The determinants of the value of US tilapia import – Evidence from a gravity model

by

Penghui Gao

A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Science

Auburn, Alabama
May 7, 2017

Keywords: Tilapia; Gravity model; International trade; Import

Approved by

Henry Kinnucan, Co-chair, Alumni Professor of Agricultural Economics and Rural Sociology
Curtis Jolly, Co-chair, Professor of Agricultural Economics and Rural Sociology
Guanqun Cao, Assistant Professor of Mathematics and Statistics

Abstract

As the biggest importing and food consuming country in the world, the United States increasingly imported large quantities of tilapia products in the past decade. In 2013, the United States imported 222 thousand tons of tilapia at a value of $0.99 billion, which is 2.48 times higher than 2003. In the United States, tilapia is popular among consumers, and becoming one of the main aquatic consumption goods. However, domestic tilapia production is limited. The tilapia markets in the United States relies mainly on imports from other countries. The main exporters are mainland China, Taiwan, Indonesia, Ecuador, Costa Rica, Honduras, Thailand, Brazil, Panama and El Salvador, accounting for over 97 percent of US's total demand in 2013. Before 2002, Taiwan was the largest tilapia exporter to the US. After 2003, mainland China dominated US tilapia import market.

This thesis summarizes the literature that seeks to explain recent developments in the tilapia market in the United States, and uses the gravity model to investigate determinants of the value of the US's tilapia imports from its 10 foreign suppliers over the period of 2003 to 2013. The results suggest the value of US tilapia imports are positively affected by GDP of exporters, a stronger US dollar, participation in the Asia Pacific Economic Cooperation (APEC). The distance between exporters and the US market have negative effects on import value. The production cost of tilapia in the exporting countries and US GDP were found to have no effect on import value. Overall, it appears that import value is most sensitive to changes in the distance (elasticity = -0.69), followed by participation in APEC (elasticity = 0.64). The exchange rates,

although statistically significant, are not empirically significant. Specifically, the elasticities of import value with respect to exchange is 0.04. For import value to increase 2%, the U.S. dollar would have to strengthen 100%.

Acknowledgments

I wish to extend my gratitude to my major professors Dr. Henry Kinnucan and Dr. Curtis Jolly, for their encouragement, support, intellectual stimulation, patience and overall guidance throughout my graduate study. I would also like to thank my other committee member, Dr. Guanqun Cao, for her time and assistance in the completion of the thesis. I would also like to thank the Department of Agricultural Economics and Rural Sociology for helping me in my study and life. My appreciation is also extended to the friends around me, for making my life more colorful. Finally, I would say thanks to my family, for their unconditional love and unlimited support.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

WTP	Willingness-to-pay
SDAIDS	Source Differentiated Almost Ideal Demand System
CARICOM	Caribbean Common Market
FTAA	Free Trade Area of the Americas
MV_{it}	The value of U.S. imports of tilapia from country i in year t
$DIST_i$	Distance in kilometers between the United States and exporter i
XR_{it}	Exporter i's real exchange rate in year t

The determinants of the value of US tilapia import – Evidence from a gravity model

1. Introduction

The quantity of tilapia US imported increased dramatically in the past decade. As the largest importing and consuming country of tilapia in the world, the US imported 231 thousand tons of tilapia in 2013. In the US, tilapia is a popular food item, and becoming one of the main aquatic consumption goods. Although the demand for tilapia is high, domestic production in US is limited. In 2013, US only produced about nine thousand tons of tilapia. This quantity is too low to satisfy the domestic market. Therefore, the US has to rely on the foreign markets for its supply. China is the biggest tilapia exporter and producer in the world, and more than 80% of tilapia produced in China are sold to the US. The other exporters to the US are: Taiwan PC, Ecuador, Costa Rica, Honduras, Indonesia, Thailand, Brazil, Panama, El Salvador. Most of the tilapia products imported in the US are frozen whole tilapia, frozen tilapia fillets, and fresh tilapia fillets.

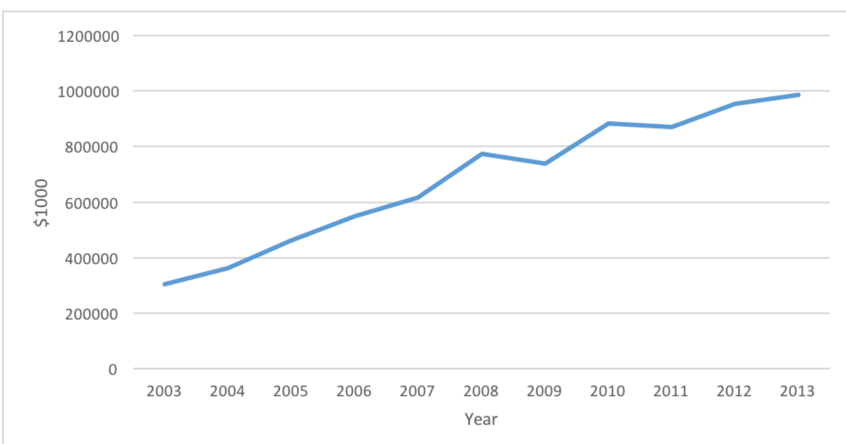

Figure 1. US tilapia total import volume from major exporters

From the trade data, we see that the import volume changes all the time from 2003 to 2013. The objective of the thesis is to access the determinants of tilapia imports to the United States from China, Taiwan PC, Ecuador, Costa Rica, Honduras, Indonesia, Thailand, Brazil, Panama, El Salvador.

Known as a ‘workhorse’ for empirical studies in international trade, the gravity model has done a remarkable job in understanding bilateral trade flows (Eichengreen & Irwin, 1998). The primary advantage of using the gravity model is that it can identify determinants that influence volume of trade as well as some underlying causes for trade (Helpman, 1998). In addition, it is easy to apply. In order to understand tilapia trade, therefore, I employed an augmented gravity model for this purpose. In this paper, I include the following factors: Gross Domestic Product, the distance between each country to the US, the production price, the exchange rate and dummy variable of whether the exporter is from the Asia Pacific Economic Cooperation or not.

2. The Background of US Tilapia Market

The tilapia imports to the US increased steadily from 2003-2013 (FAO,2016). In 2013, the United States imported 222 thousand tons of tilapia at a value of $0.99 billion, which is 2.48 times higher than 2003.

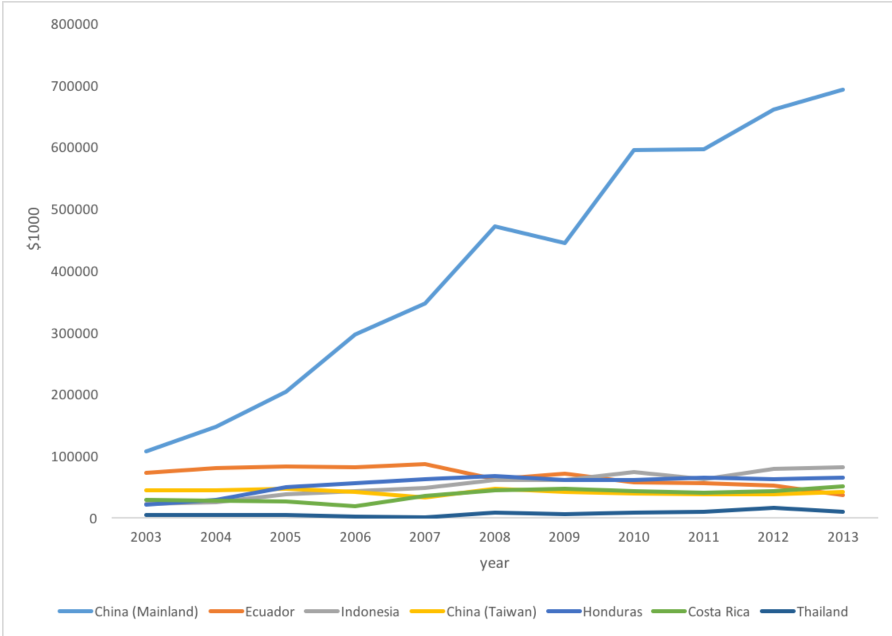

Figure 2. Tilapia imports from major exporters to the USA by country

Over the past decade, the main exporters did not change much. Most of them are developing countries. These exporters are mainland of China, Taiwan, Indonesia, Ecuador, Costa Rica, Honduras, Thailand, Brazil, Panama and El Salvador, accounting for over 97 percent of US's total demand. Before 2002, Taiwan was the largest tilapia exporter to the US. The growth of Chinese tilapia export has been incredible. After 2003, mainland China dominated US tilapia import market. In 2003, mainland of China and Taiwan accounted for over 75 percent tilapia market share of US. Comparing to these, other countries seem somewhat small markets.

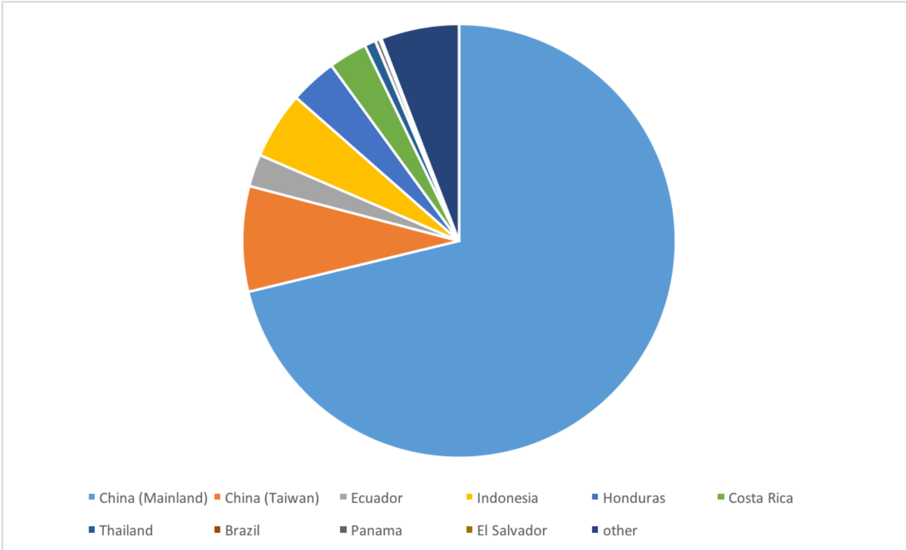

Figure 3. Each exporters' share of US tilapia market in 2013

The three main products are whole frozen tilapia, frozen fillets, and fresh fillets (Helga Josupeit, 2010). The Latin America countries, like Ecuador, Costa Rica and Honduras, control US's fresh fillets market because of their near distance to US market. In 2013, US imported 60 million pounds of fresh fillets, of these, 43 million pounds came from these countries. However, the frozen fillets, making up 70 percent of the total US tilapia import in 2013, came from Asian countries like mainland of China, Indonesia, Taiwan province of China, and Thailand (FAO, 2016).

3. Literature Review

3.1 US Tilapia Trade

Total tilapia production is mainly Oreochromis niloticus. In 2008, Nile tilapia accounted for around three quarters of total world tilapia production (Josupeit, 2010). The early purpose of tilapia introduction in the 1950s and 1960s was to display in public aquaria and to use in food production and as biological controls for aquatic weeds and insects as it was firstly introduced (Fitzsimmons, 2000). Most of the increase in tilapia production in the Americas can be contributed to improvement in aquaculture, such as aquaculture technology and infrastructure of major producers.

Having a name as “aquatic chicken”, tilapia is maintaining an important role in seafood market (Fitzsimmons, 2011). Fitzsimmons (2011) asserted that tilapia among the main farmed fishes can greatly improve the welfare of the poorest farmers in rural area. Its genetic diversity is another reason for its production expansion, from which fish breeders can hybridize several species and develop strains that incorporate various traits from each of the parent species.

Tilapia is also called “green aquaculture” because of its environmentally sustainable characters: no fish meal is absolutely required in the diet, no antibiotics, and many farms use crop effluents. Apart from being used as food, tilapia is widely used for leather, health and beauty products, tilapia pedicures and manicures. To some extent, tilapia serves as a model for how other aquaculture industries should develop (Fitzsimmons, 2013).

Ortega, Wang and Widmar (2014) showed that American consumers have higher willingness-to-pay (WTP) for enhanced food safety, use of no antibiotics, and eco-friendly environmental production practices.

According to Josupeit (2010), the demand for tilapia in the United States remained unaffected during the economic recession in 2009 although the overall fishery products consumption declined by 1.25%. Xing and Xu (2013) suggested that the absolute value of price elasticity is less than 1 in the US market. They also asserted that Chinese tilapia has its price advantage because of the comparative price, Chinese aquatic products however are easy influenced by US anti-dumping and anti-subsidy duties.

Ligeon et al (2007) used a Source Differentiated Almost Ideal Demand System (SDAIDS) model to study the competiveness of different tilapia exporting countries – which are in the Caribbean Common Market (CARICOM) and the Free Trade Area of the Americas (FTAA) members – by estimating the own, cross price, and income elasticities for these tilapia products in US market. They found that the competition among FTAA countries is minimal. The tilapia products exported form FTAA countries are more likely to compete with that in Taiwan and Thailand rather than from FTAA countries.

Some of the literature focus on the competiveness between tilapia and catfish in US market (Harvey, 2002; Josupeit, 2005; Norman-Lopez & Asche, 2008; Hong & Duc, 2009; Chidmi et al, 2012; Norman-Lopez, 2009). Because the increase in tilapia imports has coincided with a reduction in the imports of basa (catfish) from Vietnam, some scholars suggested that tilapia is competing with domestically produced catfish in the US market (Harvey, 2002; Josupeit, 2005). At the US retail market level, catfish is a strong substitute for tilapia; while tilapia is not a strong one for catfish (Chidmi, Hanson & Nguyen, 2012). However, Norman-Lopez and Asche investigated (2008) the competition between domestic catfish fillets and imported tilapia fillets in the US market. The results show that there is no competition between fresh and frozen fillets of tilapia and catfish imports in the same market. As an extension of previous work on tilapia in the US market (Norman-Lopez and Asche 2008), Norman-Lopez (2009) shows that there is no relationship between prices of fresh tilapia and catfish.

3.2 The Gravity Model

The gravity model derived from Newton's Law of universal gravitation, so that the attracting force between two particles is proportional to the product of their masses and inversely proportional to the square of their distance. Traditional trade theories can explain why trade occurs but not explain the extent of trade. However, the gravity model takes more factors into account to explain the international trade flows (Pass, 2000). Known as a "workhorse" in international economics, the gravity model has done a remarkable job in explaining bilateral trade flows (Eichengreen and Irwin, 1998). One of the important merits of gravity model is that it can show the important role of geographical distance as a cause of trade friction (Krugman, 1979).

In seafood area, gravity model has been used to study the effects of non-tariff measures and safety standards on the exports to US and EU (Disdier and Marette, 2010; Nguyen and Wilson, 2009; Pace, 2011; Anders and Caswell, 2006; Tran, Wilson and Hite, 2013; Wilson and Bray, 2010), or to analyze the determinants of specific trade flow, such as the single products shrimp and catfish imported to the US (Rabbani et al., 2011; He et al., 2013).

In 1940s, Stewart and Zipf first introduced the gravity equation into social sciences and built a gravity model to analyze the travel size. This model shows that the tourists between two cities are directly related to the population and negatively related to their generalized distance.

In 1962, Tinbergen first used the gravity equation in international trade in order to study the the effects of free trade agreements. From then on, the gravity model is widely applied to investigate bilateral international trade between different countries. The basic form of the gravity model contains three main variables: the variable representing potential overall demand of importers; the variable representing potential overall supply of exporters; and the variable representing the distance between economic centers of trade parties. In order to improve accuracy of gravity model, scholars also include some other variables potentially affecting bilateral trade, such as colonial ties, common language, policy and exchange rate. According to

Baier and Bergstrand (2007), the combination of gravity variables can explain about 60 – 80 % variation of bilateral trade volume.

The gravity model assumes bilateral trade volume are proportional to their economic size and inversely proportional to their distance. It can be specified as follows:

$$lnQ_{ij} = \beta_0 + \beta_1 lnGDP_i + \beta_2 lnGDP_j + \beta_3 lnDIST_{ij} + \beta_4 lnX_{ij} + \varepsilon_{ij}$$

Where subscript i is denoted the exporter and j is the importer. The variables are defined as follows: Q_{ij} is the dollar value of country i exports to country j, GDP_i and GDP_j are the gross domestic products of country i and country j, $Dist_{ij}$ is the distance between the economic centers of country i and country j, and X_{ij} are some factors potentially affecting bilateral trade volume, the error term ε_{ij} represents random effects and is assumed to be normally distributed.

Although it was widely employed in empirical research, the gravity model lacked theoretical foundation (Anderson, 1979). Tinbergen (1962) only based intuitive justification rather than economic theory when he first used the gravity model (Deardorff, 1998). The predictive potential of gravity model may be undermined if it lacked a strong economic foundation (Bergstrand, 1985). Therefore, the research on theoretical economic basis of gravity model received a lot attention. Some scholars like Anderson, Bergstrand, Deardorff and Wincoop are the representatives.

Anderson (1979) is generally considered to be the first scholar to develop a theoretical foundation for the gravity equation. He assumed that the simplest gravity model is rooted in a rearrangement of a Cobb-Douglas expenditure system, and constructed the pure expenditure system model. He worked out the simplest form of gravity model:

$$M_{ij} = \frac{Y_i Y_j}{\sum Y_j}$$

When assuming that every country is specialized in the production of its own good, and has the same preference on the same product. Where M_{ij} denotes the imports of product i from country j, Y_i and Y_j are income in country i and country j. Then Anderson expanded the pure expenditure system model to more sophisticated situations, when there are many tradeables in each country, and tariffs and transport costs exist.

Bergstrand (1985) asserted that the traditional gravity model is missspecified because it omits price variables. He also pointed out that the gravity model could be derived from a general equilibrium trade model by making “certain simplifying assumptions” (Bergstrand, 1985). By including price variables, he derived the gravity equation from a partial equilibrium subsystem of general equilibrium trade model when the competition between each country is imperfect.

Although former studies incorporated GDP in gravity equations, they omitted per capita incomes and population, and did not link gravity equation and factor-proportions theory of trade (Bergstrand, 1989). Therefore, Bergstrand (1989) contributed the improvement of the theoretical foundation of gravity model based on one of the famous trade theories - Heckscher-Ohlin theory. He also interpreted exporter income and per capita income as national output in terms of units of capital and the country’s capital-labor endowment ratio, respectively, by using a two-factor, two-industry, and N-country Heckscher-Ohlin-Chamberlin-Linder model.

Deardorff (1998) showed that the gravity equation could be derived from two cases of Heckscher-Ohlin theory, both frictionless trade condition and impeded trade condition.

Based on the work of Anderson (1979) and Deardorff (1998), Anderson and Wincoop (2003) added “multilateral resistance” terms - which is the average trade barriers - into gravity equation, improving the theoretical foundation. They also resolved the “border puzzle” raised by McCallum (1995) by applying the theoretical gravity model, pointing out the “border coefficients" are not that high as McCallum (1995) asserted. Anderson and Wincoop (2003) argued that, it is very important to include multilateral resistance terms into the gravity equation. Otherwise, the regression estimates will be biased. Anderson and Wincoop (2003) also suggest an alternative method: replace the multilateral resistance terms with country-specific dummy variables, i.e. using fixed effects by exporter i and importer j, and estimate by ordinary least square method.

Although the gravity model developed by Anderson and Wincoop (2003) is theoretically consistent, Baier and Bergstrand (2007) asserted that there exists an endogeneity problem, resulting from unobserved heterogeneity in trade flows between country pairs. For example, some policy-related barriers such as tariffs and domestic policies in the error terms may be correlated with trade flows. Silva and Tenreyro (2006) show a simple way to deal with this problem. They propose that under weak assumptions – essentially just that the gravity model contains the correct set of explanatory variables – the Poisson pseudo-maximum likelihood estimator provides consistent estimates of the original nonlinear model.

4. Model Specification and Data

4.1 Model Specification

The gravity model could explain how the volume of trade between two countries is affected by some factors like GDP and distance. I will include the dummy variables whether the countries operate in the same regional trade agreements. Exchange rate and price are also included in the gravity model. Usually, the gravity model is estimated for trade (imports plus exports), but I will follow the method of Zhang and Li (2009) and apply it only to the US's tilapia imports.

The model is specified in the log linear form as follows:

$$lnMV_{it} = \alpha_0 + \alpha_1 lnGDP_{it} + \alpha_2 lnGDP_t + \alpha_3 lnDIST_i + \alpha_4 lnP_{it} + \alpha_5 lnER_{it} + \alpha_6 DUMI_i + \varepsilon_{it} \quad (1)$$

where i denotes the exporter and j denotes the importer.

where MV_{it} is the value of U.S. imports of tilapia from country i in year t deflated by the U.S. CPI; GDP_t is the gross domestic product of the United States in year t deflated by the CPI; GDP_{it} is the gross domestic product of exporter i in year t deflated by exporter i's CPI; $DIST_i$ the distance in kilometers between the United States and exporter i; P_{it} is the average production price of tilapia country i in year t deflated by exporter i's CPI; ER_{it} is exporter i's real exchange rate in year t (exporter's currency unit per US currency unit) ; DUM_i is a dummy variable that takes the value of 1 for Asian countries (China, Taiwan and Thailand) and 0 otherwise; ε_{it} is a random disturbance term that is assumed to be normally distributed.

Because the United States and its exporters have no common borders, languages and colonies, I did not include these variables which are often included in traditional gravity equations.

If an exporting country has the higher level of GPD, the country's supply potential is stronger. The country exports more, which places downward pressure on price. A lower price increase demand in the importing country. Therefore, I would expect that the coefficients of GDP_i to be positive. An isolated increase in US GDP is expected to increase the US demand for imported tilapia. Hence, I expect GDP_j to be positively related to import value.

Longer distance would increase the trade cost. According to Loungani, Mody and Razin (2002), distance increases not only transportation costs, but also the information and search cost. The volume of trade should thus probably decrease between them. So I would estimate the coefficient of variable $DIST_{ij}$ is negative.

The production price decreases, meaning the production cost decreases. So, the products are more competitive. The exporter can export more goods. Thus, the coefficient of P_i is expected to be negatively related to import value.

The increase of exchange rate means the US dollar has strengthened. This makes imports less expensive. With the maintained hypothesis that import demand for tilapia is price elastic, a stronger dollar that causes price to decline will increase import value. Therefore, I expect the coefficient of P_{ij} to be positive.

The United States has become a member of Asia – Pacific Economic Cooperation (APEC) since 1989. Its primary purpose is to facilitate economic growth and prosperity in the region. This may have a positive impact on United States' tilapia imports. Therefore, I expect that the coefficient of the variable $APEC$ is positively related to US's tilapia imports.

4.2 Data Description

The data covers tilapia products trade between United States and its major importing partners from 2003 – 2013. The imports from the major ten importing partners accounts for 98.7 percent of US's total tilapia imports in 2003 and 97.1 percent in 2013 (FAO, 2016). These partners are China, Taiwan province of China, Ecuador, Indonesia, Honduras, Costa Rica, Thailand, Brazil, Panama and El Salvador.

Table 1. Summary Statistics of Variables Used to Estimate the Gravity Model for U.S. Tilapia Imports, 2003-2013

Variable	Units	United States	China	Taiwan	Indonesia	Thailand
Import value ($1000)	11	68180	--	--	--	--
Export value ($1000)	110	--	414,272	41,432	54,170	6,660
GDP ($1000)	110	--	5,184,099,090	460,064,990	597,876,288	306,915,095
DIST (km)	10	--	11,183	12,155	15,535	13,936
Production Cost ($/t)	110	--	1,448	1,406	1,322	1,194
Exchange Rate	110	--	7.32	31.32	10583.18	35.68
APEC	10	--	1	1	1	1

Table 1 Continued

Variable	Ecuador	Costa Rica	Honduras	Brazil	Panama	El Salvador
Export value ($1000)	67,198	36,995	54,423	2,458	1,830	2,359
GDP ($1000)	65664729	33223531	14757551	1,738,653,919	27,930,509	20,128,018
DIST (km)	4,833	3,556	3,002	8,088	3,774	3,106
Production Cost ($/t)	2,688	7,823	2,543	2,448	1,733	45,829
Exchange Rate	26246.52	7823.89	20.93	2.33	1.03	8.96
APEC	0	0	0	0	0	0

The summary statistics of the variables are presented by country in Table 1. The data is used as a panel model. The trade data are collected from United States Department of Agriculture (USDA) from 2003 to 2013. The GDP data are from the Word Bank Development Indicators (Word Bank, 2016). Information on distance are collected from the Centre d'Etudes Prospective et d'Informations Internationales (CEPII). The production price of tilapia is collected from the National Marine Fisheries Service (NMFS). The exchange rate data are also from United States Department of Agriculture (USDA). All the variables except dummy variable take the natural logarithms. The values are deflated by the 2013 price.

5. Results and discussion

The equation (1) is estimated by using several different methodologies for the purpose of comparison: pooled OLS, fixed effects model, random effects model and Pseudo-Poisson Maximum likelihood method. The estimated results are given in Table 1. The Hausman test ratio suggest that random effects model is better than fixed effects model for this gravity model. The total number of observations are 110 for the import model.

The estimated coefficients of the pooled OLS model in Table 1 (column 2) suggest that independent variables – excepted for the variables of Importer GDP and production price – are statistically significant with expected signs and the goodness of fit of the model is reasonable good as the R square is 0.767. It shows that the coefficients of the variables of exchange rate and APEC are positive and increase the US tilapia imports from exporting countries. The US tilapia imports are positively affected by GDP of exporting countries and negatively affected by the distance between trade partners. The coefficient of GDP of the USA and the coefficient of production price of exporting countries are both negative. However, they are not statistically significant and the coefficient of US GDP is not consistent with the expectation.

The results of random effects method are consistent with the pooled OLS model in signs of the explanatory variables excepted for the variable of production price. But the magnitudes of the coefficients are different. This is because these variables pick up the effects of the intercept as well as those of the time-invariant variables (distance and APEC membership).

Used for correcting for heteroscedasticity, Pseudo-Poisson Maximum likelihood method has lots of desirable features for applying gravity model. First, it is consistent in the presence of fixed effects, which can be added in as dummy variables as in simple OLS; second, it is simple to interpret the coefficients from Poisson model, and follows the same pattern as under OLS model (Shepherd, 2012).

Compared with OLS model, the coefficient estimates are significantly different under Pseudo-Poisson Maximum likelihood method. For instance, the APEC coefficient is smaller in absolute value. The results suggest that there exists heteroscedasticity on the original OLS estimates.

Table 2. Regression Results for the Gravity Model

Variable	OLS	Random effects	Fixed effects	PPML
Constant	125.26**	50.41	-34.41	13.02**
	(61.95)	(56.65)	(55.77)	(6.02)
Exporter GDP	1.15***	0.67***	0.83	0.11***
	(0.10)	(0.25)	(0.52)	(0.01)
Importer GDP	-3.47	-0.63	0.85	-0.30
	(2.63)	(2.26)	(2.57)	(0.26)
Distance	-6.8***	-4.96***		-0.69***
	(0.53)	(1.60)		(0.05)
Production Price	-0.01	0.19	0.28	-0.001
	(0.26)	(0.19)	(0.20)	(0.02)
Exchange Rate	0.42***	0.38***	1.56	0.04***
	(0.03)	(0.11)	(1.12)	(0.003)
APEC	6.02***	5.34***		0.64***
	(0.46)	1.67		(0.07)
No. of Observations	110	110		110
R- Square	0.767	0.722	0.301	0.770

Significant at 10% level ** Significant at 5% level*** Significant at 1% level

Based on the results of the Pseudo-Poisson Maximum likelihood method in table 2, we can make the following inferences. As expected, the coefficients of exporter GDP is positive and increase tilapia imports to the United States. The estimated elasticity of the exporter GDP is 0.11 and is statistically significant, suggesting that the US tilapia imports will increase 11 percent to a one hundred percent increase in the exporter GDP. Therefore, the stronger the exporter economy, the more tilapia it exports to the US, and less tilapia it will consume domestically. However, the total effect on trade is small.

The coefficient of importer GDP is negative, but not statistically significant. The results are not consistently with the expectation. This may be because there is only one importing country. The results should be better if more importing countries could be added.

The distance variable has a coefficient of -0.69, suggesting that the United States is apt to import more tilapia products from economies with shorter geographic distance. In today's globalizing economy, trade cost still remains a barrier to international trade. Perhaps because the main exporter China has a very long distance to the United States, the magnitude of the distance variable is not large.

Under the maintained hypothesis that import demand is price elastic, the production price is expected to be negatively associated with the US tilapia import value, since an increase in price should decrease the value of imports from exporting countries. Nonetheless, the result shows that the production price in exporting countries does not have a significant effect on imports from these countries. The result is consistent with what Xing and Xu (2013) found.

The coefficient of exchange rate variable is 0.04, and statistically significant. The exchange rate here is in trade partner country's currency per US dollar. An increase in exchange rate means foreign currency devaluation, which makes tilapia imports from exporting countries less expensive, causing the US demand for tilapia products to increase. However, as the magnitude of the coefficient is small, the total effect of exchange rate on the US tilapia imports is limited.

From the table 1, we can see the coefficient of APEC variable is 0.64 and statistically significant at 1% level. As excepted, APEC variable is positively related to the US tilapia imports. The US is likely to import more tilapia products from APEC members. Being in APEC will increase total US tilapia imports about one third, which suggests the benefits of APEC liberalization are potentially substantial.

6. Conclusion

This paper uses the gravity model to investigate the determinants of US import value of tilapia from ten major exporters – China, Taiwan PC, Ecuador, Costa Rica, Honduras, Indonesia, Thailand, Brazil, Panama and El Salvador – over the period 2003 – 2013. The model includes variables such as the GDP of the exporters, the GDP of the United States, the distance between exporters and the US, exchange rate, tilapia price and dummy variable APEC.

The results show that the US imports of tilapia are positively affected by GDP of exporters and exchange rate. The access to Asia Pacific Economic Cooperation significantly increases US tilapia imports as well. The US GDP, distance and price have negative effects on tilapia imports. However, the production price variable and US GDP variable are not statistically significant.

References

Anders, S., & Caswell, J. A. (2006, July). Assessing the impact of stricter food safety standards on trade: HACCP in US seafood trade with the developing world. In Selected paper of the 2006 American Agricultural Economics Association Annual Meetings.

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

Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: a solution to the border puzzle. the american economic review, 93(1), 170-192.

Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade?. Journal of international Economics, 71(1), 72-95.

Bergstrand, J. H. (1985). The gravity equation in international trade: some microeconomic foundations and empirical evidence. The review of economics and statistics, 474-481.

Bergstrand, J. H. (1989). The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade. The review of economics and statistics, 143-153.

Chidmi, B., Hanson, T., & Nguyen, G. (2012). Substitutions between fish and seafood products at the US national retail level. Marine Resource Economics, 27(4), 359-370.

Deardorff, A. (1998). Determinants of bilateral trade: does gravity work in a neoclassical world?. In The regionalization of the world economy (pp. 7-32). University of Chicago Press.

Disdier, A. C., & Marette, S. (2010). The combination of gravity and welfare approaches for evaluating nontariff measures. American Journal of Agricultural Economics, 92(3), 713-726.

Eichengreen, B., & Irwin, D. A. (1998). The role of history in bilateral trade flows. In The regionalization of the world economy (pp. 33-62). University of Chicago Press.

Fitzsimmons, K. (2000). Future trends of tilapia aquaculture in the Americas. Tilapia aquaculture in the Americas, 2, 252-264.

Fitzsimmons, K., Martinez-Garcia, R., & Gonzalez-Alanis, P. (2011). Why tilapia is becoming the most important food fish on the planet. BETTER SCIENCE, BETTER FISH, BETTER LIFE, 8.

Fitzsimmons, K. (2013). Latest trends in Tilapia production and market worldwide. World Aquaculture Society, Rio de Janeiro.

Harvey, D. J. (2002). In 2002, aquaculture volumes higher, but prices depressed. Aquaculture outlook.

He, C., Quagrainie, K. K., & Wang, H. H. (2013). Determinants of shrimp importation into the USA: an application of an augmented gravity model. Journal of Chinese Economic and Business Studies, 11(3), 219-228.

Helpman, E. (1998). The structure of foreign trade (No. w6752). National bureau of economic research.

Hong, T. T. K., & Duc, N. M. (2009). Competition between us catfish and imported fish: a demand system analysis. Journal of Agricultural Science and Technology, 11, 111-118.

Josupeit, H. (2005). Tilapia Market Report–Tilapia imports soar in the US market. April. Globefish, FAO.

Josupeit, H. (2010). World supply and demand of tilapia. FAO. Serial: GLOBEFISH Research Programme (FAO). Rome, Italy.

Krugman, P. R. (1979). Increasing returns, monopolistic competition, and international trade. Journal of international Economics, 9(4), 469-479.

Ligeon, C., Bayard, B., Clark, J., & Jolly, C. (2007). US import demand for tilapia from selected FTAA countries. Farm & Business: The Journal of the Caribbean Agro-Economic Society (CAES), 7(1), 139-56.

Long, P. A. W. (2013). Effect of Institutional Distance on China's Export of Rare Earth: Data Analysis of 18 Countries and Regions' Trade Based on the Gravity Model [J]. Journal of International Trade, 4, 008.

Loungani, P., Mody, A., & Razin, A. (2002). The global disconnect: the role of transactional distance and scale economies in gravity equations. Scottish Journal of Political Economy, 49(5), 526-543.

McCallum, J. (1995). National borders matter: Canada-US regional trade patterns. The American Economic Review, 85(3), 615-623.

Nguyen, A. V. T., & Wilson, N. L. (2009). Are food safety standards weighing exports down? A theoretically-consistent gravity model approach on seafood exports to the EU, Japan and US. In

Paper submitted to the International Agricultural Trade Research Consortium Meeting, Ft. Myers, FL.

Norman-Lopez, A., & Asche, F. (2008). Competition between imported tilapia and US catfish in the US market. Marine Resource Economics, 23(2), 199-214.

Norman-Lopez, A. (2009). Competition between different farmed and wild species: The US tilapia market. Marine Resource Economics, 24(3), 237-251.

Ortega, D. L., Wang, H. H., Widmar, O., & Nicole, J. (2014). Aquaculture imports from Asia: an analysis of US consumer demand for select food quality attributes. Agricultural Economics, 45(5), 625-634.

Paas, T. (2000). Gravity approach for modeling trade flows between Estonia and the main trading partners.

Pace, K. M. (2011). EU import notifications as a protectionist move: an examination of the relation between tariff and non-tariff barriers in seafood trade (Doctoral dissertation, University of Illinois at Urbana-Champaign).

Rabbani, A. G., Dey, M. M., & Singh, K. (2011). Determinants of catfish, basa and tra importation into the USA: an application of an augmented gravity model. Aquaculture Economics & Management, 15(3), 230-244.

Silva, J. S., & Tenreyro, S. (2006). The log of gravity. The Review of Economics and statistics, 88(4), 641-658.

Shepherd, B. (2012). The gravity model of international trade: A user guide. ARTNeT Books and Research Reports.

Stewart, J. Q. (1942). A measure of the influence of a population at a distance. Sociometry, 5(1), 63-71.

Tinbergen, J. (1962). Shaping the world economy; suggestions for an international economic policy. Books (Jan Tinbergen).

Tran, N., Wilson, N., & Hite, D. (2013). 5 Choosing the Best Model in the Presence of Zero Trade: A Fish Product Analysis. In Nontariff Measures with Market Imperfections: Trade and Welfare Implications (pp. 127-148). Emerald Group Publishing Limited.

Wilson, N. L., & Bray, V. (2010, July). It happened all at once: switching regressions, gravity models and food safety. In AAEA, CAES, WAEA Joint Annual Meeting, Denver, Colorado.

XING, L. R., & XU, X. (2013). Analysis of the Import Demand for Tilapia in the US Market. International Economics and Trade Research, 11, 001.

Zhang, D., & Yanshu, L. I. (2009). Forest endowment, logging restrictions, and China's wood products trade. China Economic Review, 20(1), 46-53.

Kingsley, Z. G. (1949). Human behavior and the principle of least effort: an introduction to human ecology. Addison-Wesley Press.

Zipf, G. K. (2016). Human behavior and the principle of least effort: An introduction to human ecology. Ravenio Books.