Applied Studies in Agribusiness and Commerce – APSTRACT
University of Debrecen, Faculty of Economics and Business, Debrecen
DOI: 10.19041/APSTRACT/2021/1-2/5

SCIENTIFIC PAPER

ESTIMATION OF ARMINGTON ELASTICITIES: CASE OF VEGETABLES IN MONGOLIA

Amar Uuld[1], Robert Magda[2]
[1] Doctoral School of Management and Business Administration at Szent István University, Hungary
E-mail: amar.u@muls.edu.mn

[2] Faculty of Economic and Social Sciences, Institute of Economics, Law, and Methodology
in Szent István University, Hungary and North-West University, South Africa
E-mail: magda.robert@gtk.szie.hu

Abstract: *Mongolian people often consume meat more than vegetable in diet due to traditional nomadic culture. Nowadays, the Mongolian people's diet has been changing who consume more vegetables with associated urbanization (half of the population live in urban areas, mostly in the capital city). Even though vegetable consumption has been increased recently, the vegetable market is still a high reliance on imports and threatening national food security. Since 2016, the Mongolian government has especially paid attention to increasing vegetable's domestic production and substitution to import vegetables (Ministry of food and Agriculture, 2017). Therefore, this paper provided to substitution elasticity (the Armington elasticity) between import vegetables and domestic vegetables in Mongolia. Additionally, we estimated the home bias value of vegetables. The so-called Armington elasticities are widely used for computable general equilibrium (CGE) analysis, which determines a degree of substitution between import goods and domestically produced goods. Several of the authors studied Armington elasticities at the product level. We choose six vegetables (such as potato, garlic and onion, tomato, carrot and turnips, cabbage, and cucumber) related to lack of information. The empirical result shows that the Armington elasticities in the long-run higher than the short-run with exception of potato which means that products are similar in the long-run. However, our estimated Armington elasticities are quite lower than the previous studies result which means that Mongolian people indicated more prefer home growing vegetables than import vegetables. Moreover, we found that the home bias value is high in the short-run even long -run, this appears to be a higher relative weight on home vegetables.*

Keywords: *Vegetable, Armington elasticities, home bias value*
JEL Code: F13, Q17, Q18

INTRODUCTION

Vegetable has rich in vitamins and antioxidant which reduces the incidence of cardiovascular disease and improves metabolic activities. Mongolian people do not use much of vegetables in their daily diet. Based on the 2019 data from the National Statistical Office (NSO) of Mongolia, the monthly per capita consumption rates were about 2.6 kg/month for potatoes and 1.8 kg/day for vegetables, which is less than the 3.6 kg/month of potatoes and 7.2 kg/month of vegetables recommended by the national nutrition guidelines. Also, vegetable consumption is 6 times lower than the recommended intake by World Health of Organization (WHO) guidelines. However, vegetable consumption has been steadily increasing with respect to urbanization (because half of the total population lives in the urban area in Mongolia). For instance, the standard population per capita consumption has increased approximately 3 times between 1995 and 2019 (National Statistics Office of Mongolia, 2019). And vegetable consumption who live in the urban area is approximately 40 percent higher than the rural area's consumption. Mongolia has one of the highest incidences of cardiovascular disease (rank was #14 in the world, 2019), which is also the country's leading cause of death. One of the main reasons is lower fruit and vegetable consumption to increase the risk of noncommunicable diseases (www.who.org).

Mongolia is a net importer of vegetables, and government policy is focusing on import substitution and increasing domestic production (Asian Development Bank, 2020). After a political and economic transition time, the crop sector has dropped, which was causing increasing vegetables import to supply excess demand of the population. After a massive collapse, the Mongolian government paid attention to this recession, the crop sector was substantially revived through a national program that was titled the "Third Land Rehabilitation" and implemented between 2008 and 2010. As a result of this program, we became self-sufficient in wheat and potato production. But until now, the vegetable market is a high reliance on vegetable imports such as a self-sufficient rate was approximately 50 percent (National Statistics Office of Mongolia, 2019). In recent years, many projects have been implementing in the vegetable market especially, focusing on the increase of vegetables domestic production and improving the market value chain funded by (Asian Development Bank, 2020), Japan Fund for Poverty Reduction, (2017), SDC, (2015), USAID, (2014), SECim, (2016). One of the good examples was the "Mongol potato" program implemented by the Swiss Development Cooperation (SDC). After implemented the "Mongol potato" program, in 2016, the SDC has started a new project for developing and improving the quality of vegetable seed production.

Last fifty years, international economists have modeled substitution between domestic and imported goods in consumption (called the Armington elasticity (Armington, 1969)). More specifically, Armington elasticity is a key parameter commonly used in e.g. international trade models and measures the degree of substitution between imported and domestic goods due to changes in the relative price of those goods. Most of the previous studies have made Armington elasticity estimation on industry-level data (Olekseyuk and Schürenberg-Frosch, 2016), (Gallaway, McDaniel, and Rivera, 2003), (Blonigen. A and Wilson. W, 1999), (Reinert and Roland-Holst, 1992),. But some of the authors (Wunderlich and Kohler, 2018), (Kapuscinski and Warr, 1999), (Song, 2005), carried out on sub-industry level data especially, agriculture products using the Armington model. Nowadays, the Armington elasticity is widely used for impact analysis of policy changes (McDaniel & Balistreri, 2002). The purpose of this paper is to provide estimated Armington elasticities for selected vegetables in Mongolia. Additionally, we try to estimate a home bias value using (Blonigen. A and Wilson. W, 1999) approach. The paper is organized as follows. The next section indicates material and methods (including theoretical background, econometric specification, and data), section 3 provides the result and the last section presents the conclusion.

MATERIALS AND METHODS

Theoretical background

Since the seminal work conducted by (Armington, 1969), called Armington elasticities has been widely used in international trade theory and trade policy. He formulated theory of substitution elasticity with related to consumer preference. This theory based on consumer distinguish different varieties of goods by country of origin and obtain variables satisfaction depending on the country from which is imported. In other words, the Armington elasticities provide the degree of substitution demand between homogenous products of import and domestically produced. He explained that the procedure to analyze trade elasticities in products using two kind of products such as machinery and chemicals produced in two different countries. Armington made two major assumptions. First, buyer or importing country's substitution elasticity is constant without considering the share of a product. Second, a single substitution elasticity for each product pair within a market. Also, he supposed a two-stage procedure, assuming that at the first stage, buyer or importing country decides on the total quantity to buy to maximize utility and then allocates portion of the total quantity to individual suppliers in order to minimize the costs. Armington elasticity presents a degree of substitution between products imports and produced domestically. If elasticity is higher, it indicates that domestic products are easier to substitute with import products. In other words, these two products are a fairly homogenous product for consumers. Conversely, a low value of substitution elasticity means that the two products are dissimilar and weak substitute. The traditional trade theory is indicated on the assumption of perfect substitution between import and domestically produced products. But Armington model based on imperfect substitution products that are differentiated not only by their kind, but also by their production place.

An early application of Armington model in agriculture trade analysis were Ronald A. Babula (1987), A Julian M. Alston, Colin A. Carter, Richard Green, and Daniel Pick (1990), Shoichi Ito, Dean T. Chen and E. Wesley F. Peterson (1990) et al. After that, many researchers (Wunderlich & Kohler, 2018), (Olekseyuk & Schürenberg-Frosch, 2016), (Lundmark & Shahrammehr, 2011), (Kawashima & Puspito Sari, 2010), (Welsch, 2008), (Gallaway et al., 2003), (Elena & Emilio, 2002), (Blonigen.A & Wilson.W, 1999), (Reinert & Roland-Holst, 1992) have studied to use the Armington model in comprehensive industry level. In addition, it has been used in computable general equilibrium (CGE) model such as, (Olekseyuk & Schürenberg-Frosch, 2016), (Németh, Szabó, & Ciscar, 2011), (Ha, Soo Junga, Hewings, Geoffrey, and Turner, 2009), (Kerkelä, 2008), (Zhang, 2006) et al. Therefore, sub-industry level estimates of Armington elasticities have appeared in forest and agriculture sector. For example, (Wunderlich & Kohler, 2018), (Barkaoui et al., 2011), (Lundmark & Shahrammehr, 2011), (Song, 2005), (Elena & Emilio, 2002), (Kapuscinski & Warr, 1999), et al. One of the systematic review papers has been provided by (McDaniel & Balistreri, 2002) have pointed out some findings with respect to Armington elasticities based on previous studies. They found that three robust findings from the econometric literature.

First, long-run elasticities are larger than short-run elasticities. Previous studies results showed that long-run elasticities are higher than short-run elasticities which means that there is no discrimination between domestically produced and imported goods in long-run compared to short-run.

Second, more disaggregate analyses are higher elasticity. This findings confirmed by (Németh et al., 2011), (Ha, Soo Junga, Hewings, Geoffrey, and Turner, 2009), (Welsch, 2008) et al. Most of the Armington elasticities estimates have appeared using disaggregated data confirmed by (Gallaway et al., 2003), (Gibson, 2003), (Tourinho H.Kume, 2003), (Welsch, 2006), (Feenstra, Luck, Obstfeld, & Russ, 2016) et al.

Finally, elasticities used for time series analyses are smaller than used for cross-sectional analyses. Most of the Armington estimates are using single country and time series data and there is a few number studies of cross section data or panel data analysis such as using panel data analysis in European countries (Olekseyuk & Schürenberg-Frosch, 2016), (Welsch, 2008) et al. Armington elasticities estimation studies provide very different results depending on country, estimation method, data types (time series, cross section or panel data) and industry level (aggregation or disaggregation level).

In addition, (Olekseyuk & Schürenberg-Frosch, 2016) mentioned that one findings - micro elasticity find higher than macro elasticity. Armington macro elasticity of substitution indicates that between import and domestic products, while micro elasticity of substitution shows that between different import source (Aspalter, 2016). Macro elasticities are lower than micro elasticities such as, (Németh et al., 2011) have been to estimate the European countries industrial sectoral elasticities of the two nesting models (substitution between domestically produced products and imported products-macro elasticity; substitution between imported goods according to the country of origin-micro elasticity). They found that macro elasticities are lower than micro elasticities in European countries. The work of Robert C. Feenstra, Philip Luck, Maurice Obstfeld, and Katheryn N. Russ has identified micro and macro elasticities in U.S disaggregate data between 1992 and 2007. Also, they indicated macro elasticities are lower than micro elasticities. Indeed, (Olekseyuk & Schürenberg-Frosch, 2016) mentioned that micro elasticity is higher than macro elasticity is related to countries technology characteristics and trading partners.

Armington elasticities estimation studies provide very different results depending on country, estimation method, data types (time series, cross section or panel data) and industry level (aggregation or disaggregation level). We tried to classify Armington elasticities studies based on industry level. Table 1 shows that review results of some studies. There are including proxy studies of U.S data case, Philippines data case, South African data case, Brazilian data case and European countries cases. Interestingly, the Armington estimates for agriculture, forestry and fishery, food, beverages, tobacco, textile, wearing apparel, clothing, coke, steel, petroleum, transport vehicles and equipment's elasticities found to be import elastic (approximately average elasticity coefficient $\sigma \geq 1$), while rubber and plastic products, wood and paper products, metal and chemical products, machinery including electronical equipment's elasticities were considered moderately import sensitive (Table 15, approximately average elasticity coefficient $0.5 \leq \sigma < 1$).

A.C. Wunderlich and A. Kohler (2018) mentioned that Armington elasticity for agriculture sectors is lower than other sectors especially, investment and high-added value sectors. Therefore, they discussed that this fact might be due to home bias. Because most of the countries implement many programs to buy home produced products such as to protect for home produced production. In other word, there is might be increase differentiation between import and home produced products. A number of studies have identified explaining variables for the different elasticities across the industries. For instance, A.Blonigen and Wilson.W (1999) attempted to explaining differences in Armington elasticities across industries in U.S. The authors choose the explanatory variables using three specifications: First, variables reveal discrimination of current products second, variables that show multinational companies role in U.S market and finally, variables as a proxy for political and economic variables. They defined nine explanatory variables are ratio of industry imports from developing countries, ratio of industry shipments for final consumption, ratio of industry owned by foreign parent, ratio of downstream industrial consumers owned by foreign parent, downstream importers, median firm size, dummy variables for industry to protections and ratio of union workers in industry. Empirical results have found that one of the strong variables affecting to substitution elasticity between domestic and import products is presence of foreign-owned industries. Also, there is another U.S case of (Elena & Emilio, 2002). Authors described three variables which are advertising cost for each industry, foreign direct investment and the percentage of total output sold to final consumers. They found that foreign firms more efforts to affecting greater substitutability between foreign and domestic goods. Therefore, consumers willing to buy domestic products due to domestic firms are more spending cost on advertising.

A number of recent studies have estimated Armington elasticities at an industrial level and computable general equilibrium (CGE) related with trade terms effect. (Welsch, 2008), (Lloyd & Zhang, 2006), (Zhang, 2006), (Schürenberg-frosch, 2015), (Olekseyuk & Schürenberg-Frosch, 2016), have pointed out elasticities of substitution with respect to CGE model. Armington elasticities are widely used in computable general equilibrium (CGE) models. CGE models are a class of economic models that use actual economic data to evaluate how an economy may respond to changes in policy, technology or other external factors. CGE models have turned into a valuable instrument in analyzing a number of fluctuated trade policy issues. These models have been utilized to study the economic impacts of trade policies, such as tariffs and non-tariff barriers (NTBs), also the impact of trade liberalization on an economy, in an assortment of settings (Blonigen.A & Wilson.W, 1999). CGE models are valuable to model the economies of countries for which time series data are rare or not significant, which might be because of disturbances such as regime changes. Substitution elasticities in policy-oriented computable general equilibrium (CGE) models are key parameters for model outcomes since they define to conduct in these models. These elasticities are well known for their critical role in defining model outcomes.

Armington elasticity has become increasing popular in agricultural trade analysis (Wunderlich & Kohler, 2018), (Zeraatkish, Rashidi, & Rashidi, 2018), (Song, 2005), (Elena & Emilio, 2002), (Ito et al., 1990) and (Lundmark & Shahrammehr, 2011) for forest sector. (Wunderlich & Kohler, 2018), study aim is to provide a simple estimation method that is in line with the majority of computable general equilibrium models, and particularly one that is in accordance with the Common Agricultural Policy Regionalized Impact (CAPRI) model in Switzerland some agricultural products group, in order to improve the ex- ante predictive power of the implications of policy measures for example, free trade agreements. This study result shows that estimation of substitution elasticities of some agricultural products such as apple, pears, potatoes, tomatoes, vegetables, yogurt, curd and fresh milk products in short-run and long-run term. Some products, for example apple, tomatoes and vegetables' substitution elasticities does not define in long-run term. Overall, most of the products' elasticities lower than before studies for example elasticities ≤0.5, it means that consumers indicate more preference for domestic products than importing products in Switzerland.

Table 1. Armington elasticities range from some empirical results

Industries name	(Reinert & Roland-Holst, 1992)	(Kapuscinski & Warr, 1999)	(Gallaway et al., 2003)	(Gibson, 2003)	(Tourinho H.Kume, 2003)	(Welsch, 2008)	(Olekseyuk & Schürenberg-Frosch, 2016)
Agriculture, forestry and fishery products	0.35-1.99	0.2-3.8	-0.07-1.69	1.27	2.68-3.18	0.08-1.41	–
Manufacturing sectors (Food, beverages, tobacco)	0.02-3.49	0.03-1.07	-0.27-3.13	0.94-1.57	0.95-2.47	0.05-0.85	1.3-1.9
Manufacturing sectors (textile, clothing and leather products)	0.45-2.53	0.03-0.1	0.08-1.61	1.16-2.04	0.15-2.34	0.16-1.49	1.2-1.4
Mining, coke, petroleum, gas and fuel	0.16-1.22	3.06	0.15-1.18	0.73-2.77	0.38-0.6	0.39-0.92	0.6-0.8
Wood and paper products	0.05-1.68	0.03-0.7	0.39-1.54	0.08-1.21	0.51-1.58	0.21-0.42	0.02-2.95
Rubber and plastic products	0.01-1.71	–	0.34-1.22	0.27-1.14	1.08-1.22	0.05-3.16	0.56-0.89
Metal and fabricated metal products	0.22-3.08	0.16-0.42	0.35-1.21	0.59-0.74	0.47-0.51	0.004-0.91	0.57-1.25
Chemical products	0.4-0.67	–	0.71-1.18	0.67-0.79	0.58-1.51	0.12-1.88	0.87-0.88
Machinery and equipment	0.2-1.06	–	0.18-1.21	0.49-0.74	1.84	0.22-2.43	0.92
Electronic, computer, optical and electrical equipment	0.02-2.69	1.56-2.05	0.2-1.38	0.44-1.43	0.18-0.2	0.41-1.49	0.2-0.59
Transport vehicles and equipment	0.3-1.73	1.04-2.04	0.46-1.66	0.86	0.19-5.28	1.54-1.85	1.13-1.41

Source: Own description based on previous studies

(Zeraatkish et al., 2018) they studied substitution elasticity of Armington and transmission elasticity in fishery products in Iran. The study results showed that Armington elasticity in the long-term was greater than that in the short-term and the prices of these products have been influenced by global prices and the swings in global prices can be transported all the more effectively to the internal market for these products in the long-term than in the short-term. For the fishery products, whose import demands are elastic to import prices, it is expected that the decline of import prices by tariff reduction results in the expansion in import demands, and afterward the loss of domestic production of these products. In this way, the policies for these sectors should be the ones that help to rebuild these sectors instead of the ones bringing about the abundance supply.

(Abiodun Akintunde Ogundeji, 2007), the study was to estimate Armington elasticities for selected agricultural products in South Africa. The products considered in the study, as specified under the harmonized system, were meat of bovine animals (fresh or chilled), meat of bovine animals (frozen), meat of swine (fresh, chilled or frozen), maize or corn, wheat, soybeans (broken or not broken), and sunflower seeds (broken or not broken). The result indicates short-run elasticities range from 0.60 to 3.31 and long-run elasticities range from 0.73 to 3.21. Considering the long-run elasticity results, meat of bovine animals (frozen) is the most import-sensitive product followed by maize, meat of bovine animals (fresh or chilled) and sunflower seed, while wheat and the meat of swine (fresh, chilled or frozen) are the least import- sensitive products. Regarding short-run elasticities, soybeans are the most import- sensitive product followed by the meat of bovine animals (fresh or chilled), while the meat of swine (fresh, chilled or frozen) is the least import-sensitive product. The study also considered seasonality of agricultural products by including dummy variables in the estimated equations. Dummy variables for livestock products were found to be statistically insignificant, except for quarter four for meat of swine (fresh, chilled or frozen).

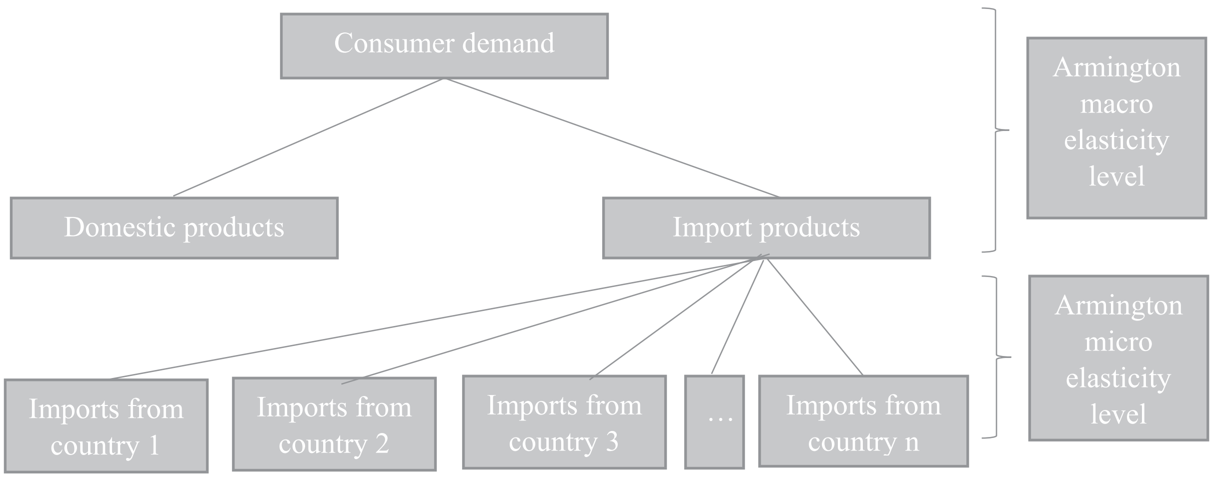
(Song, 2005), studied econometric estimates of import-demand elasticities for the agricultural sectors in Korea using the data classified following HS (Harmonized System) from five aggregated agricultural sectors (grains, livestock products, dairy products, fruits, and vegetables) to 27 disaggregated agricultural sectors using Armington specification. This specification regarded as an adequate approximation of the functional form of import-demand equation. Based on Armington approach, it is assumed that consumers distinguish goods by their source, which means consumer differentiated between domestic goods and their imported goods. The study used two estimation methods. One was the ordinary least squares (OLS) with first-order autoregressive correction (AR (1)) and the second method was the two-stage least squares (2SLS) with first-order autoregressive correction (AR (1)). The study result showed that both domestic and import prices rarely affect import-demands in the aggregated level except in the sectors of vegetables and livestock products. In the disaggregated level, import demands of the products that are classified as livestock products tend to be highly elastic to import prices. A special feature of these products such as vegetable's domestic price elasticity smaller than import price elasticity. But disaggregate level, for garlic, import demand was highly elastic to domestic price. Thus, the difference between import price and domestic price of garlic is very significant in determining the import demand of garlic. This implies that relative price of garlic affects the import demand of it. Therefore, cabbage and onion's import price elasticity was greater than domestic price elasticity, carrot, corm's import price elasticity was smaller than domestic price elasticity.

(Elena & Emilio, 2002) estimated Armington elasticities for 40 4-digit S.I.C food manufacturing industries in U.S and explained variables affecting to difference elasticities across industries. Using time series data between 1977 and 1992, they obtained seven food manufacturing industries. Elasticities were estimated between 0.09 for wines, brandy and spirits and 5.93 for soybean oil mills. In other word, elasticities result showed that quite large. Therefore, they determined explanatory variables in differentiation elasticities across industries following Blonigen and Wilson (1999) approach. The authors concluded foreign firms efforts for downstream producers and foreign direct investments are affecting to greater substitutability between foreign and domestic goods.

Econometric specification

Based on the Armington approach, the structure of Armington demand has succinctly described by following figure 1. In other words, consumer demand constitutes domestic products and import products. In the Armington model, consumers have a two-stage budgeting process. In the first stage, consumers (or importing country) decide between domestically produced and imported products (macro elasticity), and in the second-stage, imported products are differentiated by country of origin (micro elasticity). In the following (Armington, 1969), much of the occurring literature in assuming that consumer utility is given in the form of a constant elasticity of substitution (CES) sub-utility function in order to model the demand for domestic and imported product.

Figure 1. Structure of Armington demand



Source: (Wunderlich & Kohler, 2018)

If consumers are to be satisfied, demand functions state relationships that must exist among specific variables. Consumer satisfaction depends on getting the most for their money, given the available selection of products and their prices. Demand functions may along these lines be seen as statements of conditions under which an index of consumer's satisfaction is high as restricted incomes and given prices permit (Armington, 1969).

The elasticity of substitution between home goods and import goods can be derived from the two-stage budgeting process. In the first stage, the consumer determines the total quantity to buy to maximize the utility. In the second stage, the consumer allocates a share of the total quantity to the individual supplier in order to minimize the costs. We assume that consumer maximizes sub-utility U, who use domestic products and foreign products at the same time and same products. Our CES (Constant elasticity of substitution) sub-utility function is based on (Blonigen. A and Wilson. W, 1999) approach (also used in (Wunderlich & Kohler, 2018)) follow as:

$$U = (\beta M^{\frac{\sigma-1}{\sigma}} + (1-\beta) D^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}} \quad (1)$$

Where *U* is consumer sub-utility, *M* is *the* quantity of import goods, *D* is *the* quantity of domestic goods, β is a parameter that weights the import good relative to domestic good, π is the elasticity of substitution between imports and domestic goods. Additionally, we assumed that the CES sub utility function is homothetic that is means the share of income spent on domestic and imported goods does not change with income. Utility maximization of equation (1) yields the following first-order condition is given by:

$$\frac{M}{D} = [\frac{\beta}{1-\beta} \cdot \frac{P_D}{P_M}]^{\sigma} \quad (2)$$

Where P_D is the price of domestic goods, P_M is the price of import goods. Taking natural logarithm yields:

$$\ln(\frac{M}{D}) = \sigma \ln(\frac{\beta}{1-\beta}) + \sigma \ln(\frac{P_D}{P_M}) \text{ or } \ln(\frac{M}{D}) = a_0 + a_1 \ln(\frac{P_D}{P_M}) + \varepsilon \quad (3)$$

Equation (3) is our general econometric estimation model, where $a_0 = \sigma \ln(\frac{\beta}{1-\beta})$, a_1 is short-run substitution elasticity. We can calculate a home bias using substitution elasticity following as $1-\beta = \frac{1}{1+\exp(\frac{a_0}{a_1})}$. The short-run Armington elasticity can be derived directly from the relative price. However, long-run elasticity can be derived from three different ways (McDaniel & Balistreri, (2002), Wunderlich & Kohler, (2018)). First, our data (time series of quantity and price series) are stationary log-level data I(0), we estimate using the parsimonious geometric lag model (eq. 4) which is easy to extract short-run and long-run estimates. In other words, if $0<a_2<1$ is long-run elasticity can be estimated $\sigma^* = \frac{a_1}{1- \ 2}$.

$$\ln(\frac{M}{D})_t = a_0 + a_1 \ln(\frac{P_D}{P_M})_t + a_2 \ln(\frac{M}{D})_{t-1} + \varepsilon \quad (4)$$

Second, if data are both stationary I(1) and cointegrated, we use a single-equation error correction model that determines the long-run elasticity (equation 5 is unrestricted error correction model).

$$\Delta\ln(\frac{M}{D})_t = a_0 + a_1 \Delta\ln(\frac{P_D}{P_M})_t + a_2 \ln(\frac{M}{D})_{t-1} + a_3 \ln(\frac{P_D}{P_M})_{t-1} + \varepsilon \quad (5)$$

Finally, our data are stationary I(1), but not cointegrated or one series is stationary, we able to determine only short-run Armington elasticity. However, we determine short-run elasticity using the following equation.

$$\Delta\ln(\frac{M}{D})_t = a_0 + a_1 \Delta\ln(\frac{P_D}{P_M})_t + \varepsilon \quad (6)$$

Data

We estimate the substitution macro elasticity (see figure 11) and use time-series data series. We need to require four data series which are vegetables import and domestic production and the prices of those products. We choose the following vegetables due to a lack of information. These vegetables were potato, tomato, garlic and onion, cabbage, carrot and turnips, and cucumber. We use the yearly data of the National statistical yearbook, Customs yearbook (https://customs.gov.mn/statistics/, Harmonized System (HS) code was 07 categories products), and Mongol Bank (Central bank of Mongolia) yearbook data from 1995 to 2019 (Table 17). All quantities are given in a thousand tons and prices in real (base period was chosen 2015 values) MNT (Mongolian currency tugrik) per ton. Vegetables domestic production quantity was collected from Statistical yearbook for the Agriculture sector, Mongolian Statistical yearbook, and www.1212.mn official statistical website for each product. (Wunderlich & Kohler, 2018) have estimated Armington elasticities using scanner price which measured in retail stores barcode scanner. Thus, we are able to use retail price for domestic vegetables which is published by National Statistical Offices (NSO). Furthermore, vegetable import quantity gathered from Customs yearbook for each product. The import unit price was calculated as the ratio between the customs value of these vegetables and quantity multiplied by the exchange rate. In other words, the import price for each vegetable constructed from: $P_M = \frac{\sum Customs\ value\ of\ each\ prodct}{import\ quantity\ of\ each\ product} \cdot exchange\ rate$. The annual exchange rate data is used for converting US $ to MNT. The final step is all prices converted to real prices using Laspeyres index.

RESULTS AND DISCUSSION

According to the general econometric model equation (3), we estimated Armington elasticities for vegetables in Mongolia. We choose six types of vegetables namely potato, tomato, garlic, and onion, cabbage, carrot and turnips, and cucumber with related to the lack of data. But these vegetables were commonly used in the household diet. To estimate elasticities was to check whether our time series data are stationary and integrated. Indeed, if our data are stationary or the same integrated of order log level I(0) or one I(1), it is possible to determine the relationship between these two variables in the long-run. Additionally, the cointegration relationship is defined by the Engle-Granger test. The Engle-Granger test is only valid that all variables are I(1). In other words, two variables are integrated into the same order but non-stationary (please see empirical specification).

Prior to estimation, we tested data stationery or integrated using Augmented Dickey-Fuller (ADF) test. Non-stationary variables imply the risk of spurious regression unless they are cointegrated. An ADF test for identifying the order of integration for the price and quantity ratio is conducted to determine the order of integration. Most of the series are non-stationary, but integrated of order one, excluding garlic and onion (Table 2). For the cucumber series, two variables are not cointegrated, only one variable is stationary. Indeed, there is no long-run relationship between these two variables. Also, we tested the Engle-Granger test for integrated variables, we found a cointegrating relationship in other vegetables.

Therefore, we estimate elasticities for short-run and long-run using the approach of McDaniel & Balistreri, (2002).

Table 2. ADF test result

HS code	Name of vegetables	M/D	Pd/Pm
0701	Potato	I (1)	I (1)
0702	Tomato	I (1)	I (1)
0703	Garlic and onion	I (0)	I (0)
0704	Cabbage	I (1)	I (1)
0706	Carrot and turnips	I (1)	I (1)
0707	Cucumber	I (0)	I (1)

Source: 'Stata' result

Table 3 reports the estimation result of short-run and long-run substitution elasticities derived from the models (equation 4,5,6) described in the previous section. Of the six types of vegetables short-run elasticities, five vegetable elasticities had positive and significant at 1 %, 5 %, and 10 %. Cabbage's short-run elasticity was not significant. The mean value of the estimated average short-run elasticity of substitution is 1.32, with a significant range between 0.86 and 2.57. The average long-run elasticity is 2.21, with a range between 1.34 and 3.26. Our estimation results are vegetable's long-run average substitution elasticities approximately 2 times higher than short-run average elasticities. This finding is similar to one of the emerged findings from McDaniel & Balistreri, (2002). Also, this result confirmed from other authors' results such as Elena & Emilio, (2002) obtained a coefficient between 0.09 and 5.93 for food manufacturing industries, Abiodun Akintunde Ogundeji, (2007) estimates range between 0.6 and 3.31 for agriculture some products, Kapuscinski & Warr, (1999) indicated average elasticity of 1.5 for vegetables.

In reviewing the short-run elasticities, garlic, onion, and cabbage's elasticities were ≤ 1, it appears to be a quite difference between domestic and import goods. This means that substitution is becoming harder between these products in Mongolia. This result was reported by Wunderlich and Kohler, (2018) who obtained from fruits and vegetables especially, tomato's elasticities of substitution estimates are quite lower for Switzerland's some agriculture products. In other words, they concluded Swiss people exhibit a strong tendency to buy domestically produced products.

Table 3. Armington elasticities estimation result in the short and long run

HS code	Vegetable name	Short-run elasticity	Long run elasticity	Ad.R2	DW
0701	Potato	2.571**	1.343**	0.45	1.54
0702	Tomato	1.929**	3.26**	0.45	1.52
0703	Garlic and onion	0.858**	1.808**	0.32	2.01
0704	Cabbage	0.112	2.149	0.24	2.73
0706	Carrot and turnips	1.171***	2.471***	0.18	1.93
0707	Cucumber	-0.412*	-	0.12	1.97

*****, **, * -1%, 5%, 10% significance. DW- Darwin Watson**

Potato, tomato, garlic and onion, carrot, and turnips long-run substitution elasticities were estimated excluding cucumber. For the long-run elasticity, vegetables are tomato, garlic, and onion, cabbage, carrot, and turnips, long-run elasticities are higher than short-run elasticities. The higher elasticity of substitution in the long-run leads to more substitutability between domestic vegetables and imported vegetables. In other words, a greater elasticity indicates that consumers did not discriminate between domestic and imported vegetables and the consumers considered them the same. In this case, these vegetable imports will rise in the long-run in Mongolia. The only potato, import potato will decrease because short-run elasticity is higher than long-run elasticity. In other words, consumers more prefer domestic growing potatoes to import potatoes.

Table 4 shows the home bias value for vegetables in the short-run and long-run. According to the approach of Blonigen. A and Wilson. W, (1999), we calculated to home bias value using the Armington elasticities in the short-run and long-run. We found that all the vegetable home bias value was higher (1-β≥0.58), which suggested a higher relative weight on the home good in the short-run and long-run. The short-run home bias value was estimated higher than the import value in the short-run. In other words, consumers express a stronger preference for domestic vegetables for the short-run in Mongolia.

Table 4. Home bias value estimation result

Vegetable name	Short-run		Long run	
	Import share	Domestic share	Import share	Domestic share
Potato	21.6	78.4	7.8	92.2
Tomato	27.5	72.5	36.1	63.9
Garlic and onion	4.5	95.5	18.9	81.1
Cabbage	10.8	89.2	24.4	75.6
Carrot and turnips	11.2	88.8	3.8	96.2
Cucumber	41.1	58.9	-	-

Source: Own calculation

The long-run home bias value was estimated lower than the short-run value of all vegetables with the exception of potato, carrot, and turnips. For example, the tomato's home bias value is decreasing from 0.73 to 0.64 (Table 3). Our home bias value result indicates lower than the home bias estimation of Blonigen. A and Wilson. W, (1999). They primarily discussed home bias value with Armington elasticities and found that 66 percent of total industries take a higher home bias value of 0.85 or higher.

CONCLUSION

The substitution elasticity (Armington elasticity) is a key parameter of trade policy and helps policymakers. This paper provides the estimation of substitution elasticity between imported and domestically produced vegetables in Mongolia. Additionally, we calculated a home bias value of these vegetables. We choose six types of HS code vegetables (potato, tomato, garlic, onion, cabbage, carrot, turnips, and cucumber) due to data limitations. Our estimation result, most of the vegetables (excluding potato) long-run elasticity was higher than short-run elasticity which means that these products are not a perfect substitute. However, potato's substitution elasticity found that less elastic from the import. Also, we found that garlic, onion, and cabbage's elasticities were less than one in the short-run which found that these vegetables seem to be quite a heterogeneous product in the short-run. In the long-run, these indicated similar products (there is no discrimination) for consumers. Result of home bias value, consumers give weight to use domestic vegetables (average home bias value was 0.805 in the short run and 0.818 in long run). Overall, the Armington elasticity in the long-run is higher than the short-run, which means that applications of any policy are lead to support of imports in the long run.

REFERENCES

Abiodun Akintunde Ogundeji. (2007). Econometric estimation of Armington elasticities for selected agricultural products in South Africa, (November).

Armington, P. S. (1969). A Theory of Demand for Products Distinguished by Place of Production. *Staff Papers (International Monetary Fund)*, *16*(1), 159–178. https://doi.org/10.2307/3866403

Asian Development Bank. (2020). *Vegetable production and value chains in Mongolia*.

Aspalter, L. (2016). *Estimating Industry-level Armington Elasticities For EMU Countries*.

Barkaoui, A., Garcia, S., Lecocq, F., Delacote, P., Caurla, S., & Sauquet, A. (2011). Estimating Armington elasticities for sawnwood and application to the French Forest Sector Model. *Resource and Energy Economics*, *33*(4), 771–781. https://doi.org/10.1016/j.reseneeco.2011.04.001

Blonigen.A & Wilson.W. (1999). Explaining Armington: What determines substitutability between home and foreign goods. *Canadian Economics Association*, *32*(1), 1–21.

Elena, L. and, & Emilio, P. (2002). Estimates and Determinants of Armington Elasticities for the US Food Industry. *Journal of Industry, Competition and Trade*, 247–258.

Feenstra, R. C., Luck, P., Obstfeld, M., & Russ, K. N. (2016). In search of the armington elasticity, *100*(March), 135–150. https://doi.org/10.1162/REST

Gallaway, M. P., McDaniel, C. A., & Rivera, S. A. (2003). Short-run and long-run industry-level estimates of U.S. Armington elasticities. *North American Journal of Economics and Finance*, *14*(1), 49–68. https://doi.org/10.1016/S1062-9408(02)00101-8

Gibson, K. L. (2003). *Armington Elasticities for South Africa: Long- and Short-Run Industry Level Estimates. TIPS Working Paper 12-2003*.

Ha, Soo Junga, Hewings, Geoffrey, and Turner, K. (2009). Econometric Estimation of Armington import elasticities for regional CGE models of the Chicago and Illinois economies, 1–20.

Huchet, M., & Pishbahar, E. (2008). Armington elasticities and tariff regime : an application to European Union rice imports. *Journal of Agricultural Economics*.

Japan Fund for Poverty Reduction. (2017). *Mongolia : Community Vegetable Farming for Livelihood Improvement (Financed by the Japan Fund for Poverty Reduction)*.

Kapuscinski, C. A., & Warr, P. G. (1999). Estimation of Armington Elasticities : An Application to the Philippines. *Economic Modelling*, *16*, 257–278.

Kawashima, S., & Puspito Sari, D. A. (2010). Time-varying Armington elasticity and country-of-origin bias: From the dynamic perspective of the Japanese demand for beef imports. *Australian Journal of Agricultural and Resource Economics*, *54*(1), 27–41. https://doi.org/10.1111/j.1467-8489.2009.00477.x

Kerkelä, L. (2008). The Effect of Armington Structure on Welfare Evaluations in Global CGE-Models. Retrieved from ageconsearch.umn.edu/bitstream/6397/2/pp08ke20.pdf

Lloyd, J., & Zhang, X. G. (2006). *The Armington Model Staff Working Paper.*

Lundmark, R., & Shahrammehr, S. (2011). Forest biomass and Armington elasticities in Europe. *Biomass and Bioenergy*, *35*(1), 415–420. https://doi.org/10.1016/j.biombioe.2010.08.050

McDaniel, C. A., & Balistreri, E. J. (2002). *"A discussion on Armington trade substitution elasticities." US International trade commission*.

Mcdaniel, C., & Balistreri, E. (2002). A review of Armington trade substitution elasticities, (September).

Ministry of food and Agriculture. (2017). Mongolian vegetable program.

National Statistics Office of Mongolia. (2019). *Mongolian Statistical yearbook*.

Németh, G., Szabó, L., & Ciscar, J. C. (2011). Estimation of Armington elasticities in a CGE economy-energy-environment model for Europe. *Economic Modelling*, *28*(4), 1993–1999. https://doi.org/10.1016/j.econmod.2011.03.032

Olekseyuk, Z., & Schürenberg-Frosch, H. (2016). Are Armington elasticities different across countries and sectors? A European study. *Economic Modelling*, *55*, 328–342. https://doi.org/10.1016/j.econmod.2016.02.018

Reinert, K. A., & Roland-Holst, D. W. (1992). Disaggregated Armington Elasticities for the Mining and Manufacturing Sectors of the United States. *Journal of Policy Modeling*, *14*(5), 1–27.

Schürenberg-frosch, H. (2015). We couldn ’ t care less about Armington elasticities – but should we ? A systematic analysis of the influence of Armington elasticity.

SECim. (2016). *Current situation analysis of vegetable value chain in Mongolia*.

Song, W. (2005). Import Demand Elasticities for Agricultural Products in Korea, 1–30.

Swiss Agency for Development and Cooperation. (2015). Mongol potato program.

Tourinho H.Kume, A. C. de S. P. (2003). Armington elasticities for Brazil-1986-2002: New estimates. *Rio de Janiero, IPEA Discussion Paper*, (124).

USAID. (2014). *Vegetable value chain program in Mongolia*.

Welsch, H. (2006). Armington elasticities and induced intra-industry specialization : The case of France , 1970 – 1997, *23*, 556–567. https://doi.org/10.1016/j.econmod.2006.02.008

Welsch, H. (2008). Armington elasticities for energy policy modeling: Evidence from four European countries. *Energy Economics*, *30*(5), 2252–2264. https://doi.org/10.1016/j.eneco.2007.07.007

Wunderlich, A. C., & Kohler, A. (2018). Using empirical Armington and demand elasticities in computable equilibrium models : An illustration with the CAPRI model. *Economic Modelling*, (March), 1–11. https://doi.org/10.1016/j.econmod.2018.06.006

Zeraatkish, S. Y., Rashidi, F., & Rashidi, D. (2018). Estimate of Armington substitution elasticity for fishery products in Iran, *17*(3), 603–612. https://doi.org/10.22092/ijfs.2018.116681

Zhang, X.-G. (2006). *Armington Elasticities and Terms of Trade Effects in Global CGE Models*. *SSRN*. https://doi.org/10.2139/ssrn.883567