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ARMINGTON SUBSTITUTION ELASTICITIES FOR MAJOR AGRICULTURAL PRODUCTS IN MONGOLIA

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ABSTRACT
Since 2008, the Mongolian government was implemented campaign called "Atar 3" in order to reduce import demand for agricultural products and increasing domestic production. The "Atar 3" influenced for increase of crop production. Nowadays, food safety and sufficiency is considered very important and as well as the consumption of consumer goods has been increasing. Therefore, we need to have attention on the increase of the food production that meets the food hygiene standard, its production increase and fully supply of domestic consumption. Thus, I will do the research on ability to substitute the import by the domestic goods of Mongolia, the factors of domestic production increase, and in particularly the status of the legislation and legal environment for the sector of agricultural goods.
According to, the Trade Theory, it is possible to estimate substitution effect between imported goods and domestic production. This kind of study is pioneered by Armington(1969) developing the theoretical basis approach for agricultural trade elasticity.

KEY WORDS: *Armington model, elasticities, agricultural products, trade*

Introduction

In 1990, prior to the political and economic transition, agriculture sector was Mongolia's most important economic sector. Since 1990, the share of agriculture in GDP has been decreasing than mining sector.

The agricultural sector isone of the main sector in industries, agricultural sector's characteristic istraditional nomadic and pastoralist based, and considerably dependent on natural climate. Therefore, that sector is still important economic in Mongolia.

In 2016, agricultural sector produced 12.1 percent of total GDP, which of agricultural production is 80 percent of livestock sector and 20 percent of crop production. Currently, domestic production was enough to satisfy almost 100 percent of standard population's annual demand for meat and meat products, but milk, egg and other products (wheat, flour and vegetables) remain import demand. The cashmere, wool is processing, knitting for products of export.

Research objectives:*The main objective of the research paper aimed to identify the elasticity substitution of substitute the domestic major agricultural goods production for imported goods.*

In this paper, some agricultural products[A] are selected for the estimation due to lack of data for other products.

[a] – Some agricultural products are wheat, egg, milk, potato and vegetables.

Theoretical background

Armington (1969) originally developed the procedure to analyze trade in products such as chemicals under an assumption that there are no major trade restrictions. In his example, twenty suppliers of chemicals including the domestic suppliers sell in a market with no major barriers to imported products. In other words, the 'buyer' or the importing country only considers relative prices among the products from different suppliers. This restriction on the importer's behavior with respect to imported products leads to some technical problems in applying the Armington procedure for agricultural trade analyses. (Shoichi, T.Chen, & F.Peterson, 1990)

First, for Armington's first-stage equation, several problems specific to agricultural trade need to be addressed. For chemical products, which Armington used as an example, trade restrictions are generally "technical" with some cases of tariffs, and import quotas on chemical products are very few. Armington (1969) assumes that 'import demands are not residual demands depending upon domestic supply functions'. This is the reason why Armington constructed a demand function for all chemical products including both domestic and imported products in the first stage.(Armington.S, 1969)

Elasticity of Substitution is not only used for food products, but also agricultural production, mining and other industrial goods. There are many examples of successfully used CES function (David W. Roland-Holst, Kenneth A. Reinert, 1992; Alaouze, C.M., Marsden, J.S., and Zeitsch, J, 1977; Bilgic.A, King.S, Lusby.A and F.Schreiner, 2002; Alexandre Sauquet, Franck Lecocq, Philippe Delacoteb, Sylvain Caurlab, Ahmed Barkaouib, Serge Garciab, 2011; DonglanZha, Dequn Zhou, 2014; ZoryanaOlekseyuk, Hannah Schurenberg-Frosch, 2016; Chuantian He, Chunding Li, Jing Wang and John Walley, 2017).Many researchers have used empirical research in agricultural sector, mining sector and industrial sector products.

First time, we will explain about the CES function before explaining the model of Armington. In 1961, Arrow, Chenery, Minhas and Solowhave developed production function with constant elasticity of substitution (CES) as extension of Cobb-Douglas Function. It is possible to determine the optimal ratio of domestic production and imported goods.The CES function is shown below equation.

$$y = \gamma\left(\beta x_1^{-\rho} + (1-\beta)x_2^{-\rho}\right)^{-\frac{\nu}{\rho}} \qquad (1)$$

$y - output$
$x_1, x_2 - inputs$
γ *–parameter of productivity*
β *–share parameter*
ρ *–elasticity of substitution*
$\sigma = 1/(1+\rho)$
$\nu -$ *elasticty of productiondimension*

Leontief, Cobb-Douglas functions are special cases of the CES function. That is,

$\rho = 0$ *and* $\sigma = 1$ *is Cobb-Douglas function*
$\rho = -1$ *and* $\sigma = \infty$ *is linear function*
$\rho = \infty$ *and* $\sigma = 0$ *is Leontief function*

The special cases of CES function for example, that is $\nu=1, \gamma=1$ we get the CES function is shown below equation(2).

If consumers are to be satisfied, demand functions state relationships that must exist among certain variables. Consumers satisfaction entails getting the most for their money, given the available selection of products and their prices. Demand functions may thus be viewed as statements of conditions under which an index of consumers satisfaction is high as limited incomes and given prices permit. (Armington.S, 1969)

Armington attempts to differentiate products from different suppliers in a market. He employs a two-step procedure, assuming that at the first stage, a 'consumer' decides on the total volume to purchase, and at the second-stage, allocates portions of the total volume to individual suppliers in order to minimize the costs. (Shoichi, T.Chen, & F.Peterson, 1990)

For the first-stage equation is total demand cause from foreign and domestic products as the dependent variable.

We assume that consumer maximizes utility U, who use domestic products and foreign products at same time and same products.

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

Subject to (2)

$I = P_M M + P_D D$

U- consumer utility, each country

M- quantity of import goods

D- quantity of domestic goods

β - share of parameter

σ - elasticity of substitution

I - consumers income

P_D - price of domestic goods

P_M - price of import goods

The consumer's optimization problem when there are two goods, M and D. For the second-stage equation, Armington makes two main assumptions:

- The elasticity of substitution is constant regardless of the share of a goods
- There is a single elasticity of substitution between any pair of goods in the group. The two assumptions, which are together regarded as the 'single CES assumption,' allow us to reduce the number of coefficients to be estimated and make the estimation process easier.

Armington specifies the generalized CES form, we solve the optimization problem given by equations (2), we use the method of Lagrange multipliers. Which works as follows. We first write the "Lagrangian" for the problem.

$$\frac{\partial U}{\partial M} = \frac{\sigma}{\sigma-1}\left[\beta M^{\frac{\sigma-1}{\sigma}} + (1-\beta) D^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1} \cdot \frac{\sigma-1}{\sigma}\beta M^{\frac{\sigma-1}{\sigma}-1} = P_M \quad (3)$$

$$\frac{\partial U}{\partial D} = \frac{\sigma}{\sigma-1}\left[\beta M^{\frac{\sigma-1}{\sigma}} + (1-\beta) D^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1} \cdot \frac{\sigma-1}{\sigma}(1-\beta) D^{\frac{\sigma-1}{\sigma}-1} = P_D \quad (4)$$

Then, we will solve $\frac{P_M}{P_D} = \frac{\beta}{1-\beta}\left(\frac{M}{D}\right)^{\frac{-1}{\sigma}}$ (5)

Therefore, to see the implication from equation (5), we obtain ratio of domestic goods and import goods $\frac{M}{D} = \left[\frac{\beta}{1-\beta} \cdot \frac{P_D}{P_M}\right]^{\sigma}$ (6)

We taking equation (6) in natural logarithms on both sides leads to the regression function:

$$\ln\left(\frac{M}{D}\right)_t^d = \sigma \ln\left(\frac{\beta}{1-\beta}\right) + \sigma \ln\left(\frac{P_D}{P_M}\right)_t \quad (7)$$

Then,which gives us the condition for optimal ratio of import and domestic demand equation is shown below equation.

$$\ln\left(\frac{M}{D}\right)_t - \ln\left(\frac{M}{D}\right)_{t-1} = \gamma\left[\ln\left(\frac{\mathbf{M}}{\mathbf{D}}\right)_t^{\mathbf{d}} - \ln\left(\frac{M}{D}\right)_{t-1}\right] \quad (8)$$

Equation(7) is replaced by equation(8)which is established (9) equation.

$$\ln\left(\frac{M}{D}\right)_t = \gamma\sigma\ln\left(\frac{\beta}{1-\beta}\right) + \gamma\sigma\ln\left(\frac{P_D}{P_M}\right)_t + (1-\gamma)\ln\left(\frac{M}{D}\right)_{t-1} \quad (9)\text{or}$$

$$\ln\left(\frac{M}{D}\right)_t = a_0 + a_1\ln\left(\frac{P_D}{P_M}\right)_t + a_2\ln\left(\frac{M}{D}\right)_{t-1} \quad (10)$$

Hence, we see that $a_0 = \gamma\sigma\ln\left(\frac{\beta}{1-\beta}\right)$ $a_1 = \gamma\sigma$, $a_2 = 1-\gamma$ (11)where, a_0, a_1, a_2 - *estimated parameter*

$a_1 = \gamma\sigma -$ *substitution elastcity in short term*

$\sigma^* = \frac{a_1}{1-a_2}$ - *substitution elastcity in long term*

Therefore, we get $\ln\left(\frac{\beta}{1-\beta}\right) = \frac{a_0}{a_1}$.We can solve share parameter β is shown that below equation.

$$\beta = \frac{\exp\left(\frac{a_0}{a_1}\right)}{1+\exp\left(\frac{a_0}{a_1}\right)} \quad (12)$$

β - share parameter

We can demonstrate elasticity of substitution which is by ration of import goods and domestic goods.

$$\sigma = \frac{\partial\ln\left(\frac{M}{D}\right)}{\partial\ln\left(\frac{P_D}{P_M}\right)} \quad (13)$$

Here, change in the $\frac{\mathbf{M}}{\mathbf{D}}$ increasing resulting from a one percent increase in the $\frac{\mathbf{P_D}}{\mathbf{P_M}}$ or change in the $\frac{\mathbf{M}}{\mathbf{D}}$ decreasing resulting from a one percent decrease in the $\frac{\mathbf{P_D}}{\mathbf{P_M}}$. In other word, increase in import cause from increase in domestic price.

In general, the elasticity of substitution between two goods depends on the degree of product differentationconsumers see goods as imperfect substitutes when there are obvious physical product difference. The greater are the differences, the lower is the elasticity of substitution between the products. However, product differentation does not turn on actual physical differences between goods alone. Physical identical goods may be differentiated by availability in time, convenience of purchase, after sales service bundled with the good, or even consumers' perceptions of inherent unobservable quality. (Blonigen & W.Wilson, 1999)

The elasticities for price of import demand and domestic demand in short run and long run

In this part, we were calculated the price elasticities for import demand and domestic demand. We can use share parameter in this calculation. The import and domestic production causes from price of import and demand, which is is shown below equation (14) and (15).

$$lnM = \frac{1}{1-\rho} ln\beta - \frac{1}{1-\rho} lnP_M + lnD - \ln\left(\beta^{\frac{1}{1-\rho}} P_M^{-\frac{1}{1-\rho}} + (1-\beta)^{\frac{1}{1-\rho}} P_D^{-\frac{\rho}{1-\rho}}\right) \quad (14)$$

$$lnD = \frac{1}{1-\rho} \ln(1-\beta) - \frac{1}{1-\rho} lnP_D + lnM - \ln\left(\beta^{\frac{1}{1-\rho}} P_M^{-\frac{1}{1-\rho}} + (1-\beta)^{\frac{1}{1-\rho}} P_D^{-\frac{\rho}{1-\rho}}\right) \quad (15)$$

The solution to the price elasticities of import and domestic demand, whose derivities by price of import and domestic from equation (14) and (15).

$$E_{P_M}^{M} = -\frac{1}{1-\rho} - \frac{P_M}{\left(\beta^{\frac{1}{1-\rho}} P_M^{-\frac{1}{1-\rho}} + (1-\beta)^{\frac{1}{1-\rho}} P_D^{-\frac{\rho}{1-\rho}}\right)} \cdot \beta^{\frac{1}{1-\rho}} \left(-\frac{\rho}{1-\rho}\right) P_M^{-\frac{1}{1-\rho}-1} \quad (16)$$

Or

$$E_{P_M}^{M} = -\frac{1}{1-\rho} + \left(\frac{\rho}{1-\rho}\right) \frac{\beta^{\frac{1}{1-\rho}} P_M^{\frac{\rho}{1-\rho}}}{\left(\beta^{\frac{1}{1-\rho}} P_M^{-\frac{1}{1-\rho}} + (1-\beta)^{\frac{1}{1-\rho}} P_D^{-\frac{\rho}{1-\rho}}\right)} \quad (17)$$

$$E_{P_D}^{D} = -\frac{1}{1-\rho} + \frac{(1-\beta)^{\frac{1}{1-\rho}} P_D^{-\frac{\rho}{1-\rho}}}{\left(\beta^{\frac{1}{1-\rho}} P_M^{-\frac{1}{1-\rho}} + (1-\beta)^{\frac{1}{1-\rho}} P_D^{-\frac{\rho}{1-\rho}}\right)} \quad (18)$$

The σ *and* ρ *are relative below equation.*

$$, \frac{\rho}{1-\rho} = \frac{1-\sigma}{2\sigma-1}$$

ρ, σ - elasticities of substitution
$E_{P_M}^{M}$ -elasticity of import price
$E_{P_D}^{D}$ -elasticity of domestic price
P_M - import mediumprice
P_D – domestic medium price
β - share parameter or optimal allocation ratio

Current situation of Agricultural sector in Mongolia

Domestic production of Agricultural sector

The livestock sector isone of the main sector in industries, agricultural sector's characteristic istraditional nomadic and pastoralist based, and considerably dependent on natural climate.
In 2016, agricultural sector was producing 4151.7 million tugrugs products, which of the 12, 1 percent of total GDP. Mongolia has recorded the highest number of livestock at 61.5 million in 2016, that one 2.2 times higher than number of livestock in 1990. The livestock production was produced about 400 thous.tn meat, 14 million piece animal hides, 27.4 thous.tn sheep wool, 9.4 thous.tn cashmere, 891.5 thous.liter milk, 119 million.pieceegg, 459,1 thous.tn wheat, 164.1 thous.tn potato and 93.7 thous.tn vegetables in 2016.(Mongolia, 2016)

Figure 1. Domestic production for selected goods, thous.tn, by year

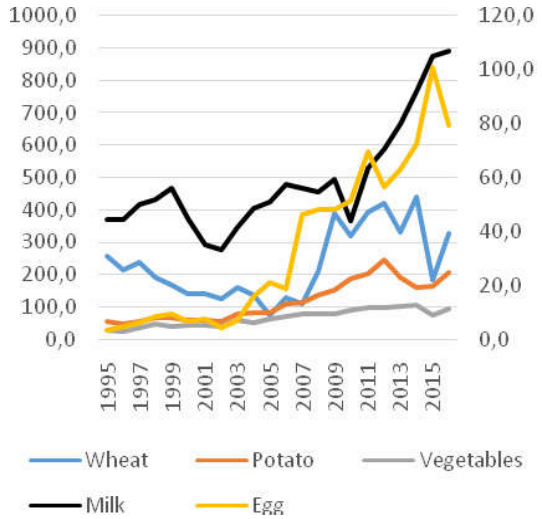
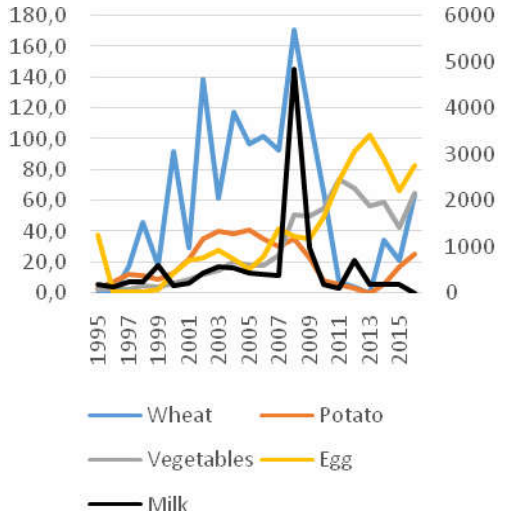


Figure 2. Import for selected goods, thous.tn, by year



Source: Mongolian Statistical yearbook, 2016

The domestic production compared to 2015, meat production decreased by 10.7 percent, sheep wool, cashmere increased separate by 6.2, 5.6 percent, milk increased by 2 percent, egg decreased by 21 percent, wheat increased by 78 percent, potato increased by 26 percent and vegetables increased by about 30 percent. (Figure 1)In general, there is increasing trend for selected goods production in 2008.For these products, domestic production was less but the import was higher between 2000 and 2008, however since 2008 when the 3rd Land Rehabilitation Programme started, domestic potato and vegetable production increased.

The import for selected goods(because meat, animal hides, wool and cashmere do not import) for example, wheat was 64.1 thous.tn, potato was 25.7 thous.tn, vegetables was 64.7 thous.tn, egg was 83.3 million piece and milk was 4.5 thous.litre. (Figure 2)There is fluctuating trend for import selected goods.

Data

Data on some agricultural products were collected from the Mongolian Statistical Yearbook and Mongolian Customs Yearbook for 22 years, from 1995 to 2016, of time series data is used for the

analysis. The estimation of Armington elasticities requires data on both import prices and real-valued imports. Therefore, Armington estimation also requires data on prices of the corresponding domestic goods and real values of domestic sales of domestic goods. The base period was chosen as 2010 years. All of price information converted to base year of 2010 years.

Estimation results

We were calculated elasticities of substitutions by using Armington model for agricultural domestic some product for import products. Table 1 shows the result of the model using the Least Squares Method for regression equations.

Table 1. Results of estimates

№	Types of products	Elasticity of substitution in short run	Elasticity of substitution in long run	t	Ad.R^2	DW
1	Wheat	0.47	1.18	2.42	0.67	2.15
2	Potato	3.93	5.24	4.48	0.63	1.51
3	Egg	0.96	1.22	3.62	0.89	1.39
4	Milk	1.76	2.28	1.39	0.88	2.42
5	Vegetables	1.32	6.29	2.04	0.29	1.93

Source: Results of E-views software
Here: t- is "t" statistic, Ad.R^2- is the adjusted R square, DW- is the Durbin-Watson statistic

The product which has the least coefficient of elasticity of substitution is wheat, and the highest are potato in short term. For long term, the vegetables have the highest coefficient of elasticity of substitution, the smallest one is wheat elasticity. Study result reveals that long-term elasticity of substitution is higher than short term, which means that those products produced domestically are highly possible to substitute the same types of imported products.

Table 2 shows that optimal allocation ratio.The β shows that optimal allocation ratio for import and domestic production. Estimation reveals that long term optimal allocation ratio is higher than short term. Thus, the optimal allocation has satisfied by share of domestic production in long term is decreasing and share of import in long term is increasing.

Table 2.Estimation of optimal allocation ratio

№	Type of products	β (in short term)		β (in long term)	
		Share of import	Share of domestic	Share of import	Share of domestic
1	Wheat	17.5	82.5	34.9	65.1
2	Potato	16.2	83.8	22.6	77.4
3	Egg	28.1	71.9	49.5	50.5
4	Milk	43.8	56.2	48.7	51.3
5	Vegetables	41.7	58.3	48.2	51.7

Source: Results of calculation

We calculated elasticities of import price and domestic price for some agricultural products. Table 3 show that estimation of elasticities of price.

Table 3. Estimation of price elasticities for import and demand

№	Type of products	Elasticity of import price		Elasticity of domestic price	
		Short term	Long term	Short term	Long term
1	Wheat	-4.833	-0.886	-4.845	-0.128
2	Potato	-0.573	-0.553	-0.427	-0.447
3	Egg	-0.579	-0.503	-0.421	-0.495
4	Milk	-0.702	-0.532	-0.301	-0.467
5	Vegetables	-0.814	-0.544	-0.194	-0.455

Source: Results of calculation

In short term, the elasticities of import and domestic price for wheat (4.8)which has highest one elasticities. Other products price elasticities are very similar in short term and in long term.

In addition, elasticities for import price is higher than domestic price elasticities. It is means consumers have bought prefer domestic production to import.In other words, a 10 percentage point increase in price, consumers prefer import products more than domestic products.

Conclusion

The main goal of this paper was to determine if there are reasons why Armington elasticities of substitution between domestic and import good selected agricultural products in Mongolia. In addition, we calculated optimal allocation ratio and elasticity of import and domestic price these products.

In Mongolia, agricultural sector's characteristic istraditional nomadic and pastoralist based, and considerably dependent on natural climate. Share of agricultural sector production is 12.1 percent of total GDP in 2016. Currently, Mongolia agricultural sector has producing livestock and crop production but, we have import demand in agricultural product. Someagricultural products (wheat, milk, potato, vegetables and egg) are selected for the estimation due to lack of data for other products. Elasticity of substitution shows that it is possible to substitute imported goods by domestic goods.For selected products, long term elasticity of substitution is higher than short term, which means that those products produced domestically are highly possible to substitute the imported products.According to, estimation of optimal allocation ratio, there is strong trend of decreasing domestic production in the future.

In price elasticities, import price elasticities calculated higher than domestic price elasticities for selected goods. It is means that consumers prefer consume import product more than domestic product.

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