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The Quality Gravity Model with an Application to Chinese Imported Fruits

Abstract: Derived from unit value and the gravity model, this paper proposes a simple model to analyze the quality determinants of imported fruits in China, and finds that (1) both quantity and price are exogenous for quality, and quality decreases in quantity but increases in price; (2) the own-income elasticity of quality is 8.55 and the partner-income elasticity is only -0.08; and (3) distance and common boundary do not play significant roles in determining quality.

Key words: Gravity model, Quality index, Quality Gravity model

1. Introduction

One of the most successful empirical trade models in the past half century is the famous gravity equation. It relates bilateral trade flows to GDP, distance and other trade barriers (Anderson and Wincoop, 2003). The gravity model was first introduced into international trade by Tinbergen. In a speech in 1962, Tinbergen indicated that trade flows between two countries were mainly determined by total income and distance, and he suggested to applying gravity equations to analyze bilateral trade flows. Using a panel data, he found that the distance played an important role in determining trade flows.

Henceforth, the gravity model has been more and more widely used and more factors are included in empirical studies to improve the fitness of the model. In 1966, Linnemann introduced population into the gravity model and found that it had a negative effect on trade flows, but on the contrary other studies found positive effects. In 1989, Bergstrand added per capital income, exchange rate, whole sale price index and regional dummy to the model, and they improved the model's capability of explanation. In the current literature, other explanatory factors include tax, common boundary, common language, common currency, membership of a free-trade area, difference in temperature and so on.

At the same time, some economists, such as Anderson (1979), Bergstrand (1985, 1989), Krugman and Helpman et al. (1996, 2008), linked the gravity model to the international trade theory and tried to set up a theoretical foundation for it. Anderson (1979) derived the gravity model from an expenditure system with assumptions that products are differentiated by the place of origin (Armington Assumption), and that consumers held an identical homothetic preference for traded goods across regions. Following this, Anderson and Wincoop (2003) developed a more consistent and efficient model by adding "multilateral resistance" and applied it to solve the famous McCallum border puzzle[1]. Bergstrand (1985) deduced the gravity equation from a general equilibrium model, starting from consumer behaviour of utility maximization and producer behaviour of profit maximization, trade flow between any two countries was assumed to be very small compared with the equilibrium quantity in the world market, which implied that price could be treated as exogenous. Then

[1] John McCallum applied the gravity model in the analysis of trade flow between the U.S. and Canada, and found that the trade between Canadian provinces was 22 times of the trade between U.S. states and Canadian provinces after controlling income and distance in 1988.

the gravity equation was just a reduced form from a partial equilibrium subsystem of a general equilibrium model. Helpman, Melitz and Rubinstein (2008) developed a two-stage estimation procedure to explain zero flow: the first stage estimated the probability of one country's export to another with a Probit model; the second stage estimated a trade flow equation based on the results from the previous stage.

Another issue related with gravity model is suggested by Feenstra et al. (2001), they tested gravity model with data of homogenous good, differentiated goods and reference-priced goods, and found that the own-income elasticity and partner-income elasticity of different commodity groups varied dramatically. After the first application of the gravity model in international trade in 1960s, it has been more and more convincing and popular. However, the current literature mainly focuses on trade flows, and the quality in trade was almost neglected. Linder (1961) first noted quality as a determinant of the direction of trade, and argued that richer countries spent more income on high-quality goods and countries with similar income per capita traded more often with one another, which was named as Linder hypothesis. Hallak (2006, 2010) tested the hypothesis and found that it was formally derived but only held in sector level. All of their works took quality as a determinant of trade flows and studied the impact of quality on trade. However, the factors determining quality of trade flow is still unclear. Harrigan and Barrows (2009) found that changes in trade policy (for example, abolishment of the import quota) not only had an impact on the quantity of trade flow, but also on the quality of trade flow. Quality is also related with income. On the production side, a positive relationship between per capital income and quality production is confirmed by Schott (2004) and Hallak (2006). On the other side, Bils and Klenow (2001) find that quality demand is strongly correlated with household income. As economy grows quickly in some emerging countries, such as Brazil, China, India, and Russia (So-called BRIC), consumers in these countries would surely increase the demand for food quality(Yu and Abler 2009). Therefore it is of particular important to study the quality of trade flow.

One can expect that the quality of the goods traded, similar with the quantity, is determined by the bilateral factors, so that the classical gravity model can be extended into the study of the quality of trade flow. Following the current literature, this paper aims to set up an economic model combining quality factors and the gravity model to identify determinants of the quality of imported goods as it has profound policy implications.

In the rest of the paper, we first introduce an index to measure the quality of trade flow; then extend the classical gravity model into the analysis of deterministic factors of quality. We name the new model the quality gravity model, which is subsequently applied to an empirical study of the quality determination of Chinese imported fruits. Fruits are very crucial for improving consumers' health (Gao, Lee, and Yu 2010). Finally, we draw a conclusion.

2. Model

2.1. Quality index

In the statistics of international trade, a certain level of aggregation is needed, as the statistics cannot report each product's trade flow. Therefore, only the quantity and value of a group of commodities are available, and the "price" for a group of products is often indicated by unit value, obtained by dividing total value by total quantity in that group. Clearly the unit value is not the real price, but a weighted price within a group of commodities, which implies that the unit value not only contains the information of price, but also of quality (Deaton, 1988；Yu and Abler, 2009). Silver (2007, 2010) compared unit value with corresponding price indices, including Fisher price index, Tornqvist price index, and found that there were some biases in unit value when it was used as proxy for price, because changes in unit value not only reflect the price variation but also the composition of that group which is just the quality.

The unit value is often endogenous. As the market prices change, consumers not only alter the total quantity they buy for the commodity group, but also change the composition within that commodity group, which in turn changes the quality. In order to study the determinants of the quality, we have to decompose the unit value into a quality index and a price index.

Following Deaton (1988) and Yu et al. (2009), assume that country k imports a commodity group j, for instance the group of bananas, which consists of n different products.

Under the condition of perfect information it is reasonable to assume that the higher the price is, the higher the quality is within the same group, We suppose that the domestic market is a perfect competitive one, so that the domestic price P_{jm} (m=1, 2, … n) for any individual product is identical, no matter where it is imported from. Similar to Deaton (1988) and Yu and Abler (2009), the price system for the group j is assumed to be linearly homogeneous.

(1) $$P_{kj} = \lambda_{kj} \begin{pmatrix} p_{j1} \\ p_{j2} \\ \vdots \\ p_{jn} \end{pmatrix} = \lambda_{kj} * P'_j$$

where k denotes the importing country, j is the commodity group, which is showed in trade statistics, such as the classification code of imported goods (e.g. HS4 used in this paper); P_{kj} is the real price vector of the j^{th} commodity group in country k, λ_{kj} measures the price level of the j^{th} commodity group; $p_{j1}, p_{j2}, \ldots, p_{jn}$ are the relative price level for each product in group j, denoted by a price vector P'_j. With the assumption of perfect competition, P'_j and λ_{kj} respectively are the same in the same market for all exporting countries.

The total import quantity of the j^{th} imported commodity group from country i, Q_{ij}, equals to the sum of import quantity of all individual products within this group.

(2) $$Q_{ij} = \left(q_{ij1}, q_{ij2}, \cdots\cdots, q_{ijn}\right) * \begin{pmatrix} 1 \\ 1 \\ \vdots \\ \vdots \\ 1 \end{pmatrix} = Q'_{ij} * I$$

The total value of the commodity group imported from country i, denoted by V_{ij}, is the sum of values of all imported products within this group from this country. Combining Equation (1) and (2), we have

(3) $$V_{ij} = Q'_{ij} * P_{kj} = \lambda_{kj} * Q'_{ij} * P'_j$$

The data of total value and quantity is available in trade statistics, and we can calculate the unit value as follows.

(4) $$UV_{ij} = \frac{V_{ij}}{Q_{ij}} = \frac{\lambda_{kj} * Q'_{ij} * P'_j}{Q'_{ij} * I} = \lambda_{kj} * \frac{Q'_{ij} * P'_j}{Q'_{ij} * I} = \lambda_{kj} * Z_{ij}$$

where Z_{ij} is defined as the quality index for group j imported from country i. Equation (4) shows that the unit value is the product of the price index and the quality index.

Taking the logarithm on both sides in the equation (4) shows

(5) $$\ln UV_{ij} = \ln\lambda_{kj} + \ln Z_{ij}$$

The assumption of perfect competition indicates that the prices for all products in group j move with same proportion, so that the price index λ_{kj} is a function of time.

In practice, we often have a panel datasets for imported products, so that we can set up a dummy variable for each period t to capture the price effect, and use the fixed-effects model to decompose the unit value into a price index and a quality index.

(6) $$\ln UV_{ijt} = C_j + \beta_{jt} * T_t + \omega_{ij} + u_{ijt}$$

That is,

(7) $$\ln\lambda_{kjt} = C_j + \beta_{jt}, \ \ln Z_{ijt} = \omega_{ij} + u_{ijt}$$

where C_j is a constant term; T_t is a time dummy variable; ω_{ij} stands for the average quality of the j^{th} commodity group from country i; u_{ijt} is an error term. The sum of the constant term and the time dummy is defined as the price index, which is the same for all export countries in any given time. Then $\omega_{ij}+u_{ijt}$ are defined as the quality effect.

By Equation (5), the difference between the logarithm of the unit value and the price index is the quality index, so that the quality index is,

(8) $$\ln Z_{ijt} = \ln UV_{ijt} - \ln\lambda_{kjt} = \ln V_{ijt} - \ln Q_{ijt} - \ln\lambda_{kjt}$$

2.2 The gravity model

The classical gravity model in international trade is often specified as

(9) $$V_{ik} = V_{ik}(Y_i, Y_k, H_i, H_k, D_{ik})$$

where V_{ik} is the total value of imported goods from country i to country k; Y_i and Y_k are respectively GDP or national income for country i and k; H_i and H_k are respectively the population sizes of i and k; D_{ik} is the distance between the two countries, measuring the friction factor of the bilateral trade (Anderson, 1979).

In recent empirical studies, the gravity model has been expanded by adding some other explainable variables, such that

(10) $$V_{ik} = V_{ik}(Y_i, Y_k, H_i, H_k, D_{ik}, A_{ik})$$

where A_{ik} denotes all other factors affecting trade flow. In the current literature, A_{ik} include common boundary, common language, common religious, membership in the same free-trade area, exchange rate, openness and so on (Bergstrand, 1989; Laura et al., 2007).

2.3. The quality-gravity model

Substituting the gravity model-Equation (10) into Equation (8), we can obtain the quality gravity model.

(11) $$\ln Z_{ijt} = \ln V_{ijt}(Y_i, Y_k, H_i, H_k, D_{ik}, A_{ik}) - \ln Q_{ijt} - \ln\lambda_{kjt}$$

Or in general,

(12) $$Z_{ij} = Z_{ij}(Y_i, Y_k, H_i, H_k, D_{ik}, A_{ik}, Q_{ij}, \lambda_j)\ .$$

where the quality is a function of incomes, population sizes, distance, import quantity, price and other factors.

Furthermore, consumers in one country determine the food quality usually by per capita income rather than by economy size from the perspective of demand theory (Yu and Abler 2009). And Bergstrand (1989) also suggested replacing population by per capital income in gravity model in analyzing trade flows of a specific good. Therefore, we can specify Equation (11) by taking double-logarithm form and rewrite it as

(13) $$\ln Z_{ijt} = \ln\alpha_{jt} + \beta_j \ln Y_{it} + \gamma_j \ln Y_{kt} + \delta_j \ln I_{it} + \varepsilon_j \ln I_{kt} + \theta_j \ln D_{ik} + \mu_j \ln A_{ikt} + \rho_j \ln Q_{ijt} + \pi_j \ln\lambda_{kjt} + \varphi_j T_t + u_{ijt}$$

where I_{it} and I_{kt} are respectively per capita income (or per capita GDP) for country i and k at time t. A_{ikt} still denotes all other factors, which in this paper include common boundary, , openness and membership of free-trade area, as often used in the current literature. Because we use data of fruit, which is agricultural products, so we add share of agriculture in GDP as one independent variable in the model.

Even though equation (13) gives a good form of econometric model to estimate, we should pay attention to the endogeneity problem. Specifically, consumers may make the decision on quantity and quality simultaneously, which implies that the quantity in equation (13) is endogenous. In addition, China is a big country in international trade, so that she might not be a price taker, and can impact the world price when the imported quantity or quality changes. In light of this, price might also me endogenous. In this study, we will use the Hausman Test (1979) to test the endogeneity.

3. Data

The data used in this paper is the imported fruits in China from 1998 through 2007 (HS chapter 8- Edible Fruit and Nuts, Peel of Citrus Fruit or Melons)[2], collected from FAOSTAT and all values are CIF prices. The total value of imported fruits in China from 1998-2007 is USD $4.70 billion. The largest importer is Thailand, which exported $1.123 billion fruit to China, accounting for 24% in total imported fruits in China; Philippine is the second largest and exported USD$ 802 million, accounting for 17%; followed by the US, Vietnam, Chile, Ecuador, New Zealand, Russia, Korea and Iran. The top ten importers accounts for about 90% of the total value of imported fruits, and hence the ten countries are used in this study.

[Insert Table 1]

[2] According to the common used harmonized system (HS), all traded goods are divided into 21 sections, 96 chapters and more than 5000 headings; each heading consists of many individual commodities.

Because the classification code in FAO is different from that in HS, we first need convert the original data in FAO into HS4 data. The fruits are divided into 14 headings in HS, but China didn't import HS0811, HS0812 and HS0814. As a result, there are 11 groups of the imported fruits in China.[3]

In order to construct the quality index, we first need to calculate the unit values for imported fruits from each country by dividing the total value by total quantity(1000 dollar per ton). Then we can decompose the unit value into the quality index and the price index by Equation (6).

The variables of economic size and per capital income are taken from United Nations Statistics Division (UNSD), the former is measured by GDP at constant price of 1990 (1 billion dollar), and the latter is measured by per capita GNI. Distance is represented by the great circle distance between two capitals, which is collected from timeanddate.com (kilometre). Openness is measured by the ratio of export to GDP, which is taken from World Bank (WB). Agriculture share in exporting countries is represented by the output value of primary industry divided by GDP, which is also from WB.

4. Results

[3] They are 0801 (coconuts, brazil nuts & cashew nuts, fresh or dry), 0802 (nuts nesoi, fresh or dried), 0803 (Bananas and plantains, fresh or dried), 0804(dates, figs, pineapples, avocados etc, fresh or dried), 0805 (citrus fruit, fresh or dried), 0806 (grapes, fresh or dried), 0807 (melons and papayas, fresh), 0808 (apples, pears and quinces, fresh), 0809 (apricots, cherries, peaches, plums & sloes, fresh), 0810 (fruit nesoi, fresh), 0813 (fruit dried nesoi, mixtures of nuts or dried fruit)

4.1 Quality

We calculate the average quality of imported fruits for each country and each year, and the results are shown in table 2. The quality trend for each country during that period is ambiguous, while the average qualities of imported fruits in some countries like Russia are obviously higher than other countries like Vietnam. But it doesn’t mean that the quality of fruits imported from Russia is higher than that from Vietnam, because we can't compare quality across commodity groups directly. Table 3 presents the average qualities of each commodity group in each year and there are no obvious trend during this period in general.

[Insert Table 2 & Table 3]

4.2 Model comparison

As aforementioned, we have the dataset of the imported fruits in China for 11 product groups from 10 countries from 1998 through 2007. Because the quality across different groups might be different, we control product groups as fixed-effects in the panel regression. Except for the zero trade flow, we obtain 487 observations.

We tried different econometric exercises and the results are reported in Table 4. The estimators include a pooled regression (OLS), a fixed-effects regression(FE), a random-effects regression(RE), three instrumental-variable fixed-effects regression with instrument variables for quantity (QIVFE), for Price(PIVFE) and for both price and quantity (2IVFE). The specification tests between these models are shown in Table 5. The R-squared indicates that each model fits the data well, and the main results for different models are quite similar which indicates that the results are quite robust.

[Insert Table 4 and Table 5]

First, F-tests in Table 5 reject the null hypothesis of no differences among the countries and products and hence favour the panel models. In addition, a Hausman test also rejects the null hypothesis of no systematic difference between different fruits groups and hence prefers the fixed-effects model to the random-effects model.

Furthermore, three Hausman tests can not reject the null hypothesis of no systematic difference between the fixed-effects model and the instrumental-variable fixed-effects models. Therefore, the fixed-effects model is the most favourable one. The tests also reveal that both price and quantity are exogenous. It indicates that quantity is still prior to quality for importing fruits in China, and China is a price-taker in the international fruits market. Then the following discussion will be based on the results of the fixed-effects model.

4.3 Discussion

First, the most important finding is that the coefficient for logarithm of the import quantity is -0.0069 and statistically significant at 1%. It indicates that an increase in the quantity of the imported fruits by 1%, the quality of imported fruits will decrease by 0.0069%. The negative impact of quantity is small but still significant. It is plausible that consumers in China have a trade-off between quantity and quality, and quantity is still prior to quality.

The coefficient for price is 0.5298 and also statistically significant at 1%. It can be explained by the fact that when the prices of a group of fruits increase, consumers usually cut down the quantity of consumption, which in turn makes consumers shift to higher-quality products within that group. It is consistent with the negative effect of quantity.

The estimation results also indicate that economic sizes in both exporting and importing countries are not statistically significant, but per capita income in both countries are. In particular, the coefficient for per capita income in China is 8.55 and statistically significant at 10%, which implies that as income in China increase by 1%, the quality of imported fruits will increase by 8.5478%. The quality of imported fruits is highly sensitive with respect to the per capita income in China. One can expect that the quality of imported fruits in China will increase significantly in a near future as the income in China grows quickly in the past decades. The coefficient for per capita income in exporting countries is -0.0769 and statistically significant at 5%. It implies that when the exporting countries become richer, they will reduce the quality of exported fruits as they will increase the quality of the domestic supply. Distance and common boundary have no significant impacts on quality. But it is worth to note that the measure of distance represented by the distance between two capitals is not the true transport distance, which is declining over time due to technical innovations (Laura et al. 2007), while the geographic distance is constant. Moreover, distance in the gravity model denotes the friction in trade flow, particularly in trade quantity, and the distance might be not important for quality.

The quality of the fruits from less open countries is significantly higher. This means countries which do not depend much on trade tend to export higher quality fruits in order to obtain more foreign reserves. While countries with a higher share of agriculture in GDP are more likely to export lower quality fruits to China. It is plausible that these countries with a bigger agriculture sector are developing economies with lower level of technologies and the quality of their exports are in general lower compared with the developed economies.

Fruits imported from WTO members and non-WTO members have no significant difference in quality, even though the coefficient is positive. We also find that the quality of imported fruit increased significantly after China entered WTO.

Fruits imported from CAFTA (China-ASEAN Free Trade Area) have a higher quality. CAFTA is a free-trade area founded by China and ten ASEAN (Association of Southeast Asian Nations) countries, which start to reduce the tariffs on agriculture goods from January 2004. It seems plausible that a free trade area can help improve the quality of imported goods. When China became more open, the quality of imported fruits declined significantly, which might result from that a rapid quantity expansion lowers the quality. We also find a downward trend of quality in China after controlling all other variables.

5. Conclusion

As income grows very fast in the past decades in some emerging economies, such as Brazil, China, India and Russia, consumers in these countries will surely boost the demand for high- quality food which will has significant impact on international agricultural trade. The gravity model modelling trade flows widely used in the current literature so far only focuses the trade volume while not in quality.

Following Deaton (1988), we first construct a quality index for imported goods which is then combined with the classical gravity model, to obtain the quality gravity model which can be applied to study the determinants of the quality of trade flow. The methodology provided in this study fills in the gap in the current literature

In addition, the method is also applied to empirically study the determinants of Chinese imported fruits during the period 1998 -2007.

The main findings of this paper include,

1) Though consumers in China may have a trade-off between quantity and quality, the study reveals that quantity is exogenous which implies that quantity is still prior to quality for importing fruits in China. As the quantity of imported fruits increase, the quality will decrease. The effect is small but significant.

2) The price is also exogenous. In particular, as the price increases, the quality of imported fruits also increases.

3) The quality of imported fruits is highly sensitive to income in China. In particular, the

quality elasticity with respect to income is 8.55. One can expect that the quality of imported fruits in China will increase significantly in a near future as the income in China is still growing quickly. On the contrary, the imported quality is negatively correlated with income in exporting countries.

4) And distance and common boundary however do not play significant role in determining quality.

Finally, the empirical results in general are quite robust, and hence have profound implications for trade policies.

References

Anderson J. E. 1979. “A theoretical foundation for the gravity equation”, *The American Economic Review*, Vol. 69(1):106-116.

Anderson J. E. and Wincoop E. V. 2003. “Gravity with gravitas: a solution to the border puzzle”, *The American Economic Review*, Vol. 93(1):170-192.

Bergstrand J. H. 1985. “The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence”, *The Review of Economics and Statistics*, Vol. 67(3):474-481.

Bergstrand J. H. 1989. “The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade”, *The American Economic Review*, Vol. 71(1):143-153.

Bils M. and P. Klenow 2001. “Quantifying Quality Growth”, *The American Review*, Vol. 91(4): 1006-1030.

Deaton A. 1988. “Quality, Quantity, and Spatial Variation of Price”, *The American Economic Review*, Vol. 78(3):418-430.

Deardorff A. V. 1995. “Determinates of Bilateral Trade: Does gravity work in a Neoclassical world”, NBER Working paper 5377.

Feenstra R. C. 1988. “Quality Change Under Trade Restraints in Japanese Autos”, *The Quarterly Journal of Economics*, Vol. 103(1):131-146.

Feenstra R. C., Markusen J. R. and Rose A. K. 2001. “Using the gravity equation to differentiate among alternative theories of trade”, *Canadian Journal of Economics*, Vol. 34(2): 430-447.

Gao Z., Lee J.Y. and Yu X. 2010." Consumer Demand for Healthy Diet: New Evidence from Healthy Eating Index”. Selected Presentation in 2010 AAEA Meeting, Denver, USA.

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

Hallak J. C. 2010. “A product-quality view of the Linder hypothesis”, *The Review of Economics and Statistics*, Vol. 92 (3): 453-466.

Harrigan J. and Barrows G. 2009. “Testing the theory of trade policy: evidence from the abrupt end of the multifiber arrangement”, *The Review of Economics and Statistics*, Vol. 91(2):282-294.

Hausman J.A. 1978. “Specification Tests in Econometrics.” *Econometrica* 46(6):1251–71.

Helpman E. and Krugman P. 1996. *Market Structure and Foreign Trade, Increasing Returns, Imperfect Competition and the International Economy*, Cambridge, MA: MIT Press.

Helpman E., Melitz M. and Rubinstein Y. 2008 “Estimating trade flows: trading partners and trading volumes”, The Quarterly Journal of Economics, Vol. 123(2): 441-487.

Howard J. W. 1999. “Using the Gravity Model to Estimate the Costs of Protection”, *Review* *of Federal Reserve Bank of St. Louis*, 33-40.

Inmaculada M. Z. and Felicitas N. L. 2003. "Augmented gravity model: an empirical application to mercosur-european union trade flows", *Journal of Applied Economics*, Vol. 6(2):219-316.

Laura M. R., Inmaculada M. Z. and Celestino S. B. 2007. "The role of distance in gravity regression: Is there really a missing globalisation puzzle?" *The B.E. Journal Economic Analysis and Policy*, Vol. 7(1):1-23.

Linder S. 1961. "An essay on trade and transformation", Stockholm: Almqvist and Wiksell.

Porojan A. 2001. "Trade flows and spatial effects: The gravity model revisited", *Open Economies Review*, Vol. 12:265-280.

Randi B. and Feenstra R. C. 1987. "Quality Upgrading and Its Welfare Cost in U.S. Steel Imports, 1969–74", NBER working paper 2452.

Schott P. 2004. "Across-Product versus Within-Product Specialization in International Trade", *Quarterly Journal of Economics*, Vol. 119(2); 647-678.

Silver M. 2007. "Do unit value export, import, and terms of trade indices represent or misrepresent price indices", IMF working paper.

Silver M. 2010. "The wrongs and rights of unit value indices", *Review of Income and Wealth*, Vol.56: 206-223.

Yu X. and D. Abler (2009) "The demand for food quality in rural China", *American Journal of Agricultural Economics*, Vol. 91(1): 57-69.

Table 1. Top Ten Fruits Exporters to China

Country	Share	Total Value (1000 $)
Vietnam	10.76%	505287
Iran	2.11%	98931
Thailand	23.91%	1122547
Chile	6.90%	324004
Korea	2.43%	114320
New Zealand	4.98%	233778
Ecuador	5.58%	262231
Philippines	17.08%	801908
America	12.93%	607200
Russia	3.27%	153409

Table 2. Average Quality in Each Exporting Country

Year	Chile	Ecuador	Iran	New Zealand	Philippines	Korea	Russia	Thailand	America	Vietnam	Average
1998	0.9827	1.0973	0.9126	1.0031	1.0838	0.9809	1.2357	0.9934	1.0933	0.8969	1.0164
1999	0.9169	1.1592	0.9110	0.9469	1.0619	0.9873	1.1792	0.9978	1.1406	0.8508	0.9990
2000	1.0010	0.9892	0.9592	1.0450	1.2448	1.4712	1.1014	1.1007	0.9843	0.6874	1.0199
2001	1.0639	1.1617	0.8826	1.3848	1.2100	1.0665	1.1103	0.9514	1.1180	0.7368	1.0366
2002	1.0192	1.1743	1.0805	1.0282	1.2644	1.6015	1.1813	0.9811	1.0822	0.7376	1.0454
2003	1.0226	1.2476	1.2308	1.3627	1.1637	1.3842	1.0744	0.9695	1.1741	0.7240	1.0595
2004	1.0598	1.2055	1.0489	0.9807	1.2318	0.9257	1.1268	0.9522	1.3111	0.6453	1.0315
2005	1.0438	1.1554	1.0159	1.0341	1.1517	1.1632	1.0965	1.1111	1.2641	0.6684	1.0490
2006	1.0428	1.1098	0.8830	1.2394	1.0281	1.0370	1.7708	1.0188	1.2306	0.7167	1.0663
2007	1.1729	1.1430	1.0191	1.0066	1.0538	1.0797	1.7701	1.0205	1.1743	0.6053	1.0512
Average	1.0286	1.1302	1.0029	1.1081	1.1412	1.0892	1.3490	1.0049	1.1511	0.7327	

Table 3. Average Quality for Each Product Group

Fruit	0801	0802	0803	0804	0805	0806	0807	0808	0809	0810	0813
1998	1.0236	1.0116	1.0776	0.9873	0.9829	1.0151	1.0760	1.0060	1.0392	0.9354	1.0784
1999	0.9942	0.9999	1.0786	1.0106	1.0299	1.0130	1.0549	1.0042	0.9430	0.9470	0.9756
2000	0.9945	1.0908	0.9929	0.9893	1.0307	0.9953	1.0977	1.0133	0.9302	0.9909	1.0799
2001	1.0672	1.1379	1.1166	0.9923	1.0151	0.9947	0.9908	1.0052	1.0268	0.9911	0.9899
2002	1.2073	1.0522	1.0221	0.9728	1.0166	0.9947	0.9531	0.9971	1.1672	0.9673	1.0434
2003	1.1524	1.0195	1.0202	1.0306	1.0042	0.9942	1.0474	0.9887	1.0023	0.9837	1.2795
2004	1.1266	1.0372	1.0152	1.0815	0.9380	0.9997	1.0813	0.9971	1.0215	0.9912	1.0617
2005	0.9387	1.0637	1.0027	1.1869	1.0141	0.9955	1.1044	0.9970	1.0762	0.9987	1.0616
2006	1.1164	0.9950	1.0021	1.2112	1.0143	0.9954	1.0515	1.0045	1.0509	1.2581	0.9355
2007	0.9266	1.0309	1.0037	1.1151	1.0307	0.9977	1.0674	0.9972	1.0404	1.2560	0.9998

Notes: 0801, 0802,…, 0813 denote HS4 code.

Table 4. Estimation Results

Variables	OLS	FE	RE	PIVFE	QIVFE	2IVFE
Log (Import quantity)	-0.0118 (-3.72)***	-0.0069 (-0.315)***	-0.0118 (-3.72)***	-0.0031 (-1.01)	-0.0108 (-3.49)***	-0.0076 (-2.39)**
Log (Price level)	0.2169 (11.46)***	0.5298 (29.77)***	0.2169 (11.46)***	0.6162 (14.91)***	0.5039 (23.59)***	0.6010 (15.49)***
Log (GDP of China)	-9.5366 (-1.05)	-8.2891 (-1.40)	-9.5366 (-1.05)	-2.3074 (-0.34)	-1.5683 (-0.24)	-1.7245 (-0.25)
Log (GDP of exporter)	0.0210 (1.00)	0.0065 (0.46)	0.0210 (1.00)	-0.0076 (-0.47)	-0.0049 (-0.31)	-0.0075 (-0.46)
Log (Per capita income of China)	7.7373 (1.12)	8.5478 (1.90)*	7.7373 (1.12)	4.0289 (0.73)	2.8050 (0.52)	3.4176 (0.62)
Log (Per capita income of exporter)	-0.2207 (-4.54)***	-0.0769 (-2.27)**	-0.2207 (-4.54)***	-0.0578 (-1.48)	-0.0790 (-2.13)**	-0.0555 (-1.42)
Log (Distance)	-0.0529 (-1.32)	0.0051 (0.18)	-0.0529 (-1.32)	-0.0014 (-0.04)	-0.2120 (-0.61)	-0.0047 (-0.13)
Common boundary	-0.0567 (-1.28)	-0.0311 (-1.06)	-0.0567 (-1.28)	-0.0398 (-1.23)	-0.0538 (-1.73)*	-0.0387 (-1.20)
Openness of exporter	-0.4055 (-3.99)***	-0.1253 (-1.81)*	-0.4055 (-3.99)***	-0.0779 (-1.02)	-0.1316 (-1.82)*	-0.0822 (-1.08)
Agriculture share of exporter	-0.9676 (-2.34)**	-0.5984 (-2.11)**	-0.9676 (-2.34)**	-0.7409 (-2.12)**	-0.9129 (-2.74)***	-0.7288 (-2.10)**
WTO member	0.1660 (3.80)***	0.0329 (1.10)	0.1660 (3.80)***	-0.0071 (-0.21)	0.0151 (0.48)	-0.0066 (-0.20)
CAFTA member	-0.0015 (-0.04)	0.0489 (2.20)*	-0.0015 (-0.04)	0.0943 (3.40)***	0.0641 (2.54)**	0.0915 (3.34)***
Openness of China	-0.8528 (-0.83)	-2.5007 (-3.69)***	-0.8528 (-0.83)	-2.9973 (-4.00)***	-2.29 (-3.31)***	-2.9234 (-3.95)***
China WTO	0.0464 (1.05)	0.0887 (3.08)***	0.0464 (1.05)	0.0660 (1.67)*	0.0493 (1.29)	0.0614 (1.56)
Time	0.0149 (0.22)	-0.0772 (-1.73)*	0.0149 (0.22)	-0.0892 (-1.73)*	-0.0613 (-1.24)	-0.0814 (-1.59)
Constant	4.3554 (0.70)	-2.0584 (-0.50)	4.3553 (0.70)	-4.8100 (-1.16)	-3.0344 (-0.76)	-4.5370 (-1.10)
Observations	487	487	487	388	388	388
R^2 within		0.7853	0.6657	0.7872	0.7998	0.7895
R^2 overall		0.4105	0.4838	0.4005	0.4363	0.4070
Adjust R^2	0.4673					

Notes: 1. ***,** and * respectively denotes the significant level at 1%, 5% and 10%.

2. CAFTA began to cut tax since January 1st 2004, so the value of dummy variable is set to be 1 for Thailand, Philippine and Vietnam after 2004. China became a member of WTP since December 11th 2001, so China WTO becomes 1 after 2002.

3. The numbers in bracket are t-ratios.

Table 5. Comparison Tests

Test	OLS and FE	FE and RE	FE and PIVFE	FE and QIVFE	FE and 2IVFE
F	F(10,459)=64.76***				
Hausman test		χ^2_{15}=7299.44***	χ^2_{15}=8.29	χ^2_{15}=3.82	χ^2_{15}=9.22
Results	Reject	Reject	Can't reject	Can't reject	Can't reject
Choice	FE	FE	FE	FE	FE

Notes: OLS refers to the ordinary least square model; FE and RE respectively refer to the fixed-effects model and the random-effects model without instrument variables; PIVFE and QIVFE are the fixed-effects models respectively using one-year-lag price and quantity as the instrument variables; 2IVFE is the fixed-effects model with both instrument variables for price and quanity. *** denotes 1% significant level.