

Three Essays on China's Agricultural Trade

by

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Abstract

This dissertation consists of three chapters. In the context of the appreciation pressure that is faced by the Chinese currency (Renminbi, RMB) in recent years, using an Equilibrium Displacement Model, Chapter 1 studies the incidence of an appreciation of RMB on Chinese and U.S. tilapia markets. Results indicate that only 23%-26% of the exchange rate changes are absorbed by Chinese tilapia producers. Still, they bear a larger portion of welfare loss, and China's deadweight loss increases with the increase in the U.S. import demand elasticity. This chapter also emphasizes the importance of considering the relationship between the exchange rates of the U.S. and the rest of the world, which, if ignored, would lead to an overestimation of the exchange rate pass-through.

The export tax rebate policy, which enables the export enterprises to get a part or total refund of their value-added tax (VAT), was implemented in 1985. Due to the heated debate over whether or not the export tax rebate should be cancelled, Chapter 2 examines the effects of this policy on the welfare changes of Chinese consumers, producers, and foreign consumers in the fishery market. It takes into account the linkage between the retail-level market and the farm-level market. Simulation results indicate that although the export tax rebate improves the Chinese producer surplus, it works more like a subsidy on the foreign consumers due to the large export supply elasticity of China.

China signed the Framework Agreement between China and the countries of the Association of Southeast Asian Nations (ASEAN) in 2002, according to which the China-ASEAN Free Trade Area was established in 2004. Then, the Chinese

consumers could purchase the imported tropical fruits with a lower cost. This is regarded as bringing about an increase in the competition between Chinese domestically produced tropical fruits and the tropical fruits imported from the ASEAN countries. Chapter 3 estimates the expenditure, own-price and cross-price elasticities of both domestic and imported fruits, using a Restricted Source-Differentiated AIDS (RSDAIDS) model. Results indicate that Chinese produced bananas and pineapples have strong potential in the Chinese market, and they do not compete directly with the products imported from the ASEAN countries. Moreover, a decrease in the import prices can improve the revenues of the exporting countries, thus the China-ASEAN FTA can lead to a win-win situation in Chinese tropical fruit market between China and the ASEAN countries.

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Chapter 1. Incidence of an Appreciation of Chinese Renminbi on Chinese and U.S. Tilapia Markets

I. Introduction

China reformed its currency on July 21st, 2005 and thus the fixed exchange rate regime was replaced by a managed floating exchange rate regime. Then the Chinese currency (Renminbi, RMB) stopped being pegged to the dollar and instead, the exchange rate was set to float according to the market under some management. After that, RMB began to appreciate and the accumulative appreciation percentage had reached 20% in fewer than 5 years (Figure 1.1), with the speed of appreciation slowing in 2011. Although Chinese economists have not reached a conclusion on whether RMB will appreciate or depreciate in the future, RMB is facing appreciation pressure from other countries, especially the U.S. It was said in the Semiannual Report on International Economic and Exchange Rate Policies in 2010 that RMB may be undervalued by up to 40%, which can be considered as a subsidy on Chinese exports. Although China has not been regarded as a currency manipulator, the report published on November 25th, 2012 still insisted that RMB was significantly undervalued and hence harms the U.S. economy.

Agriculture is China's traditional export industry and it plays an important role in the development of the economy. However, primary products with low value added account for 80% of Chinese agricultural exports. The biggest advantage of such products is their low prices. According to international trade theory, the appreciation of RMB reduces the comparative advantage of Chinese agricultural products and thus has an adverse impact on exports of these kinds of products. Hence, in recent years people focus more and more on the influence brought about by the appreciation of

RMB on Chinese agricultural trade and agricultural income.

China is the world's leading producer of tilapia. China's production of tilapia accounts for 50% of the world's tilapia (Figure 1.2). Up to 2009, China's export of tilapia was 259 thousand tons (including fresh tilapia, frozen tilapia, frozen tilapia fillets, and pickled tilapia, etc.), with an income of 710 million dollars from the export. It is also a pillar industry for some southern provinces of China (Guangdong, Guangxi, Fujian, etc.). The distribution of markets of China's export of tilapia concentrates on the U.S., Mexico, and Russia. Among these countries, U.S. imports of Chinese tilapia account for more than 58% of Chinese exports (Figure 1.3). Hence, the effects of exchange rate changes between China and the U.S. on tilapia markets of these countries is of interest.

In a perfectly competitive market with no distortions, theory indicates that an appreciation of a country's currency is split between a rise in the export price of a commodity and a fall in its domestic price. The purpose of this paper is to determine the incidence of the appreciation of RMB against the U.S. dollar on Chinese tilapia markets of China and the U.S. In particular, to determine how a single percent appreciation of RMB could be split between Chinese producers and U.S. consumers, and what is its impact on their welfare changes. Also, since an appreciation may increase the consumer surplus of the exporting country, another purpose of this paper is to determine the total welfare effects of China when Chinese domestic consumers are also taken into account. This research may provide information for policymakers, for example, on whether subsidization of tilapia enterprises is needed, what determines the exchange rate absorption, and how the welfare is redistributed between producers and consumers due to the exchange rate changes. Moreover, this research takes into consideration the linkage between the currencies of the rest of the world

(ROW) and the U.S. dollar, which, if ignored, may lead to an overestimation of the exchange rate pass-through and hence understate the loss for Chinese producers.

The outline of this chapter is as follows. Section 2 is a review of previous studies. Section 3 presents a graphical analysis. Section 4 presents the model that is used to simulate the effects of exchange rate changes on China's export of tilapia. Section 5 presents the information of the parameters used in the model. Section 6 discusses the reduced-form elasticities. Section 7 analyzes the welfare changes and Section 8 concludes.

II. Literature Review

According to international trade theory, appreciation of a currency increases the prices of export products, and thus, has a harmful impact on the exports of a country. Conversely, currency depreciation improves exports of the country by reducing the prices of the country's exports. Some previous research is consistent with this theory. Doroodian *et al.* (1999) found that a devaluation of the U.S. dollar has a significant and long lasting impact on U.S. agricultural exports. Orden (2002) estimated the impact of appreciation of the U.S. dollar in the 1980s and found that appreciation of the U.S. dollar reduces agricultural exports of the U.S. by about one third. Orden (1986a) used a vector autoregressive model to analyze the link between changes in the exchange rate and agricultural export. The results indicate a 20% reduction in quantity and a 10% increase in export price was caused by a 1% appreciation in the U.S. dollar. Kwon and Koo (2009) found that a depreciation of the U.S. dollar that began in 2000 increased agricultural exports of the U.S. by about 70 billion dollars each year. Their research includes both the exchange rate and the interest rate, and results show that the macroeconomic shocks could influence the agriculture sector by about 21% to

29%. Huchet-Bourdon and Korinek (2011) compared agriculture and manufacturing, and results show that a 10% depreciation in the Euro increases the quantity of agricultural export from European countries to the U.S. by about 22%, but has no effect on agricultural export to China. A 10% devaluation of the U.S. dollar against the RMB increases the quantity of agricultural imports by China from the U.S. by about 38%. This comparison shows that exports of the agriculture sector are more likely to be affected by exchange rate changes than that of the manufacturing sector. Their research also implies that exports are more sensitive to exchange rate changes than imports and it can be partly explained by the difference in price transmission mechanisms.

There is also some research that found no significant impact of exchange rate changes on trade balance, at least in the long run (e.g. Baek and Koo 2009). Kost (1976) explained this as being the result of small demand and supply elasticities. According to the Marshall-Lerner Condition, depreciation improves trade balances only if the sum of demand elasticities of both the export and import countries is greater than one in absolute value. Schuh (1974) considered exchange rate changes, agricultural exports and macroeconomic policies at the same time. He took supply elasticities into consideration and analyzed the effects of an overvalued currency. He found that the effects of the exchange rate changes on prices depend on the export supply and import demand elasticities.

By affecting agricultural trade, exchange rate changes affect the agriculture sector and agricultural income as well. Gfizel and Kulshreshtha (1995) found that a devaluation changes the relative prices of the agricultural and non-agricultural sectors and in favor of the agriculture sector. As a result, more resources come to the agriculture sector and thus enhance the factor income of the agriculture sector. The

results of their paper also indicate a negative impact of appreciation on the income of agricultural households. According to Gale and Tuan (2007), it is because of the important influence of exchange rate changes on the agriculture sector and agricultural income that the Chinese government is cautious about the appreciation of the RMB. The authors stated that an undervaluing of the RMB lowered the relative prices of domestic agricultural products, so the imports from the U.S. had no attraction for Chinese consumers. An appreciation of the RMB not only reduces the relative price of imports, but also provides Chinese consumers more purchasing power and thus increases the demand for imports. Therefore, the appreciation imposes a big pressure on the agriculture sector of China and is harmful for the agricultural households.

Aquacultural exports comprise the largest portion compared to other agricultural products. Sittert *et al.* (2006) estimated the effects of exchange rate changes on fish exports in South Africa. The exchange rate is the most important determinant of fish exports in this country and a long period of depreciation of the Rand provides the aquatic products with their only competitiveness. As a result, the appreciation of the Rand in recent years has a significant negative effect on aquatic exports. However, Anders and Caswell (2007) found an inconclusive relationship between exchange rate and seafood trade because the results change with different specification of models.

A useful tool to determine the effects of exogenous variables is the Equilibrium Displacement Model (EDM). In an EDM, the market in an industry is represented by a set of supply and demand equations, changes in some exogenous variables lead the equilibrium to displace from the initial equilibrium. Then the shift of endogenous variables caused by the changes of exogenous variables can be estimated. Then, following Sun and Kinnucan (2001), the welfare changes will be calculated using the

simulated reduced-form elasticities.

Published by The State Administration of Foreign Exchange of China, the exchange rates between China and countries other than the U.S. are calculated based on the exchange rate between China and the U.S. and the exchange rate between the U.S. and the other countries. Stated differently, the exchange rate between China and countries except for the U.S. are related to the exchange rate between China and the U.S. Hence, the exchange rate linkage will be taken into account.

Current research mainly focuses on the effects of exchange rate changes on agricultural exports or agricultural income. Few focus on the incidence on Chinese tilapia industry, which is a pillar industry and the most important source of agricultural income in some southern provinces of China. This paper attempts to determine the incidence of the exchange rate changes between China and the U.S., and the welfare impacts in the market of tilapia. Moreover, since the appreciation of RMB increases the quantity and reduces the price of tilapia in the domestic market, China's domestic consumers benefit from the appreciation. Hence, the net welfare change is also of interest. Furthermore, the linkage between the exchange rate of the rest of the world and the U.S. is considered. Thus, the effects of ignoring this currency linkage on the simulation of exchange rate pass-through can be determined.

III. Graphical Analysis

To make the diagram simple and focus on the issues discussed in this paper, there are some assumptions to be made: there is only one exporting country and one importing country; an appreciation happens to the exporting country's currency relative to the importing country's currency and other countries are not taken into consideration. Other assumptions include: homogenous products, competitive market, large exporter

and ignoring the tariffs or other trade barriers.

Figure 1.4 indicates how the exchange rate changes affect the trade between China and the U.S. in a partial equilibrium setting. Before the appreciation of RMB, the intersection of excess demand and excess supply determines the market price for both domestic and export markets. The difference between S^0 and D^0 equals the initial export X^0 . After the appreciation of RMB, price in the domestic market is changed into P_{CH} and the export price is replaced by P_{US} . The excess demand curve ED rotates inward to ED' ; under the new prices, domestic quantity demanded increases and the exported quantity decreases to X' .

The welfare changes of Chinese producers, Chinese consumers and U.S. consumers can be obtained from Figure 1.2. To make it simple to derive the formulas of welfare changes, points A-M are used as the intersections. For example, point A is the intersection of the original price (P^0) and the domestic demand curve, and point B is the intersection of the original domestic demand (D^0) and the domestic price after appreciation (P_{CH}).

The change in Chinese consumer surplus equals the area of rectangle P^0ABP_{CH} plus the area of triangle ABC. The change in Chinese producer surplus equals the area of rectangle P^0DEP_{CH} plus the area of triangle DEF. The U.S. consumer surplus can also be obtained from the figure. It equals the sum of the areas of rectangle $P_{US}GJH$ and triangle HJM. The welfare changes will be discussed in detail in section 6.

IV. Model

The model is based on the following assumptions on tilapia trade between China and the U.S.:

- a) China is a net exporter of tilapia in the world.

b) China is considered to be a large economy. This assumption is realistic due to the large market share of China (more than 70%)¹ in the international tilapia market.

c) Tilapia is homogeneous. According to A Guide of China's Export of Agricultural Product, tilapia is facing a pressure that comes from the homogeneous competition in the international market. Furthermore, agricultural products, including seafood, are often assumed to be homogeneous products (Krugman 1990; Kilkenny 1998).

d) The Law of One Price (LOP) holds across all markets. LOP means that the price of tilapia is the same across the world once transport costs have been taken into account. It implies the market for tilapia between China and its major trading partners is perfectly competitive. In this formulation, export price commonly is specified as a multiplicative function of the domestic price, exchange rate, tariff rate and transportation cost (Kinnucan and Myrland 2002). This paper focuses on the exchange rate, thus transportation cost and other exogenous variables that affect demand and supply are suppressed.

e) Competitive market clearing.

Consider the following structural model for Chinese tilapia:

$$(1) \quad D = D(P_{CH}) \quad \text{(Domestic demand)}$$

$$(2) \quad S = S(P_{CH}) \quad \text{(Domestic supply)}$$

$$(3) \quad X_{US} = X_{US}(P_{US}) \quad \text{(Export demand from U.S.)}$$

$$(4) \quad X_{ROW} = X_{ROW}(P_{ROW}) \quad \text{(Export demand from ROW)}$$

$$(5) \quad P_{US} = P_{CH} E_{US/CH} \quad \text{(U.S. price)}$$

¹ Source: "Sustaining the Tilapia Value Chain in China". EU FPT Funded Project No. 222889 (2009-2013)

$$(6) P_{ROW} = P_{CH} E_{ROW/CH} \quad (\text{ROW price})$$

$$(7) E_{ROW/CH} = E_{ROW/US} E_{US/CH} \quad (\text{Exchange rate linkage between ROW and U.S.})$$

$$(8) S = D + X_{US} + X_{ROW} \quad (\text{Market clearing})$$

where $E_{US/CH}$ means the indirect exchange rate between China and the U.S. or the rest of the world. This means the exchange rate is quoted as the foreign currency per unit of the domestic currency, so that an increase in the exchange rate indicates an appreciation of the RMB. Similarly, $E_{ROW/CH}$, $E_{ROW/US}$ are the exchange rates between the ROW and China and between the ROW and the US; D and S are domestic demand and supply, respectively; X_{US} and X_{ROW} are the exports to the US and the ROW; P_{CH} , P_{US} and P_{ROW} are the Chinese price, US price and the ROW price, respectively.

In this model, the assumption that there is only one exporting country and one importing country is relaxed, so China's exports to the rest of the world are also taken into consideration. Furthermore, two scenarios will be considered: 1) there is no linkage between the ROW currencies and the U.S. dollar, and 2) the ROW currencies are related to the U.S. dollar. In this way, the effects of ignoring the currency linkage can be determined.

Then, the market demand is divided into three segments: domestic demand, represented by equation (1); exports to the U.S., represented by equation (3); and exports to the rest of the world, represented by equation (4). Equation (2) represents domestic production; equations (5) and (6) link the domestic market price to the world price through the exchange rate; equation (7) links the ROW currencies to the U.S. dollar; equation (8) represents the equilibrium condition.

Under scenario 1, the model contains seven endogenous variables: D , S , X_{US} , X_{ROW} , P_{CH} , P_{US} , P_{ROW} ; and two exogenous variables: $E_{US/CH}$ and $E_{ROW/CH}$. Under

scenario 2, the model contains one more endogenous variable $E_{ROW/CH}$, and the two exogenous variables are $E_{US/CH}$ and $E_{ROW/US}$.

Converting the structural model to percentage changes yields²:

$$(9) \quad D^* = \eta_{CH} P_{CH}^*$$

$$(10) \quad S^* = \varepsilon_{CH} P_{CH}^*$$

$$(11) \quad X_{US}^* = \eta_{US} P_{US}^*$$

$$(12) \quad X_{ROW}^* = \eta_{ROW} P_{ROW}^*$$

$$(13) \quad P_{US}^* = P_{CH}^* + E_{US/CH}^*$$

$$(14) \quad P_{ROW}^* = P_{CH}^* + E_{ROW/CH}^*$$

$$(15) \quad E_{ROW/CH}^* = E_{ROW/US}^* + E_{US/CH}^*$$

$$(16) \quad S^* = k_{CH} D^* + k_{US} X_{US}^* + k_{ROW} X_{ROW}^*$$

where the asterisked variables refer to relative changes (e.g. $P_{CH}^* = dP_{CH} / P_{CH}$).

Equations (9) - (16) are called the Equilibrium Displacement Model (EDM), which links the relative changes between variables using elasticities. Definitions of parameters are in Table 1.1. For normal sloping supply and demand curves, $\eta < 0$ and $\varepsilon > 0$.

The issue here is to determine the exchange rate pass-through into U.S. price, and the exchange rate absorption into the Chinese domestic price. By imposing the market clearing conditions, the reduced form of the endogenous variables for both scenario 1 and scenario 2 can be obtained. First, assume the ROW currencies are not related to the U.S. dollar (which means that equation (15) is dropped). By dropping equations (11) and (12) and solving the remaining equations simultaneously the export supply curve for the U.S. market is obtained:

² See appendix for the derivation.

$$(17) \quad X_{US}^* = \varepsilon_{US} P_{CH}^* - \frac{k_{ROW} \eta_{ROW}}{k_{US}} E_{ROW/CN}^*$$

where

$$(18) \quad \varepsilon_{US} = \frac{\varepsilon_{CH} - k_{CH} \eta_{CH} - k_{ROW} \eta_{ROW}}{k_{US}}$$

is China's export supply elasticity corresponding to the U.S. market. How the changes in ROW/RMB exchange rate affect the exports to the U.S. can be seen from

$-\frac{k_{ROW} \eta_{ROW}}{k_{US}}$. For normal parameter values, the export supply curve is upward sloping,

and because an increase in $E_{ROW/CH}$ means an appreciation of RMB, equation (17) indicates that an appreciation of the RMB against ROW increases China's export supply to the U.S.

Then, we focus on the reduced-form of prices. The Chinese domestic price can be obtained by setting (17) equal to (11) and substituting (13) to yield:

$$(19) \quad P_{CH}^* = \frac{\eta_{US}}{\varepsilon_{US} - \eta_{US}} E_{US/CH}^* + \frac{k_{ROW} \eta_{ROW}}{k_{US} (\varepsilon_{US} - \eta_{US})} E_{ROW/CH}^*$$

where $-1 < \frac{\eta_{US}}{\varepsilon_{US} - \eta_{US}} < 0$ is the absorption of the exchange rate appreciation into

Chinese domestic price, which indicates that an appreciation in RMB against the U.S. dollar reduces China's domestic price by less than the amount of the appreciation.

$\frac{k_{ROW} \eta_{ROW}}{k_{US} (\varepsilon_{US} - \eta_{US})} < 0$ indicates that an appreciation of RMB against ROW currencies

also decreases China's domestic price, and whether the effect is larger or smaller than the amount of appreciation depends on the relative importance of the market shares, and the relative magnitudes of supply and demand elasticities in the export markets.

Then the assumption that there is no linkage between ROW currencies and the U.S. dollar is relaxed by substituting equation (15) into equation (19) to yield:

$$(20) \quad P_{CH}^* = \frac{\eta_{US} + \Phi}{\varepsilon_{US} - \eta_{US}} E_{US/CH}^* + \frac{k_{ROW} \eta_{ROW}}{k_{US} (\varepsilon_{US} - \eta_{US})} E_{ROW/US}^*$$

where $\Phi = \frac{k_{ROW} \eta_{ROW}}{k_{US}} < 0$ is the linkage parameter between ROW currencies and the U.S. dollar. Equation (20) indicates that with the assumption that the ROW currencies are related to the U.S. dollar, the absorption of the exchange rate changes into Chinese domestic price is magnified by the currency linkage. Stated differently, ignoring the currency linkage understates the exchange rate absorption.

Exchange rate pass-through can be obtained by substituting equation (20) into (13) to yield:

$$(21) \quad P_{US}^* = \frac{\varepsilon_{US} + \Phi}{\varepsilon_{US} - \eta_{US}} E_{US/CH}^* + \frac{k_{ROW} \eta_{ROW}}{k_{US} (\varepsilon_{US} - \eta_{US})} E_{ROW/US}^*$$

where $\frac{\varepsilon_{US} + \Phi}{\varepsilon_{US} - \eta_{US}}$ is the pass-through of movements in the USD/RMB exchange rate into the U.S. price. It has an upper limit of 1 and a lower limit of 0. Equation (21) indicates that the linkage between ROW currencies and the U.S. dollar attenuates the effects of appreciation of RMB against the U.S. dollar on the U.S. price. That is, ignoring the possible linkage between ROW currencies and the U.S. dollar may lead to an overestimation of the exchange rate pass-through.

The exchange rate pass-through into the U.S. price is inversely related to the U.S. import demand elasticity for Chinese exports. If China were a small exporter with a perfectly elastic demand curve ($\eta_{US} = \infty$), the pass-through would reach its lower limit of 0, then the entire burden of the price change would be borne by Chinese producers. If China were faced with a perfectly inelastic demand curve ($\eta_{US} = 0$) and there would be no linkage between currencies ($\Phi = 0$), the pass-through would reach its upper limit of 1 and all the burden of price adjustment would be borne by the U.S.

importers.

Therefore, when the ROW currencies are not related to the U.S. dollar, and with the maintained hypothesis that LOP holds, an appreciation in RMB against the U.S. dollar is split between a rise in the U.S. price and a fall in China's domestic price. The incidence depends on the relative magnitudes of the supply and demand elasticities of the countries, and the less elastic side of the market bears the greater burden of the price adjustment.

In order to get the values of reduced-form elasticities, the model is first expressed in a matrix as follows:

$$(22) \Pi Y = \Gamma Z^3$$

Under the assumption that the ROW currencies are unrelated to the U.S. dollar (scenario 1), Π is a 7*7 matrix of parameters corresponding to the model's endogenous variables, Y is a 7*1 vector of endogenous variables, Γ is a 7*2 matrix of parameters corresponding to the model's exogenous variables, and Z is a 2*1 vector of exogenous variables. If ROW currencies are assumed to be related to the U.S. dollar (scenario 2), Π is an 8*8 matrix of parameters corresponding to the model's endogenous variables, Y is a 8*1 vector of endogenous variables. Γ is an 8*2 matrix of parameters corresponding to the model's exogenous variables, and Z is a 2*1 vector of exogenous variables.

By pre-multiplying equation (22) by Π 's inverse yields:

$$(23) Y = EZ$$

where $E = \Pi^{-1} \Gamma$ is a 7*2 (or 8*2 if there is currency linkage) matrix containing the parameters of reduced form coefficients or elasticities. After having assigned the

³ See appendix for detail.

numerical values of parameters, E can be computed through $E = \Pi^{-1} \Gamma$. Then the matrix Y can be obtained, which represents the changes in endogenous variables due to the changes in exogenous variables.

V. Parameterization

The numerical values for the parameters are needed to obtain the price and trade flow changes caused by the exchange rate changes. These values are listed in Table 1.1.

Domestic demand elasticity is set to -0.8, which is based on the assumption of the report of the Asian Development Bank (ADB). Moreover, Ahmed and Lorica (2002) studied the relationship between aquaculture and food security. They found that for high-value fish, price elasticity of demand is higher, while for low-value fish, such an elasticity is lower. According to Ahmed and Ahmed (2009), tilapia can be regarded as a kind of low-value fish. Dey (2000a) found that tilapia has a high demand elasticity in some countries (India, Thailand and the Philippines, for example), but not in China. These results are all consistent with ADB's assumption about the demand elasticity. Therefore, ADB's value of demand elasticity will be used in this paper.

Also, ADB's report provides an assumption that the supply elasticity of tilapia is 0.5 for China, Indonesia, the Philippines, Vietnam, and Thailand. In this paper, this value will be used as China's supply elasticity of tilapia.

Norman-López and Asche (2006) used data from 2001 to 2005 to estimate the import elasticity of tilapia in the U.S. and got the value -1.342 for frozen tilapia, which means import demand is elastic. Also, they mentioned in their paper that the U.S. imports most of the fresh tilapia fillets from South American countries, but its frozen whole tilapia and frozen tilapia fillets are mainly imported from mainland

China and Taiwan⁴. In another paper by Norman-Lopez and Asche (2008), data from 1997 to 2006 was used to estimate the elasticities and the import demand elasticity of frozen tilapia is -0.689. In To and Nguyen's (2009) research, five models were used to estimate the import demand elasticity of frozen tilapia. Three of the five results indicate an elastic demand (-1.27, -1.27 and -1.13) and the other two imply an inelastic demand (-0.84 and -0.86). Due to the variance of the elasticities obtained in different research, two values for the import demand elasticity of the U.S. will be used in this paper, one of which indicates an inelastic demand (-0.689) and the other indicates an elastic demand (-1.342).

The import demand elasticity for ROW is set to -3.47, which is the mean of the values provided by Graham *et al.* (1998) for some APEC countries. This value is consistent with the range provided by literature about import elasticities of seafood. (Tokrisna and Thambamrung 2008). Furthermore, according to Holland *et al.* (1999), import demand for tilapia is highly elastic, thus, in this paper, this value will be used as the import elasticity of the rest of the world.

According to A Guide for China's Export of Agricultural Product, the quantity shares of China, the U.S. and ROW are 0.82, 0.10 and 0.08, respectively.

VI. Reduced-Form Elasticities

The reduced-form elasticities indicate how an endogenous variable changes in response to a change in an exogenous variable allowing other endogenous variables in the model adjust. For example, the reduced-form elasticity of U.S. price of tilapia with respect to the RMB/USD exchange rate indicates the percentage change in the

⁴ Hence, all data used in this article covers only frozen tilapia and frozen tilapia fillets because they are the most common tilapia products that are exported by China.

U.S. price per one percent change in RMB/USD taking into account induced changes in China's price. The reduced-form elasticities are in Table 1.2.

Focusing first on scenario 1, the signs of reduced-form elasticities show that as expected, an appreciation depresses China's domestic price and increases the U.S. price, thus reduces the export to the U.S. When $\eta_{US} = -0.689$, which means an inelastic import demand for the U.S., a one percent appreciation in RMB against the U.S. dollar is split between a 0.05 percent decrease in China's domestic price and a 0.95 percent increase in the U.S. price. However, when $\eta_{US} = -1.342$, the burden of price adjustment for Chinese producers and U.S. consumers are 0.09 percent and 0.91 percent, respectively. Both results indicate that compared to Chinese producers, the U.S. consumers bear a much larger burden of the adjustment of prices. But the burden of U.S. consumers is smaller when the U.S. has an elastic import demand than would be the case if it has an inelastic import demand.

The changes in prices cause more tilapia to be sold in China's domestic market. When $\eta_{US} = -0.689$, the quantity demanded in China's domestic market increases by 0.04 percent, and the exports to the U.S. decreases by 0.66 percent. When $\eta_{US} = -1.342$, the increase in quantity demanded in China's domestic market is 0.07 percent, and the exports to the U.S. decreases by approximately 1.23 percent, almost twice as it would be if $\eta_{US} = -0.689$.

Turning to scenario 2, as calculated before, with the currency linkage the burden of Chinese producers is larger than it would be without that linkage. When $\eta_{US} = -0.689$, a one percent appreciation of RMB against the U.S. dollar decreases China's domestic price by 0.23 percent, which is 4.6 times of this effect if there is no currency linkage, while the U.S. price is only increased by 0.77 percent. As a result,

quantity demanded in domestic market increases by 0.18 percent, 4.5 times as it would be without the linkage. The decrease in the exports to the U.S. is only 0.53 percent. Moreover, when $\eta_{US} = -1.342$, the price adjustment caused by one percent appreciation of RMB against the U.S. dollar is even worse for Chinese producers, who bear a 0.26 percent decrease in the domestic price and the increase in the U.S. price is 0.74 percent.

Therefore, when $\Phi < 0$, although U.S. consumers still bear the larger part of the price changes, the burden is much smaller than that without the currency linkage. Hence, ignoring the currency linkage between the ROW currencies and the U.S. dollar overstates the exchange rate pass-through into the U.S. price. Moreover, for both scenarios, a more elastic import demand of the U.S. indicates a smaller burden for the U.S. consumers and a larger burden for Chinese producers.

It is also worth noting that, the signs of effects on ROW price and quantity are different under different assumptions about the currency linkage. When there is no linkage between ROW currencies and the U.S. dollar, an appreciation of RMB against the U.S. dollar reduces the ROW price and thus increases the export to these countries. However, when $\Phi < 0$, the appreciation decreases exports to ROW due to an increase in ROW prices..

VI. Welfare Analysis

Following the calculation method provided by Sun and Kinnucan (2001), the equations below are obtained⁵ for calculating the welfare changes of Chinese producers, Chinese consumers and U.S. consumers:

⁵ See Appendix for derivation.

$$(24) \quad \Delta CS_{CH} = -P^0 D^0 P_{CH}^* \left(1 + \frac{1}{2} D^*\right)$$

$$(25) \quad \Delta PS_{CH} = P^0 S^0 P_{CH}^* \left(1 + \frac{1}{2} S^*\right)$$

$$(26) \quad \Delta CS_{US} = -P^0 X_{US}^0 P_{US}^* \left(1 + \frac{1}{2} X_{US}^*\right)$$

where ΔCS_{CH} , ΔPS_{CH} are the changes in Chinese domestic consumer and producer surplus associated with the exchange rate changes, and ΔCS_{US} is the changes in the U.S. consumer surplus due to the changes in the exchange rate. $P^0 D^0$ is the domestic consumer expenditure in the initial equilibrium. $P^0 S^0$ is the total revenue of Chinese producers from both domestic and export markets in the initial equilibrium. $P^0 X_{US}^0$ is the U.S. consumer expenditure on Chinese tilapia. P_{CH}^* and P_{US}^* are the relative changes in domestic price and U.S. price. D^* , S^* and X_{US}^* are the relative changes in domestic demand, total supply and export to the U.S. associated with the changes in exchange rate.

In order to assess the welfare changes that are caused by the exchange rate changes, inserting the reduced-form elasticities yields:

$$(27) \quad \Delta CS_{CH} = -P^0 D^0 \frac{P_{CH}^*}{E_{US/CH}^*} E_{US/CH}^* \left(1 + \frac{1}{2} \frac{D^*}{E_{US/CH}^*} E_{US/CH}^*\right)$$

$$(28) \quad \Delta PS_{CH} = P^0 S^0 \frac{P_{CH}^*}{E_{US/CH}^*} E_{US/CH}^* \left(1 + \frac{1}{2} \frac{S^*}{E_{US/CH}^*} E_{US/CH}^*\right)$$

$$(29) \quad \Delta CS_{US} = -P^0 X_{US}^0 \frac{P_{US}^*}{E_{US/CH}^*} E_{US/CH}^* \left(1 + \frac{1}{2} \frac{X_{US}^*}{E_{US/CH}^*} E_{US/CH}^*\right)$$

The values from 2007 are chosen as the initial equilibrium values of $P^0 D^0$, $P^0 S^0$ and $P^0 X_{US}^0$. The baseline values used in these equations are in table 1.3. $\frac{P_{CH}^*}{E_{US/CH}^*}$,

$\frac{P_{US}^*}{E_{US/CH}^*}$, $\frac{D^*}{E_{US/CH}^*}$, $\frac{S^*}{E_{US/CH}^*}$ and $\frac{X_{US}^*}{E_{US/CH}^*}$ are set equal to the corresponding

reduced-form elasticities given in Table 1.2. Then the welfare impacts of the appreciation of RMB against the U.S. dollar during 2007-2011 can be obtained and results are in Table 1.4.

Comparison indicates that the loss in Chinese producer surplus is much bigger under scenario 2 than would be the case under scenario 1. For example, when $\eta_{US} = -0.689$, ΔPS_{CH} with the currency linkage is almost five times as it would be without the linkage. Under the assumption of $\eta_{US} = -0.689$, if the currency linkage is not taken into consideration, the loss of welfare due to an appreciation of RMB against the U.S. dollar are 19.97 and 40.53 million dollars for Chinese producers and U.S. consumers, respectively. U.S. consumers bear most of the welfare loss. However, in scenario 2, the loss of Chinese producer surplus becomes 91.04 million dollars, much more than the welfare loss of U.S. consumers, which is only 33.26 million dollars.

Furthermore, a more elastic import demand elasticity magnifies the welfare loss of Chinese producers and reduces the loss of U.S. consumers, regardless of whether or not the ROW currencies are related to the U.S. dollar. Take scenario 1 for example, when U.S. consumers face an inelastic import demand ($\eta_{US} = -0.689$), loss in Chinese producers' welfare is only 19.97 million dollars while they have to bear a loss of 35.88 million dollars if the import demand of U.S. is elastic ($\eta_{US} = -1.342$).

When it comes to Chinese consumers' welfare changes, the currency linkage magnifies the increase in Chinese consumers welfare. However, total welfare of China is still decreased by the currency linkage due to the fact that the loss in producer surplus is larger than the gain in consumer surplus, and the deadweight loss becomes larger when the U.S. import demand becomes more elastic.

Values in the brackets are obtained by dividing the welfare changes by total

revenue or total expenditures. For example, under scenario 2, when the import demand elasticity of the U.S. is -1.342, the welfare loss of Chinese producers caused by the appreciation of RMB against U.S. dollar during 2007-2011 equals to 4.63 percent of their total revenue. The loss in U.S. consumers' welfare equals 12.14 percent of their total expenditure on imports from China.

Results in Table 1.4 show that an appreciation of RMB against the U.S. dollar decreases the welfare of both Chinese producers and U.S. consumers. Nevertheless, under different assumptions about whether or not there is a currency linkage, the larger burden falls on different sides of the market. Without considering the linkage between ROW currencies and the U.S. dollar, the welfare loss of Chinese producers is smaller than that of U.S. consumers. Under the assumption that the ROW currencies are related to U.S. dollar, the loss in Chinese producer surplus is magnified and exceeds the loss in U.S. consumer surplus. Therefore, failure to consider the currency linkage underestimates the loss of Chinese producer surplus. Moreover, the larger of the import demand elasticity, the larger of the loss of Chinese producers' welfare. Although an appreciation of RMB against the U.S. dollar increases Chinese consumer surplus, the total welfare of China is still decreasing with the increase in the import demand elasticity of the U.S.

VII. Concluding Comments

This paper emphasizes the importance of taking into account possible simultaneous changes in exchange rates when evaluating their effects in a particular market. The simulation shows that the exchange rate pass-through will be overestimated without taking the exchange rate linkage into consideration, and the exchange rate absorption to Chinese producers will be underestimated.

After considering the currency linkage between ROW currencies and the U.S. dollar, a one percent appreciation of RMB against the U.S. dollar is split between a 23 percent (when $\eta_{US} = -0.689$) or 26 percent (when $\eta_{US} = -1.342$) decrease in China's domestic price and a 74 (when $\eta_{US} = -1.342$) or 77 ($\eta_{US} = -0.689$) percent increase in the U.S. price, which means that the U.S. consumers bear a larger portion of the price adjustment.

However, when it comes to welfare changes, the Chinese producers bear a larger welfare loss after the currency linkage is considered, compared to the U.S. consumers. Also, there is a deadweight loss in China's welfare on the tilapia market even if Chinese consumers' welfare change is taken into account, and the loss is increasing with the increase of the import demand elasticity of the U.S.

The results have some policy implications. From the U.S. perspective, the appreciation of RMB against the U.S. dollar depresses the welfare of U.S. consumers on the tilapia market by approximately 13.14-13.20 percent of the total expenditure on Chinese tilapia, especially for the consumers with low income, because the market positioning of Chinese tilapia are consumers with a relatively lower income. ,

From China's perspective, the appreciation of RMB on the Chinese tilapia market moves some of the producers' welfare to domestic lower-income group consumers. The loss in producer surplus equals 4.10 percent or 4.63 percent of the total revenue. The percentages are large considering the low profit margin (about 3%) of enterprises that produce tilapia and other similar species. Hence, policies are needed to offset the adverse effects of the appreciation. One way in dispute is the export tax rebate. A view on this policy at the Tilapia Industry Development Forum in 2012 is that it does little to help domestic tilapia enterprises due to the fact that it works more like a subsidy to the U.S. consumers.

Also, both reduced form and simulated results indicate that the exchange rate pass-through depends on the relative magnitudes of the export supply elasticity of China and the import demand elasticity of the U.S. The more elastic the import demand of U.S. relative to the Chinese supply, the smaller of the exchange rate pass-through to the U.S. consumers, and the bigger of the exchange rate absorption to Chinese producers. This result indicates that one possible way to minimize the burden of Chinese producers is to increase the export supply elasticity, which is affected by efficiency of resource allocation, management of production and so on.

FIGURES:

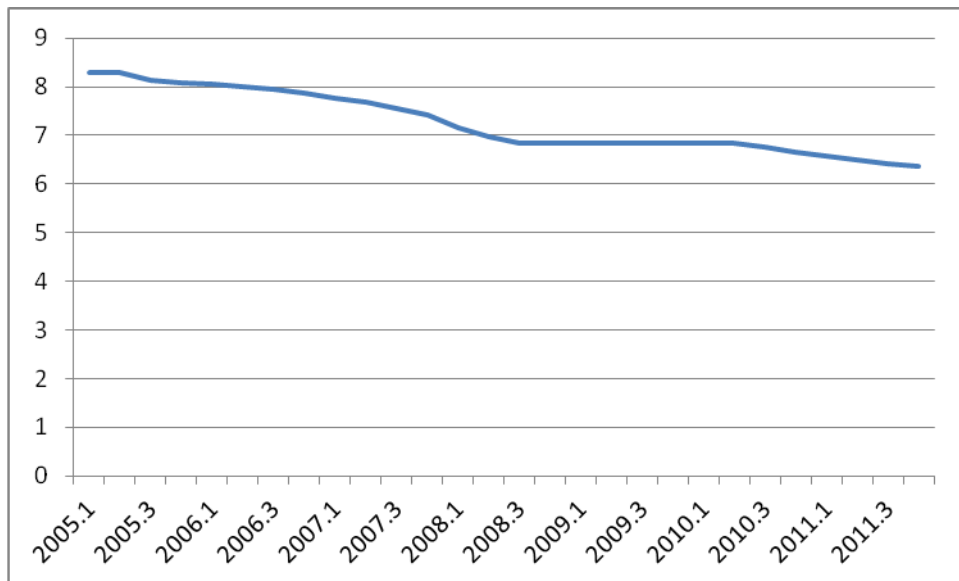


Figure 1.1(a) Quarterly Changes in the Nominal Exchange Rate between RMB and U.S. Dollar. (2005-2011)

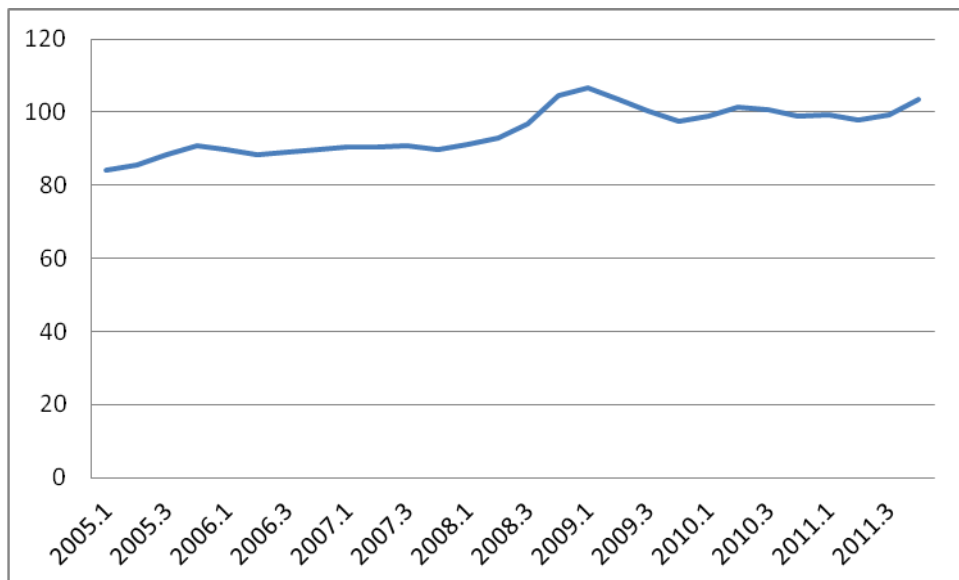


Figure 1.1(b) Quarterly Changes in the Effective Exchange Rate Indices between RMB and U.S. Dollar. (2005-2011)

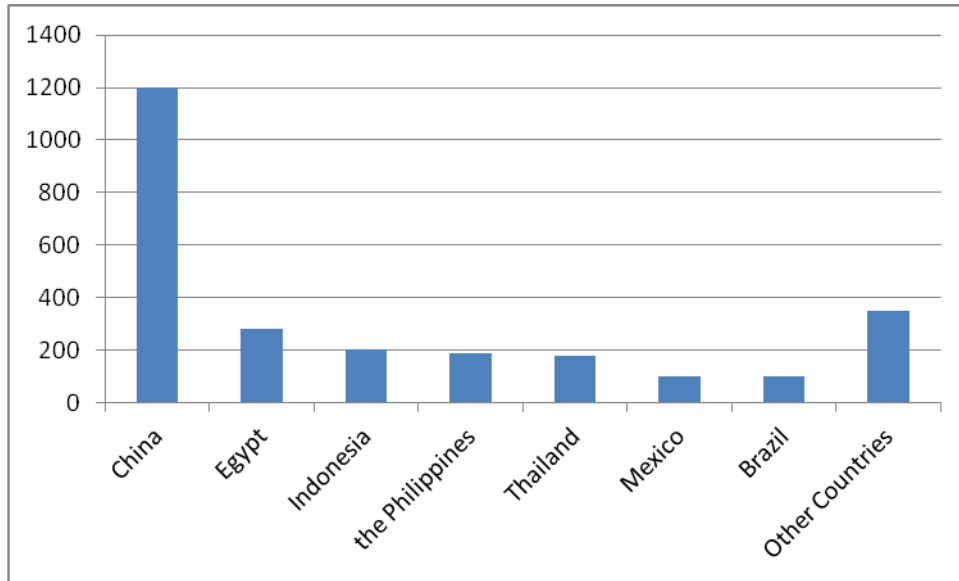


Figure 1.2 World Production of Tilapia

Source: A Guide of China's Export of Agricultural Product.

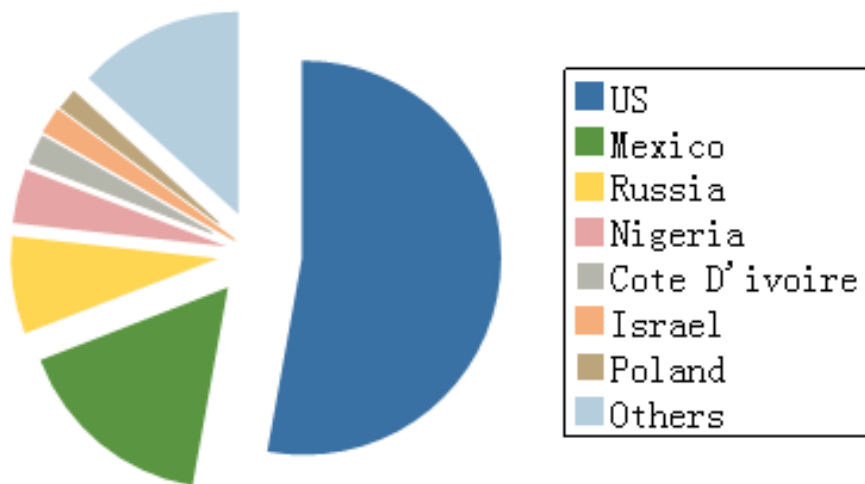


Figure 1.3 Distribution of China's Export of Tilapia

Source: A Guide of China's Export of Agricultural Product.

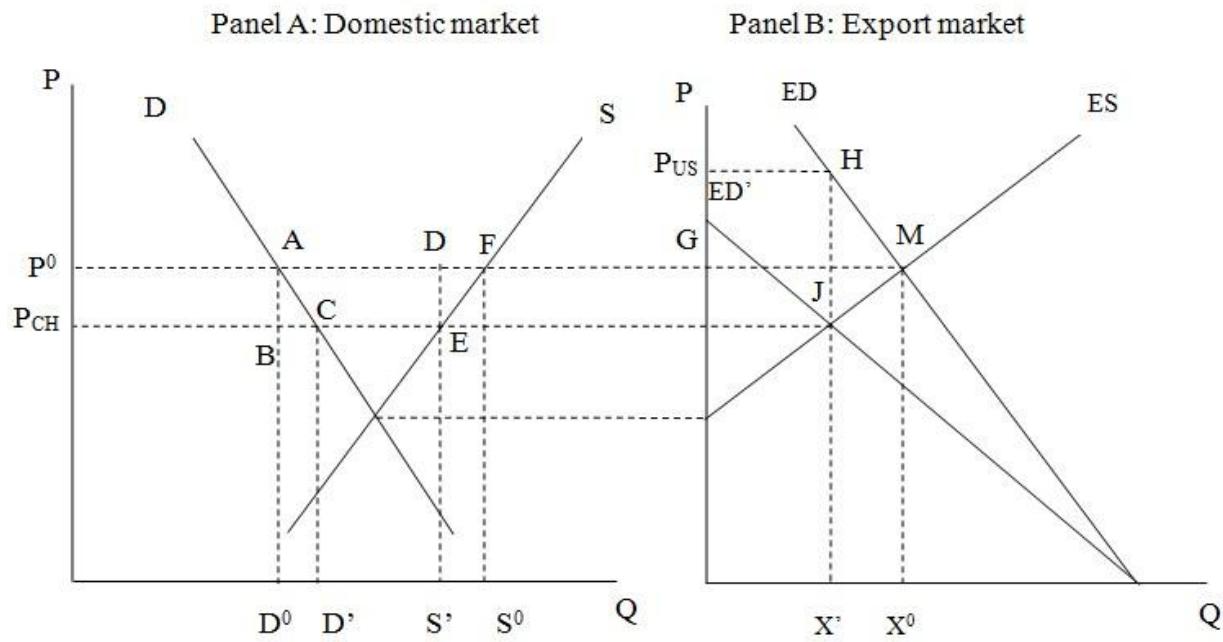


Figure 1.4 The Effects of an Appreciation of RMB on Chinese Tilapia Markets

TABLES:

Table 1.1 Parameter Definitions and Values

Parameter	Definition	Value ^a
η_{CH}	China's domestic demand elasticity	-0.8
ε_{CH}	China's supply elasticity	0.5
η_{US}	US import demand elasticity for Chinese tilapia	-0.689, -1.342
η_{ROW}	ROW import demand elasticity for Chinese tilapia	-3.47
k_{CH}	Domestic quantity share (=D/S)	0.82
k_{US}	US quantity share (=X _{US} /S)	0.10
k_{ROW}	ROW quantity share (=X _{ROW} /S)	0.08

a. See text for detail.

Table 1.2 Reduced-form Elasticities

$\Phi = 0$				
	$E_{US/CH}$	$E_{ROW/CH}$	$E_{US/CH}$	$E_{ROW/CH}$
	$\eta_{US} = -0.689$		$\eta_{US} = -1.342$	
P_{CH}^*	-0.05	-0.18	-0.09	-0.18
P_{US}^*	0.95	-0.18	0.91	-0.18
P_{ROW}^*	-0.05	0.82	-0.09	0.82
D^*	0.04	0.15	0.07	0.14
S^*	-0.02	-0.09	-0.04	-0.09
X_{US}^*	-0.66	0.13	-1.23	0.24
X_{ROW}^*	0.16	-2.83	0.30	-2.86
$\Phi < 0$				
	$E_{US/CH}$	$E_{ROW/US}$	$E_{US/CH}$	$E_{ROW/US}$
	$\eta_{US} = -0.689$		$\eta_{US} = -1.342$	
P_{CH}^*	-0.23	-0.18	-0.26	-0.18
P_{US}^*	0.77	-0.18	0.74	-0.18
P_{ROW}^*	0.77	0.82	0.74	0.82
D^*	0.18	0.15	0.21	0.14
S^*	-0.12	-0.09	-0.13	-0.09
X_{US}^*	-0.53	0.13	-0.99	0.24
X_{ROW}^*	-2.67	-2.83	-2.56	-2.86

Table 1.3 Baseline Values

Item	Definition	Value ^a
P^0S^0	Total revenue of Chinese producers in 2007	2223
P^0D^0	Domestic consumer expenditure in 2007	1780
P^0X^0	U.S. consumer expenditure on Chinese tilapia in 2007	252
E^*	Relative changes in exchange rate between China and U.S. from 2007 to 2011	18%

a. Unit for P^0S^0 , P^0D^0 and P^0X^0 is million dollars.

Table 1.4 Welfare Effects of an Appreciation of RMB Against U.S. Dollar During 2007-2011 (million US\$)

	Scenario 1 ($\Phi = 0$)		Scenario 2 ($\Phi < 0$)	
	$\eta_{US} = -0.689$	$\eta_{US} = -1.342$	$\eta_{US} = -0.689$	$\eta_{US} = -1.342$
ΔPS_{CH}	-19.97 (0.0090)	-35.88 (0.0161)	-91.04 (0.0410)	-102.82 (0.0463)
ΔCS_{CH}	16.08 (0.0090)	29.02 (0.0163)	74.89 (0.0421)	84.88 (0.0477)
ΔCS_{US}	-40.53 (0.1608)	-36.71 (0.1457)	-33.26 (0.1320)	-30.58 (0.1314)
ΔTS_{CH}	-3.89	-6.86	-16.15	-17.94

Appendix I

Derivation of the Equilibrium Displacement Model (part 1)

To obtain equation (9) , take the total differential of equation (1):

$$dD = \frac{dD}{dP_{CH}} dP_{CH}$$

Then we get:

$$\frac{dD}{D} = \frac{dD}{\partial P_{CH}} \frac{P_{CH}}{D} \frac{dP_{CH}}{P_{CH}}$$

So we can get equation (9):

$$D^* = \eta_{CH} P_{CH}^*$$

where $\eta_{CH} = \frac{dD}{dP_{CH}} \frac{P_{CH}}{D}$ is the price elasticity of demand.

In the same way, we can get equation (10), equation (11) and (12).

Appendix II

Derivation of the Equilibrium Displacement Model (part 2)

To obtain equation (13), take the total differential of equation (5):

$$dP_{US} = E_{US/CH} dP_{CH} + P_{CH} dE_{US/CH}$$

Then we get:

$$\frac{dP_{US}}{P_{US}} = \frac{P_{CH}}{P_{US}} \frac{dP_{CH}}{P_{CH}} E_{US/CH} + \frac{dE_{US/CH}}{E_{US/CH}} \frac{P_{CH}}{P_{US}} E_{US/CH}$$

Therefore:

$$P_{US}^* = P_{CH}^* + E_{US/CH}^*$$

In the same way, we can get equation (14).

Appendix III

Derivation of the Equilibrium Displacement Model (part 3)

To obtain equation (15), take the total differential of equation (7):

$$dE_{ROW/CH} = E_{US/CH} dE_{ROW/US} + E_{ROW/US} dE_{US/CH}$$

Then we get:

$$\frac{dE_{ROW/CH}}{E_{ROW/CH}} = \frac{E_{US/CH}}{E_{ROW/CH}} \frac{dE_{ROW/US}}{E_{ROW/US}} E_{ROW/US} + \frac{E_{ROW/US}}{E_{ROW/CH}} \frac{dE_{US/CH}}{E_{US/CH}} E_{US/CH}$$

Therefore:

$$E_{ROW/CH}^* = E_{ROW/US}^* + E_{US/CH}^*$$

Appendix IV

Derivation of the Equilibrium Displacement Model (part 4)

From equation (8) we get:

$$dS = dD + dX_{US} + dX_{ROW}$$

Then we get:

$$\frac{dS}{S} = \frac{D}{S} \frac{dD}{D} + \frac{X_{US}}{S} \frac{dX_{US}}{X_{US}} + \frac{X_{ROW}}{S} \frac{dX_{ROW}}{X_{ROW}}$$

Therefore:

$$S^* = k_{CH} D^* + k_{US} X_{US}^* + k_{ROW} X_{ROW}^*$$

where $k_{CH} = \frac{D}{S}$, $k_{US} = \frac{X_{US}}{S}$, $k_{ROW} = \frac{X_{ROW}}{S}$.

Appendix V

The Equilibrium Displacement Model in Matrix Form

Equation (9) - (16) can be written in matrix form when equation (15) is dropped:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & -\eta_{CH} & 0 & 0 \\ 0 & 1 & 0 & 0 & -\varepsilon_{CH} & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & -\eta_{US} & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & -\eta_{ROW} \\ 0 & 0 & 0 & 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 1 \\ -k_{CH} & 1 & -k_{US} & -k_{ROW} & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} D^* \\ S^* \\ X_{US}^* \\ X_{ROW}^* \\ P_{CH}^* \\ P_{US}^* \\ P_{ROW}^* \end{pmatrix} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{pmatrix} \begin{pmatrix} E_{US/CH} \\ E_{ROW/CH} \end{pmatrix}$$

$$\text{Here, } \Pi = \begin{pmatrix} 1 & 0 & 0 & 0 & -\eta_{CH} & 0 & 0 \\ 0 & 1 & 0 & 0 & -\varepsilon_{CH} & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & -\eta_{US} & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & -\eta_{ROW} \\ 0 & 0 & 0 & 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 1 \\ -k_{CH} & 1 & -k_{US} & -k_{ROW} & 0 & 0 & 0 \end{pmatrix}, Y = \begin{pmatrix} D^* \\ S^* \\ X_{US}^* \\ X_{ROW}^* \\ P_{CH}^* \\ P_{US}^* \\ P_{ROW}^* \end{pmatrix},$$

$$\Gamma = \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{pmatrix} \text{ and } Z = \begin{pmatrix} E_{US/CH} \\ E_{ROW/CH} \end{pmatrix}$$

When equation (15) is included, Equation (9) - (16) can be written in matrix form as

follows:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & -\eta_{CH} & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & -\varepsilon_{CH} & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & -\eta_{US} & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & -\eta_{ROW} & 0 \\ 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ -k_{CH} & 1 & -k_{US} & -k_{ROW} & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} D^* \\ S^* \\ X_{US}^* \\ X_{ROW}^* \\ P_{CH}^* \\ P_{US}^* \\ P_{ROW}^* \\ E_{ROW/CH}^* \end{pmatrix} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 1 & 1 \\ 0 & 0 \end{pmatrix} \begin{pmatrix} E_{US/CH} \\ E_{ROW/US} \end{pmatrix}$$

$$\text{Here, } \Pi = \begin{pmatrix} 1 & 0 & 0 & 0 & -\eta_{CH} & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & -\varepsilon_{CH} & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & -\eta_{US} & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & -\eta_{ROW} & 0 \\ 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ -k_{CH} & 1 & -k_{US} & -k_{ROW} & 0 & 0 & 0 & 0 \end{pmatrix}, Y = \begin{pmatrix} D^* \\ S^* \\ X_{US}^* \\ X_{ROW}^* \\ P_{CH}^* \\ P_{US}^* \\ P_{ROW}^* \\ E_{ROW/CH}^* \end{pmatrix},$$

$$\Gamma = \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 1 & 1 \\ 0 & 0 \end{pmatrix} \text{ and } Z = \begin{pmatrix} E_{US/CH} \\ E_{ROW/US} \end{pmatrix}$$

Thus the Equilibrium Displacement Model can be written as: $\Pi Y = \Gamma Z$

Appendix VI

Welfare Changes

The welfare changes for Chinese consumers:

$$\Delta CS_{CH} = - (\text{rectangle } P^0ABP_{CH} + \text{triangle } ABC)$$

$$= -[(P^0 - P_{CH})D^0 + \frac{1}{2}(D' - D^0)(P^0 - P_{CH})]$$

$$= -(P^0 - P_{CH})[D^0 + \frac{1}{2}(D' - D^0)]$$

$$= -(P^0 - P_{CH})\frac{1}{2}(D' + D^0)$$

$$= -(P^0 - P_{CH})\frac{1}{2}(D^0 + D^0 + \Delta D)$$

(where $\Delta D = D' - D^0$)

$$= -(P^0 - P_{CH})(D^0 + \frac{1}{2}\Delta D)$$

$$= -P^0 D^0 P_{CH}^* (1 + \frac{1}{2} D^*)$$

The welfare changes for Chinese producers:

$$\Delta PS_{CH} = - (\text{rectangle } P^0DEP_{CH} + \text{triangle } DEF)$$

$$= -[(P^0 - P_{CH})S' + \frac{1}{2}(P^0 - P_{CH})(S^0 - S')]$$

$$= -(P^0 - P_{CH})[S' + \frac{1}{2}(S^0 - S')]$$

$$= -(P^0 - P_{CH})\frac{1}{2}(S' + S^0)$$

$$= -(P^0 - P_{CH})\frac{1}{2}(S^0 + S^0 + \Delta S)$$

(where $\Delta S = S' - S^0$)

$$\begin{aligned}
&= -(P^0 - P_{CH})(S^0 + \frac{1}{2}\Delta S) \\
&= \Delta P(S^0 + \frac{1}{2}\Delta S) \\
&= \frac{\Delta P}{P^0} P^0 S^0 (1 + \frac{1}{2} \frac{\Delta S}{S^0}) \\
&= P^0 S^0 P^* (1 + \frac{1}{2} S^*)
\end{aligned}$$

The welfare changes for the U.S. consumers:

$$\Delta CS_{US} = - (\text{rectangle } P_{US}GJH + \text{triangle } HJM)$$

$$\begin{aligned}
&= -[(P_{US} - P^0)X' + \frac{1}{2}(X^0 - X')(P_{US} - P^0)] \\
&= -(P_{US} - P^0)[X' + \frac{1}{2}(X^0 - X')] \\
&= -(P_{US} - P^0)\frac{1}{2}(X' + X^0) \\
&= -\frac{1}{2} \frac{(P_{US} - P^0)}{P^0} P^0 (X' + X^0) \\
&= -\frac{1}{2} \frac{(P_{US} - P^0)}{P^0} P^0 (X^0 + X^0 + \Delta X)
\end{aligned}$$

(where $\Delta X = X' - X^0$)

$$\begin{aligned}
&= -\frac{(P_{US} - P^0)}{P^0} P^0 X^0 (1 + \frac{1}{2} \frac{\Delta X}{X^0}) \\
&= -\frac{\Delta P_{US}}{P^0} P^0 X^0 (1 + \frac{1}{2} X^*) \\
&= -P_{US}^* P^0 X^0 (1 + \frac{1}{2} X^*)
\end{aligned}$$

Chapter 2. The Effectiveness of the Export Tax Rebate on China's Fishery Market

I. Introduction

China has the largest production and exports of fishery products, which are an important part of China's agricultural exports. According to the data of the United Nations Food Agriculture Organization (FAO), the value of China's exports of fishery products was 19 billion dollars, which accounts for 14.8% of global exports. However, China's fishery products have low value added and a low profit margin due to the low technical content. Data from the Chinese Ministry of Commerce of China indicate that the average profit rate of Chinese fishery products enterprises is below 3%. Moreover, in recent years, these enterprises have had to face the problem of appreciation of Chinese currency and the increasing costs of labor.

The fishery industry is believed to have a comparative advantage and development potential for China. Therefore, in order to improve the competitiveness of Chinese fishery enterprises and increase their profits, in 2008, the rate of the export tax rebate (ETR) for some types of fishery products⁶ was increased from 5% to 13%, which is a dramatic increase. China began to implement the export tax rebate policy in 1985. This policy enables the export enterprises to get a part or total refund of their value-added tax (VAT). The rebate rate has been adjusted several times after it was implemented and the rate is different for different types of commodities.

The view of most aquatic product processing enterprises is that such a policy not only provides the exporting firms with a higher profit, but also enhances the income of Chinese fishermen due to the connection between retail and farm markets, and thus

⁶ Include frozen tilapia, frozen tilapia fillets, frozen crustacean, molluscs, etc.

alleviates the poverty of Chinese fishermen. For example, at the 8th Tilapia Industry Development Forum in 2011, most enterprises believed that the ETR enabled them to be more competitive in the international market. Also, they believed that the ETR helped to maintain rural economic growth and the living quality of the rural population. However, many financial commentators have a different view. They pointed out that the ETR is stimulating the export by subsidizing foreign consumers and that the domestic exporting firms are getting few benefits. Thus, it is a waste of taxpayers' money.

Expenditure on the ETR was totally borne by the central government before 2003. After a reform of the ETR in 2003, the expenditure was borne by the central government and the local government together, and the ratio between their expenditures is 75:25. Nevertheless, the burden on the local government was regarded too high in 2004, and after 2005, the ratio changed to 92.5:7.5. Figure 2.1 shows the percentage of the ETR in the central government's total expenditures. It indicates that there was a sharp reduction in the percentage of the ETR in 1995 and 1996. This was because the government reduced the rate of the ETR in 1995 and 1996, respectively. However, due to the rate increase in 1998, the percentage has been fluctuating increasingly after that. The amount of the ETR almost reached 50% of the total expenditure of the central government in 2011. That is why some people argue that if the tax rebate only enhances the welfare of foreign consumers and has little effect on the domestic producers, it should be abolished.

Nevertheless, there is little literature about whether China's ETR can really improve the welfare of Chinese producers. In view of such a situation, this chapter simulates the effects of this policy on prices, trade flows, and welfare on the Chinese fishery market. Furthermore, this chapter also tries to find out what affects the

effectiveness of this policy, including the demand and supply elasticities and the market shares. Moreover, it will not only consider the retail-level market which is affected directly by this policy, but also consider the farm market which is influenced by this policy through the linkage between the two market levels. Then it can determine the effects of the policy not only on exporting firms, but also on fishermen, most of whom are living in poverty.

The outline of this chapter is as follows. Section 2 is a review of previous studies. Section 3 is a graphical analysis. Section 4 presents the model that is used to simulate the effects of the export tax rebate. Section 5 presents the information on the parameters used in the model. Section 6 discusses the reduced-form elasticities. Section 7 analyzes the welfare changes and Section 8 concludes.

II. Literature Review

The ETR is expected to increase competitiveness of the exporting firms and enhance their profits. Previous literature has studied how tax rebates affect exports or the profits of exporting firms in China. Some researchers found a positive relationship between the tax rebate and exports. For example, Chen et al. (2006) used the data from 1985 to 2002 to estimate the effects of a value added tax rebate. They found that the policy really increases the output level and profits of domestic firms and reduces those of foreign competitors. Chandra and Long (2013) found that a one percent increase in the export tax rebate rate increases the export by about 13 percent. If measured in U.S. dollars, the results show that when the export tax rebate increases by one dollar, the value of exports increases by 4.7 dollars. Whereas Chi-Chur et al. (2006) simulated the simultaneous effects of an export tax rebate and import duty drawback (which reduces the prices of importing inputs). They found that although

these policies enhance exports, only several sectors can benefit, and there is little effect on agriculture and food industries. Chao et al. (2001) considered the welfare effects for consumers. Their results indicate that in an economy in which there is unemployment in some sectors, the export tax rebate has a positive impact on exports and the development of the industry, but at the expense of the welfare of the exporting country. This is because the tax rebate reduces the consumer surplus and the tax revenue, and increases the unemployment rate.

The export tax rebate works as an export subsidy (Ma et al., 2008), and according to theory, an export subsidy increases domestic price and reduces the export price. As a result, domestic producers and foreign consumers benefit from the policy at the expense of domestic consumers. Theory suggests that there is a net welfare loss for exporting countries with an export subsidy because the loss of the domestic consumers and the government outweigh the gain of domestic producers. Jarvis (2012) focused on the situation of Brazil, where the export subsidy is implemented together with export quota. The subsidy increases the price of Brazil coffee and the changes in price affect the futures market. The results show that the subsidy reduces the total welfare of Brazil. However, there is also some literature that found a positive effect of the export subsidy on the welfare of the exporting countries. Brander and Spencer (1985) concluded that under the assumption of imperfect competition, the export subsidy changes the terms of trade and increases the welfare of the country. Mai and Hwang (1987) found that the export subsidy increases the welfare of both exporting and importing countries. Yin and Yin (2005) indicated that the export promotion policies can enhance total welfare only when certain conditions are satisfied.

Although the policy is implemented on the retail-level market, it also affects the

farm-level market due to the linkage between these two markets. There is already much literature focusing on the impacts of changes of the retail price or quantity on the changes of the farm price. Marsh (2003) studied the effects of retail beef demand on the farm-level price and production. Results show that a 32.1 percent decrease in retail price reduces the farm price by 8 percent, and an 11.2 percent decrease in the retail-level production causes a 22.6 percent decrease in farm-level production. Liu et al. (2012) estimated the price transmission elasticity from retail-level markets to farm-level markets of 12 commodities in China. Results indicate that for most commodities this elasticity is between 0 and 1, with some exceptions for apples, pork, beefs and citrus. Therefore, lack of considering the effects of the ETR on the farm-level market may produce an inaccurate result.

In order to study the demand for farm output, Wohlgenant (1989) used a structural model, in which the retail-level supply and the farm-level demand are both determined by the retail price and farm price simultaneously. Kinnucan et al. (1995) focused on the profitability of advertising in the catfish industry in the U.S. In their paper, the structural model contains a wholesale demand equation and a farm supply equation. The wholesale market and the farm market are linked by a price linkage function. Thus, the effect of generic advertising of wholesale market on the farm market can be determined. Gardner (1975) used a different method to link the retail market and the markets of two inputs. The two inputs are included in the production function which determines the supply of the retail-level products. In this chapter, Wohlgenant's (1989) method will be followed, the retail-level market and the farm-level market will be linked through the retail price and the farm price.

Moreover, in this chapter, an Equilibrium Displacement Model will be used, which is often used to estimate the effects of policies, and which represent the

markets by a system of demand and supply equations. Then the changes in the endogenous variables due to the variations of the exogenous variables can be determined. After that, following the methodology of Sun and Kinnucan (2001), the welfare changes caused by the changes of the ETR can be simulated, which is the main purpose of this paper.

III. Graphical Analysis

Assume a simplified situation in which the retail producers purchase an input from the farm market to produce products and sell them in both domestic and export markets. An export subsidy (or an ETR) is implemented on the retail-level for the goods that are sold on the export market. The goods are assumed homogeneous across all markets. Ignoring all tariffs and other trade barriers, the effects of the export subsidy on the export products are indicated in Figure 2.2.

When there is no export subsidy, the intersection between the excess demand curve ED and excess supply curve $ES(P_F)$ determines the original price P_R^0 for both domestic and export markets. When there is a subsidy or an ETR, the excess supply curve shifts down from $ES(P_F)$ to $ES'(P_F)$. As shown in Panel B, without considering the linkage between the input market and the retail market, the domestic price is increased to P_R'' and the export price is decreased to P_R^X . Therefore, the export subsidy causes a welfare loss for domestic consumers and a welfare gain for the domestic producers and foreign consumers.

However, when the vertical linkage is taken into account, the increase of the excess supply enhances the demand for inputs, and causes farm price increases from P_F to P_F' , which is shown in Panel C. A higher input price causes the retail supply curve to shift up, as shown in Panel A. The upward shift of the supply curve causes

the export supply to shift up also. Then, as shown in Panel B, the higher excess supply curve implies a higher domestic price and a higher export price. Thus, compared to the case without the vertical linkage, the export subsidy increases the domestic price to P_R' instead of P_R'' , and increases the export price to $P_R^{X'}$ instead of P_R^X .

Since an export subsidy (or an ETR) improves the producers' welfare and the importers' welfare at the expense of the domestic consumers' welfare, then the issue here is to determine to what degree the ETR improves the producer surplus and whether it really works more like a subsidy for foreign consumers than for the domestic producers. The welfare changes caused by the VAT can be measured using the areas in the figure, which will be discussed in detail in Section 7.

IV. Model

Consider a country that produces homogeneous fishery products. A VAT is imposed on all kinds of products in this country. To stimulate the product exports, the government implements a policy that refunds a proportion of the VAT to the exporting enterprises. The fishery market is divided into two levels: the retail-level market and the farm-level market. The former includes two types of markets: domestic and export. The Law of One Price holds across all markets. The economy is large in that it can affect the world price. There is no market power so that the competitive market clearing can be reached. With these assumptions, the structural model can be written as follows:

Retail market:

$$(1) D_R = D_R(P_R^D) \quad \text{(Domestic demand at retail market)}$$

$$(2) P_R^S = P_R^S(S_R, P_F, P_N) \quad \text{(Inverse supply at retail market)}$$

$$(3) X_R = X_R(P_R^X) \quad (\text{Export demand at retail market})$$

$$(4) P_R^D = P_R^S \cdot VAT \quad (\text{Domestic price at retail market})$$

$$(5) P_R^X = P_R^D \cdot VAT / ETR \quad (\text{Export price at retail market})$$

$$(6) S_R = D_R + X_R \quad (\text{Retail market clearing})$$

Farm market:

$$(7) P_F = P_F(D_F, P_R^S, P_N) \quad (\text{Inverse Demand at farm market})$$

$$(8) S_F = S_F(P_F) \quad (\text{Supply at farm market})$$

$$(9) S_F = D_F \quad (\text{Farm market clearing})$$

In this model, D_R and S_R are the retail-level domestic demand and supply, respectively; X_R is the retail-level exports; P_R^D is the retail-level domestic demand price; P_R^X is the retail-level export demand price; P_R^S is the retail-level supply price; D_F and S_F are the farm-level demand and supply, respectively; and P_F is the farm-level price. The variables VAT and ETR are the value-added tax and the export tax rebate, respectively. Both the VAT and ETR are included in this model because they are closely related and it will be convenient to discuss them together. So that an isolated increase in VAT increases both the domestic and export prices, while an isolated increase in the ETR increases the domestic price and reduces the export price. P_N is the price of non-farming inputs. The retail-level and farm-level markets are linked by the domestic retail supply equation and the farm-level demand equation. This model contains nine endogenous variables: $D_R, S_R, X_R, P_R^D, P_R^X, P_R^S, D_F, S_F, P_F$; and three exogenous variables: VAT, ETR, and P_N .

Converting the structural model to percentage changes yields⁷:

Retail market:

$$(10) D_R^* = \eta_R^D P_R^{D*}$$

$$(11) P_R^{S*} = \frac{1}{\varepsilon_R} S_R^* + \phi_{RF} P_F^* + \phi_{RN} P_N^*$$

$$(12) X_R^* = \eta_R^X P_R^{X*}$$

$$(13) P_R^{D*} = P_R^{S*} + VAT^*$$

$$(14) P_R^{X*} = P_R^{S*} + VAT^* - ETR^*$$

$$(15) S_R^* = k_D D_R^* + k_X X_R^*$$

Farm market:

$$(16) P_F^* = \frac{1}{\eta_F} D_F^* + \phi_{FR} P_R^{S*} + \phi_{FN} P_N^*$$

$$(17) S_F^* = \varepsilon_F P_F^*$$

$$(18) D_F^* = S_F^*$$

where the asterisked variables refer to relative changes (e.g. $P_R^{D*} = dP_R^D / P_R^D$).

Definitions of parameters are in Table 2.1. For normal sloping supply and demand curves, $\eta's < 0$ and $\varepsilon's > 0$.

Of key interest here is to determine the effects of the ETR on the prices. By imposing the market clearing conditions and dropping equations (12) and (14), China's export supply equations can be obtained as following:

$$(19) X_R^* = \varepsilon_R^X P_R^{S*} + \varepsilon_F^X P_F^* + \varepsilon_N^X P_N^* - \frac{k_D \eta_R^D}{k_X} VAT^*$$

⁷ See appendix for the derivation.

where $\varepsilon_R^X = \frac{\varepsilon_R - k_D \eta_R^D}{k_X}$ is China's export supply elasticity with respect to the retail

supply price. For normal parameter values, $\varepsilon_R^X > 0$, which indicates that the increase in the supply price increases the export supply to the international market.

$\varepsilon_F^X = -\frac{\phi_{RF} \varepsilon_R}{k_X}$ and $\varepsilon_N^X = -\frac{\phi_{RN} \varepsilon_R}{k_X}$ is the export supply elasticity with respect to the

farm price and the non-farm input price, respectively. Both of them are negative, which implies that a higher input price reduces the export supply. How VAT affects

the export supply can be seen from $-\frac{k_D \eta_R^D}{k_X}$, which has a positive value. It means

that a higher VAT on the retail-level domestic market enhances the export supply.

Then, by setting equation (19) equal to (12) and substituting (14), the retail supply price can be obtained:

$$(20) \quad P_R^{S*} = -\frac{k_X \eta_R^X + k_D \eta_R^D}{k_X (\eta_R^X - \varepsilon_R^X)} VAT^* + \frac{\eta_R^X}{\eta_R^X - \varepsilon_R^X} ETR^* + \frac{\varepsilon_F^X}{\eta_R^X - \varepsilon_R^X} P_F^* + \frac{\varepsilon_N^X}{\eta_R^X - \varepsilon_R^X} P_N^*$$

When the linkage between the farm market and the retail market is not considered, the reduced form elasticity of supply price with respect to the ETR is

simply $\frac{\eta_R^X}{(\eta_R^X - \varepsilon_R^X)}$, which is restricted to a positive value. It indicates that an ETR on

the export products increases the supply price. Hence the effect of the ETR on the supply price is determined by the relative magnitude of the export demand and supply elasticities. When Chinese producers of fishery products face a perfectly elastic export

demand curve, then $-\frac{\eta_R^X}{(\eta_R^X - \varepsilon_R^X)} = -1$, which means that the ETR is completely

passed through to Chinese producers, and then it has the largest effect. When China

has a perfectly elastic export supply curve, $-\frac{\eta_R^X}{(\eta_R^X - \varepsilon_R^X)} = 0$, the ETR has no impact

on Chinese producers. As derived above, the export supply elasticity is determined by the retail supply elasticity, the domestic demand elasticity, and the market shares of Chinese domestic market and the export market. It can be seen from $\varepsilon_R^X = \frac{\varepsilon_R - k_D \eta_R^D}{k_X}$ that a larger retail supply elasticity, domestic demand elasticity or a larger market share of the domestic market increases the export supply elasticity and thus reduces the effectiveness of the export tax rebate. This result is consistent with the study of Ishikawa and Kuroda (2007), who find that whether or not an export promotion policy improves the welfare of the exporting country may depend on the slope of the inverse demand curve and the market share.

If the linkage between the farm and retail markets is taken into consideration, the reduced-form supply price is:

$$(21) \quad P_R^{S*} = -\frac{k_X \eta_R^X + k_D \eta_R^D}{k_X (\eta_R^X - \varepsilon_R^X + \xi)} VAT^* + \frac{\eta_R^X}{\eta_R^X - \varepsilon_R^X + \xi} ETR^* + \frac{\varepsilon_N^*}{(\eta_R^X - \varepsilon_R^X)(\eta_R^X - \varepsilon_R^X + \xi)} P_N^*$$

where $\xi = \frac{\varepsilon_F^X \phi_{FR} \eta_F}{\eta_F - \varepsilon_F} > 0$, which indicates that, as shown in figure 2.2, after

considering the linkage of different level markets, the effects of the ETR on Chinese producers' supply price becomes larger.

Turning to the effects of the ETR on the farm price, the relationship between the farm price and the retail supply price can be obtained by imposing the market clearing condition in the farm market:

$$(22) \quad P_F^* = \frac{\phi_{FR} \eta_F}{\eta_F - \varepsilon_F} P_R^{S*} + \frac{\phi_{FN} \eta_F}{\eta_F - \varepsilon_F} P_N^*$$

where $\frac{\phi_{FR} \eta_F}{\eta_F - \varepsilon_F} > 0$, which indicates that the effects of a VAT and an ETR on the farm

price have the same direction as the effects on the retail supply price. Therefore, an

increase in the VAT on the export market depresses the farm price. In other words, the farm price can be increased by an ETR. For the farm price, the effectiveness of the ETR is not determined only by the relative magnitude of the demand and supply elasticity of export and the market shares, but also by the relative magnitude of the demand and supply elasticity on the farm market and the price transmission elasticity from the retail market to the farm market. A higher price transmission elasticity implies a larger effect of the ETR on the farm price. Due to the fact that

$$0 < \frac{\eta_F}{\eta_F - \varepsilon_F} < 1, \quad \frac{\phi_{FR}\eta_F}{\eta_F - \varepsilon_F} \text{ has an upper limit of } \phi_{FR} \text{ and a lower limit of } 0.$$

V. Parameterization

In this section the model will be applied to Chinese fishery market data. There are seven parameters needed to obtain the price and trade flow changes caused by the VAT and the ETR.

A report written by Dey et al. (2008) provides some discussion and explanation about the demand elasticities of some Asian developing countries, including China. After reviewing previous literature and asking for experts' opinions, they decide that the demand elasticity for rural and urban China is -0.8 and -0.45, respectively. In this chapter, the mean of these two values (-0.625) will be used as the own price elasticity of demand in China. The supply elasticity in the retail market is set to 0.67, which is also provided by the report of Dey et al. (2008).

The export demand elasticity is set to -1.06, which is the average of the values provided by the paper of Graham et al. (1998) for all APEC countries.

Previous literature has not provided farm-level elasticities for Chinese fishery. However, according to Tewari (2003), farm-level elasticities can be obtained through the equation below:

$$(23) \quad \eta_F = \eta_R \frac{P_F}{P_R}$$

where η_F is the elasticity on the farm market, η_R is the elasticity on the retail market, P_F and P_R are the prices on the farm-level and retail-level markets, respectively. In this way, the values of 0.55 and -0.59 can be obtained for farm-level supply and farm-level demand elasticities, respectively.

Price transmission elasticities are the elasticity of the farm price with respect to the retail price and that of the retail price with respect to the farm price. It represents to what extent the farm market and the retail market are connected. According to theory, in a two-input, one-output supply and demand system, the price transmission elasticities can be represented as follows:⁸

$$(24) \quad \phi_{RF} = \frac{|\varepsilon_{RF}|}{\varepsilon_R}$$

$$(25) \quad \phi_{FR} = \frac{\eta_{FR}}{|\eta_F|}$$

where ε_{RF} and η_{FR} are the elasticity of retail supply with respect to farm price and the elasticity of farm demand with respect to the retail price. In a two-input, one-output supply and demand system, imposing the restrictions of homogeneity and symmetry, the value of ε_{RF} and η_{FR} can be obtained⁹. Then I can get the value of ϕ_{RF} and ϕ_{FR} , which are in Table 2.1.

VI. Reduced Form Elasticities

To obtain the value of the reduced form elasticities, the model is first expressed in a

⁸ See the appendix for detail.

⁹ See the appendix for detail.

matrix as follows:

$$(26) \Pi Y = \Gamma Z$$

where Π is a 9×9 matrix of parameters corresponding to the model's endogenous variables, Y is a 9×1 vector of endogenous variables, Γ is a 9×3 matrix of parameters corresponding to the model's exogenous variables, and Z is a 3×1 vector of exogenous variables.

By pre-multiplying equation (26) by Π 's inverse yields:

$$(27) Y = EZ$$

where $E = \Pi^{-1} \Gamma$ is a 9×3 matrix containing the parameters of reduced form coefficients or elasticities. After having assigned the numerical values of the parameters, E can be computed through $E = \Pi^{-1} \Gamma$. Then the matrix Y can be obtained, which represents the changes in endogenous variables due to the changes in exogenous variables. So that the effects of the ETR on the prices and quantities on both markets can be determined. The results are in Table 2.2.

Focusing on the retail market, the reduced form elasticities indicate that a one percent increase in the value-added tax increases the domestic demand price by about 0.33 percent and decreases the supply price by about 0.67 percent. The higher domestic demand price reduces the quantity demanded in the domestic market by about 0.21 percent. The lower supply price reduces the quantity of supply by about 0.22 percent. The export price is also increased by about 0.33 percent with a one percent increase of the VAT, and thus exports decrease by about 0.35 percent. Therefore, the VAT has a greater effect on the export than on the domestic demand.

As expected, an increase in the ETR enhances the supply price. Table 2.2 shows that a one percent increase in the ETR only enhances the supply price by about 0.08 percent, and the export price is reduced by about 0.92 percent. This is because, as

discussed before, the positive effect of the ETR on the supply price depends on the relative magnitude of the export supply and demand elasticities. If the export supply elasticity is much larger than the export demand elasticity, as is the case in China, an ETR has a small effect on increasing the supply price and has a large effect on the export price. The quantity of export is increased by 0.98 percent, while the quantity of supply is only increased by about 0.02 percent.

Then focusing on the farm market, an increase in VAT reduces the quantity of supply in the retail market, and thus reduces the price on the farm market and also reduces the quantity of supply and demand. On the other hand, a one percent increase in the ETR increases the farm quantity by 0.03 percent. The farm price is increased by 0.05 percent by a one percent increase in the ETR.

Results without the consideration of the farm-retail linkage are also shown in Table 2.2. Comparison indicates that, as calculated before, the change in the domestic supply price will be underestimated without the consideration of the linkage. However, the changes in the quantity of supply will be overestimated, so the effects of failure to consider the farm-retail linkage is ambiguous.

VII. Welfare Analysis

In this section the welfare changes of consumers and producers caused by the ETR are obtained, which is the most important issue in this paper. Sun and Kinnucan's (2001) method is followed and the formulas are as follows: ¹⁰

$$(28) \quad \Delta CS^D = -P_R^0 D_R^0 P_R^{D*} \left(1 + \frac{1}{2} D_R^*\right) \quad (\text{Domestic consumer surplus})$$

$$(29) \quad \Delta PS^D = -P_R^0 S_R^0 (V_S - P_S^*) \left(1 + \frac{1}{2} S_R^*\right) \quad (\text{Chinese producer surplus})$$

¹⁰ See the Appendix for derivation.

$$(30) \quad \Delta CS^X = -P_R^0 X_R^0 P_R^{X^*} \left(1 + \frac{1}{2} X_R^*\right) \quad (\text{Foreign consumer surplus})$$

$$(31) \quad \Delta CS_F = -P_F^0 D_F^0 (V_D - P_F^*) \left(1 + \frac{1}{2} D_F^*\right) \quad (\text{Farm consumer surplus})$$

$$(32) \quad \Delta PS_F = P_F^0 S_F^0 P_F^* \left(1 + \frac{1}{2} S_F^*\right) \quad (\text{Farm producer surplus})$$

$$(33) \quad \Delta GR = P_R^0 X_R^0 (P_R^{X^*} - P_R^{D^*}) (X_R^* + 1) \quad (\text{Government Revenue})$$

where ΔCS^D is the change in Chinese domestic consumer surplus associated with the ETR changes; ΔPS^D is the change in Chinese producer surplus, which, according to Alston, Norton and Pardey (1995), in a vertical market, is the sum of producer surplus of farm inputs and the producers surplus of other inputs. ΔCS^X is the change in the foreign consumer surplus due to a change in the ETR; ΔCS_F is the change in the consumer surplus in the farm market; ΔPS_F is the change in farm producer surplus associated with the changes in the ETR. ΔGR is the change in Chinese government revenue. $P_R^0 D_R^0$ is the retail-level domestic consumer expenditure in the initial equilibrium. $P_R^0 S_R^0$ is the total revenue of Chinese producers from both domestic and export markets in the initial equilibrium. $P_R^0 X_R^0$ is the foreign consumer expenditure on Chinese fishery products. $P_R^{D^*}$, $P_R^{S^*}$ and $P_R^{X^*}$ are the relative changes in retail-level domestic demand price, supply price and the export price, and P_F^* is the relative change in the farm price. D_R^* , $P_R^{S^*}$ and X_R^* are the relative changes in retail-level domestic demand, total supply, and exports associated with the changes in the ETR. D_F^* and S_F^* are the relative changes in farm-level supply and demand. V_D is the percentage change in the farm price when the farm quantity change equals zero. V_S is the percentage change in the retail price when the retail quantity change is zero.

In order to calculate the welfare changes caused by the ETR changes, inserting the reduced form elasticities yields:

$$(34) \quad \Delta CS^D = -P_R^0 D_R^0 \frac{P_R^{D*}}{ETR^*} ETR^* \left(1 + \frac{1}{2} \frac{D_R^*}{ETR^*} ETR^*\right) \quad (\text{Domestic consumer surplus})$$

$$(35) \quad \Delta PS^D = -P_R^0 S_R^0 \left(V_S - \frac{P_S^*}{ETR^*} ETR^*\right) \left(1 + \frac{1}{2} \frac{S_R^*}{ETR^*} ETR^*\right) \quad (\text{Chinese producer surplus})$$

$$(36) \quad \Delta CS^X = -P_R^0 X_R^0 \frac{P_R^{X*}}{ETR^*} \left(1 + \frac{1}{2} \frac{X_R^*}{ETR^*} ETR^*\right) \quad (\text{Foreign consumer surplus})$$

$$(37) \quad \Delta CS_F = -P_F^0 D_F^0 \left(V_D - \frac{P_F^*}{ETR^*} ETR^*\right) \left(1 + \frac{1}{2} \frac{D_F^*}{ETR^*} ETR^*\right) \quad (\text{Farm consumer surplus})$$

$$(38) \quad \Delta PS_F = P_F^0 S_F^0 \frac{P_F^*}{ETR^*} ETR^* \left(1 + \frac{1}{2} \frac{S_F^*}{ETR^*} ETR^*\right) \quad (\text{Farm producer surplus})$$

$$(39) \quad \Delta GR = P_R^0 X_R^0 \left(\frac{P_R^{X*}}{ETR^*} ETR^* - \frac{P_R^{D*}}{ETR^*} ETR^*\right) \left(\frac{X_R^*}{ETR^*} ETR^* + 1\right) \quad (\text{Government Revenue})$$

The baseline values used in these equations are in table 2.3. $\frac{P_R^{D*}}{ETR^*}$, $\frac{P_R^{S*}}{ETR^*}$,

$\frac{P_R^{X*}}{ETR^*}$, $\frac{P_F^*}{ETR^*}$, $\frac{D_R^*}{ETR^*}$, $\frac{S_R^*}{ETR^*}$, $\frac{D_F^*}{ETR^*}$ and $\frac{S_F^*}{ETR^*}$ are set equal to the corresponding

reduced form elasticities given in Table 2.2. The simulated welfare changes are in Table 2.4.

The results indicate that an increase in the ETR on the export products improves the welfare of Chinese producers and foreign consumers at the expense of Chinese consumers and the Chinese government. China has a net benefit loss as a whole.

Chinese domestic consumers have a welfare loss of 0.018 billion dollars due to one percent increase in the ETR, while Chinese producers have a welfare gain of 0.01 billion dollars, which is smaller than the welfare loss of Chinese consumers. However,

foreign consumer surplus is increased by about 0.023 billion dollars, which is much larger than the welfare gain of Chinese producers. From this aspect, the ETR works more like a subsidy on foreign importers than on Chinese producers.

The welfare benefits for foreign consumers are even larger when looking at the ratio of the welfare changes and the total expenditure or total revenue. The increase in Chinese producer surplus caused by a one percent increase in the ETR is only 0.04 percent of the producers' total revenue, while that in the foreign consumer surplus is 0.92 percent of the foreign consumers' total expenditure. Furthermore, there is a net welfare loss of 0.033 billion dollars for China if the loss of government revenue is also included.

As mentioned before, the change in Chinese producer surplus is the sum of the changes of the surpluses of all inputs that contribute to the production of the finished fish products. An important issue in this paper is to determine the effects of the ETR on the welfare changes of farm producers. Results in Table 2.4 also show the welfare changes on the farm market. Both consumers and producers on the farm market benefit from the ETR. Both farm producers and farm consumers have a welfare gain of 0.01 billion dollars caused by a one percent increase of the ETR, which is about 0.05 percent of the total revenue.

Comparison between the cases with and without the farm-retail linkage indicates that, although Chinese supply price will be underestimated without considering the linkage, the welfare gain of Chinese producers will be overestimated, and the welfare loss of Chinese consumers will be underestimated. As a result, the total loss of Chinese welfare will be underestimated.

Therefore, the foreign consumers benefit most from the ETR among different groups. Chinese domestic consumers have a welfare loss which is larger than the total

welfare gain of Chinese producers. When considering the loss of Chinese government revenue, there is a large net welfare loss for China.

VIII. Concluding Comments

Due to disputes on whether the export tax rebate policy should be kept or abolished, this chapter focuses on the effects of VAT rebate on prices, trade flows, and the welfare changes. It emphasizes the importance of taking into consideration the linkage between the retail market and the farm market. The derivation of the reduced form indicates that without considering this linkage, the effects on Chinese supply price may be underestimated, while the effects on the welfare change of Chinese producers may be overestimated.

This chapter finds that the pass-through of the ETR depends on the relative magnitude of the export supply and import demand elasticities. When the exporting country has a large export supply elasticity, the effects of an ETR are very limited. The simulated reduced form elasticities indicate that when the ETR is increased by one percent, the export price is decreased by 0.92 percent, while the Chinese retail supply price is only increased by 0.08 percent. That is, the foreign consumers gain more from an ETR.

The results of this chapter have several policy implications: First, although the ETR increases the supply price of both market levels and thus improves the welfare of producers, it works more to subsidize foreign consumers than to help the domestic producers. This effect is more obvious when considering the small total expenditure of the foreign consumers and the large total revenue of Chinese producers of both market levels.

Moreover, due to the linkage between retail and farm markets, although the ETR is imposed on the retail market, the farm producers can also benefit from the policy. Therefore, the ETR can contribute to improve the welfare condition of Chinese fishermen.

Furthermore, this paper indicates that the export supply elasticity is determined by the supply elasticity, domestic demand elasticity, and the market shares. Take the market shares for example, the larger the share of the domestic market, the higher the export supply elasticity will be. Although China is one of the most important exporters of fishery products, considering the much larger share of the domestic market, it is no wonder that China has a large export supply elasticity. This is why the ETR does not work as expected.

Figures

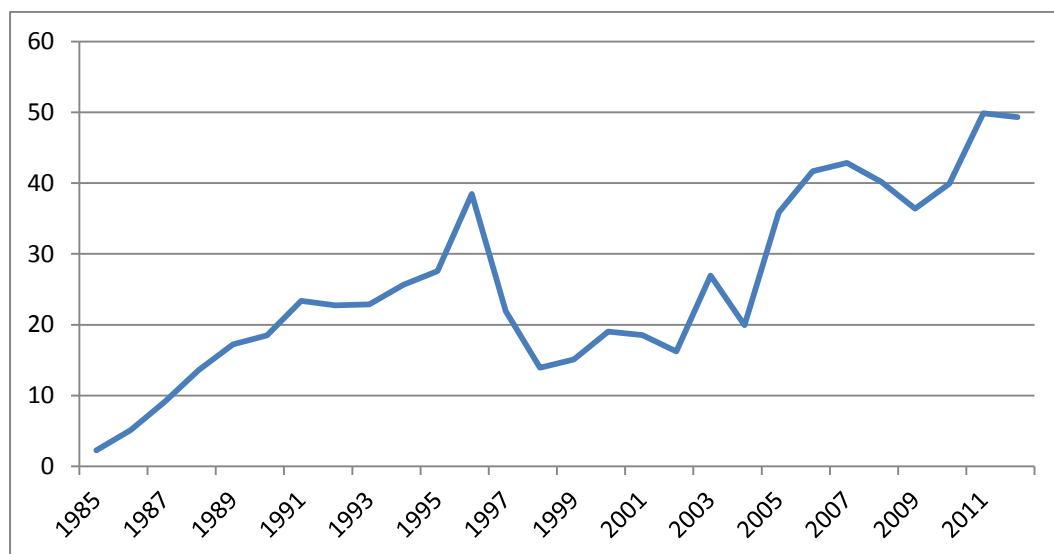


Figure 2.1 Percentage of the Export Tax Rebate in Central Government's Total Expenditure.

Data Sources: Ministry of Commerce of China: <http://www.mofcom.gov.cn/>

State Administration of Taxation: <http://www.chinatax.gov.cn/>

A. Domestic Market for Finished Fish Products

B. Export Market for Finished Fish Products

C. Domestic Market for Raw Fish Input

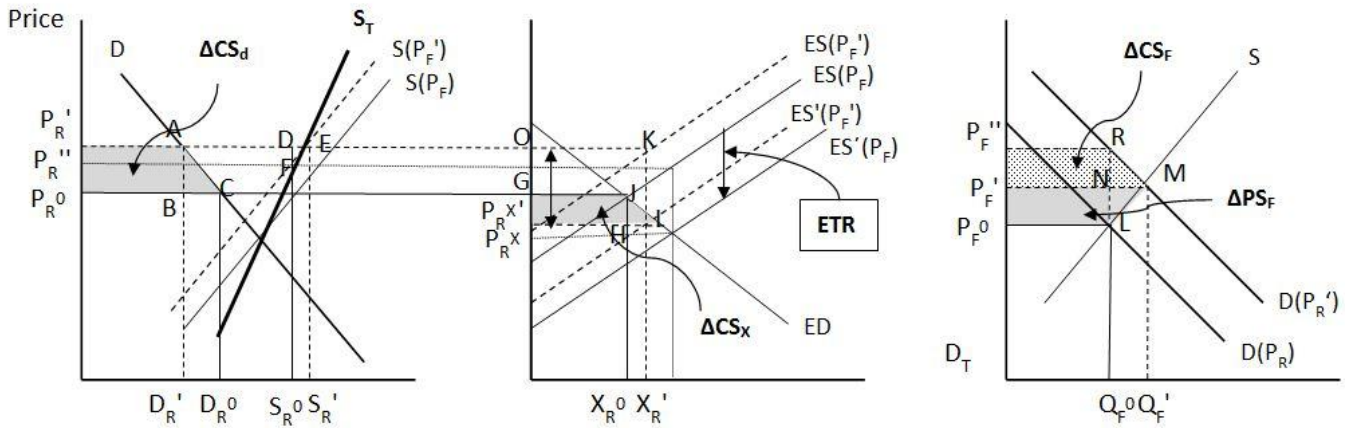


Figure 2.2 The Effects of a Subsidy (or an ETR) on the Export Market

TABLES:

Table 2.1 Parameter Definitions and Values

Parameter	Definition	Value
η_R^D	Retail-level domestic demand elasticity	-0.625 ^a
ε_R	Retail-level supply elasticity	0.67 ^a
η_F	Demand elasticity for farm-level products for retail supply	-0.55 ^a
η_R^X	Retail-level export demand elasticity	-1.06 ^a
ε_F	Farm-level supply elasticity	0.59 ^a
ϕ_{RF}	Price transmission elasticity from the farm market to the farm market	0.73 ^a
ϕ_{FR}	Price transmission elasticity from the retail market to the farm market	1.45 ^a
k_D	Retail-level domestic quantity share (=D _R /S _R)	0.93 ^b
k_X	Retail-level export quantity share (=X _R /S _R)	0.07 ^b

a. Source: See text for details.

b. Source: Chinese Yearbook of Fishery Statistics (2012), United Nations Commodity Trade Statistics Database.

Table 2.2 Reduced form Elasticities

	VAT*	ETR*	P _N *
$\xi > 0$			
Retail Market			
D _R *	-0.21	-0.05	-0.05
S _R *	-0.22	0.02	-0.05
X _R *	-0.35	0.98	-0.08
P _R ^{D*}	0.33	0.08	0.08
P _R ^{X*}	0.33	-0.92	0.08
P _R ^{S*}	-0.67	0.08	0.08
Farm Market			
D _F *	-0.28	0.03	-0.10
S _F *	-0.28	0.03	-0.10
P _F *	-0.47	0.05	-0.16
$\xi = 0$			
D _R *	-0.32	-0.03	
S _R *	-0.33	0.04	
X _R *	-0.54	1.00	
P _R ^{D*}	0.51	0.06	
P _R ^{X*}	0.51	-0.94	
P _R ^{S*}	-0.49	0.06	

Table 2.3 Definitions and Baseline Values

Item	Definition	Value (Billion Dollars)
$P_R^0 S_R^0$	Total revenue of retail-level producers in 2012	25.13 ^a
$P_R^0 D_R^0$	Domestic retail-level consumer expenditure in 2012	22.64 ^a
$P_R^0 X_R^0$	Foreign consumer expenditure on Chinese fishery products in 2012	2.49 ^a
$P_F^0 D_F^0$	Total expenditure on farm-level products in 2012	22.15 ^a
$P_F^0 S_F^0$	Total revenue of farm-level producers in 2012	22.15 ^a
V_D	Percentage change in the farm price when the farm quantity is vertical	0.001 ^b
V_S	Percentage change in the retail price when the retail quantity is vertical	0.0004 ^b

a. Source: Chinese Yearbook of Fishery Statistics (2012) and Report of Ministry of Agriculture of China. All data include tilapia, crustacean and molluscs.

b. See the appendix for calculation.

Table 2.4 Welfare Effects of One Percent Change in the ETR (Billion Dollars)

Group	A One Percent Change in the ETR	Welfare Change/Total Revenue (Total Expenditure)
		$\xi > 0$
Chinese Producers	0.01	0.04%
Chinese Consumers	-0.018	0.08%
Farm Producers	0.01	0.05%
Farm Consumers	0.01	0.05%
Foreign Consumers	0.023	0.92%
Chinese Government	-0.025	
Total Chinese Welfare	-0.033	
		$\xi = 0$
Chinese Producers	0.015	0.06%
Chinese Consumers	-0.014	0.06%
Foreign Consumers	0.024	0.96%
Chinese Government	-0.025	
Total Chinese Welfare	-0.024	

Appendix I

Derivation of the Equilibrium Displacement Model

Take equation (10) for example, take the total differential of equation (1):

$$dD_R = \frac{dD_R}{dP_R^d} dP_R^d$$

Then we get:

$$\frac{dD_R}{D_R} = \frac{dD_R}{dP_R^d} \frac{P_R^d}{D_R} \frac{dP_R^d}{P_R^d}$$

So we can get equation (10):

$$D_R^* = \eta_R^D P_R^{D^*}$$

where $\eta_R^D = \frac{dD_R}{dP_R^d} \frac{P_R^d}{D_R}$ is the price elasticity of demand.

To get Equation (14), take the total differential of equation (5):

$$dP_R^X = \frac{VAT}{ETR} dP_R^S + \frac{P_R^S}{ETR} dVAT + \frac{-P_R^S VAT}{ETR^2} dETR$$

Then we get:

$$\frac{dP_R^X}{P_R^X} = \frac{P_R^S}{P_R^X} \frac{dP_R^S}{P_R^S} \frac{VAT}{ETR} + \frac{VAT}{P_R^X} \frac{dVAT}{VAT} \frac{P_R^S}{ETR} - \frac{ETR}{P_R^X} \frac{dETR}{ETR} \frac{P_R^S VAT}{ETR^2}$$

So we can get equation (14):

$$P_R^{X^*} = P_R^{S^*} + VAT^* - ETR^*$$

Appendix II

Obtain the Price Transmission Elasticities

In a two-inputs, one-output demand and supply system, the output supply and the input demand functions are given by:

$$S_R = S_R(P_R^S, P_F, P_N)$$

$$D_F = D_F(P_R^S, P_F, P_N)$$

$$D_N = D_N(P_R^S, P_F, P_N)$$

Take the logarithmic total differential of the first two equations we get:

$$d \ln S_R = \varepsilon_R d \ln P_R^S + \varepsilon_{RF} d \ln P_F + \varepsilon_{RN} d \ln P_N$$

and

$$d \ln D_F = \eta_{FR} d \ln P_R^S + \eta_F d \ln P_F + \eta_{FN} d \ln P_N$$

Thus we get:

$$\phi_{RF} = \frac{\partial \ln P_R^S}{\partial \ln P_F} = \frac{|\varepsilon_{RF}|}{\varepsilon_R}$$

And

$$\phi_{FR} = \frac{\partial \ln P_F}{\partial \ln P_R^S} = \frac{\eta_{FR}}{|\eta_F|}$$

Appendix III

The Calculation of ε_{RF} and η_{FR}

A two-inputs, one-output demand and supply system can be written as:

$$S_R^* = \varepsilon_R P_R^{S*} + \varepsilon_{RF} P_F^* + \varepsilon_{RN} P_N^*$$

$$D_F^* = \eta_{FR} P_R^{S*} + \eta_F P_F^* + \eta_{FN} P_N^*$$

$$D_F^* = \eta_{NR} P_R^{S*} + \eta_{NF} P_F^* + \eta_N P_N^*$$

With the restrictions of homogeneity and symmetry:

$$\varepsilon_R + \varepsilon_{RF} + \varepsilon_{RN} = 0$$

$$\eta_{FR} + \eta_F + \eta_{FN} = 0$$

$$\eta_{NR} + \eta_{NF} + \eta_N = 0$$

$$\frac{\varepsilon_{RF}}{\eta_{FR}} = -\frac{P_F F}{P_R R}$$

$$\frac{\varepsilon_{RN}}{\eta_{NR}} = -\frac{P_N N}{P_R R}$$

$$\frac{\eta_{FN}}{\eta_{NF}} = \frac{P_N N}{P_F F}$$

Together with the values of ε_R , η_F and η_N , the values of ε_{RF} and η_{FR} can be obtained.

Appendix IV

Obtain the Values of V_D and V_S

$$V_D = P^* |_{Q^*=0} = \frac{D_F^*}{\eta_F} + \phi_{FR} P_R^{S^*} + \frac{\eta_{FN}}{\eta_F} P_N^*$$

When $D_F^* = 0$ and $P_N^* = 0$,

$$V_D = \phi_{FR} P_R^{S^*} = \phi_{FR} \frac{P_R^{S^*}}{ETR^*} ETR^* = 0.001$$

$$V_S = P^* |_{Q^*=0} = \frac{1}{\varepsilon_R} S_R^* + \phi_{RF} P_F^* + \phi_{RN} P_N^*$$

When $S_R^* = 0$ and $P_N^* = 0$,

$$V_S = \phi_{RF} P_F^* = \phi_{RF} \frac{P_F^*}{ETR^*} ETR^* = 0.0004$$

Appendix V

Derivation of the Welfare Changes

$$\Delta CS_R^D = -(\text{rectangle } P_R'ABP_R^0 + \text{triangle } ABC)$$

$$\begin{aligned}
&= -(P_R' - P_R^0)D_R' + \frac{1}{2}(D_R^0 - D_R')(P_R' - P_R^0) \\
&= -(P_R' - P_R^0)[D_R' + \frac{1}{2}(D_R^0 - D_R')] \\
&= -(P_R' - P_R^0)(D_R' - D_R^0 + D_R^0 + \frac{1}{2}D_R^0 - \frac{1}{2}D_R') \\
&= -P_R^0 D_R^0 \frac{(P_R' - P_R^0)}{P_R^0} (1 + \frac{1}{2} \frac{D_R' - D_R^0}{D_R^0}) \\
&= -P_R^0 D_R^0 P_R^{D*} (1 + \frac{1}{2} D_R^*)
\end{aligned}$$

$$\Delta PS_R^D = (\text{rectangle } P_R' D F P_R'' + \text{triangle } DEF)$$

$$\begin{aligned}
&= (P_R' - P_R'')S_R^0 + \frac{1}{2}(P_R' - P_R'')(S_R' - S_R^0) \\
&= (P_R' - P_R'')[S_R^0 + \frac{1}{2}(S_R' - S_R^0)] \\
&= -(P_R'' - P_R') [S_R^0 + \frac{1}{2}(S_R' - S_R^0)] \\
&= -(P_R'' - P_R^0 + P_R^0 - P_R') [S_R^0 + \frac{1}{2}(S_R' - S_R^0)] \\
&= -(\frac{P_R'' - P_R^0}{P_R^0} - \frac{P_R' - P_R^0}{P_R^0}) P_R^0 S_R^0 (1 + \frac{1}{2} \frac{S_R' - S_R^0}{S_R^0}) \\
&= -P_R^0 S_R^0 (V_S - P_S^*) (1 + \frac{1}{2} S_R^*)
\end{aligned}$$

$$\Delta CS_X = - \text{rectangle } P_X' H J G + \text{triangle } H I J$$

$$\begin{aligned}
&= -[(P_R^X' - P_R^0)X_R^0 + \frac{1}{2}(X_R' - X_R^0)(P_R^X - P_R^0)] \\
&= -(P_R^X' - P_R^0)[X_R^0 + \frac{1}{2}(X_R' - X_R^0)] \\
&= -P_R^0 X_R^0 \frac{P_R^X' - P_R^0}{P_R^0} (1 + \frac{1}{2} \frac{X_R' - X_R^0}{X_R^0}) \\
&= -P_R^0 X_R^0 P_X^* (1 + \frac{1}{2} X_R^*)
\end{aligned}$$

$$\Delta GR = \text{rectangle } P_X' I K O$$

$$\begin{aligned}
&= (P_R^X - P_R^D)X' \\
&= (P_R^X - P_R^0 + P_R^0 - P_R^D)(X' - X_R^0 + X_R^0) \\
&= P_R^0 X_R^0 \left(\frac{P_R^X - P_R^0}{P_R^0} - \frac{P_R^D - P_R^0}{P_R^0} \right) \left(\frac{X' - X_R^0}{X_R^0} + 1 \right) \\
&= P_R^0 X_R^0 (P_R^{X^*} - P_R^{D^*})(X_R^* + 1)
\end{aligned}$$

$$\Delta CS_F = - (\text{rectangle } P_F'NRP_F'' + \text{triangle } RMN)$$

$$\begin{aligned}
&= (P_F'' - P_F')D_F^0 + \frac{1}{2}(P_F'' - P_F')(D_F' - D_F^0) \\
&= (P_F'' - P_F')[D_F^0 + \frac{1}{2}(D_F' - D_F^0)] \\
&= (P_F'' - P_F^0 - P_F' + P_F^0)[D_F^0 + \frac{1}{2}(D_F' - D_F^0)] \\
&= [(P_F'' - P_F^0) - (P_F' - P_F^0)][D_F^0 + \frac{1}{2}(D_F' - D_F^0)] \\
&= \left(\frac{P_F'' - P_F^0}{P_F^0} - \frac{P_F' - P_F^0}{P_F^0} \right) P_F^0 D_F^0 \left(1 + \frac{1}{2} \frac{D_F' - D_F^0}{D_F^0} \right) \\
&= P_F^0 D_F^0 (V_D - P_F^*)(1 + \frac{1}{2} D_F^*)
\end{aligned}$$

$$\Delta PS_F = - (\text{rectangle } P_F^0LNP_F' + \text{triangle } LMN)$$

$$\begin{aligned}
&= (P_F' - P_F^0)S_F^0 + \frac{1}{2}(P_F' - P_F^0)(S_F' - S_F^0) \\
&= (P_F' - P_F^0)[S_F^0 + \frac{1}{2}(S_F' - S_F^0)] \\
&= \frac{P_F' - P_F^0}{P_F^0} P_F^0 S_F^0 \left(1 + \frac{1}{2} \frac{S_F' - S_F^0}{S_F^0} \right) \\
&= P_F^0 S_F^0 P_F^* \left(1 + \frac{1}{2} S_F^* \right)
\end{aligned}$$

Chapter 3. A Source-differentiated Analysis of China's Demand for Tropical Fruits

I. Introduction

China is the leading consumer of fruits and it produces both non-tropical and tropical fruits. Most of China's productions of tropical fruits are consumed domestically. However, imports of tropical fruits are still needed to meet the demand of Chinese consumers and although the imports are only a small proportion of the total consumption, the quantity of imports is increasing dramatically in the recent decades (Figure 3.1). This brings about an anxiety for the Chinese producers. For example, in 2012, the imports of tropical fruits accounted for only 1.2% of China's total consumption. This number is increased to 3% within only one year.¹¹ Due to the short distance between China and the Association of Southeast Asian Nations (ASEAN) and the fact that tropical fruits cannot be stored for long, China is the best market for tropical fruits from these countries. Therefore, more than 95% of China's imports of tropical fruits are from ASEAN countries (especially from the Philippines and Thailand) (Figure 3.2). Take the banana for example, China is the first largest export destination of Thailand and the second largest one of the Philippines.

China signed the Framework Agreement on Comprehensive Economic Cooperation Between China and ASEAN (the Framework Agreement) on November, 4th, 2002, in which they planned to establish the China and ASEAN Free Trade Area (China-ASEAN FTA) in 2010. Under this Framework, the import tariffs on agricultural products between China and the ASEAN countries were reduced from

¹¹. Data source: UN Comtrade.

13.1% in 2003¹² to zero in 2006. Thus, the fruits from the ASEAN countries can enter the Chinese market with a lower cost.

The increase in the imports of ASEAN tropical fruits in the Chinese market causes some worry for Chinese producers of tropical fruits. The reason is that compared with those produced in China, tropical fruits from the ASEAN countries are believed to have some advantages: first, the ASEAN countries have more of the typical tropical climate that is needed for production of tropical products; second, due to the difference in production cycles between China and the ASEAN countries, the tropical fruits of the ASEAN countries can enter the market earlier than those of China, thus having an advantage in occupying the market; third, the cost of labor of the ASEAN countries is lower than that of China's main producing areas of tropical fruits.

There have been many researchers that studied the consumption patterns of fruits in China (Han and Wahl (1998), Gale and Huang (2007), etc.). This literature studied the demand of fruits as part of the food consumption and did not take the different sources into consideration. However, the consumers may consider products from various origins different and hence there may be either substitutability or complementary relationships among products from different sources. Moreover, it is also unknown whether the consumption of tropical fruits can be affected by the prices of non-tropical fruits.

Therefore, the purpose of this chapter is to fill a knowledge gap on Chinese consumers' preferences for tropical fruits from different origins, including China itself, and to find out whether or not the growth of imports increases the competition for Chinese producers. Thus, it may provide implications for the policy makers, the

¹². Data source: The official website of China-ASEAN Exposition.

producers and the investors.

The outline of this paper is as follows. Section 2 is a review of previous studies. Section 3 presents the model that is used to estimate the coefficients. Section 4 introduces the sources of the data used in this paper. Section 5 introduces the estimation procedure. Section 6 presents the tests of block separability and product aggregation. Section 7 discusses the results and Section 8 concludes.

II. Literature Review

Many researchers have focused on the consumption patterns of fruits in China. Some of them studied fruits as a whole, while others considered specific kinds. They found that the consumption of fresh fruits in China is increasing with the rise of income. Han and Wahl (1998) used a two stage budgeting LES-LA/AIDS model to study the demand of Chinese rural households for fresh fruits and vegetables. They found larger own-price elasticity for the fruits than for vegetables. In this study, they considered specific kinds of fruits and find that most fruits are price-elastic except for apples, and grapes have the largest own-price elasticity. Nevertheless, in a study of Liao and Chern (2007), which focuses on Chinese urban households, the own-price elasticities of fruits are smaller than one, which implies that the demands for fruits are inelastic to their own prices.

Some studies take different income levels into consideration. For example, Han and Wahl (1998) found a similar demand pattern across different income levels. However, Gale and Huang (2007) studied the demand of both rural and urban households and find that for fruits, although the demand is increasing with the rise of income for both kinds of households, the changes of elasticities with the changes of income levels are opposite for rural and urban households. Liu et al. (2008) studied

the structure of fruit and vegetable consumption. They especially focus on how the consumption structure changes over time and whether or not it is different among regions. They found that there is an increase in the consumption in the central and southern parts of China, and that the difference is significant only on a higher consumption level.

Nevertheless, no research has taken the different sources into consideration. Consumers may consider the commodities imported from various sources as different and there may be a competitive or complementary relationship among them. As mentioned before, the tropical fruits from the ASEAN countries have some advantages and they may be different from Chinese produced tropical fruits in both appearances and taste.

The competitive relationship between China and the ASEAN countries and the impacts of China-ASEAN FTA have been discussed by some research (Yue, 2004; Tongzon, 2005; etc.). Most of them focuses on the impact of China on the markets of the ASEAN countries. Only a few researchers focus on the effects of China-ASEAN FTA on China's agricultural trade. For instance, Qiu et al. (2007) considered the different effects of the FTA on China's agricultural trade across different regions in China. As for the trade of fruits, the authors point out that the FTA increases the import of tropical fruits and decreases the welfare of the producers in south and southeast China. The simulation results indicate that although the prices of agricultural products produced in north China can be enhanced, the prices of those produced in south China are decreased by a larger degree. Tan et al. (2011) focused on Chinese tropical fruit industry. The authors find that the increasing imports of tropical fruits induced by the China-ASEAN FTA and the Early Harvest Agreement caused the trade deficit against the ASEAN countries. Although the economic

efficiency is improved and thus the whole economy benefits from the China-ASEAN FTA, Chinese tropical fruit producers have to face a big challenge.

A source-differentiated demand analysis is a frequently used method to analyze the competitive relationship across different sources of a commodity. Mutondo and Henneberry (2007) studied the demand of the U.S. for meat using a source-differentiated Rotterdam model. They try to explore the competitive relationship between domestically produced meat and imported meat. They point out that the source of origin can be regarded as an intrinsic quality attribute, which, if ignored, may produce biased results and thus cannot reveal the true demand responses. To determine whether to choose a source-differentiated model or a non-source differentiated model, a common method is to test for the assumption of product aggregation, which is to test the assumption that the parameters of the source-differentiated estimates and the non-source differentiated estimates are the same. Muhammad (2012) considered the fact that the price risk, which represents the unexpected fluctuations of the prices, may also be source specific. He develops a model that includes the price risk in a source-differentiated analysis and applied it to data of carnation imports of the U.K.

Most source-differentiated demand analyses are based on the Almost Ideal Demand System (AIDS), which was developed by Deaton and Muellbauer (1980). For example, Nzaku et al. (2010) studied the demand for tropical fruit imports in the U.S. and found a competitive relationship among bananas from different countries and between bananas and other tropical fresh fruits. Similarly, Tshikala and Fonsah (2012) estimated the import demand of different kinds of melons of the U.S. and find a substitution relationship among most of the goods studied in that paper.

To deal with the problem of small samples, Yang and Koo (1994) developed a

Restricted Source-Differentiated Almost Ideal Demand System (RSDAIDS) to save the degree of freedom. RSDAIDS assumes the block substitutability, which means that the cross-price effects between commodity i from origin h and commodity j are the same regardless of the origin of commodity j . The RSDAIDS model was then applied to the demand estimation of Japanese meat imports. Then, it was applied to study the Indonesian import demand of fruits by Andayani and Tilley (1997), the Japanese and South Korean imports of meats by Mutondo and Henneberry (2007), the South Korean imports of meats by Henneberry and Hwang (2007), and the Mexican dairy import by Ramirez and Wolf (2008), etc.

Despite the rising attention to the relationship between imported and domestically produced fruits, little research has taken the different origins of the products into consideration. In this chapter, the competitive and complementary relationships of fruits across different sources are considered and the expenditure elasticities, own-price elasticities, cross-price elasticities and Allen elasticities of the tropical fruits in the Chinese market are estimated. This may be helpful for future studies on welfare changes, and may provide information for the policy makers and the related producers and investors.

III. Model

A source-differentiated model takes the different origins of goods into consideration. That is, it does not assume that the prices of goods from different sources move together by the same proportion. The Armington model, the source-differentiated Rotterdam model, and the source-differentiated AIDS model are all widely used to study the source-differentiated demands. Nevertheless, the Armington model suffers from its restrictive assumptions of constant elasticity of substitution and

homotheticity. This is the disadvantage compared with the other two models. When it comes to whether to choose the Rotterdam or AIDS model, economic theory provides no information on this issue, and mostly the choice is made arbitrarily in advance (Alston and Chalfant, 1993). However, Tshitala and Fonsah (2012) pointed out that much research has shown that the AIDS model does better in fitting the consumer demand analysis. The source-differentiated AIDS model is specified as follows:

$$(1) \quad w_{i_h} = \alpha_{i_h} + \sum_j \sum_k \gamma_{i_h j_k} \ln(P_{j_k}) + \beta_{i_h} \ln\left(\frac{E}{P^*}\right),$$

$$\forall i = 1, \dots, M, j = 1, \dots, M, i \neq j$$

where α , β , γ are parameters, w_{i_h} is the budget share of good i from source h . P_{j_k} is the price of good j from source k . The subscripts i and j denote different products; h and k denote different sources. And P^* is the Stone's price index defined as:

$$(2) \quad \ln(P^*) = \sum_i \sum_h w_{i_h} \ln(P_{i_h})$$

Using this price index may cause a simultaneous equation bias since w_{i_h} is also used as a dependent variable in equation (1). To avoid simultaneity, in most research the lagged w_{i_h} is used as suggested by Eales and Unnevehr (1988).

The general restrictions are:

$$\text{Adding-up:} \quad \sum_i \sum_h \alpha_{i_h} = 1; \quad \sum_i \sum_h \gamma_{i_h j_k} = 0; \quad \sum_i \sum_h \beta_{i_h} = 0;$$

$$\text{Homogeneity:} \quad \sum_j \sum_k \gamma_{i_h j_k} = 0;$$

$$\text{Symmetry:} \quad \gamma_{i_h j_k} = \gamma_{j_k i_h}.$$

However, due to the small sample of the data, the estimation of such a model will suffer from a degree-of-freedom problem. To avoid this problem, Yang and Koo (1994) suggest using a Restricted Source Differentiated AIDS model (RSDAIDS),

which assumes block substitutability among goods. That is, assuming that the cross-price effects of good j on the demand of good i from the source h are the same for good j from all sources.

The specification of the RSDAIDS model is as follows:

$$(3) \quad w_{i_h} = \alpha_{i_h} + \sum_k \gamma_{i_h k} \ln(P_{i_k}) + \sum_{j \neq i} \gamma_{i_h j} \ln(P_j) + \beta_{i_h} \ln\left(\frac{E}{P^*}\right),$$

where $\ln(P_j) = \sum_k w_{jk} \ln(P_{jk})$.

The general restrictions are:

Adding-up: $\sum_i \sum_h \alpha_{i_h} = 1; \sum_h \gamma_{i_h k} = 0; \sum_i \sum_h \gamma_{i_h j} = 0; \sum_i \sum_h \beta_{i_h} = 0;$

Homogeneity: $\sum_k \gamma_{i_h k} + \sum_{j \neq i} \gamma_{i_h j} = 0;$

Symmetry: $\gamma_{i_h k} = \gamma_{i_h k}.$

Due to block substitutability, the Symmetry conditions are only applied among different sources within each kind of goods.

IV. Data

There are four kinds of fruits in this study: bananas, pineapples, other tropical fruits, and non-tropical fruits. For bananas, the sources include China, the Philippines, Ecuador and the rest of the world (ROW). For pineapples, the sources include China, Thailand, the Philippines and ROW. These are the major and traditional sources for the Chinese market. For other tropical fruits, the sources include China and ROW, and non-tropical fruits are not separated by sources.

The production cycles of tropical fruits are different in China and the ASEAN countries. Thus, the fruits are harvested and marketed during different time periods. Take bananas for example: most Chinese bananas are harvested and sold between

November and the next May, while the bananas from the ASEAN countries can be purchased during the whole year. This is one of their advantages compared with Chinese bananas. However, the monthly or quarterly data are not available. Therefore, in this chapter, all data used are annual data from 1992 to 2013. The summary statistics are in Table 3.1. Figure 3.3 indicates the changes of the budget shares of Chinese domestic products of bananas and pineapples. There was a sharp decrease in the budget share of domestic products in 1998 for both bananas and pineapples. For bananas, the budget share is stable compared with pineapples, for which the budget share of domestic products is decreasing since 2005.

For imported goods, the import value and the import quantity data are from the website of UN Comtrade (the Harmonized System). The import prices by origin are not available. However, Shiells (1991) suggests that one can get similar estimates by using unit value indices as an alternative of price indices. Thus, the prices are calculated by dividing the values of imports by the quantities of imports, and converting into Chinese currency using the exchange rate of each year. For the years in which there is no import from a certain country, the world import price is used as the import price from that country. The prices used in this chapter are all CIF prices.

For domestic goods, the data on domestic production are from the database of the National Bureau of Statistics of China. The data on the exports are from the database of UN Comtrade. The quantity data on China's domestic consumption is calculated by deducting the export from domestic production. For most of the products, the price data are also provided by FAOSTAT, which is a dataset of producer prices (FAOSTAT explains them as farm gate prices or wholesale prices). For the years in which there is no price data provided, the data is calculated using the price indices provided by FAOSTAT.

V. Estimation Procedure

The RSDAIDS model consisted of 11 equations. Four equations are used to estimate the demand for bananas, four are used to estimate the demand for pineapples, two are used for other tropical fruits, and the last one is used for non-tropical fruits. According to LaFrance (1991), the group expenditure is not exogenous. Therefore, the conventional least squares estimators may be inconsistent or inefficient. To deal with this problem, Edgerton (1993) suggests using predicted values of the auxiliary equation for the log of expenditure:

$$(4) \log(E) = f(p, q, y),$$

where p is the Stone's price index for each good, q is the consumer price index, y is the per capita private consumption. Data for q and y are both from the database of the National Bureau of Statistics of China. A three stage least square method is used to estimate the model with the restrictions of homogeneity and symmetry imposed. Due to the adding-up condition of the demand system, the equation of the non-tropical fruits is dropped to avoid the singularity problem. The assumptions of block separability and product aggregation are tested.

VI. Block Separability and Product Aggregation

Block separability assumes that the consumers' preferences within each group of goods can be studied as a separable category from other groups of goods. In this chapter, it means that the demand for each kind of fruit can be explained independently of the demand of other kinds of fruit. Following Hayes, Wahl and Williams (1990), the block separability test is to test the following restriction:

$$\gamma_{i_n, j} = \bar{w}_i \bar{w}_j \gamma_{ij} \quad \forall i \neq j,$$

where $\gamma_{i_h j}$ is the cross-price parameter between good i from source h and good j estimated with a RSDAIDS model. γ_{ij} is the cross-price parameter between good i and good j of a non-source differentiated AIDS model; \bar{w}_{i_h} is the mean of the budget share of good i from source h ; \bar{w}_j is the mean of the budget share of good j from all sources. The results of the test are in table 3.2. Results indicate that the null hypothesis that each kind of fruit can be studied independently from other kinds of fruit is rejected at the one percent significance level.

Product aggregation assumes that the parameters of the source-differentiated AIDS model are the same as those of a non-source differentiated AIDS model. The null hypothesis is that each kind of fruits can be estimated using the non-source differentiated model. That is, to test the following restrictions:

$$\alpha_{i_h} = \alpha_i \quad \forall h \in i,$$

$$\gamma_{i_h j} = \gamma_{ij} \quad \forall h, k \in i, j,$$

$$\beta_{i_h} = \beta_i \quad \forall h \in i.$$

where α_{i_h} , $\gamma_{i_h j}$ and β_{i_h} are intercepts, cross-price parameters and expenditure parameters estimated using a restricted source-differentiated AIDS model presented in equation (3); α_i , γ_{ij} and β_i are the intercepts, cross-price parameters and expenditure parameters of the non-source differentiated AIDS model. The results of the test are also shown in table 3.2. They indicate that the null hypothesis is rejected at the one percent significance level. Therefore, the parameters should be estimated using a source-differentiated model.

VII. Results

The estimated coefficients are in Table 3.3. They reveal the responses of budget share

for each kind of goods to their own prices, the prices of related goods and the total expenditure changes. Then the Marshallian own-price and cross-price elasticities are calculated using the following equations:

$$(5) \quad \varepsilon_{i_h i_h} = -1 + \frac{\gamma_{i_h i_h}}{w_{i_h}} - \beta_{i_h},$$

$$(6) \quad \varepsilon_{i_h i_k} = \frac{\gamma_{i_h i_k}}{w_{i_h}} - \beta_{i_h} \frac{w_{i_k}}{w_{i_h}},$$

$$(7) \quad \varepsilon_{i_h j} = \frac{\gamma_{i_h j}}{w_{i_h}} - \beta_{i_h} \frac{w_j}{w_{i_h}}.$$

The expenditure elasticities are calculated through:

$$(8) \quad \eta_{i_h} = 1 + \frac{\beta_{i_h}}{w_{i_h}}$$

where γ 's and β 's are parameters estimated through equation (3). The Hicksian elasticities are calculated as follows:

$$(9) \quad \delta_{i_h i_h} = -1 + \frac{\gamma_{i_h i_h}}{w_{i_h}} + w_{i_h},$$

$$(10) \quad \delta_{i_h i_k} = \frac{\gamma_{i_h i_k}}{w_{i_h}} + w_{i_h},$$

$$(11) \quad \delta_{i_h j} = \frac{\gamma_{i_h j}}{w_{i_h}} + w_j.$$

The Allen elasticities are calculated to explore the relative strength of each source. Allen elasticities are calculated using the following equations:

$$(12) \quad e_{i_h i_k}^A = \frac{\delta_{i_h i_k}}{w_{i_h}},$$

$$(13) \quad e_{i_h j}^A = \frac{\delta_{i_h j}}{w_{i_h j}}.$$

The Marshallian, Hicksian, and Allen elasticities are shown in Table 3.4, Table 3.5, and Table 3.6, respectively. Following Yeager et al. (2011), the significance of the elasticities is based on the significance of the coefficients. The Marshallian and Hicksian elasticities are similar to each other. One explanation is that according to Green and Alston (1990), when the expenditure shares of the goods in the study are small, the uncompensated elasticities are approximately equal to the compensated elasticities.

Except for pineapples from ROW, all expenditure elasticities are positive and most of them are statistically significant (Table 3.4). Both Chinese bananas and Chinese pineapples are normal goods, but not luxuries. Bananas from the Philippines have much larger expenditure elasticity (1.37) than those from China (0.59) or ROW (0.55). This suggests that the Philippines' bananas are considered as luxury goods in the Chinese fruit market. Moreover, as the expenditure on fruit consumption increases, people spend more on the Philippines' bananas than on China's or ROW's. The elasticities of pineapples from China and ROW have different signs (0.71 for China and -0.90 for ROW), which implies that when the expenditure increases, people tend to consume more pineapples produced in China and import a smaller amount of pineapples from the ROW. However, for other tropical fruits, those from both sources are luxuries (1.25 for China and 1.61 for ROW), which means that when the expenditure increases, the demand for them rises by a larger proportion.

Regarding the own-price elasticities, most of them are statistically significant (Table 3.4). All of the own-price elasticities are negative, except for Ecuador bananas, which is not statistically significant. The own-price elasticities for Chinese fruits are all smaller than one (-0.38 for bananas and -0.30 for pineapples), with the exception of the other tropical fruits (-1.05). They indicate that for bananas and pineapples, the

demand for goods produced in China is not sensitive to changes of their own prices. For bananas, the demand for the Philippines' products is the most sensitive to its own price (-4.31), and the ROW's bananas have the least sensitive demand to its own price (-0.30). For pineapples, the demands for the Philippines' and Thailand's products are price elastic, and the imports from Thailand have the largest elasticity (-1.79). Demand for other tropical fruits from China is sensitive to the changes of its own price (-1.05).

The compensated cross-price elasticities reveal the net substitution or complementary relationships among different fruits or different sources (Table 3.5). For bananas, the demand elasticity of Chinese bananas with respect to the price of Ecuador bananas is positive (0.04), which indicates that a reduction in the price of bananas from Ecuador reduces the demand of Chinese bananas. This relationship is asymmetric, Chinese consumption of Ecuador bananas can be affected to a much greater extent by the price of Chinese bananas. Moreover, the prices of the Philippines and ROW have no significant effect on the demand of Chinese bananas. Competitive relationships exist between Ecuador and Philippines, as well as between Ecuador and ROW. For pineapples, no significant competitive relationship is found between China and the Philippines, as well as between China and Thailand. The demand elasticity of Chinese pineapples with respect to the price of the ROW is also positive (0.002), which implies that pineapples from China and those from the ROW are substitutes. Moreover, there is no significant competitive or complementary relationship between China and the ROW in the Chinese market of other tropical fruits.

With regard to the cross-price elasticities among different kinds of fruits, there is a significant complementary relationship between non-tropical fruits and Chinese bananas (-0.91), and a significant substitute relationship between pineapples and

Chinese bananas (0.83). For Chinese pineapples, both other tropical fruits and non-tropical fruits are its complements (-0.19 and -0.71). Nevertheless, bananas and Chinese pineapples are found to be substitutes (1.18). The demand elasticity of Chinese other tropical fruits with respect to the prices of bananas shows a complementarity between them (-0.42). In contrast, pineapples and non-tropical fruits are substitutes of other tropical fruits produced in China (0.73 and 0.02, respectively).

The relative strength of the substitution relationship among goods can be shown by Allen elasticities. Table 3.6 indicates that, among the significant results, the ranking of the strongest competitions is: Chinese pineapple-ROW pineapple (221.27), Chinese banana-pineapple (95.41), Chinese other tropical fruits-pineapple (83.60), Chinese banana-Ecuador banana (46.00) and Chinese pineapple-banana (16.25). Therefore, in China's tropical fruit market, Chinese produced pineapples face the strongest competition.

VIII. Concluding Comments

This chapter estimates the demand elasticities of fruits in China, using a source-differentiated AIDS model. Block separability and product aggregation are tested and results indicate that the assumptions of block separability and product aggregation are both rejected. Therefore, the demand for each kind of fruit should be studied considering related products, and consumers have different preferences for each kind of fruits across different sources.

The estimated elasticities indicate that both Chinese domestic bananas and pineapples are insensitive to the changes of expenditure or their own prices, while the expenditure and own-price elasticities of the other tropical fruits produced in China are both larger than one. The higher expenditure elasticities of bananas from the

Philippines and the other tropical fruits may imply that these fruits are still considered luxuries in the Chinese market.

However, the compensated elasticities imply no significant competitive relationship between China and the ASEAN countries in the Chinese tropical fruit market, which implies that products from these sources are so different that they do not compete in the same market (Yang and Koo, 1994). Nevertheless, there is a competitive relationship between pineapples and Chinese bananas and between bananas and Chinese pineapples. Non-tropical fruits are complements to both bananas and pineapples from China.

A country is considered as having a strong competitive advantage if demand for its products is not sensitive to their own prices and is increasing with the rise of the total expenditure. Therefore, the results indicate that the strongest competitive potential is from China and ROW, instead of ASEAN countries, which are considered to be the strongest rivals by some Chinese producers and investors.

Furthermore, given that the Framework Agreement enables Chinese consumers to purchase the imported tropical fruits with a lower cost without decreasing the demand for domestic produced products, the elastic import demand for bananas from the Philippines and for pineapples from Thailand reveals that the Framework Agreement can lead to a win-win situation between China and the Philippines, and between China and Thailand.

Another implication for the foreign suppliers is that the exporters, other than the ASEAN countries, can also be influenced by the Framework Agreement. For example, due to the substitution relationship between Ecuador and the Philippines for the supply of bananas, the export from Ecuador to China can be significantly decreased by the reduction in price of the products from the Philippines.

FIGURES:

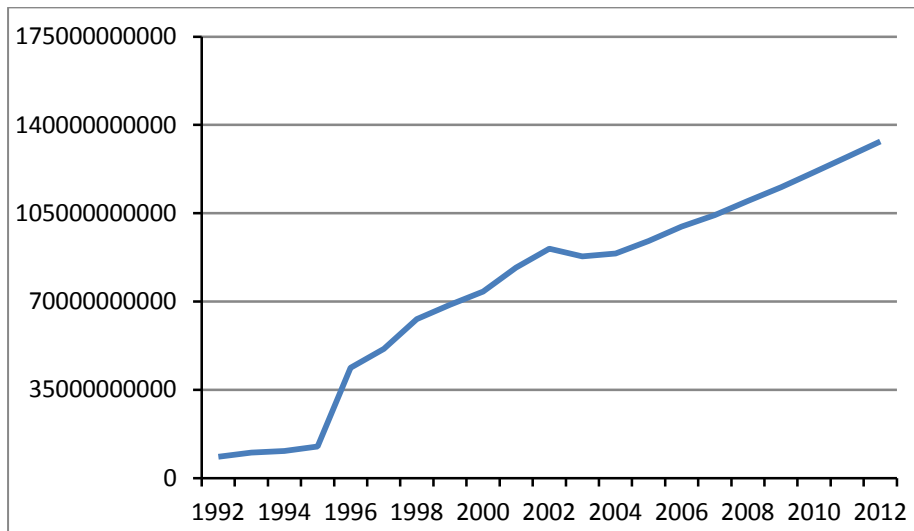


Figure 3.1 Tropical Fruit Imports of China

Data source: UN Comtrade Database.

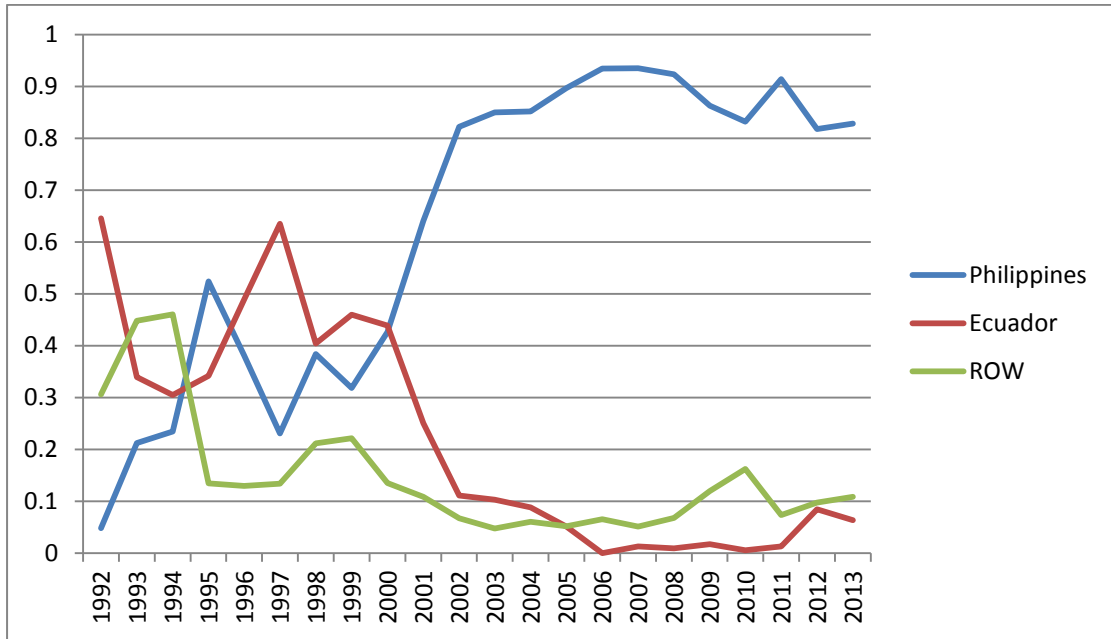


Figure 3.2(a) Chinese Banana Import Shares (by value).

Data source: UN Comtrade Database.

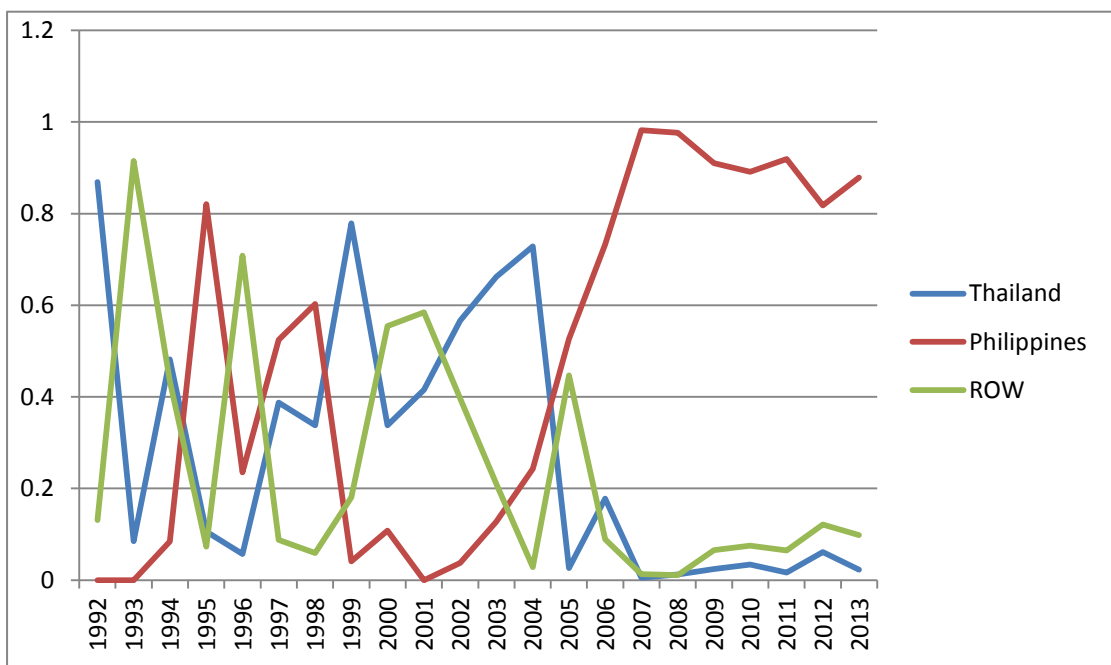


Figure 3.2(b). Chinese Pineapple Import Shares (by value).

Data source: UN Comtrade Database.

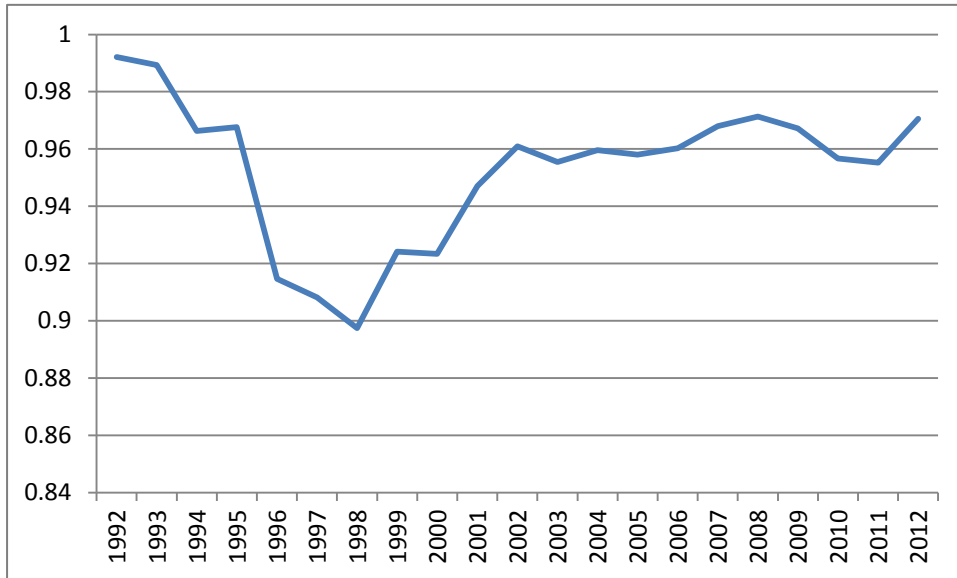


Figure 3.3(a) Budget Share of Chinese Domestic Products (Banana).

Data Source: UN Comtrade Database.

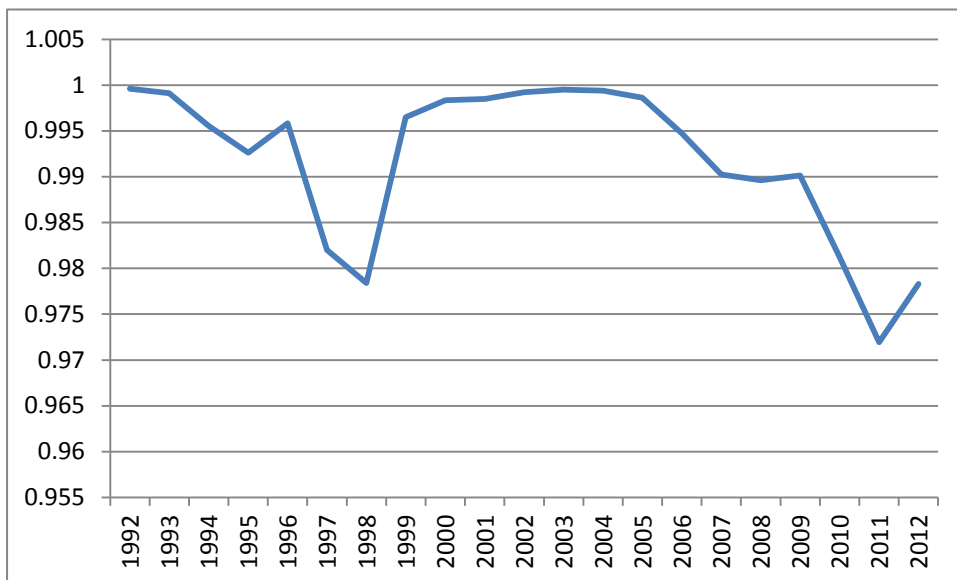


Figure 3.3(b) Budget Share of Chinese Domestic Products (Pineapple).

Data Source: UN Comtrade Database.

TABLES:

Table 3.1 Summary Statistics

Variable	Mean	Std.Dev.	Minimum	Maximum
Quantity of Banana ^a				
China	6070000000	3010000000	2450000000	12100000000
Philippines	2680000000	1660000000	606062	6940000000
Ecuador	70758329	99364414	36400	343000000
ROW	72745363	47371391	6513564	226000000
Price of Banana ^b				
China	3.4578	1.2020	1.4980	6.5900
Philippines	2.5639	0.6303	1.9230	4.2939
Ecuador	2.8853	0.7711	1.4131	4.7476
ROW	1.6421	0.6897	0.4494	2.7489
Budget Share of Banana				
China	0.0823	0.0279	0.0445	0.1500
Philippines	0.0021	0.0009	0.00005	0.0035
Ecuador	0.0012	0.0016	0.00000023	0.0054
ROW	0.0006	0.0006	0.0001	0.0019
Quantity of Pineapple ^a				
China	7990000000	2.43000000	440000000	1290000000
Thailand	1102339	2668899	3730	9766753
Philippines	7708923	11191854	0	35398028
ROW	911703.1	1098186	2317	3937277
Price of Pineapple ^b				
China	2.9606	1.6135	0.5120	6.3222
Thailand	10.0710	12.2780	1.1480	46.2418
Philippines	3.2803	1.2778	1.5368	6.1899
ROW	4.1398	2.3060	0.9454	9.1846

Budget Share of Pineapple				
China	0.0086	0.0024	0.0054	0.0128
Thailand	0.00001	0.00003	0.0000002	0.0001
Philippines	0.00005	0.00006	0	0.0002
ROW	0.000008	0.000008	0.0000001	0.00003
Quantity of Other Tropical Fruits ^a				
China	67900000000	37200000000	560000000	121000000000
ROW	238000000	242000000	9377310	743000000
Price of Other Tropical Fruits ^b				
China	1.6711	1.2796	0	4.9282
ROW	3.3752	0.7368	2.2008	5.2935
Budget Share of Other Tropical Fruits				
China	0.3640	0.0923	0.1842	0.5529
ROW	0.0019	0.0009	0.0006	0.0033
Quantity of Non-tropical Fruits ^a				
	34200000000	165000000000	188000000	64800000000
Price of Non-tropical Fruits ^b				
	4.3489	2.8743	1.3564	15.0681
Budget Share of Non-tropical Fruits				
	0.5932	0.0720	0.3703	0.6544

a. Unit: kilogram.

b. Unit: Yuan.

Table 3.2 Block Separability and Product Aggregation Test

Hypothesis Tested	Pr>F
Block Separability Test	
H ₀ : Banana is separable from all other kinds of fruits.	0.0001
H ₀ : Pineapple is separable from all other kinds of fruits.	0.0001
H ₀ : Other tropical fruits are separable from all other kinds of fruits.	0.0001
H ₀ : Non-tropical fruits are separable from all other kinds of fruits.	0.0001
H ₀ : All of the above.	0.0001
Product Aggregation Test	
H ₀ : Banana can be aggregated.	0.0001
H ₀ : Pineapple can be aggregated.	0.0001
H ₀ : Other tropical fruits can be aggregated.	0.0001
H ₀ : All of the above.	0.0001

Table 3.3 Estimated Coefficients of RSDAIDS for China's Tropical Fruit Consumption, 1992-2013.

	BAN _{CH}	BAN _{EC}	BAN _{PH}	BAN _{ROW}	PIN _{CH}	PIN _{PH}	PIN _{TH}	PIN _{ROW}	OTH _{CH}	OTH _{ROW}
Intercept	0.7893*** (5.4)	0.0129 (0.91)	-0.0161 (-1.68)	0.0083** (2.3)	0.0760*** (6.39)	0.0005 (0.54)	-0.0002 (-0.39)	0.0005*** (4.24)	-3.1603*** (-10.41)	-0.0288*** (-4.89)
lnPBAN _{CH}	0.0404*** (4.96)	0.0028*** (3.13)	0.0008 (1.34)	-0.0002 (-1.05)						
lnPBAN _{EC}	0.0028*** (3.13)	0.0012 (0.88)	0.0019** (2.3)	0.0011*** (4.35)						
lnPBAN _{PH}	0.0008 (1.34)	0.0019** (2.3)	-0.0078*** (-7.5)	0.0007*** (3.38)						
lnPBAN _{ROW}	-0.0002 (-1.05)	0.0011*** (4.35)	0.0007*** (3.38)	0.0005*** (7.9)						
lnPPIN _{CH}					0.0063*** (14.64)	0.0001 (1.54)	8.81E-06 (0.44)	0.00002*** (4.75)		
lnPPIN _{PH}					0.0001 (1.54)	-0.00004 (-1.63)	-0.00003*** (-3.17)	-4.60E-06 (-1.28)		
lnPPIN _{TH}					8.81E-06 (0.44)	-0.00003*** (-3.17)	-0.00001** (-2.21)	7.86E-07 (0.53)		
lnPPIN _{ROW}					0.00002*** (4.75)	-4.60E-06 (-1.28)	7.86E-07 (0.53)	1.57E-06 (0.8)		
lnPOTH _{CH}									0.0534*** (6.2)	-0.0001 (-0.57)
lnPOTH _{ROW}									-0.0001 (-0.57)	0.0013*** (3.85)
lnPBAN					0.0100*** (6.37)	-0.0002 (-1.63)	0.000021 (0.29)	8.12E-06 (0.57)	-0.2821** (-2.68)	-0.0079*** (-3.59)
lnPPIN	0.0566***	0.0001	0.0032**	0.0058**					0.4141***	0.0079***

	(2.4)	(0.42)	(2.05)	(2.26)					(3.96)	(3.63)
lnPOTH	-0.0145	-0.0059***	0.0011	-0.0014***	-0.0069***	0.0002***	4.60E-06	2.68E-06		
	(-1.53)	(-5.34)	(1.38)	(-5)	(-12.17)	(3.37)	(0.16)	(0.47)		
lnPNON	-0.0859***	-0.002	0.0002	-0.0004	-0.0095***	0.00005	0.00001	-0.00003**	-0.1853***	-0.0013
	(-3.94)	(-0.95)	(0.14)	(-0.68)	(-6.35)	(0.42)	(0.16)	(-2.02)	(-4.56)	(-1.7)
ln(E/P)	-0.0278***	-0.0006	0.0009**	-0.0004**	-0.0026***	-0.00002	0.00001	-0.00002***	0.1450***	0.0012***
	(-4.49)	(-1.05)	(-2.15)	(-2.32)	(-5.39)	(-0.47)	(0.46)	(-4)	(11.35)	(4.87)
System Weighted R2	0.9077									

t-ratios are in parentheses.

Variables: $\ln\text{PBAN}_{\text{CH}}$ = banana from China, $\ln\text{PBAN}_{\text{EC}}$ = banana from Ecuador, $\ln\text{PBAN}_{\text{PH}}$ = banana from the Philippines, $\ln\text{PBAN}_{\text{ROW}}$ = banana from ROW,

$\ln\text{PPIN}_{\text{CH}}$ = pineapple from China, $\ln\text{PPIN}_{\text{PH}}$ = pineapple from the Philippines, $\ln\text{PPIN}_{\text{TH}}$ = pineapple from Thailand, $\ln\text{PPIN}_{\text{ROW}}$ = pineapple from ROW,

$\ln\text{POTH}_{\text{CH}}$ = other tropical fruits from China, $\ln\text{POTH}_{\text{ROW}}$ = other tropical fruits from ROW.

** and *** represent significance at the 5 percent and 1 percent level.

Table 3.4 Marshallian Elasticities for Fruit Demand in China.

	BAN _{CH}	BAN _{EC}	BAN _{PH}	BAN _{ROW}	PIN _{CH}	PIN _{PH}	PIN _{TH}	PIN _{ROW}	OTH _{CH}	OTH _{ROW}
BAN _{CH}	-0.38***	3.14***	0.31	-0.26						
BAN _{EC}	0.04***	0.38	0.79**	1.36***						
BAN _{PH}	0.012	2.11**	-4.31***	0.85***						
BAN _{ROW}	-0.003	1.20***	0.28***	-0.30***						
PIN _{CH}					-0.30***	0.74	0.69	2.01***		
PIN _{PH}					0.006	-1.52	-2.37***	-0.44		
PIN _{TH}					0.001	-0.39***	-1.79**	0.07		
PIN _{ROW}					0.002***	-0.06	0.06	-0.85		
OTH _{CH}									-1.05***	-0.39
OTH _{ROW}									-0.001	-0.34***
BAN					1.12***	-2.73	1.60	0.91	-0.51**	-3.95**
PIN	0.83***	1.10	1.33**	7.47**					0.72***	3.94***
OTH	-0.21	0.41***	0.27	-1.50***	-0.60***	2.48***	1.20	0.22		
NON	-1.11***	-1.99	-0.04	-0.33	-0.95***	0.80	0.60	-2.20**	-0.41**	-0.86
Expenditure	0.59***	0.29	1.37**	0.55**	0.71***	0.74	1.79	-0.90***	1.25***	1.61***

** and *** represent significance at the 5 percent and 1 percent level. Significance based on significance of coefficients in Table 3.3.

Table 3.5 Hicksian Elasticities for Fruit Demand in China.

	BAN _{CH}	BAN _{EC}	BAN _{PH}	BAN _{ROW}	PIN _{CH}	PIN _{PH}	PIN _{TH}	PIN _{ROW}	OTH _{CH}	OTH _{ROW}
BAN _{CH}	-0.34***	3.16***	0.40	-0.23						
BAN _{EC}	0.04***	0.38	0.79**	1.36***						
BAN _{PH}	0.01	2.11**	-4.30***	0.86***						
BAN _{ROW}	-0.003	1.20***	0.28***	-0.30***						
PIN _{CH}					-0.29***	0.74	0.70	2.00***		
PIN _{PH}					0.006	-1.52	-2.36***	-0.44		
PIN _{TH}					0.001	-0.39***	-1.79**	0.07		
PIN _{ROW}					0.002***	-0.06	0.06	-0.85		
OTH _{CH}									-0.33***	0.53
OTH _{ROW}									0.002	-0.34***
BAN					1.18***	-2.67	1.73	0.84	-0.42**	-3.83**
PIN	0.83***	1.11	1.34**	7.47**					0.73***	3.93***
OTH	0.36	-6.06***	1.05	-1.18***	-0.19***	2.90***	0.94	-0.83		
NON	-0.91***	-1.89	0.43	-0.14	-0.71***	1.05	1.21	-2.51**	0.02**	-0.31

** and *** represent significance at the 5 percent and 1 percent level. Significance based on significance of coefficients in Table 3.3.

Table 3.6 Allen Elasticities

	BAN _{CH}	PIN _{CH}	OTH _{CH}
BAN _{CH}	-4.99***		
BAN _{EC}	46.00***		
BAN _{PH}	5.87		
BAN _{ROW}	-3.31		
PIN _{CH}		-32.31***	
PIN _{PH}		81.95	
PIN _{TH}		77.6	
PIN _{ROW}		221.27***	
OTH _{CH}			-0.58***
OTH _{ROW}			0.92
BAN		16.25***	-5.77***
PIN	95.41***		83.60***
OTH	0.63	-0.33***	
NON	-2.65***	-2.06***	0.06***

** and *** represent significance at the 5 percent and 1 percent level. Significance based on significance of coefficients in Table 3.3.

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