr}^* - (b + cN)\frac{\tau_{1r}}{2}, \quad r = 3,4. \tag{18}$$

Note that from these demand functions, high trade costs raise the domestic demand for each national variety at the expense of varieties produced abroad. This is the substitution effect. This effect decreases when varieties become more differentiated (when c decreases). Similarly, the intra-regional demand for each locally produced variety and the international demand increases at the expense of the variety produced in the other region within a country when the transportation costs of one's own country rise.

Alternative interpretations of the model

So far, we have presented our model as a two-country model in which each country has two regions. However, we can also reinterpret our model as a four-country model. Because our approach is for medium-term equilibrium where labor mobility across any regions is strictly prohibited, this can be thought as the immobility usually assumed between two countries. There is only one anomalous feature at play in interpreting our model for four countries, which is that population growth must be in perfect harmony among two particular countries due to the assumption of a constant population share. More importantly for the empirical section of this paper, we can alternatively interpret our model as having two foreign countries versus one country with two regions.

3. Home market effect and relative home market effect

In this section, we investigate the effect of the decline in trade costs and the increase in the population of the foreign country on the exports in one region. We therefore aim to investigate the regional version of the gravity model. The theoretical foundation for the traditional gravity model with the effect of trade cost and income of two countries on bilateral trade is given in Anderson (1979).

First, we define the new variable. We define the export of region 1 as E_1, which is represented as follows:

$$E_{1r} = n_1 p_{1r}^* q_{1r}^* \left(\frac{A}{2} + L_r \right), \quad r = 3,4. \tag{19}$$

Before we begin, we must note the assumption we impose. In our paper, we assume that N is fixed, which means that $dL_H = -dL_F$. In other words, the increase in the population of a country involves the decrease in that of the other country. This assumption seems to be unsuited to describing the real world. However, for simplicity's sake, we assume that N is fixed. An examination of the case in which N can vary remains a task for future study.

First, we examine the effect of the decreases in trade costs on exports. Note that price and demand depend on trade costs.

$$\frac{\partial E_{1r}}{\partial \tau_{1r}} = n_1 \left(\frac{A}{2} + L_r \right) \frac{\partial p_{1r}^* q_{1r}^*}{\partial \tau_{1r}}, \quad r = 3,4. \tag{20}$$

It is clear that the sign of (20) is determined by that of $\partial p_{1r}^* q_{1r}^* / \partial \tau_{1r}$.

$$\frac{\partial p_{13}^* q_{13}^*}{\partial \tau_{13}} = q_{13}^* \frac{\partial p_{13}^*}{\partial \tau_{13}} + p_{13}^* \frac{\partial q_{13}^*}{\partial \tau_{13}}. \tag{21}$$

Note that the effect of trade costs on price is positive and that the effect on demand is negative. Thus, the overall effect on exports is determined by the magnitude of each effect. Using (13), (15), and (18), (21) is written as follows,

$$\frac{\partial p_{13}^* q_{13}^*}{\partial \tau_{13}} = \frac{b+cN}{2(2b+cN)^2} \left[\{2a + c(n_2\tau_{23} + n_4\tau_F)\}cn_1 - \{4(2b+cN)^2 - (cn_1)^2\}\tau_{13} \right]. \tag{22}$$

From this equation, we find the following result.

$$\frac{\partial p_{13}^* q_{13}^*}{\partial \tau_{13}} < (\geq)0, \quad if \quad \tau_{13} > (\leq) \frac{\{2a + c(n_2\tau_{23} + n_4\tau_F)\}cn_1}{4(2b+cN)^2 - (cn_1)^2}. \tag{23}$$

Note that the effect of the decrease in trade costs on exports is not monotonic. When trade costs are larger than critical value represented in (23), export increases as trade costs decrease. Suppose that trade costs continue to decrease and become lower than the critical value. Once trade costs are smaller than the critical value, export decreases as trade costs decrease. This result is derived from that when trade costs are sufficiently

low, the effect such that export decreases is weak.

Then, deriving the effect of the increase in the population of the foreign country on the export of region 1, we find that this overall effect consists of three smaller effects.

$$\frac{\partial E_{13}}{\partial L_F} = p^*_{13}q^*_{13}\left(\frac{A}{2} + L_3\right)\frac{\partial n_1}{\partial L_F} + n_1\left(\frac{A}{2} + L_3\right)\frac{\partial p^*_{13}q^*_{13}}{\partial L_F} + n_1 p^*_{13}q^*_{13}\frac{\partial L_3}{\partial L_F}. \quad (24)$$

The first term of RHS in (24) provides the effect of the decrease in the number of firms located in the home country, which is implicit when we assume that N is fixed. The second term of RHS in (24) reports the effect of the increase in the size of population on the value of export to region 3. The last term of RHS in (24) demonstrates the effect of the increase in population of each region in the foreign country.

It is obvious that the first term of RHS in (24) is negative because $\partial n_1/\partial L_F = -[\lambda_H/\phi] < 0$. This term represents that the increase in the population of the foreign country has a negative effect through the decrease in the number of firms located in one's own country derived from the decrease in the population of one's own country. This effect emerges because it is assumed that N is fixed.

Next, the second term of RHS in (24) is examined. As shown before, the demand function for each variety is the function of prices. Therefore, each nominal export for both regions in the foreign country is also the function of prices. That is, the increase in the population of the foreign country affects nominal exports per capita through varying prices. Calculating $\partial p^*_{13}q^*_{13}/\partial L_F$, we find the following results:

$$\frac{\partial p^*_{13}q^*_{13}}{\partial L_F} = -\frac{c(b+cN)}{\phi(2b+cN)}p^*_{33}\{\lambda_H\tau_{13} + (1-\lambda_H)\tau_{23} - (1-\lambda_F)\tau_F\} < 0. \quad (25)$$

Note that the sign of $\lambda_H\tau_{13} + (1-\lambda_H)\tau_{23} - (1-\lambda_F)\tau_F$ is positive because we assume that transportation costs are lower than trade costs: that is, $\tau_F < \tau_{13}$ and $\tau_F < \tau_{23}$. Therefore, we find that $\partial p^*_{13}q^*_{13}/\partial L_F < 0$. The increase in the population of the foreign country leads to the increase in the number of firms located in the foreign country, which results in the decrease in the prices in the foreign country. The low prices give rise to the decreases in nominal imports per capita of the foreign country.

The third term of RHS in (24) represents the positive effect of the increase in population (the number of consumers) of the foreign country on exports. In other words, this term represents the increases in the aggregate demand of each region of the foreign country due to the increases in population.

To investigate the overall effect, summarizing the above results and rearranging

$\partial E_1 / \partial L_F$, we show that

$$\frac{\partial E_{13}}{\partial L_F} = -\frac{\lambda_H}{\phi}\left[\frac{A}{2}\left(p_{13}^* q_{13}^* + p_{14}^* q_{14}^*\right) + \lambda_F\left(L_F - L_H\right)p_{13}^* q_{13}^*\right] + n_1\left(\frac{A}{2} + L_3\right)\frac{\partial p_{13}^* q_{13}^*}{\partial L_F}. \quad (26)$$

Because the second term of RHS in (23) is negative, the sign of $\partial E_1 / \partial L_F$ is determined by that of $\left(A/2\right)\left(p_{13}^* q_{13}^* + p_{14}^* q_{14}^*\right) + \lambda_F\left(L_F - L_H\right)p_{13}^* q_{13}^*$. It is clear that the first term of RHS in (25) is negative if $L_F > L_H$. Therefore, if $L_F > L_H$, $\partial E_1 / \partial L_F$ is negative.

In short, the effect of the increase in the population of the foreign country on the export of one region under the case in which N is fixed is negative if the population of the foreign country is larger than that of the home country. In addition, when the population of the foreign country is not larger than that of the home country, the positive effect represented by the third term of RHS in (24) is weak, so that the other effects represented by the first and second terms of RHS in (24) dominate this positive effect. These results can be formally stated as the following proposition[2].

Proposition 1 (home market effect):
Suppose that the number of varieties in the economy is fixed. When Home country is endowed with relatively less skilled labor, i.e., $L_H < L_F$, Export from home regions increase if the gap in skilled labor becomes smaller.

Proposition 1 can still hold even if Home country is endowed with relatively *more* skilled labor. However, when Home country is not endowed with relatively less skilled labor, i.e., $L_H > L_F$, export from home region decreases as the number of workers of foreign country increases, if the positive effect of foreign population on home export through the increase in population of region is weaker than the negative effect of foreign population on home export through two channels, the decrease in home regional population (by assumption) and the decrease in export value in per capita.

How can we apply the results of proposition 1 to real world examples? We have two possible scenarios for the interpretation of proposition 1: the international migration of the labor force and the home market effect.

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[2] We investigate regional export to only one foreign region. However, proposition 1 remains the same when we extend our analysis to regional aggregate exports to a foreign country; i.e., $E_{13} + E_{14}$.

Scenario 1 (international migration of labor force):

Because we assume the world population to be constant and a simultaneous increase its foreign labor force and decrease its domestic labor force, we can interpret this comparative analysis as an instance of the labor force's migrating from the domestic country to the foreign country. This interpretation is most likely to be applicable to the case of Europe. A large portion of the population migrated from Hungary and Poland to Germany, especially with the accession of the former countries to the EU. Proposition 1 claims that in this case there should be fewer exports from Hungary and Poland to Germany. However, we need to be careful in directly applying our proposition without taking heed of some subtle issues. First, these migrations largely consist of unskilled labor rather than skilled labor. Second, there were large migrations in terms of capital from Germany to these emerging countries. Unless we control for these factors, proposition 1 cannot be applied to empirical examinations in this context.

Scenario 2 (home market effect):

Another interpretation of proposition 1 entails the home market effect. Krugman (1980) coined the term for his theoretical result in which an increase in the domestic labor force causes a more proportional increase in exports than in domestic production. In other words, the home market effect implies that the impact on exports from the domestic country is larger based on an increase in the domestic labor force than based on an increase in the foreign labor force[3]. Proposition 1 assumes a simultaneous increase in the foreign labor force and decrease in the domestic labor force with both of equal size. Because these changes' directions are opposite, a negative outcome in terms of the total effect implies that a decrease in the domestic labor force exerts a larger impact on exports in the absolute. Therefore, if we assume that the labor force increases with the same magnitude in both countries at equilibrium, we should obtain home market effect results. This is the scenario we apply in the next section regarding the regional export of Japan.

Next, we consider the share of exports of each region in one region. Because

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[3] We note that the home market effect does not necessarily hold in general. Davis (1988) shows that the relative size of trade cost in the differentiated and the homogeneous sectors can affect the existence of the home market effect. Yu (2005) also shows that the demand elasticity of substitution between the two sectors can even reverse the home market effect.

the studies on international economics have focused on aggregate variables, this share has been neglected. Our setting allows us to examine the share of exports of various regions.

The proportion of exports of region 1 is defined as follows.

$$S_{1r} \equiv \frac{E_{1r}}{E_{1r} + E_{2r}}, \quad r = 3,4. \tag{27}$$

We would like to investigate the effect of the increase in the population of the foreign country on this proportion. Differentiating this proportion with respect to the population of the foreign country, we find that

$$\frac{\partial S_{1r}}{\partial L_F} = \frac{1}{\left(E_{1r} + E_{2r}\right)^2}\left(E_{1r}\frac{\partial E_{2r}}{\partial L_F} - E_{2r}\frac{\partial E_{1r}}{\partial L_F}\right), \quad r = 3,4. \tag{28}$$

The sign of this derivation is determined by that of the equation in parenthesis. Using demand functions, price functions, and the derivation of exports with regard to the population of the foreign country, we obtain the following relationship.

$$\frac{\partial S_{1r}}{\partial L_F} = \left(\frac{A}{2} + L_r\right)^2 \frac{\lambda_H(1-\lambda_H)L_H^2}{\left(E_1 + E_2\right)^2}\left(p_{2r}^* q_{2r}^* \frac{\partial p_{1r}^* q_{1r}^*}{\partial L_F} - p_{1r}^* q_{1r}^* \frac{\partial p_{2r}^* q_{2r}^*}{\partial L_F}\right), \quad r = 3,4. \tag{29}$$

It is clear that the sign of (29) is determined by that of the equation in parentheses. Using (25), the equation in parenthesis in (29) is found to be negative. Thus, the sign of (29) is negative. We have to note that in this examination, we continue to impose that N is fixed; that is, the increase in the population of the foreign country involves the decrease in the population of one's own country. This result is summarized as follows.

Proposition 2 (export share hypothesis, relative home market effect):
When the number of varieties in the economy is fixed, the export share of region 1(2) increases (decreases) with an increase in the population of the foreign country.

This proposition is interpreted as indicating that when the population of the foreign country increases, the difference in export share in home country becomes smaller. This means that regional heterogeneity becomes less as the population of the foreign country increases.

Given the result of proposition 1, we know that both regions export less when the relative population of foreign country increases. We interpreted the result as home market effect. At that point, the relative magnitude of home market effect among regions could not be discussed with proposition 1 alone. With proposition 2, however,

we know that a region with an advantage of trade cost loses more than proportionately when the relative population of foreign country increases. We call this result as *relative home market effect* for convenience. We must carefully consider the determinants that derive proposition 2. Note that in this examination, the number of varieties in the economy is fixed.

4. An application to Japanese Exports

Figures 4 and 5 show how the production of industry can be sparsely distributed across the nation. Figure 4 shows production in 2005 for two related industries: computers and integrated circuits. Production for industrial robot and medical equipment is also shown in Figure 5. These figures can provide the intuition that production is relatively dispersed across regions within a country; however, it falls short in telling us what exports from these regions may look like.   We use port-level export data of Japan in this section to address the region-based propositions provided in the previous section.

Data

Export data are taken from the database of the Japanese Customs, the Ministry of Finance. Japanese Customs provides finely disaggregated export data for each international port/airport in addition to national aggregate export data.   The original annual export series is provided at a Harmonized System (HS) 9-digit level and by each destination country.   Our aggregation process takes three steps. In the first step, HS 9-digit commodities are aggregated over HS 2-digit industries. For the second step, we aggregated these port-level exports at the HS 2-digit level for each prefecture.   At this point, we decided to further aggregate these prefecture exports for two reasons. Some prefectures do not report any exports due to a lack of international ports in their prefectures.   Firms in these prefectures, however, export from ports in another prefecture. Similarly, there exist some firms, especially near at the border, that use international ports in adjacent prefectures. To minimize this cross-border export's effect on our estimates, we decided to group 47 prefectures into nine regions. In the last step, we constructed the export series at the HS 2-digit level for nine regions in Japan. The details of these regions are given in Appendix B. Eight importing countries were selected: China, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, and Thailand.

Regional GDP is constructed based on the Japanese Prefecture Income. For the years between 1990 and 2004, continuous series are readily available. We added two

additional years prior to 1990 and after 2004 from different report files. Regional employment data is taken from the Census in Japan. GDP and employment data for nine Asian countries are taken from the World Development Indicators, the World Bank. The original GDP series in terms of current US dollars are converted to Japanese yen values by period average foreign exchange rates. All series are adjusted to be expressed in terms of one unit of Japanese yen.

The distance between the Japanese regions and Asian countries is measured in two steps. First, the distance to each Asian country is measured from each prefecture. Then, the distance between an Asian country and a region is defined as the shortest distance between the country and the prefectures in the region.

Estimation Model

For each HS 2-digit industry, we estimate the following export equation in a panel framework:

$$E_{ijt} = \mathbf{X}_t \boldsymbol{\beta} + \varepsilon_{ijt} = \beta^i + \beta^j + \beta_1 L_{it} + \beta_2 L_{jt} + \beta_3 \tau_{ij} + \varepsilon_{ijt} \tag{30}$$

where $\mathbf{X}_t$ is a row vector of explanatory variables and $\boldsymbol{\beta}$ is a column vector of coefficients. β^i and β^j are fixed effects for Asian country (i) and Japanese region (j), respectively; L_{it} and L_{ji} are the size of the economy for Asian country (i) and Japanese region (j); and τ_{ij} is the trade cost between the Asian country (i) and the Japanese region (j). For the size of the economy, L_{it} and L_{ji}, the gross domestic product and population, are used alternatively. As a proxy to trade cost, we use distance between an importing country and a region.

Home Market Effect

Table 1 provides estimated coefficients for the gross domestic product of importing countries and Japanese regions, as well as for distance. In conformity with the results of other trade models, the expected signs of both economy size variables are positive: $\beta_1 > 0$ and $\beta_2 > 0$. The estimated coefficients in the first and second columns show that the income effect of both the importing country and the region is positive for all industries. The third column in Table 1 indicates that estimators for distance are negative for all industries. Thus, the result achieved using our region-based gravity model is quite consistent with previous empirical studies using country-based gravity models.

In addition, our theoretical model predicts the relative size of these coefficients

as the home-market effect: $\beta_2 > \beta_1$. We test this hypothesis formally using a one-sided test with the null hypothesis of H0: $\beta_2 - \beta_1 = 0$ against the alternative H1: $\beta_2 - \beta_1 > 0$.

$$\text{HME} = \frac{\beta_2 - \beta_1}{\sqrt{Var(\beta_1) + Var(\beta_2) - 2Cov(\beta_1, \beta_2)}} \tag{31}$$

We use the statistics in equation (31) as HME test statistics of which the distribution is asymptotically normal under regular conditions.

Table 1 also provides HME test statistics along estimated coefficients for economic size and trade costs. The HME, surprisingly, holds for almost all industries when the statistical significance level is at ten percent. There were only 4 out of 96 industries for which the null hypothesis could not be rejected: HS1 (live animals), HS50 (silk), HS75 (nickel and nickel products), and HS93 (arms and ammunition). Even for the five-percent statistical significance level, there were only 15 industries for which the null hypothesis could not be rejected. However, at the one-percent statistical significance level, industries with home market effects became a smaller portion of the entire body of industries; 33 industries still allowed the rejection of the null hypothesis and therefore demonstrate home market effects.

The noteworthy element here is that there seems to be no relationship between the degree of HME and industry characteristics. Industries with the highest HME statistics are HS2 (meat), HS8 (fruits and nuts), HS10 (cereals), HS11 (products of cereals), HS24 (tobacco), and HS79 (zinc and zinc products). The most highly differentiated product industries, such as HS84 (general machinery), HS85 (electrical appliances), HS87 (vehicles), and HS90 (precision machinery), do not appear as in the extreme cases.

We also replaced population with gross domestic product in estimation equation (30) and obtained qualitatively similar results for all coefficients. For all industries, β_1 and β_2 are positive and β_3 is negative. The size of β_1 is larger than that of β_2. However, HME statistics could not reject the null hypothesis of there being no home-market effect[4]. This inconsistency with our theoretical predictions when the population variable is used could be related to the assumption of a Ricardian type of production in the model versus the use of many factors of production in the real world. For theoretical tractability and expositional purposes, we assumed that production uses

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[4] The regression results when population is used to indicate the size of economy can be made available upon request to the authors.

only two types of labor. Labor is simultaneously the only factor of production and of consumers in the model. However, using labor as the explanatory variable in an empirical model may undermine the effect of economy size on exports.

Robustness

Given the well-known fact that trade data can contain many zeros, especially when disaggregated data is used, the ordinary least squares method may not produce efficient estimators. We therefore estimated the same empirical model using probit estimation.

$$\Pr ob(E_{ijt} > 0 | X_t) = \Phi(\mathbf{X}_t\boldsymbol{\beta}) \tag{32}$$

where Φ denotes the standard normal distribution function and $\mathbf{X}_t\boldsymbol{\beta}$ is given in equation (30).

The result of the probit estimation is given in Table 2. The coefficients for Japanese regional income are positive and large in magnitude for all industries, while the signs of the coefficients for the income of importing countries are sometimes negative. With regard to the home market effect, in comparing the size of coefficients β_1 and β_2, we obtained even stronger support for home market effects. Even at a one-percent statistical significance level, only two industries indicate no evidence of the home market effect.

Table 2 also reworks the order of industries according to the value of HME statistics. More interestingly, the order of industries is very different from the ones in Table 1. The top three industries with the highest HME statistics are HS37 (photographic products), HS30 (pharmaceutical products), and HS92 (musical instruments). These industries may be categorized as differentiated-product industries. We should not take these three samples as representative of the entire sample because we also find homogenous product industries with very high HME statistics. On the other hand, the lowest three industries are HS47 (pulp), HS6 (trees and plants), and HS41 (hide and leather). At the lower end of the HME statistics, homogenous product industries seem to be appropriately representative for probit estimation.

Our strong support of the home-market effect on a wide range of industries is consistent with the findings of Davis and Weinstein (2003) for OECD countries, although their approach involves relative changes in productions and demand. They find strong evidence of home-market effects for a broad segment of manufacturing

industries.[5] It is also important to mention the work of Davis and Weinstein (1999), which uses the same approach as do Davis and Weinstein (2003) for Japanese prefectures. Their findings are less strong than ours; they find evidence of the home-market effect for eight of 19 manufacturing industries. Feenstra et al. (2001) separate differentiated goods from homogeneous goods using Rauch's (1999) measures. They find evidence of a home-market effect in differentiated goods but not in homogeneous goods.

Export share hypothesis

Proposition 2 in the theoretical section proposes another empirical prediction. The export share between two domestic regions moves in favor of region 1, which is located further from the foreign country, increasing with respect to an increase in foreign labor. In this subsection, we empirically test the prediction of proposition 2.

For proposition 2, we need to construct the dependent variable as the export share of the region in total export. We divided regional export by the sum of exports from all regions. To determine the effect of foreign labor force, we need to classify each region as the region-1 type (located relatively further from the foreign country) and the region-2 type (located closer to the foreign country) because the effect has the opposite sign for the two regions. We introduce an indicator function, $f(\tau_{ij})$, which takes a positive value for the region-1 type and a negative value for the region-2 type. Specifically, we implement the specification for an indicator function in which region-specific distance is subtracted from the average distance between two countries. This indicator function is multiplied by the figure for foreign labor. The net effect of foreign labor is then measured by multiplying the estimated coefficient and the indicator function. With this function, proposition 2 implies that the coefficient, γ_1 is positive, indicating the net effect of a foreign labor increase to be positive for the region-1 type.

In addition, we need to control for the relative size of regions because a larger region is likely to have a larger export share. Our estimation model for testing proposition 2 is given in equation (33),

$$\left(\frac{E_{ijt}}{\sum_{i=1}^{9} E_{ijt}}\right) = \gamma_1 f(\tau_{ij}) \times L_{jt} + \gamma_2 \left(\frac{L_{it}}{\sum_{i=1}^{9} L_{it}}\right) + \varepsilon_{ijt} \tag{33}$$

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[5] Head and Ries (2001), on the other hand, find evidence against home market effect, using sector level trade between the US and Canada.

where $f(\tau_{ij}) = \tau_{ij} - (1/9)\sum_{i=1}^{9}\tau_{ij}$, region-specific distance adjusted by average distance from Japan.

The estimation results are shown in Table 3. The first column gives estimators for γ_1, the coefficients of foreign labor growth with adjustment for region-types. Surprisingly, most of estimated coefficients have negative signs. Out of 96 industries, 56 industries have negative coefficients with statistical significance, whereas only five industries have positive coefficients with statistical significance. For a robustness check, we also estimated equation (33) with region-importer dummies. The results are qualitatively similar: 50 industries have negative coefficients with statistical significance.

How should we interpret this counter-evidence for proposition 2? This empirical result suggests that regions with a geographical proximity advantage gain a higher export share as the size of foreign country increases. This result is more appealing to our intuition than proposition 2. However, we need to be careful with our underlying assumptions in deriving the results for proposition 2. We maintained the world population to be constant for mathematical convenience when we derived our results from the comparative statics. Thus, the appropriate measurement to take in empirically testing proposition 2 is an adjustment of γ_1 based on the effects of simultaneous decline in regional economies. This leads us to use a similar approach in testing proposition 1: export share is regressed simultaneously on labor forces of foreign countries and domestic regions.

$$\left(\frac{E_{ijt}}{\sum_{i=1}^{9} E_{ijt}}\right) = \bar{\gamma}_1 f(\tau_{ij}) \times L_{jt} + \bar{\gamma}_2 f(\tau_{ij}) L_{it} + \bar{\gamma}^{ij} + \varepsilon_{ijt} \tag{34}$$

where the second term is replaced by the local region labor variable with the previous indicator function and fixed-effect dummy $\bar{\gamma}_{ij}$ for the control variable is introduced.

The correctly measured statistics for the export share effect of proposition 2 are $\bar{\gamma}_1 - \bar{\gamma}_2 > 0$. We test this hypothesis formally using a one-sided test with the null hypothesis of H0: $\bar{\gamma}_1 - \bar{\gamma}_2 = 0$ against the alternative H1: $\bar{\gamma}_1 - \bar{\gamma}_2 > 0$.

$$\frac{\bar{\gamma}_1 - \bar{\gamma}_2}{\sqrt{Var(\bar{\gamma}_1) + Var(\bar{\gamma}_2) - 2Cov(\bar{\gamma}_1, \bar{\gamma}_2)}} \tag{35}$$

We use as export share test statistics, of which the distribution is asymptotically normal under regular conditions.

Table 4 provides estimated coefficients in the regression equation (34) and

export share statistics and p-values for the test statistics. At the ten-percent statistical significance level, the export share test is positive for 46 industries and negative for 24 industries. At the one-percent statistical significance, the test statistics for 37 industries support proposition 2, while the statistics are negative for only 18 industries. Overall, the test statistics are in favor of proposition 2.

It is noteworthy that we obtained the negative coefficient for interaction term between foreign labor, L_{jt}, and adjusted distance, $f(\tau_{ij})$. Since adjusted distance term is negative for a Japanese region with geographical advantage, i.e., region 1 in our theoretical model, our result implies that the growth in foreign country will raise the export ratio of this region.

Our approach shares some resemblance with the approach taken in Hanson and Xiang (2004). They use the difference-in-difference approach for treatment industries and control industries and find strong evidence of a home-market effect in a panel of 107 exporting countries and 58 importing countries. Their test of home-market effects is whether larger countries export relatively more high-transportation-cost, low-substitution-elasticity goods. Our test of the export share effect is whether larger regions export relatively more when regions possess geographical advantage.

5. Discussions and conclusions

In this paper, we introduced a two-region, two-country trade model. Our crucial assumptions are that regions are heterogeneous in terms of trade cost with regard to foreign countries and population shares of regions are fixed in our analytical period. With this model, we are able to establish a foundation for region-based gravity predictions in which trade between a region in the home country and a region in the foreign country depends on the incomes of both regions and the trade cost between them. More specifically regarding the relative size of income coefficients, our region-based trade model predicts the home market effect. More interestingly, our theoretical model is explicitly for the first time able to predict a change in the relative share of regional exports in the home country when foreign market grows.

With Japanese trade data disaggregated in regions, we applied a region-based gravity model for exports of 97 industries from nine Japanese regions to eight Asian countries. First, we found strong support for a region-based home market effect. For most of industries, income coefficient of Japanese region is found to be larger than the income coefficient of importing countries. Second, empirical evidence is also in favor for export ratio hypothesis, or relative home market effect. Our empirical results suggest

that proximity to trade partner countries and the recent rapid growth of Asian economies have led regions with relative advantage in geographical location to become export platforms for some industries.

There are several trade models that consider regions within a country besides Krugman and Elizondo (1996) and Behrens et al. (2007). Rossi-Hansberg (2005) considers a continuum segmented line model in which countries are intervals on the line. This approach is flexible enough to allow for various types of regional production patterns within a county. Marjit and Beladi (2009) also consider a Ricardian model with a continuum region within a country. However, international (or intra-national) trade in these models is only necessitated by specialization in one of two products, so its direct application to empirical excise is limited. Our model is also capable of making predictions regarding regional productions, regional export ratios, and export tendencies with industry characteristics, among other issues. These will remain tasks for our future research.

Appendix A. The conditions on trade and transportation costs

In this Appendix, we show the conditions of trade and transportation costs such that trade occurs between any two regions at equilibrium prices. That trade occurs means that $q_{rs} > 0$. Using this, we can derive the conditions.

First of all, we show the conditions under which intra-national trade emerges. When intra-national trade occurs in any county, $q_{12} > 0$, $q_{21} > 0$, $q_{34} > 0$ and $q_{43} > 0$. Using demand functions, we obtain the following condition:

$$\max\{\tau_H, \tau_F\} \equiv \tau_{\text{intra}} = \frac{2a}{2b + cN}.$$

Then, we show the conditions under which international trade occurs in the same way. In this way, we find the following conditions:

$$\max\{\tau_{13}, \tau_{23}, \tau_{14}, \tau_{24}\} \equiv \tau_{\text{inter}} = \frac{2a}{2b + cN}.$$

In our paper, we focus on the situation in which intra-national and international trade occurs. Therefore, we impose these conditions on trade and transportation costs.

Appendix B. Classification of Regions

(1)Hokkaido, (2)Aomori, Iwate, Miyagi, Akita, Yamagata, Fukushima, (3)Ibaragi, Tochigi, Gunma, Saitama, Chiba, Tokyo, Kanagawa, (4)Niigata, Toyama, Ishikawa, Fukui, Yamanashi, Nagano, Gifu, Shizuoka, Aichi, (5)Mie, Shiga, Kyoto, Osaka, Hyogo, Nara, Wakayama, (6)Tottori, Shimane, Okayama, Hiroshima, Yamaguchi, (7)Tokushima, Kagawa, Ehime, Kochi, (8)Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima, (9)Okinawa.

Appendix C. Descriptions of Chapters (Two-digit HS classification codes)

1 Live animals.
2 Meat and edible meat offal.
3 Fish & crustacean, mollusc & other aquatic invertebrate
4 Dairy prod; birds' eggs; natural honey; edible prod nes
5 Products of animal origin, nes or included.
6 Live tree & other plant; bulb, root; cut flowers etc
7 Edible vegetables and certain roots and tubers.
8 Edible fruit and nuts; peel of citrus fruit or melons.
9 Coffee, tea, mat・and spices.
10 Cereals.
11 Prod mill indust; malt; starches; inulin; wheat gluten
12 oil seed, oleagi fruits; miscell grain, seed, fruit etc
13 Lac; gums, resins & other vegetable saps & extracts.
14 Vegetable plaiting materials; vegetable products nes
15 Animal/veg fats & oils & their cleavage products; etc
16 Prep of meat, fish or crustaceans, molluscs etc
17 Sugars and sugar confectionery.
18 Cocoa and cocoa preparations.
19 Prep of cereal, flour, starch/milk; pastrycooks' prod
20 Prep of vegetable, fruit, nuts or other parts of plants
21 Miscellaneous edible preparations.
22 Beverages, spirits and vinegar.
23 Residues & waste from the food indust; prepr ani fodder
24 Tobacco and manufactured tobacco substitutes.
25 Salt; sulphur; earth & ston; plastering mat; lime & cem
26 ores, slag and ash.
27 Mineral fuels, oils & product of their distillation; etc
28 Inorgn chem; compds of prec met, radioact elements etc
29 organic chemicals.
30 Pharmaceutical products.
31 Fertilizers.
32 Tanning/dyeing extract; tannins & derivs; pigm etc
33 Essential oils & resinoids; perf, cosmetic/toilet prep
34 Soap, organic surface-active agents, washing prep, etc
35 Albuminoidal subs; modified starches; glues; enzymes.
36 Explosives; pyrotechnic prod; matches; pyrop alloy; etc
37 Photographic or cinematographic goods.
38 Miscellaneous chemical products.
39 Plastics and articles thereof.
40 Rubber and articles thereof.
41 Raw hides and skins (other than furskins) and leather.
42 Articles of leather; saddlery/harness; travel goods etc
43 Furskins and artificial fur; manufactures thereof.
44 Wood and articles of wood; wood charcoal.
45 Cork and articles of cork.
46 Manufactures of straw, esparto/other plaiting mat; etc
47 Pulp of wood/of other fibrous cellulosic mat; waste etc
48 Paper & paperboard; art of paper pulp, paper/paperboard
49 Printed books, newspapers, pictures & other product etc
50 Silk.
51 Wool, fine/coarse animal hair, horsehair yarn & fabric
52 Cotton.
53 other vegetable textile fibres; paper yarn & woven fab
54 Man-made filaments.
55 Man-made staple fibres.

56 Wadding, felt & nonwoven; yarns; twine, cordage, etc
57 Carpets and other textile floor coverings.
58 Special woven fab; tufted tex fab; lace; tapestries etc
59 Impregnated, coated, cover/laminated textile fabric etc
60 Knitted or crocheted fabrics.
61 Art of apparel & clothing access, knitted or crocheted.
62 Art of apparel & clothing access, not knitted/crocheted
63 other made up textile articles; sets; worn clothing etc
64 Footwear, gaiters and the like; parts of such articles.
65 Headgear and parts thereof.
66 Umbrellas, walking-sticks, seat-sticks, whips, etc
67 Prepr feathers & down; arti flower; articles human hair
68 Art of stone, plaster, cement, asbestos, mica/sim mat
69 Ceramic products.
70 Glass and glassware.
71 Natural/cultured pearls, prec stones & metals, coin etc
72 Iron and steel.
73 Articles of iron or steel.
74 Copper and articles thereof.
75 Nickel and articles thereof.
76 Aluminium and articles thereof.
78 Lead and articles thereof.
79 Zinc and articles thereof.
80 Tin and articles thereof.
81 other base metals; cermets; articles thereof.
82 Tool, implement, cutlery, spoon & fork, of base met etc
83 Miscellaneous articles of base metal.
84 Nuclear reactors, boilers, mchy & mech appliance; parts
85 Electrical mchy equip parts thereof; sound recorder etc
86 Railw/tramw locom, rolling-stock & parts thereof; etc
87 Vehicles o/t railw/tramw roll-stock, pts & accessories
88 Aircraft, spacecraft, and parts thereof.
89 Ships, boats and floating structures.
90 optical, photo, cine, meas, checking, precision, etc
91 Clocks and watches and parts thereof.
92 Musical instruments; parts and access of such articles
93 Arms and ammunition; parts and accessories thereof.
94 Furniture; bedding, mattress, matt support, cushion etc
95 Toys, games & sports requisites; parts & access thereof
96 Miscellaneous manufactured articles.
97 Works of art, collectors' pieces and antiques.
98 Special Classification Provisions
99 Special Transaction Trade.

Note: Descriptions are from OECD International Trade by Commodity Statistics

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Figure 1. The share of the labor force in Europe
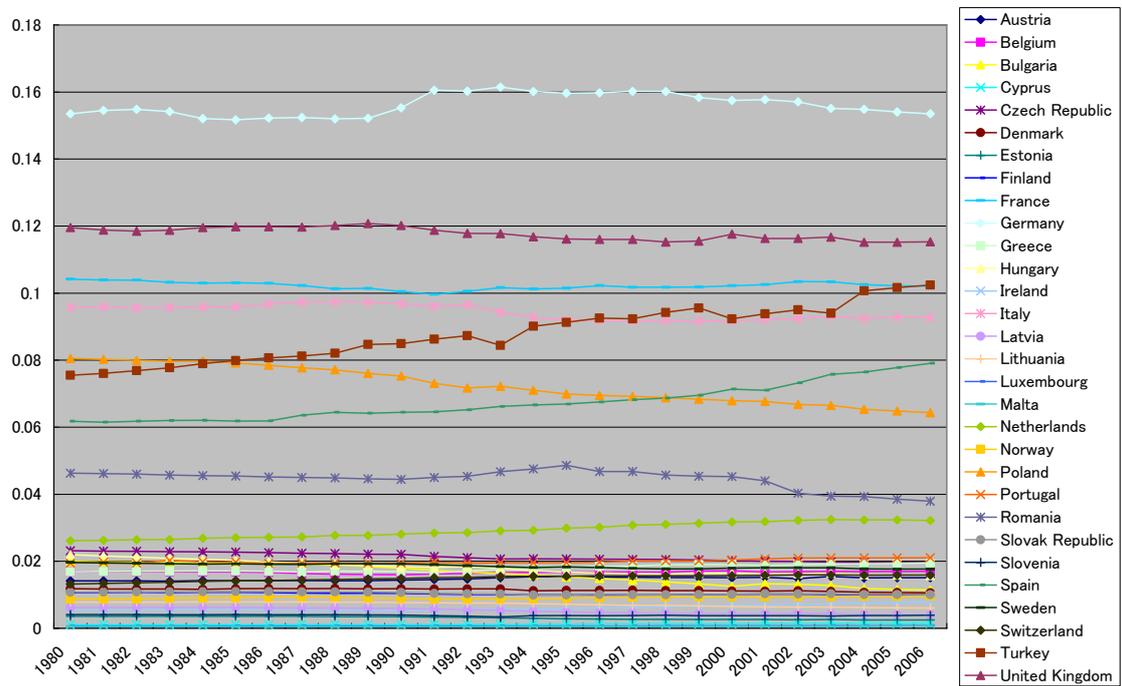
Note: Annual series of total labor force for 30 European countries are taken from the *World Development Indicator*, (2008 vintage).

Figure 2. The state population share in the US
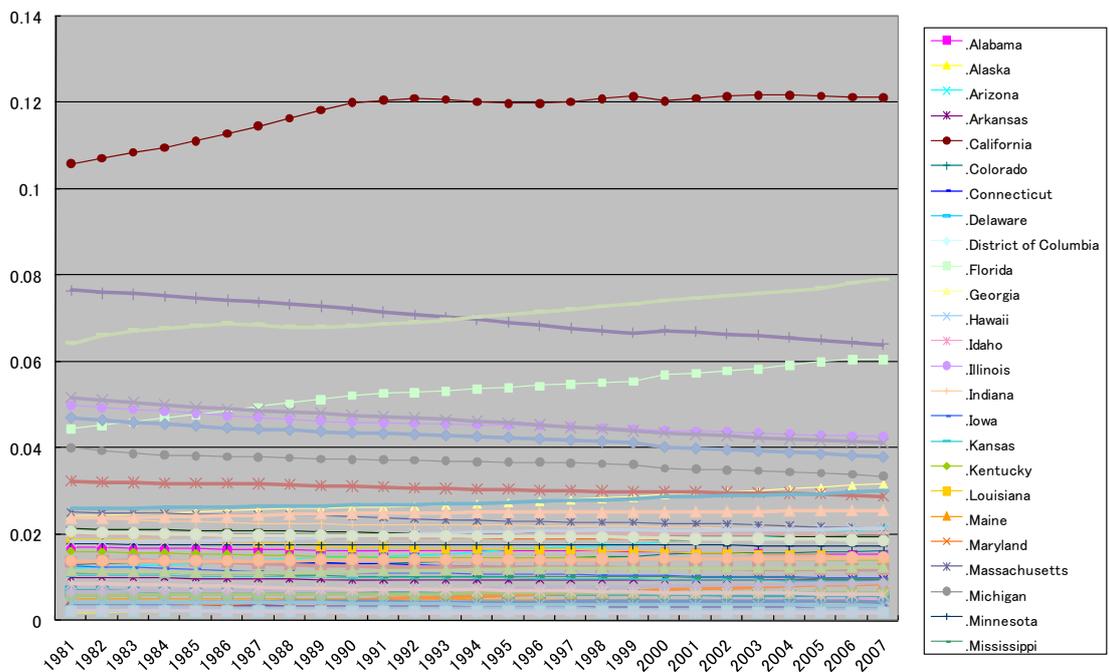
Note: Annual series of state population are taken from the U.S. Bureau of the Census.

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Figure 3. The geography of the two-region and two-country model
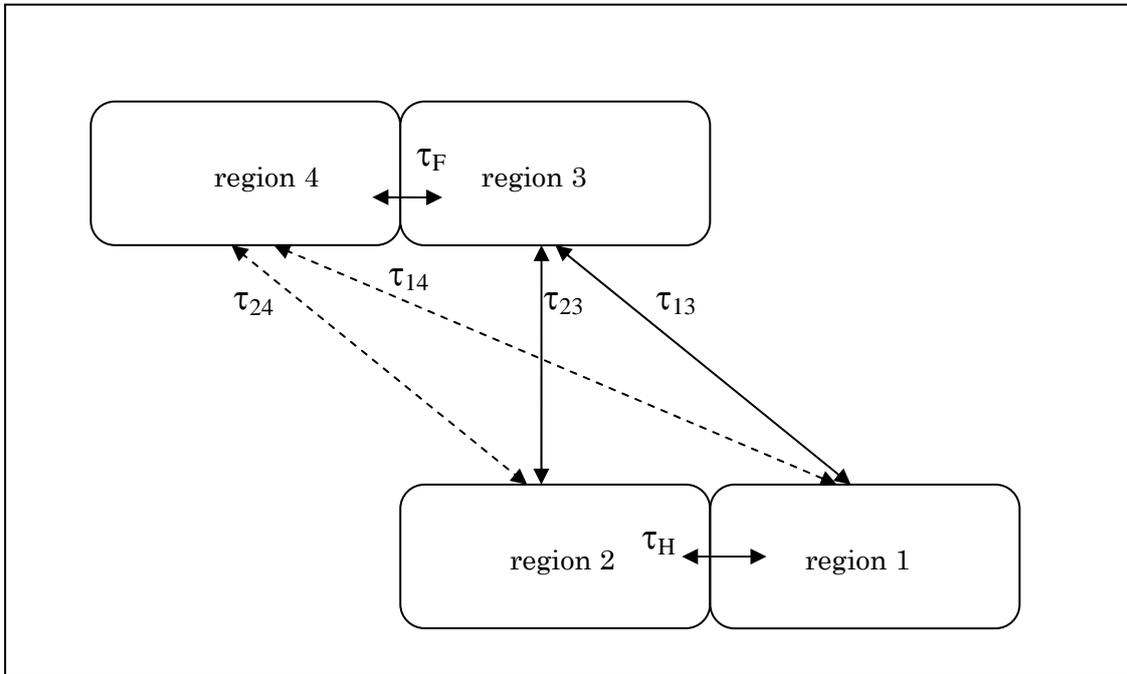
Note: Region 1 and 2 represents the Home country and region 3 and 4 are foreign country. International trade costs are represented by the length of arrows between two regions.

Figure 4. Regional production in 2005:

computer [JSIC2822] and integrated circuits [JSIC2913]
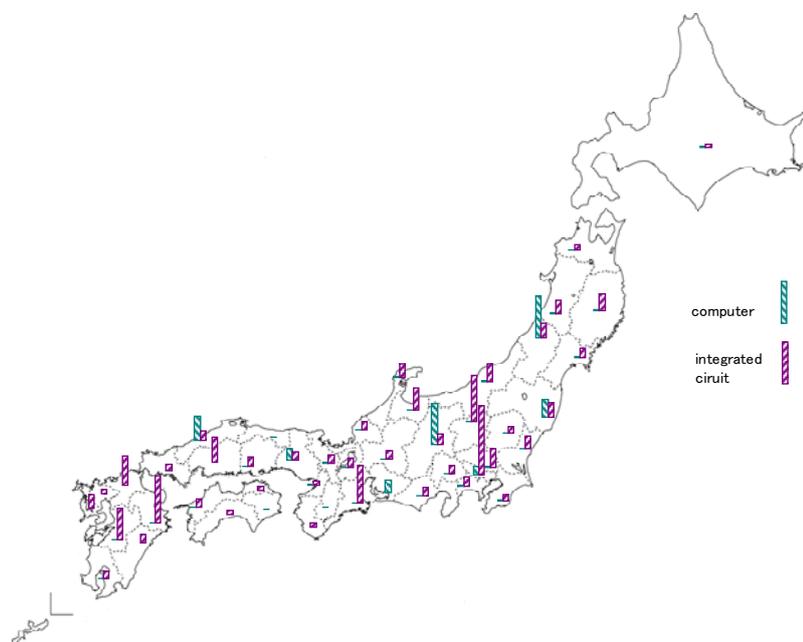
Note: The value of production for each industry in prefectures are represented in a relative height of bar.   Figures are calculated by authors, using the *Census of Manufactures*.

Figure 5. Regional production in 2005:

industrial robot [JSIC2698] and medical equipment [JSIC3131]
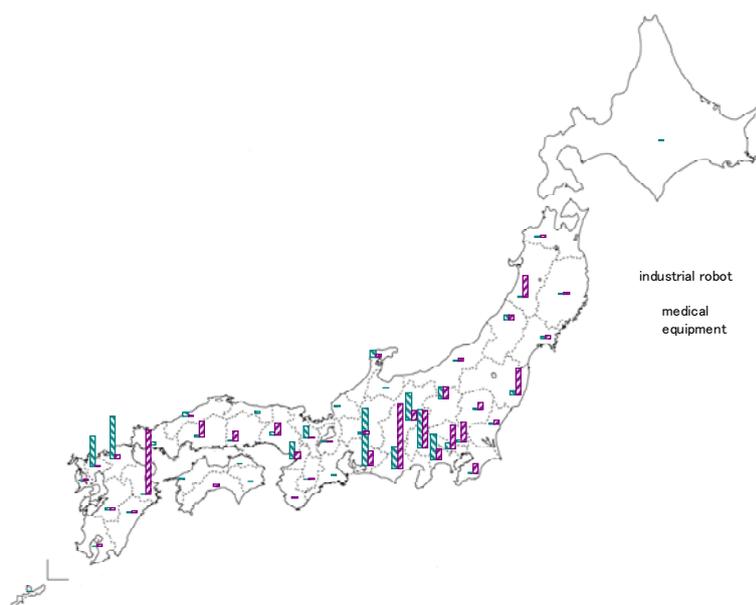
Note: the same as in Figure 4.

Table1. Least Squares Estimates and HME Test Statistics

(HS2) Industry	GDPIM	GDPR	Distance	HMEtest	adj. R2	(HS2) Industry	GDPIM	GDPR	Distance	HMEtest	adj. R2
(10)Cereals.	0.28992 (0.34676)	4.352*** (0.91652)	-102760*** (25626)	3.77	0.047	(63)other made up textile articles; sets; worn clothing etc	23.913*** (9.2648)	96.372*** (24.488)	-2800400*** (684680)	2.52	0.028
(8)Edible fruit and nuts; peel of citrus fruit or melons.	4.8458 (6.9921)	78.68*** (18.48)	-1914500*** (516720)	3.40	0.023	(96)Miscellaneous manufactured articles.	161.8*** (61.802)	642.67*** (163.35)	-18953000*** (4567200)	2.51	0.027
(24)Tobacco and manufactured tobacco substitutes.	19.851 (24.635)	278.71*** (65.113)	-6630200*** (1820600)	3.38	0.022	(60)Knitted or crocheted fabrics.	155.49*** (57.432)	593.64*** (151.8)	-17925000*** (4244300)	2.46	0.027
(2)Meat and edible meat offal.	0.37708 (0.40095)	4.2912*** (1.0597)	-107050*** (29630)	3.14	0.024	(20)Prep of vegetable, fruit, nuts or other parts of plants	6.9094*** (2.2931)	24.281*** (6.0607)	-714040*** (169460)	2.44	0.029
(11)Prod mill indust; malt; starches; inulin; wheat gluten	5.4295 (6.1244)	64.961*** (16.187)	-1630900*** (452600)	3.13	0.023	(56)Wadding, felt & nonwoven; yarns; twine, cordage, etc	139.04*** (49.132)	507.31*** (129.86)	-15145000*** (3630900)	2.41	0.028
(79)Zinc and articles thereof.	27.201 (17.642)	192.25*** (46.628)	-5067900*** (1303700)	3.01	0.025	(59)Impregnated, coated, cover/laminated textile fabric etc	150.6*** (52.853)	546.51*** (139.69)	-16469000*** (3905900)	2.41	0.028
(16)Prep of meat, fish or crustaceans, molluscs etc	48.623 (32.384)	344.39*** (85.592)	-9049300*** (2393200)	2.94	0.024	(5)Products of animal origin, nes or included.	4.8498*** (1.8003)	18.31*** (4.7584)	-536750*** (133040)	2.41	0.026
(42)Articles of leather; saddlery/harness; travel goods etc	6.9859* (4.1145)	44.107*** (10.875)	-1179000*** (304060)	2.91	0.024	(36)Explosives; pyrotechnic prod; matches; pyrop alloy; etc	1.0009** (0.45054)	4.3653*** (1.1908)	-126790*** (33295)	2.40	0.026
(86)Railw/tramw locom, rolling-stock & parts thereof; etc	138.02* (78.261)	834.33*** (206.85)	-22773000*** (5783500)	2.87	0.023	(85)Electrical mchy equip parts thereof; sound recorder etc	22826*** (7413.8)	76495*** (19595)	-2328100000*** (547880000)	2.33	0.029
(19)Prep of cereal, flour, starch/milk; pastrycooks' prod	20.987* (11.636)	124.03*** (30.755)	-3358300*** (859910)	2.85	0.025	(48)Paper & paperboard; art of paper pulp, paper/paperboard	460.27*** (152.42)	1560.9*** (402.86)	-47270000*** (11264000)	2.33	0.029
(22)Beverages, spirits and vinegar.	19.139** (9.5717)	103.56*** (25.299)	-2830700*** (707350)	2.84	0.025	(54)Man-made filaments.	431.82*** (141.39)	1448.1*** (373.71)	-44623000*** (10449000)	2.31	0.029
(89)Ships, boats and floating structures.	256.55* (155.05)	1619.7*** (409.82)	-43209000*** (11459000)	2.83	0.027	(52)Cotton.	242.63*** (83.009)	836.51*** (219.4)	-26105000*** (6134800)	2.30	0.029
(7)Edible vegetables and certain roots and tubers.	2.809 (2.5474)	25.106*** (6.7329)	-664040*** (188250)	2.82	0.022	(78)Lead and articles thereof.	7.3745*** (2.2181)	23.165*** (5.8626)	-703460*** (163920)	2.29	0.030
(91)Clocks and watches and parts thereof.	111.15 (84.176)	847.44*** (222.48)	-22437000*** (6220700)	2.82	0.024	(95)Toys, games & sports requisites; parts & access thereof	309.77*** (93.595)	974.31*** (247.38)	-29680000*** (6916700)	2.29	0.031
(45)Cork and articles of cork.	0.26866* (0.14931)	1.5552*** (0.39464)	-42070*** (11034)	2.77	0.026	(9)Coffee, tea, mat・and spices.	5.0514*** (1.5997)	16.362*** (4.2282)	-503650*** (118220)	2.28	0.030
(71)Natural/cultured pearls, prec stones & metals, coin etc	613.23** (304.7)	3217*** (805.34)	-88744000*** (22517000)	2.75	0.026	(81)other base metals; cermets; articles thereof.	293.24*** (88.549)	915.06*** (234.04)	-28077000*** (6543800)	2.26	0.030
(41)Raw hides and skins (other than furskins) and leather.	43.52** (21.495)	227.05*** (56.813)	-6163700*** (1588500)	2.75	0.024	(57)Carpets and other textile floor coverings.	5.5005*** (1.8425)	18.39*** (4.8698)	-569270*** (136160)	2.25	0.028
(4)Dairy prod; birds' eggs; natural honey; edible prod nes	2.0074** (0.9581)	10.15*** (2.5323)	-282740*** (70804)	2.74	0.025	(76)Aluminium and articles thereof.	586.21*** (177.42)	1825.7*** (468.94)	-56568000*** (13112000)	2.25	0.031
(88)Aircraft, spacecraft, and parts thereof.	5.6849** (2.6369)	28.079*** (6.9696)	-778410*** (194870)	2.73	0.027	(68)Art of stone, plaster, cement, asbestos, mica/sim mat	264.13*** (77.678)	803.54*** (205.31)	-24559000*** (5740500)	2.24	0.031
(18)Cocoa and cocoa preparations.	9.2962** (3.9059)	42.143*** (10.323)	-1167800*** (288640)	2.71	0.026	(83)Miscellaneous articles of base metal.	155.39*** (48.016)	488.36*** (126.91)	-15319000*** (3548400)	2.23	0.030
(64)Footwear, gaiters and the like; parts of such articles.	12.16** (5.1928)	55.487*** (13.725)	-1552900*** (383750)	2.69	0.027	(58)Special woven fab; tufted tex fab; lace; tapestries etc	77.87*** (23.68)	241.5*** (62.587)	-7690500*** (1749900)	2.23	0.030
(80)Tin and articles thereof.	22.606** (8.9199)	95.175*** (23.576)	-2723200*** (659180)	2.62	0.028	(51)Wool, fine/coarse animal hair, horsehair yarn & fabric	110.95*** (34.744)	350.68*** (91.831)	-11240000*** (2567600)	2.22	0.030
(62)Art of apparel & clothing access, not knitted/crocheted	35.01*** (13.276)	141.47*** (35.089)	-4093300*** (981080)	2.58	0.027	(55)Man-made staple fibres.	275.96*** (86.363)	868.16*** (228.26)	-27536000*** (6382300)	2.21	0.030
(61)Art of apparel & clothing access, knitted or crocheted.	33.537*** (12.658)	133.81*** (33.455)	-3852700*** (935400)	2.55	0.027	(35)Albuminoidal subs; modified starches; glues; enzymes.	159.44*** (45.017)	468.08*** (118.98)	-14472000*** (3326800)	2.21	0.032

Note: For expository purpose, coefficients for GDPIM and GDPR are presented after original estimated coefficients are multiplied by 1,000,000. Figures in parenthesis are heteroskedastic consistent standard errors. *, **, *** denote statistical significance at ten, five, and one percent level, respectively. HME test represents statistics given in equation (31) and critical value for ten percent significance level is 1.282.

Table1 (continued). Least Squares Estimates and HME Test Statistics

(HS2) Industry	GDPIM	GDPR	Distance	HMEtest	adj. R2
(21)Miscellaneous edible preparations.	106.62*** (29.95)	311.07*** (79.159)	-9671700*** (2213300)	2.20	0.032
(46)Manufactures of straw, esparto/other plaiting mat; etc	0.18253*** (0.060437)	0.59473*** (0.15974)	-18462*** (4466.3)	2.20	0.028
(47)Pulp of wood/of other fibrous cellulosic mat; waste etc	205.11*** (60.299)	611.07*** (159.38)	-19630000*** (4456200)	2.17	0.030
(53)other vegetable textile fibres; paper yarn & woven fab	11.288*** (3.5495)	34.945*** (9.3816)	-1121200*** (262310)	2.15	0.028
(17)Sugars and sugar confectionery.	20.465*** (5.4645)	56.778*** (14.443)	-1746000*** (403830)	2.14	0.033
(37)Photographic or cinematographic goods.	904.41*** (247.71)	2546.6*** (654.7)	-79822000*** (18306000)	2.13	0.032
(6)Live tree & other plant; bulb, root; cut flowers etc	6.231*** (1.8902)	18.732*** (4.9958)	-601200*** (139680)	2.13	0.029
(65)Headgear and parts thereof.	2.8447*** (0.77654)	7.9682*** (2.0525)	-248670*** (57387)	2.12	0.032
(33)Essential oils & resinoids; perf, cosmetic/toilet prep	285.3*** (76.623)	790.05*** (202.52)	-24639000*** (5662500)	2.12	0.032
(40)Rubber and articles thereof.	820.59*** (230.71)	2332.9*** (609.77)	-74354000*** (17049000)	2.11	0.032
(66)Umbrellas, walking-sticks, seat-sticks, whips, etc	0.25997*** (0.099362)	0.90868*** (0.26262)	-26142*** (7342.9)	2.10	0.027
(82)Tool, implement, cutlery, spoon & fork, of base met etc	497.21*** (138.25)	1395.5*** (365.4)	-44793000*** (10217000)	2.09	0.032
(73)Articles of iron or steel.	1460.5*** (426.56)	4223.4*** (1127.4)	-135010000*** (31523000)	2.09	0.031
(32)Tanning/dyeing extract; tannins & derivs; pigm etc	888.73*** (240.42)	2445.1*** (635.45)	-77985000*** (17767000)	2.08	0.032
(74)Copper and articles thereof.	2126*** (591.53)	5941.4*** (1563.5)	-191150000*** (43715000)	2.08	0.031
(39)Plastics and articles thereof.	5573.3*** (1504.1)	15244*** (3975.5)	-489940000*** (111150000)	2.07	0.032
(84)Nuclear reactors, boilers, mchy & mech appliance; parts	20329*** (5480.1)	55327*** (14484)	- 1778500000***	2.06	0.032
(69)Ceramic products.	199.37*** (52.363)	532.1*** (138.4)	-16594000*** (3869700)	2.05	0.034
(90)optical, photo, cine, meas, checking, precision, etc	7858.8*** (2062)	20930*** (5450)	-674600000*** (152380000)	2.04	0.033
(87)Vehicles o/t railw/tramw roll-stock, pts & accessories	4998.1*** (1383.9)	13732*** (3657.7)	-447160000*** (102270000)	2.03	0.032
(44)Wood and articles of wood; wood charcoal.	20.207*** (5.2833)	53.149*** (13.964)	-1685000*** (390440)	2.01	0.033
(31)Fertilizers.	11.354*** (4.0793)	36.346*** (10.782)	-1127300*** (301470)	1.97	0.034
(38)Miscellaneous chemical products.	2743.2*** (677.58)	6832.5*** (1790.9)	-222580000*** (50074000)	1.94	0.034
(34)Soap, organic surface-active agents, washing prep, etc	408.74*** (101.68)	1019*** (268.74)	-33250000*** (7514000)	1.93	0.034

(HS2) Industry	GDPIM	GDPR	Distance	HMEtest	adj. R2
(28)Inorgn chem; compds of prec met, radioact elements etc	975.12*** (244.43)	2440.7*** (646.04)	-79473000*** (18063000)	1.93	0.034
(92)Musical instruments; parts and access of such articles	43.935*** (11.397)	112.19*** (30.123)	-3696400*** (842250)	1.93	0.036
(3)Fish & crustacean, mollusc & other aquatic invertebrate	306.07*** (73.908)	745.45*** (195.34)	-24033000*** (5461900)	1.91	0.034
(97)Works of art, collectors' pieces and antiques.	6.7409*** (1.5894)	15.971*** (4.2009)	-521230*** (117460)	1.87	0.035
(30)Pharmaceutical products.	199.99*** (46.291)	461.49*** (122.35)	-15421000*** (3420900)	1.82	0.036
(12)oil seed, oleagi fruits; miscell grain, seed, fruit etc	25.359*** (5.8747)	57.943*** (15.527)	-1926000*** (434140)	1.79	0.035
(70)Glass and glassware.	1507.4*** (338.73)	3359.3*** (895.3)	-113110000*** (25033000)	1.76	0.036
(15)Animal/veg fats & oils & their cleavage products; etc	15.468*** (3.4402)	33.747*** (9.0926)	-1108500*** (254230)	1.71	0.037
(67)Prepr feathers & down; arti flower; articles human hair	1.3066*** (0.28416)	2.7818*** (0.75105)	-97075*** (20999)	1.67	0.038
(49)Printed books, newspapers, pictures & other product etc	160.49*** (35.71)	341.64*** (94.385)	-11954000*** (2639000)	1.63	0.036
(26)ores, slag and ash.	38.783*** (8.212)	80.209*** (21.705)	-2740300*** (606870)	1.62	0.038
(13)Lac; gums, resins & other vegetable saps & extracts.	8.8347*** (1.734)	17.543*** (4.583)	-578940*** (128140)	1.62	0.042
(94)Furniture; bedding, mattress, matt support, cushion etc	196.21*** (43.388)	405.68*** (114.68)	-14674000*** (3206400)	1.55	0.037
(14)Vegetable plaiting materials; vegetable products nes	0.34279*** (0.083889)	0.74172*** (0.22172)	-21482*** (6199.4)	1.53	0.029
(29)organic chemicals.	6345.2*** (1315.2)	12583*** (3476.1)	-446910000*** (97193000)	1.53	0.038
(27)Mineral fuels, oils & product of their distillation; etc	1740.5*** (358.9)	3430.4*** (948.59)	-122130000*** (26523000)	1.52	0.038
(25)Salt; sulphur; earth & ston; plastering mat; lime & cem	173.56*** (35.454)	339.17*** (93.707)	-11976000*** (2620100)	1.50	0.040
(72)Iron and steel.	10715*** (2149.2)	20593*** (5680.4)	-726050000*** (158830000)	1.48	0.040
(23)Residues & waste from the food indust; prepr ani fodder	26.072*** (4.8963)	46.72*** (12.941)	-1592300*** (361840)	1.36	0.042
(43)Furskins and artificial fur; manufactures thereof.	0.35125*** (0.12551)	0.86631*** (0.33173)	-31225*** (9275.1)	1.32	0.029
(93)Arms and ammunition; parts and accessories thereof.	0.063405*** (0.014129)	0.11457*** (0.037344)	-3955.4*** (1044.1)	1.17	0.045
(75)Nickel and articles thereof.	198.4*** (33.074)	313.38*** (87.416)	-11619000*** (2444200)	1.12	0.049
(50)Silk.	30.363*** (5.7777)	49.987*** (15.271)	-2022100*** (426970)	1.09	0.041
(1)Live animals.	3.1794*** (0.46937)	4.367*** (1.2406)	-165880*** (34686)	0.81	0.056

Note: For expository purpose, coefficients for GDPIM and GDPR are presented after original estimated coefficients are multiplied by 1,000,000. Figures in parenthesis are heteroskedastic consistent standard errors. *,
, * denote statistical significance at ten, five, and one percent level, respectively. HME test represents statistics given in equation (31) and critical value for ten percent significance level is 1.282.

Table2. Probit Estimates and HME Test Statistics

(HS2) Industry	GDPIM	GDPR	Distance	HMEtest	adj. R2	(HS2) Industry	GDPIM	GDPR	Distance	HMEtest	adj. R2
(37)Photographic or cinematographic goods.	-4.3001*** (0.88003)	23.628*** (1.275)	-0.00045945*** (0.000024016)	16.07	0.640	(45)Cork and articles of cork.	-4.6389*** (0.73257)	7.527*** (0.41996)	-0.00036374*** (0.000017928)	13.11	0.239
(30)Pharmaceutical products.	-4.258*** (0.81153)	17.009*** (0.87524)	-0.00035491*** (0.000019823)	15.90	0.529	(62)Art of apparel & clothing access, not knitted/crocheted	1.8177* (0.96632)	24.56*** (1.3342)	-0.00050805*** (0.000025812)	12.90	0.665
(92)Musical instruments; parts and access of such articles	-2.9717*** (0.80554)	18.701*** (0.96419)	-0.00044946*** (0.000022335)	15.65	0.593	(59)Impregnated, coated, cover/laminated textile fabric etc	-0.91034 (0.92925)	24.623*** (1.512)	-0.0003715*** (0.000022567)	12.84	0.567
(78)Lead and articles thereof.	-3.101*** (0.8089)	16.127*** (0.82622)	-0.00041647*** (0.000020819)	15.01	0.548	(38)Miscellaneous chemical products.	-0.2149 (1.1972)	41.226*** (2.7178)	-0.00031403*** (0.000026944)	12.84	0.498
(33)Essential oils & resinoids; perf, cosmetic/toilet prep	-1.9281** (0.83562)	18.837*** (0.99857)	-0.0004045*** (0.000021508)	14.45	0.568	(28)Inorgn chem; compds of prec met, radioact elements etc	-0.53682 (1.1598)	39.01*** (2.5806)	-0.00029091*** (0.000026113)	12.78	0.460
(88)Aircraft, spacecraft, and parts thereof.	-5.0418*** (0.76868)	9.8337*** (0.52288)	-0.00039148*** (0.000019211)	14.42	0.364	(52)Cotton.	1.767* (0.91861)	21.485*** (1.1315)	-0.00050175*** (0.000025091)	12.77	0.644
(91)Clocks and watches and parts thereof.	-2.0723** (0.88085)	21.942*** (1.2189)	-0.00041144*** (0.000022327)	14.39	0.594	(96)Miscellaneous manufactured articles.	-0.086412 (1.0334)	30.445*** (1.9487)	-0.00036904*** (0.00002437)	12.40	0.554
(13)Lac; gums, resins & other vegetable saps & extracts.	-1.8917** (0.80079)	15.647*** (0.79369)	-0.00047145*** (0.000023098)	14.32	0.557	(40)Rubber and articles thereof.	-0.72882 (1.1765)	39.547*** (2.7465)	-0.00024245*** (0.000026409)	12.31	0.428
(69)Ceramic products.	-3.5949*** (0.94939)	29.663*** (1.8488)	-0.00041071*** (0.00002499)	14.12	0.605	(15)Animal/veg fats & oils & their cleavage products; etc	0.2166 (0.83035)	15.975*** (0.85006)	-0.00038606*** (0.000020067)	12.23	0.533
(75)Nickel and articles thereof.	-1.5122* (0.84708)	18.116*** (0.96301)	-0.00035778*** (0.000019751)	13.86	0.541	(49)Printed books, newspapers, pictures & other product etc	0.27345 (1.0251)	29.04*** (1.8849)	-0.00035394*** (0.00002389)	12.08	0.541
(81)other base metals; cermets; articles thereof.	-0.31972 (0.91547)	23.573*** (1.2933)	-0.0004231*** (0.000022963)	13.77	0.614	(61)Art of apparel & clothing access, knitted or crocheted.	1.9053** (0.90353)	19.028*** (0.99414)	-0.00044532*** (0.000022724)	11.99	0.599
(79)Zinc and articles thereof.	-1.8517** (0.81074)	16.452*** (0.88216)	-0.00032594*** (0.000018887)	13.74	0.504	(64)Footwear, gaiters and the like; parts of such articles.	0.84711 (0.87576)	17.335*** (0.92539)	-0.00036122*** (0.000019901)	11.98	0.532
(71)Natural/cultured pearls, prec stones & metals, coin etc	-1.9401** (0.88916)	22.737*** (1.3348)	-0.00036437*** (0.000021482)	13.74	0.568	(74)Copper and articles thereof.	3.3585** (1.3731)	40.16*** (2.551)	-0.00038463*** (0.000027562)	11.81	0.548
(42)Articles of leather; saddlery/harness; travel goods etc	-0.38199 (0.84591)	18.376*** (0.94986)	-0.00043028*** (0.000021998)	13.65	0.583	(18)Cocoa and cocoa preparations.	-3.2571*** (0.72947)	7.5488*** (0.42788)	-0.00034786*** (0.000017372)	11.74	0.273
(58)Special woven fab; tufted tex fab; lace; tapestries etc	0.34696 (0.89848)	22.42*** (1.1971)	-0.00049319*** (0.000024896)	13.64	0.644	(29)organic chemicals.	0.43959 (1.1419)	33.05*** (2.279)	-0.00025775*** (0.000024394)	11.61	0.426
(80)Tin and articles thereof.	-2.1859*** (0.78109)	13.355*** (0.68789)	-0.00040313*** (0.000020183)	13.56	0.496	(32)Tanning/dyeing extract; tannins & derivs; pigm etc	0.23254 (1.0715)	29.746*** (2.0635)	-0.00026926*** (0.000023366)	11.41	0.459
(68)Art of stone, plaster, cement, asbestos, mica/sim mat	-0.9717 (1.1664)	42.805*** (2.7172)	-0.00035987*** (0.000027484)	13.54	0.530	(9)Coffee, tea, mat · and spices.	-1.0878 (0.75622)	10.397*** (0.5531)	-0.0003688*** (0.000018373)	11.29	0.412
(65)Headgear and parts thereof.	-2.8619*** (0.75975)	11.391*** (0.59285)	-0.00040712*** (0.000019964)	13.50	0.447	(34)Soap, organic surface-active agents, washing prep, etc	1.1045 (1.0718)	27.951*** (1.8456)	-0.00032318*** (0.000023134)	11.28	0.511
(82)Tool, implement, cutlery, spoon & fork, of base met etc	-0.63069 (1.2013)	43.837*** (2.793)	-0.00035015*** (0.000027761)	13.43	0.527	(35)Albuminoidal subs; modified starches; glues; enzymes.	0.87845 (1.0499)	26.883*** (1.8208)	-0.00031129*** (0.000022813)	11.14	0.508
(60)Knitted or crocheted fabrics.	0.98801 (0.90343)	21.657*** (1.13)	-0.00051202*** (0.000024931)	13.37	0.655	(90)optical, photo, cine, meas, checking, precision, etc	4.0725** (1.6343)	48.826*** (3.4903)	-0.00033087*** (0.000031017)	11.12	0.471
(70)Glass and glassware.	-1.5544 (0.98102)	32.094*** (2.0415)	-0.00032427*** (0.000023952)	13.36	0.527	(94)Furniture; bedding, mattress, matt support, cushion etc	1.3897 (1.0992)	28.806*** (1.9525)	-0.00031654*** (0.00002347)	11.04	0.503
(11)Prod mill indust; malt; starches; inulin; wheat gluten	-1.3641* (0.7843)	14.22*** (0.72116)	-0.00037645*** (0.000019425)	13.34	0.515	(17)Sugars and sugar confectionery.	-0.14816 (0.80472)	12.829*** (0.71585)	-0.00031491*** (0.000017614)	10.99	0.446
(57)Carpets and other textile floor coverings.	-1.8325** (0.76588)	13.19*** (0.689)	-0.00038493*** (0.000019598)	13.27	0.481	(73)Articles of iron or steel.	1.7948 (1.4917)	48.578*** (3.778)	-0.00022446*** (0.000031521)	10.97	0.380
(83)Miscellaneous articles of base metal.	-0.71507 (1.0571)	34.746*** (2.1822)	-0.00036449*** (0.000025362)	13.18	0.549	(19)Prep of cereal, flour, starch/milk; pastrycooks' prod	0.2689 (0.8337)	14.199*** (0.79884)	-0.00030644*** (0.000017936)	10.96	0.460

Note: For expository purpose, coefficients for GDPIM and GDPR are presented after original estimated coefficients are multiplied by 1,000,000,000,000,000. Figures in parenthesis are heteroskedastic consistent standard errors. *, **, *** denote statistical significance at ten, five, and one percent level, respectively. HME test represents statistics given in equation (31) and critical value for ten percent significance level is 1.282.

Table2 (continued). Probit Estimates and HME Test Statistics

(HS2) Industry	GDPIM	GDPR	Distance	HMEtest	adj. R2
(86)Railw/tramw locom, rolling-stock & parts thereof; etc	-0.26789 (0.77684)	11.627*** (0.63556)	-0.00033356*** (0.000017952)	10.93	0.435
(36)Explosives; pyrotechnic prod; matches; pyrop alloy; etc	-3.7785*** (0.73131)	6.0788*** (0.3907)	-0.00036283*** (0.000017718)	10.87	0.166
(55)Man-made staple fibres.	1.0581 (0.92843)	19.171*** (1.1959)	-0.00029291*** (0.000019529)	10.85	0.482
(67)Prepr feathers & down; arti flower; articles human hair	-2.0372*** (0.71794)	7.7787*** (0.44283)	-0.00039179*** (0.000018786)	10.79	0.295
(76)Aluminium and articles thereof.	3.3421*** (1.278)	33.04*** (2.1911)	-0.00035278*** (0.000025399)	10.73	0.538
(56)Wadding, felt & nonwoven; yarns; twine, cordage, etc	2.764** (1.1502)	28.406*** (1.9116)	-0.00035069*** (0.0000239)	10.48	0.529
(54)Man-made filaments.	2.6639*** (1.0304)	22.646*** (1.4329)	-0.00035401*** (0.000021857)	10.37	0.541
(48)Paper & paperboard; art of paper pulp, paper/paperboard	1.7699 (1.3829)	37.525*** (2.8994)	-0.00015482*** (0.000027425)	10.35	0.358
(95)Toys, games & sports requisites; parts & access thereof	3.4949*** (1.0977)	25.048*** (1.5816)	-0.00040034*** (0.000023587)	10.26	0.583
(24)Tobacco and manufactured tobacco substitutes.	-3.072*** (0.72791)	6.2188*** (0.4054)	-0.00042684 (0.000019989)	10.21	0.197
(20)Prep of vegetable, fruit, nuts or other parts of plants	0.98811 (0.81658)	12.697*** (0.69928)	-0.00034613*** (0.000018606)	10.03	0.464
(39)Plastics and articles thereof.	3.8287** (1.6629)	44.065*** (3.4438)	-0.00022313*** (0.00030007)	9.91	0.378
(63)other made up textile articles; sets; worn clothing etc	2.2054** (1.018)	20.454*** (1.3569)	-0.00027285*** (0.000019839)	9.72	0.473
(46)Manufactures of straw, esparto/other plaiting mat; etc	-1.2726* (0.72293)	7.4905*** (0.42901)	-0.00039797*** (0.00001882)	9.72	0.295
(4)Dairy prod; birds' eggs; natural honey; edible prod nes	-1.4667** (0.71125)	6.9827*** (0.40966)	-0.00034636*** (0.00001715)	9.53	0.253
(85)Electrical mchy equip parts thereof; sound recorder etc	3.0625 (1.8663)	63.494*** (5.9518)	-0.00019981*** (0.000038992)	9.39	0.323
(97)Works of art, collectors' pieces and antiques.	-0.52926 (0.72872)	7.818*** (0.44319)	-0.00041116 (0.000019245)	9.19	0.327
(31)Fertilizers.	-0.94913 (0.73858)	7.9491*** (0.5038)	-0.00014432*** (0.00001435)	9.06	0.255
(22)Beverages, spirits and vinegar.	2.227*** (0.85469)	13.048*** (0.72846)	-0.00033819*** (0.000018542)	8.97	0.469
(2)Meat and edible meat offal.	-2.5829*** (0.70819)	5.2189*** (0.37598)	-0.00035161*** (0.000017337)	8.90	0.162
(16)Prep of meat, fish or crustaceans, molluscs etc	1.0021 (0.8107)	10.923*** (0.64347)	-0.00026377*** (0.00001655)	8.74	0.385
(93)Arms and ammunition; parts and accessories thereof.	-3.9767*** (0.73491)	3.5374*** (0.36121)	-0.00034411*** (0.00001756)	8.35	0.030
(87)Vehicles o/t railw/tramw roll-stock, pts & accessories	2.0429 (1.2771)	26.512*** (2.297)	0.000067858** (-)	8.35	0.233
(8)Edible fruit and nuts; peel of citrus fruit or melons.	-1.8716*** (0.68099)	5.1478*** (0.35889)	-0.00026252*** (0.000015089)	8.34	0.162
(7)Edible vegetables and certain roots and tubers.	0.34026 (0.73573)	8.0321*** (0.45777)	-0.00032475*** (0.000016812)	8.28	0.320
(23)Residues & waste from the food indust; prepr ani fodder	1.6735* (0.88876)	12.834*** (0.84378)	-0.00017965*** (0.000016365)	8.22	0.363
(14)Vegetable plaiting materials; vegetable products nes	-0.44256 (0.71773)	6.8178*** (0.40893)	-0.00038545*** (0.0000184)	8.22	0.263
(50)Silk.	1.5283*** (0.76794)	9.2415*** (0.49386)	-0.00043352*** (0.000020397)	8.11	0.415
(21)Miscellaneous edible preparations.	5.1303*** (1.1214)	18.742*** (1.1148)	-0.0003505*** (0.000020398)	7.99	0.537
(12)oil seed, oleagi fruits; miscell grain, seed, fruit etc	5.5245*** (1.0248)	16.37*** (0.87536)	-0.00048471*** (0.000023991)	7.83	0.602
(84)Nuclear reactors, boilers, mchy & mech appliance; parts	3.3846 (2.1999)	63.684*** (7.1282)	-0.000081686** (0.000041665)	7.74	0.269
(25)Salt; sulphur; earth & ston; plastering mat; lime & cem	5.5551*** (1.3798)	25.345*** (1.8813)	-0.00025223*** (0.000022611)	7.71	0.424
(66)Umbrellas, walking-sticks, seat-sticks, whips, etc	-0.81307 (0.7125)	5.9734*** (0.40456)	-0.00043025 (0.000019967)	7.70	0.232
(3)Fish & crustacean, mollusc & other aquatic invertebrate	3.6447*** (1.1203)	17.348*** (1.1922)	-0.00014119*** (0.000018191)	7.62	0.347
(44)Wood and articles of wood; wood charcoal.	5.0932*** (1.1912)	19.63*** (1.3012)	-0.00028206*** (0.000019645)	7.56	0.481
(10)Cereals.	-3.872*** (0.72428)	2.6261*** (0.34585)	-0.00028794*** (0.000015918)	7.35	0.412
(51)Wool, fine/coarse animal hair, horsehair yarn & fabric	3.4013*** (0.83693)	10.844*** (0.55547)	-0.0004421*** (0.000021057)	7.23	0.490
(72)Iron and steel.	7.3268*** (1.9992)	32.146*** (2.7081)	-0.00015189*** (0.000026988)	6.87	0.345
(89)Ships, boats and floating structures.	3.9627*** (1.1007)	15.213*** (1.1167)	-0.00011243*** (0.000017758)	6.50	0.281
(27)Mineral fuels, oils & product of their distillation; etc	7.3128*** (1.5119)	23.69*** (1.7376)	-0.0002663*** (0.000022011)	6.47	0.442
(43)Furskins and artificial fur; manufactures thereof.	0.8091 (0.72146)	6.3416*** (0.40825)	-0.00042196 (0.000019531)	6.29	0.283
(53)other vegetable textile fibres; paper yarn & woven fab	3.2606*** (0.80682)	9.3454*** (0.50295)	-0.00043642*** (0.000020539)	6.22	0.437
(1)Live animals.	0.59372 (0.71572)	6.0334*** (0.40734)	-0.00044556 (0.00002048)	6.19	0.257
(26)ores, slag and ash.	1.367* (0.74417)	5.7226*** (0.38966)	-0.00019256*** (0.000014126)	4.81	0.208
(5)Products of animal origin, nes or included.	4.1217*** (0.82363)	8.8039*** (0.4825)	-0.00039176*** (0.000018797)	4.74	0.433
(41)Raw hides and skins (other than furskins) and leather.	6.8762*** (1.0708)	11.858*** (0.70188)	-0.00034621*** (0.000018903)	3.73	0.471
(6)Live tree & other plant; bulb, root; cut flowers etc	4.2697*** (0.77858)	6.0453*** (0.39919)	-0.00037593*** (0.000018057)	1.95	0.330
(47)Pulp of wood/of other fibrous cellulosic mat; waste etc	7.885*** (1.0648)	6.7691*** (0.44477)	-0.00028072*** (0.000015933)	-0.93	0.339

Note: For expository purpose, coefficients for GDPIM and GDPR are presented after original estimated coefficients are multiplied by 1,000,000,000,000,000. Figures in parenthesis are heteroskedastic consistent standard errors. *, **, *** denote statistical significance at ten, five, and one percent level, respectively. HME test represents statistics given in equation (31) and critical value for ten percent significance level is 1.282.

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Table 3. Export ratio regression

Industry	f(dist)*L_im	Ratio_L_reg	NOB	Adj. R²	Industry	f(dist)*L_im	Ratio_L_reg	NOB	Adj. R²
(1)Live animals.	-0.0012378*** (0.00038633)	1.2662*** (0.04273)	1044	0.387	(25)Salt; sulphur; earth & ston; plastering mat; lime & cem	-0.0026779*** (0.00028314)	0.65127*** (0.027917)	1368	0.048
(2)Meat and edible meat offal.	-0.0010115*** (0.00036965)	1.2859*** (0.040755)	1044	0.426	(26)ores, slag and ash.	-0.0014585*** (0.0003781)	0.77963*** (0.037684)	1332	0.065
(3)Fish & crustacean, mollusc & other aquatic invertebrate	0.00019069 (0.00025316)	0.9554*** (0.024961)	1368	0.323	(27)Mineral fuels, oils & product of their distillation; etc	-0.0014868*** (0.00023767)	0.91121*** (0.023434)	1368	0.290
(4)Dairy prod; birds' eggs; natural honey; edible prod nes	-0.00057096 (0.00035207)	1.2388*** (0.035896)	1269	0.407	(28)Inorgn chem; compds of prec met, radioact elements etc	-0.0013373*** (0.00018549)	1.0281*** (0.018289)	1368	0.534
(5)Products of animal origin, nes or included.	-0.0014813*** (0.00034843)	1.0545*** (0.034871)	1323	0.265	(29)organic chemicals.	-0.0024452*** (0.00015809)	0.88172*** (0.015587)	1368	0.461
(6)Live tree & other plant; bulb, root; cut flowers etc	-0.0013898*** (0.00037574)	0.97803*** (0.039299)	1179	0.188	(30)Pharmaceutical products.	0.00027406 (0.00023622)	1.2104*** (0.023291)	1368	0.596
(7)Edible vegetables and certain roots and tubers.	-0.00080915** (0.00032556)	1.2005*** (0.032608)	1314	0.416	(31)Fertilizers.	-0.0030462*** (0.00032262)	0.66553*** (0.031809)	1368	0.049
(8)Edible fruit and nuts; peel of citrus fruit or melons.	-0.0017473*** (0.00045871)	0.87065*** (0.04607)	1287	0.082	(32)Tanning/dyeing extract; tannins & derivs; pigm etc	-0.0003958* (0.00021169)	1.1602*** (0.020872)	1368	0.602
(9)Coffee, tea, mat・and spices.	-0.00051814* (0.00028927)	1.2575*** (0.028521)	1368	0.524	(33)Essential oils & resinoids; perf, cosmetic/toilet prep	0.00048511** (0.00020952)	1.2936*** (0.020658)	1368	0.726
(10)Cereals.	0.00040877 (0.00039783)	1.3388*** (0.048533)	765	0.465	(34)Soap, organic surface-active agents, washing prep, etc	-0.00073063*** (0.00021786)	1.1214*** (0.021481)	1368	0.549
(11)Prod mill indust; malt; starches; inulin; wheat gluten	-0.00093607*** (0.0002475)	1.1895*** (0.024403)	1368	0.545	(35)Albuminoidal subs; modified starches; glues;	0.00023363 (0.00018393)	1.231*** (0.018135)	1368	0.735
(12)oil seed, oleagi fruits; miscell grain, seed, fruit etc	-0.00046296* (0.00026796)	1.1677*** (0.026421)	1368	0.487	(36)Explosives; pyrotechnic prod; matches; pyrop alloy; etc	-0.00036507 (0.00043166)	1.1376*** (0.043175)	1278	0.252
(13)Lac; gums, resins & other vegetable saps & extracts.	-0.00011903 (0.0002738)	1.2115*** (0.026997)	1368	0.517	(37)Photographic or cinematographic goods.	0.0012228*** (0.00029033)	1.5145*** (0.028626)	1368	0.723
(14)Vegetable plaiting materials; vegetable products nes	-0.0020454*** (0.00039585)	1.0799*** (0.040588)	1233	0.240	(38)Miscellaneous chemical products.	-0.00044608*** (0.00019382)	1.1373*** (0.01911)	1368	0.625
(15)Animal/veg fats & oils & their cleavage products; etc	0.00016008 (0.00026481)	1.1584*** (0.02611)	1368	0.490	(39)Plastics and articles thereof.	-0.00040721*** (0.00014764)	1.161*** (0.014557)	1368	0.768
(16)Prep of meat, fish or crustaceans, molluscs etc	-0.00096898*** (0.00030395)	1.1127*** (0.029969)	1368	0.373	(40)Rubber and articles thereof.	-0.00064856*** (0.00013068)	1.0734*** (0.012885)	1368	0.741
(17)Sugars and sugar confectionery.	-0.00040965 (0.00026916)	1.0464*** (0.026538)	1368	0.374	(41)Raw hides and skins (other than furskins) and leather.	-0.00089918*** (0.00028287)	1.1349*** (0.027967)	1359	0.428
(18)Cocoa and cocoa preparations.	-0.00016412 (0.00038911)	1.1371*** (0.03875)	1332	0.288	(42)Articles of leather; saddlery/harness; travel goods	-0.00024323 (0.00025773)	1.2796*** (0.025412)	1368	0.605
(19)Prep of cereal, flour, starch/milk; pastrycooks' prod	-0.0002037 (0.00022918)	1.274*** (0.022597)	1368	0.662	(43)Furskins and artificial fur; manufactures thereof.	-0.000491 (0.00040106)	1.1212*** (0.041957)	1143	0.273
(20)Prep of vegetable, fruit, nuts or other parts of plants	-0.00077003*** (0.00027586)	1.1942*** (0.0272)	1368	0.494	(44)Wood and articles of wood; wood charcoal.	-0.00028785 (0.00026811)	0.946*** (0.026435)	1368	0.282
(21)Miscellaneous edible preparations.	-0.0003942** (0.00017979)	1.2597*** (0.017727)	1368	0.765	(45)Cork and articles of cork.	0.00035546 (0.00035478)	1.2322*** (0.035554)	1314	0.405
(22)Beverages, spirits and vinegar.	-0.00057382** (0.00027023)	1.2197*** (0.026644)	1368	0.528	(46)Manufactures of straw, esparto/other plaiting mat; etc	-0.00065473* (0.00036228)	1.1454*** (0.03707)	1242	0.325
(23)Residues & waste from the food indust; prepr ani fodder	0.00013721 (0.00025462)	0.95193*** (0.025105)	1368	0.316	(47)Pulp of wood/of other fibrous cellulosic mat; waste etc	-0.00090861** (0.00035393)	1.0542*** (0.035336)	1332	0.260
(24)Tobacco and manufactured tobacco substitutes.	0.0000014776 (0.00041915)	1.3405*** (0.043337)	1152	0.413	(48)Paper & paperboard; art of paper pulp, paper/paperboard	-0.000079789 (0.00013866)	1.0025*** (0.013671)	1368	0.657

Note: For expository purpose, coefficients for f(dist)*L_im are presented after original estimated coefficients are multiplied by 1,000,000,000,000,000. Figures in parenthesis are heteroskedastic consistent standard errors. *, **, *** denote statistical significance at ten, five, and one percent level, respectively.

Table 3 (continued). Export ratio regression

Industry	f(dist)*L_im	Ratio_L_reg	NOB	Adj. R²	Industry	f(dist)*L_im	Ratio_L_reg	NOB	Adj. R²
(49)Printed books, newspapers, pictures & other product etc	-0.00034596 (0.00021442)	1.271*** (0.021141)	1368	0.692	(73)Articles of iron or steel.	-0.00079398*** (0.00013891)	1.078*** (0.013696)	1368	0.720
(50)Silk.	-0.0021406*** (0.00040583)	0.97502*** (0.040482)	1332	0.161	(74)Copper and articles thereof.	-0.00096911*** (0.00016284)	1.0947*** (0.016056)	1368	0.665
(51)Wool, fine/coarse animal hair, horsehair yarn & fabric	-0.0014636*** (0.00042243)	0.91975*** (0.041765)	1359	0.118	(75)Nickel and articles thereof.	-0.00080956*** (0.00029901)	1.0787*** (0.029482)	1368	0.352
(52)Cotton.	-0.001852*** (0.00047439)	0.87503*** (0.046774)	1368	0.077	(76)Aluminium and articles thereof.	0.000077295 (0.00015805)	1.2042*** (0.015583)	1368	0.777
(53)other vegetable textile fibres; paper yarn & woven fab	-0.0017884*** (0.00045148)	0.90864*** (0.044515)	1368	0.100	(78)Lead and articles thereof.	-0.00016937 (0.00026798)	1.1895*** (0.026422)	1368	0.508
(54)Man-made filaments.	-0.0017212*** (0.00040561)	0.87549*** (0.039992)	1368	0.103	(79)Zinc and articles thereof.	0.0000085929 (0.00029418)	1.0373*** (0.029006)	1368	0.330
(55)Man-made staple fibres.	-0.0020004*** (0.00040649)	0.81293*** (0.040079)	1368	0.073	(80)Tin and articles thereof.	0.00065708** (0.00028466)	1.3119*** (0.02815)	1359	0.584
(56)Wadding, felt & nonwoven; yarns; twine, cordage, etc	-0.0015067*** (0.00031252)	0.96165*** (0.030814)	1368	0.231	(81)other base metals; cermets; articles thereof.	-0.000019509 (0.00025469)	1.2393*** (0.025112)	1368	0.579
(57)Carpets and other textile floor coverings.	-0.0012068*** (0.00036652)	1.007*** (0.036138)	1368	0.211	(82)Tool, implement, cutlery, spoon & fork, of base met etc	0.000087518 (0.00014971)	1.1658*** (0.014761)	1368	0.769
(58)Special woven fab; tufted tex fab; lace; tapestries etc	-0.0014923*** (0.00035109)	0.9727*** (0.034616)	1368	0.200	(83)Miscellaneous articles of base metal.	-0.00031258 (0.00020907)	1.1382*** (0.020613)	1368	0.589
(59)Impregnated, coated, cover/laminated textile fabric etc	-0.00095491*** (0.0002972)	1.0746*** (0.029304)	1368	0.350	(84)Nuclear reactors, boilers, mchy & mech appliance; parts	-0.00044811*** (0.00011791)	1.143*** (0.011625)	1368	0.834
(60)Knitted or crocheted fabrics.	-0.0016457*** (0.00044166)	0.87928*** (0.043547)	1368	0.090	(85)Electrical mchy equip parts thereof; sound recorder etc	-0.00008372 (0.00014188)	1.224*** (0.013989)	1368	0.833
(61)Art of apparel & clothing access, knitted or crocheted.	-0.001294*** (0.00031167)	1.0484*** (0.03073)	1368	0.305	(86)Railw/tramw locom, rolling-stock & parts thereof; etc	-0.00079973** (0.00033166)	1.1338*** (0.032701)	1368	0.350
(62)Art of apparel & clothing access, not knitted/crocheted	-0.00087503*** (0.00029313)	1.1017*** (0.028902)	1368	0.381	(87)Vehicles o/t railw/tramw roll-stock, pts & accessories	-0.0005186*** (0.00017674)	1.0752*** (0.017427)	1368	0.610
(63)other made up textile articles; sets; worn clothing etc	-0.00092255*** (0.00023743)	1.1044*** (0.02341)	1368	0.488	(88)Aircraft, spacecraft, and parts thereof.	0.00053562 (0.0003535)	1.3058*** (0.034854)	1368	0.461
(64)Footwear, gaiters and the like; parts of such articles.	-0.0014247*** (0.00028745)	1.0827*** (0.028342)	1368	0.371	(89)Ships, boats and floating structures.	-0.0028855*** (0.00032862)	0.59342*** (0.032401)	1368	0.020
(65)Headgear and parts thereof.	-0.00069436** (0.00030556)	1.2509*** (0.030285)	1350	0.489	(90)optical, photo, cine, meas, checking, precision, etc	0.00031334* (0.00018368)	1.3269*** (0.01811)	1368	0.809
(66)Umbrellas, walking-sticks, seat-sticks, whips, etc	0.00046662 (0.0003501)	1.275*** (0.038703)	990	0.468	(91)Clocks and watches and parts thereof.	0.0005244** (0.00026288)	1.3353*** (0.02592)	1368	0.644
(67)Prepr feathers & down; arti flower; articles human hair	-0.00005493 (0.00035621)	1.242*** (0.035948)	1287	0.409	(92)Musical instruments; parts and access of such articles	-0.00036615 (0.00034005)	1.0139*** (0.033528)	1368	0.247
(68)Art of stone, plaster, cement, asbestos, mica/sim mat	-0.00015896 (0.00015023)	1.1472*** (0.014813)	1368	0.751	(93)Arms and ammunition; parts and accessories thereof.	-0.00056065 (0.00049162)	1.091*** (0.050765)	891	0.227
(69)Ceramic products.	-0.00055853** (0.00023499)	1.0954*** (0.02317)	1368	0.487	(94)Furniture; bedding, mattress, matt support, cushion	-0.00043946** (0.00019943)	1.1673*** (0.019663)	1368	0.638
(70)Glass and glassware.	-0.00026026 (0.00019227)	1.1543*** (0.018957)	1368	0.645	(95)Toys, games & sports requisites; parts & access	-0.00075818*** (0.00023122)	1.1644*** (0.022798)	1368	0.559
(71)Natural/cultured pearls, prec stones & metals, coin etc	0.00024474 (0.00027604)	1.3975*** (0.027217)	1368	0.663	(96)Miscellaneous manufactured articles.	-0.00066787*** (0.00020852)	1.2071*** (0.02056)	1368	0.650
(72)Iron and steel.	-0.0019524*** (0.00014899)	0.92143*** (0.014691)	1368	0.529	(97)Works of art, collectors' pieces and antiques.	-0.0001177 (0.00034407)	1.2879*** (0.035355)	1206	0.469

Note: For expository purpose, coefficients for f(dist)*L_im are presented after original estimated coefficients are multiplied by 1,000,000,000,000,000. Figures in parenthesis are heteroskedastic consistent standard errors. *, **, *** denote statistical significance at ten, five, and one percent level, respectively.

Table 4. Export ratio regression and Export ratio statistics

Industry	f(dist)*L_im	f(dist)*L_reg	NOB	Adj. R²	ER Stat	ER test
(1)Live animals.	-0.00019907 (0.00074648)	-0.017564*** (0.004276)	1044	0.526	0.017	3.821
(2)Meat and edible meat offal.	-0.0019576*** (0.00071162)	-0.01361*** (0.0036141)	1044	0.545	0.012	3.013
(3)Fish & crustacean, mollusc & other aquatic invertebrate	-0.00026839 (0.00042042)	-0.0027221 (0.0018262)	1368	0.626	0.002	1.241
(4)Dairy prod; birds' eggs; natural honey; edible prod nes	-0.0016424** (0.00068054)	-0.021584*** (0.0031392)	1269	0.538	0.020	5.898
(5)Products of animal origin, nes or included.	0.00051734 (0.00066906)	-0.0053671* (0.00313)	1323	0.459	0.006	1.747
(6)Live tree & other plant; bulb, root; cut flowers etc	-0.00073101 (0.00076819)	-0.0086128** (0.0035533)	1179	0.309	0.008	2.059
(7)Edible vegetables and certain roots and tubers.	-0.00043406 (0.00059926)	-0.0074432*** (0.0025972)	1314	0.606	0.007	2.504
(8)Edible fruit and nuts; peel of citrus fruit or melons.	-0.00053383 (0.0005434)	0.0060516** (0.0023706)	1287	0.773	-0.007	-2.597
(9)Coffee, tea, mat · and spices.	-0.00010012 (0.00050532)	-0.0080848*** (0.0021951)	1368	0.688	0.008	3.361
(10)Cereals.	-0.0013942* (0.00081063)	-0.018151** (0.008237)	765	0.572	0.017	1.984
(11)Prod mill indust; malt; starches; inulin; wheat gluten	-0.00011925 (0.00047037)	0.00006821 (0.0020432)	1368	0.655	0.000	-0.085
(12)oil seed, oleagi fruits; miscell grain, seed, fruit etc	-0.0007083** (0.00027468)	-0.0012806 (0.0011932)	1368	0.889	0.001	0.443
(13)Lac; gums, resins & other vegetable saps & extracts.	-0.0014011*** (0.00050343)	0.01265*** (0.0021868)	1368	0.656	-0.014	-5.937
(14)Vegetable plaiting materials; vegetable products nes	-0.0013363* (0.00077672)	-0.011408*** (0.0036596)	1233	0.407	0.010	2.560
(15)Animal/veg fats & oils & their cleavage products; etc	-0.00053211 (0.00033233)	0.0028804** (0.0014436)	1368	0.835	-0.003	-2.184
(16)Prep of meat, fish or crustaceans, molluscs etc	-0.003093*** (0.00044758)	0.0060216*** (0.0019442)	1368	0.725	-0.009	-4.332
(17)Sugars and sugar confectionery.	-0.0018921*** (0.00047373)	0.0029071 (0.0020578)	1368	0.612	-0.005	-2.155
(18)Cocoa and cocoa preparations.	-0.00049693 (0.0006839)	0.0029127 (0.0030008)	1332	0.571	-0.003	-1.054
(19)Prep of cereal, flour, starch/milk; pastrycooks' prod	-0.0016192*** (0.00036352)	-0.0087262*** (0.0015791)	1368	0.807	0.007	4.158
(20)Prep of vegetable, fruit, nuts or other parts of plants	-0.0018144*** (0.00052533)	0.0068742*** (0.002282)	1368	0.617	-0.009	-3.518
(21)Miscellaneous edible preparations.	-0.0011129*** (0.00025668)	-0.0070829*** (0.001115)	1368	0.884	0.006	4.947
(22)Beverages, spirits and vinegar.	-0.00073988** (0.00035363)	-0.0018544 (0.0015361)	1368	0.829	0.001	0.670
(23)Residues & waste from the food indust; prepr ani fodder	-0.00086675** (0.00039011)	-0.0069112*** (0.0016946)	1368	0.678	0.006	3.296
(24)Tobacco and manufactured tobacco substitutes.	0.0022015*** (0.00082926)	-0.029514*** (0.0033604)	1152	0.581	0.032	8.631
(25)Salt; sulphur; earth & ston; plastering mat; lime & cem	-0.00053577 (0.00037448)	0.00079151 (0.0016267)	1368	0.621	-0.001	-0.754
(26)ores, slag and ash.	-0.00024748 (0.00065431)	0.0081626*** (0.0029013)	1332	0.446	-0.008	-2.683
(27)Mineral fuels, oils & product of their distillation; etc	0.000019927 (0.00039957)	0.0055058*** (0.0017357)	1368	0.595	-0.005	-2.920
(28)Inorgn chem; compds of prec met, radioact elements etc	-0.0002247 (0.00025442)	-0.0045849*** (0.0011052)	1368	0.824	0.004	3.645
(29)organic chemicals.	-0.00044785** (0.00022022)	-0.0032023*** (0.0009566)	1368	0.780	0.003	2.661
(30)Pharmaceutical products.	-0.00053374* (0.00029796)	-0.00040396 (0.0012943)	1368	0.863	0.000	-0.093
(31)Fertilizers.	-0.00010134 (0.00050561)	-0.00073933 (0.0021963)	1368	0.490	0.001	0.268
(32)Tanning/dyeing extract; tannins & derivs; pigm etc	-0.00026513 (0.00025872)	0.0042531*** (0.0011238)	1368	0.875	-0.005	-3.715
(33)Essential oils & resinoids; perf, cosmetic/toilet prep	-0.00067084*** (0.00022733)	-0.0078226*** (0.00098751)	1368	0.923	0.007	6.692
(34)Soap, organic surface-active agents, washing prep, etc	-0.00074552*** (0.0002625)	0.0031151*** (0.0011403)	1368	0.866	-0.004	-3.128
(35)Albuminoidal subs; modified starches; glues;	-0.00079492*** (0.00025788)	0.0037694*** (0.0011202)	1368	0.880	-0.005	-3.765
(36)Explosives; pyrotechnic prod; matches; pyrop alloy; etc	-0.00088861 (0.00072097)	-0.0091914*** (0.0031619)	1278	0.568	0.008	2.429
(37)Photographic or cinematographic goods.	-0.0013179*** (0.00025324)	-0.014696*** (0.0011004)	1368	0.943	0.013	11.233
(38)Miscellaneous chemical products.	-0.000087163 (0.00027844)	0.0011588 (0.0012095)	1368	0.838	-0.001	-0.952
(39)Plastics and articles thereof.	-0.00080439*** (0.0001808)	-0.0012949* (0.00078537)	1368	0.923	0.000	0.577
(40)Rubber and articles thereof.	-0.00029957 (0.00018553)	-0.0026755*** (0.00080593)	1368	0.893	0.002	2.724
(41)Raw hides and skins (other than furskins) and leather.	-0.00033848 (0.00043146)	0.0085659*** (0.0019265)	1359	0.730	-0.009	-4.283
(42)Articles of leather; saddlery/harness; travel goods	-0.0013454*** (0.00043815)	-0.0045725** (0.0019033)	1368	0.747	0.003	1.566
(43)Furskins and artificial fur; manufactures thereof.	-0.0011524* (0.00062235)	-0.0010322 (0.0031226)	1143	0.639	0.000	-0.036
(44)Wood and articles of wood; wood charcoal.	-0.00059708 (0.00039753)	-0.0058316*** (0.0017269)	1368	0.684	0.005	2.801
(45)Cork and articles of cork.	-0.0010233 (0.00069235)	0.0057157* (0.0030206)	1314	0.546	-0.007	-2.067
(46)Manufactures of straw, esparto/other plaiting mat; etc	-0.0002369 (0.00070705)	-0.0042934 (0.0034159)	1242	0.479	0.004	1.104
(47)Pulp of wood/of other fibrous cellulosic mat; waste etc	0.00087714 (0.00068381)	0.0063894** (0.0029886)	1332	0.447	-0.006	-1.706
(48)Paper & paperboard; art of paper pulp, paper/paperboard	-0.00072355*** (0.00019193)	-0.0037712*** (0.00083371)	1368	0.869	0.003	3.378

Note: For expository purpose, coefficients for f(dist)*L_im and ER statistics are presented after original estimated coefficients are multiplied by 1,000,000,000,000,000. Figures in parenthesis are heteroskedastic consistent standard errors. *, **, *** denote statistical significance at ten, five, and one percent level, respectively. ER stat is the difference between two coeeficients and ER test represents statistics given in equation (35) where critical value for ten percent significance level is 1.282.

Table 4 (continued). Export ratio regression and Export ratio statistics

Industry	f(dist)*L_im	f(dist)*L_reg	NOB	Adj. R^2	ER Stat	ER test
(49)Printed books, newspapers, pictures & other product etc	-0.0017477*** (0.00031614)	-0.01226*** (0.0013733)	1368	0.845	0.011	7.073
(50)Silk.	-0.00057918 (0.00052805)	-0.0051926** (0.0023039)	1332	0.716	0.005	1.851
(51)Wool, fine/coarse animal hair, horsehair yarn & fabric	-0.00042499 (0.00037522)	0.0052675*** (0.0016754)	1359	0.861	-0.006	-3.149
(52)Cotton.	-0.00037479 (0.00026953)	0.0019147 (0.0011708)	1368	0.940	-0.002	-1.807
(53)other vegetable textile fibres; paper yarn & woven fab	-0.00018732 (0.0003842)	0.0047946*** (0.0016689)	1368	0.869	-0.005	-2.758
(54)Man-made filaments.	-0.00021328 (0.00028868)	0.0032002** (0.001254)	1368	0.909	-0.003	-2.515
(55)Man-made staple fibres.	-0.00044069 (0.00030237)	0.00153 (0.0013135)	1368	0.896	-0.002	-1.386
(56)Wadding, felt & nonwoven; yarns; twine, cordage, etc	-0.00016805 (0.00026148)	0.0012314 (0.0011358)	1368	0.892	-0.001	-1.138
(57)Carpets and other textile floor coverings.	-0.00049194 (0.0005452)	-0.0028792 (0.0023683)	1368	0.651	0.002	0.931
(58)Special woven fab; tufted tex fab; lace; tapestries etc	-0.00037258 (0.00031474)	0.00086551 (0.0013672)	1368	0.872	-0.001	-0.837
(59)Impregnated, coated, cover/laminated textile fabric etc	-0.0004284 (0.00026491)	0.0055781*** (0.0011507)	1368	0.896	-0.006	-4.823
(60)Knitted or crocheted fabrics.	0.000019281 (0.00028192)	-0.0004235 (0.0012246)	1368	0.925	0.000	0.334
(61)Art of apparel & clothing access, knitted or crocheted.	-0.00010828 (0.00032714)	-0.0033713** (0.0014211)	1368	0.847	0.003	2.122
(62)Art of apparel & clothing access, not knitted/crocheted	0.00052856 (0.00037457)	-0.0091225*** (0.0016271)	1368	0.796	0.010	5.480
(63)other made up textile articles; sets; worn clothing etc	-0.0005174 (0.00033346)	-0.0043434*** (0.0014485)	1368	0.795	0.004	2.441
(64)Footwear, gaiters and the like; parts of such articles.	-0.00027274 (0.00035435)	-0.0040012*** (0.0015393)	1368	0.808	0.004	2.238
(65)Headgear and parts thereof.	-0.0017565*** (0.00050264)	0.0087151*** (0.0022786)	1350	0.707	-0.010	-4.266
(66)Umbrellas, walking-sticks, seat-sticks, whips, etc	-0.0015364** (0.00062564)	0.0094108*** (0.0028819)	990	0.618	-0.011	-3.520
(67)Prepr feathers & down; arti flower; articles human hair	-0.00053894 (0.00065768)	-0.016827*** (0.0029724)	1287	0.577	0.016	5.078
(68)Art of stone, plaster, cement, asbestos, mica/sim mat	-0.0012088*** (0.00022605)	-0.0020128** (0.00098195)	1368	0.877	0.001	0.756
(69)Ceramic products.	-0.00070478* (0.00040973)	0.0061992*** (0.0017798)	1368	0.684	-0.007	-3.584
(70)Glass and glassware.	-0.000065167 (0.00032909)	0.00015113 (0.0014295)	1368	0.780	0.000	-0.140
(71)Natural/cultured pearls, prec stones & metals, coin etc	-0.0010591*** (0.00032964)	-0.0098825*** (0.0014319)	1368	0.884	0.009	5.693
(72)Iron and steel.	0.00028783** (0.00013725)	-0.003739*** (0.00059622)	1368	0.918	0.004	6.240

Industry	f(dist)*L_im	f(dist)*L_reg	NOB	Adj. R^2	ER Stat	ER test
(73)Articles of iron or steel.	0.000091482 (0.00020005)	-0.00073713 (0.00086898)	1368	0.881	0.001	0.881
(74)Copper and articles thereof.	-0.00098693*** (0.00025441)	-0.00026648 (0.0011051)	1368	0.832	-0.001	-0.602
(75)Nickel and articles thereof.	-0.0012352*** (0.0004642)	-0.0019334 (0.0020164)	1368	0.686	0.001	0.320
(76)Aluminium and articles thereof.	-0.00079563*** (0.00027021)	0.00057075 (0.0011738)	1368	0.849	-0.001	-1.076
(78)Lead and articles thereof.	-0.0012947*** (0.00049353)	0.000066174 (0.0021438)	1368	0.652	-0.001	-0.587
(79)Zinc and articles thereof.	-0.00042379 (0.00053494)	-0.010244*** (0.0023237)	1368	0.557	0.010	3.905
(80)Tin and articles thereof.	0.00045949 (0.00049672)	0.0014089 (0.0021947)	1359	0.719	-0.001	-0.400
(81)other base metals; cermets; articles thereof.	-0.00049633 (0.0004222)	-0.0061917*** (0.001834)	1368	0.750	0.006	2.869
(82)Tool, implement, cutlery, spoon & fork, of base met etc	-0.0006445*** (0.00021506)	-0.0032904*** (0.00093418)	1368	0.894	0.003	2.617
(83)Miscellaneous articles of base metal.	-0.00040017 (0.00026952)	0.0035644*** (0.0011708)	1368	0.858	-0.004	-3.129
(84)Nuclear reactors, boilers, mchy & mech appliance; parts	-0.00034104** (0.00016064)	-0.0043*** (0.00069781)	1368	0.929	0.004	5.242
(85)Electrical mchy equip parts thereof; sound recorder etc	-0.00070894*** (0.00018086)	-0.010308*** (0.00078565)	1368	0.931	0.010	11.289
(86)Railw/tramw locom, rolling-stock & parts thereof; etc	-0.00060494 (0.00063492)	-0.016896*** (0.0027789)	1368	0.510	0.016	5.417
(87)Vehicles o/t railw/tramw roll-stock, pts & accessories	-0.00033082 (0.0002281)	-0.0047335*** (0.00099086)	1368	0.868	0.004	4.105
(88)Aircraft, spacecraft, and parts thereof.	-0.00093608 (0.00062197)	-0.0091132*** (0.0027018)	1368	0.645	0.008	2.796
(89)Ships, boats and floating structures.	0.0015512*** (0.00058074)	0.00030218 (0.0025227)	1368	0.306	0.001	0.457
(90)optical, photo, cine, meas, checking, precision, etc	-0.00098084*** (0.00021778)	-0.0079733*** (0.00094602)	1368	0.927	0.007	6.829
(91)Clocks and watches and parts thereof.	-0.00086941*** (0.00042187)	-0.014439*** (0.0018326)	1368	0.788	0.014	6.842
(92)Musical instruments; parts and access of such articles	-0.00053235* (0.00027641)	-0.0031585*** (0.0012007)	1368	0.901	0.003	2.021
(93)Arms and ammunition; parts and accessories thereof.	-0.0013133 (0.0013712)	-0.0053205 (0.0041167)	891	0.406	0.004	0.860
(94)Furniture; bedding, mattress, matt support, cushion	-0.0015391*** (0.00031328)	-0.0083349*** (0.0013608)	1368	0.810	0.007	4.614
(95)Toys, games & sports requisites; parts & access	-0.0008681** (0.00034394)	-0.0048957*** (0.001494)	1368	0.796	0.004	2.491
(96)Miscellaneous manufactured articles.	-0.00017238 (0.00027631)	-0.0019227 (0.0012003)	1368	0.866	0.002	1.347
(97)Works of art, collectors' pieces and antiques.	0.000012087 (0.00068532)	-0.010347*** (0.0030557)	1206	0.536	0.010	3.140

Note: For expository purpose, coefficients for f(dist)*L_im and ER statistics are presented after original estimated coefficients are multiplied by 1,000,000,000,000,000. Figures in parenthesis are heteroskedastic consistent standard errors. *, **, *** denote statistical significance at ten, five, and one percent level, respectively. ER stat is the difference between two coeeficients and ER test represents statistics given in equation (35) where critical value for ten percent significance level is 1.282.