Armington elasticities and tariff regime: An application to European Union rice imports

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Abstract

Most of the European Union's (EU) import sources for rice are in developing countries and the least-developed countries (LDCs). The EU has moreover made a commitment to allow duty-free and quota-free access to rice imports originating in the LDCs from September 2009 onward. The purpose of this article is to answer two questions – First: Does the inclusion of import tariffs in the specification lead to different estimated Armington elasticities? Second: When a discriminating tariff is introduced, what happens to the market share of large rice exporters to the EU, especially to the market share of poor countries? Consequently, we present the Armington model, derived from a constant elasticity of substitution (CES) utility function, and a *non-homothetic CES utility* functional form, which is more flexible. Then, we estimate the Armington model, with and without the inclusion of a tariff, and we compare the elasticities. Lastly, we model five scenarios with different discriminating import tariff rates to calculate the changes in the market access of large rice exporters to the EU. Our empirical results show that it is worthwhile to consider non-homothetic preferences and import tariffs. When the model is estimated, ignoring the import tariffs and the non-homothetic parameter, results may be biased and of uncertain validity. Furthermore the simulation findings demonstrate that in spite of a large difference between import tariff rate of Suriname and other countries (scenario V), its market access would not change greatly. This may be caused by supply side problems like poor infrastructures, weak technology and small capacity production in LDCs.

Keywords: Armington elasticity, tariff discrimination, non-homothetic, utility function, EU, rice.

JEL classification: C2, D1, F1, Q1

Élasticités d'Armington et droits de douane :
Une application aux importations européennes de riz

Résumé

La plupart des sources d'importation européennes de riz proviennent des pays en développement (PED) et des pays les moins avancés (PMA). L'Union Européen (UE) s'est d'ailleurs engagée à permettre un libre accès aux importations de riz provenant des PMA à partir de septembre 2009. Le but de cet article est de répondre à deux questions. La prise en compte des droits de douane à l'importation dans la spécification du modèle mène-t-elle à différentes élasticités estimées ? Quand un droit de douane discriminant est introduit, qu'en est-il de la part de marché des grands exportateurs de riz vers l'UE, particulièrement en ce qui concerne celle des pays pauvres ? En conséquence, nous présentons le modèle d'Armington, dérivé d'une fonction d'utilité à élasticité de substitution constante (CES), et une fonction d'utilité CES non-homothétique plus flexible. Puis, nous estimons le modèle d'Armington, avec et sans la prise en compte d'un droit de douane, et nous comparons les élasticités. Pour finir, nous modélisons cinq scénarios avec différents droits de douane pour calculer les changements de parts de marché des grands exportateurs de riz. Nos résultats empiriques montrent : a) quand le droit de douane est omis, les élasticités d'Armington peuvent être sous-estimées et b) avec le droit de douane discriminatoire, le modèle d'Armington original est plus sensible que le modèle non-homothétique. Il est donc intéressant de considérer des préférences non-homothétiques puisque, si le modèle est estimé en ignorant le droit de douane et le paramètre non-homothétique, les résultats peuvent être biaisés et non fiables. Finalement, des simulations sont réalisées à partir de cinq scénarii. Les résultats montrent que, malgré une grande différence entre les droits de douane du Suriname et ceux dans d'autres pays (scénario V), la part de marché du Suriname ne changerait pas beaucoup. Ce problème peut être causé par la faible capacité de production dans ce pays (un problème d'offre). Cela montre la difficulté de ces pays (les PMA) à concurrencer les pays développés comme les États-Unis.

Mots-clés : Elasticité d'Armington, discrimination tarifaire, non-homothétique, fonction d'utilité, UE, riz.

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Armington elasticities and tariff regime:
An application to European Union rice imports

1. Introduction

The European Union (EU) is the largest agricultural market in the world and accounts for approximately 20% of total exports and imports of agricultural products. Most of the EU's import sources are in developing countries and the least developed countries (LDCs), and the increase of agricultural exports plays a key role in the development and reduction of poverty in these countries. Furthermore, EU programmes include the Generalized System of Preferences (GSP), which contains a special scheme for the LDCs known as the 'Everything But Arms Agreement' (EBA), the Cotonou Agreement with Africa, Caribbean and Pacific countries (ACP) and the Euro-Mediterranean Agreements (EMA). The EBA provides the LDCs with duty-free accesses to EU markets, without quotas or other restrictions, for most agricultural products. Within the framework of the EBA, the EU has made a commitment to allow duty-free and quota-free access to imports of rice originating in the LDCs, starting in September 2009. In this context, intensified price competition among rice producing countries is foreseeable. Thus, to calculate changes in market shares, accurate estimation of substitution elasticities (or Armington elasticities) between import sources is crucial.

Prior to the last reform of the Common Agricultural Policy (CAP), signed in 2003 and entering into force in 2005 or later, the EU imposed a common tariff on the rice exporters. Nevertheless, since the price of rice is not the same for each trading partner, this tariff represented from 20% to 50% of the import price (depending on the type of rice, the source and the period under consideration). According to the new agreement (EBA), the EU intends to reduce or remove the tariff for some rice exporting countries in 2009 (particularly for LDCs such as Suriname and Guyana). In addition, the EU has many regional trade agreements (RTAs) with other countries, especially with rice exporting countries (Thailand and the USA).

Therefore, the most interesting questions are: *After the change in tariffs, will the market shares change?* Namely, with a discriminating tariff, what happens to the market share of poor countries in the EU market, or: *Could this new tariff regime help the LDCs increase their exports?* The identification of the elasticity of substitution plays a key role in the answer to these questions.

The Armington elasticities have a crucial function in applied models used in assessing the impacts of policy changes such as tariffs and taxes. They are based on the assumption that consumers distinguish different varieties of goods by country of origin and, in the case of rice, obtain variable satisfaction depending on the country from which the rice is imported. In addition, these elasticities are important for computable general equilibrium (CGE) models because the degree to which a policy change will affect the country's economic aggregates depends on the level of the elasticity used in the model. The size of these elasticities can also have a large effect on the terms of trade (the ratio of export to import prices that are sometimes used as a proxy for the relative social welfare of a country) and the implied tariff equivalent of trade agreements.

Despite their determinant role, before reaching the conclusions of this article, we found many studies[1] in the literature that did not take into consideration tariffs when estimating Armington elasticities. They justify this omission by the shortage or absence of sufficient data and, allowing themselves a certain latitude as well, they use an untested hypothesis, i.e. that the same tariff applied on all import sources does not change the relative price, thus does not lead to changes in elasticities (regardless of the type of tariff). Most of *World Bank* and *GTAP* (Global Trade Analysis Project) studies view this conception with leniency, but if this negligence leads to changes in the value of substitution elasticities, then the results of these studies cannot be considered entirely valid.

Therefore, we first try to answer the following questions: Does the inclusion of an import tariff in the estimation lead to different estimated Armington elasticities? Second, as was mentioned above: With a discriminating tariff, what happens to the market share of large rice exporters to EU, especially to the market share of the poor countries?

After the removal of obstacles and barriers to trade and the creation of monetary union, agricultural products can be carried and re-exported very easily between EU Member States. Consequently, in this study we remove the re-exports between EU Member States and only consider the external EU trade.

Most of EU rice import tariffs are fixed-rate tariffs. The fixed-rate term means that the same import tax per unit is applied no matter how much is imported or regardless of the international or domestic prices of the commodity. For example, a fixed-rate tariff on a certain

[1] Armington, 1969; Sarris, 1983; Alston et al., 1990; Ito et al., 1990; Yang and Koo, 1993; Davis and Kruse, 1993; Kapuscinski and Warr, 1999; Surry et al., 2001 Gallaway et al., 2003; and Saito, 2004.

class of rice (100610 - rice in the husk) shipped into the EU was 211 Euros per 1000 kilograms in 2001, whatever its market price or imported value (see table 1 in the next section). The weight of the fixed-rate tariff plainly decreases as the price rises.

Therefore, in order to answer the above questions, we first estimate the Armington model, with and without the inclusion of tariffs, over the period 1962-2004, and we compare the elasticities in both cases. Then, we simulate five scenarios with respect to import tariff rates (tariff discrimination) and, with the estimated elasticities from the previous section, we calculate the market access of large rice exporters to the EU.

The paper is organized as follows: The next section provides an overview of EU's rice tariff regime. Section 3 presents the Armington model derived from a CES utility function, and a non-homothetic CES utility functional form model, which is more flexible. Data are described in section 4. Then the results are presented in section 5. The final section concludes.

2. EU's rice tariff regime

The EU is one of the world's largest rice importers in value terms, with approximately 29% of the world's imports (FAOSTAT database). We focus on the two most imported rice types, *rice in the husk* and *rice glazed or polished*, for which we have data available. (For greater detail on rice type and classification, see section 4).

In order to protect domestic producers and to control market access, the EU has established both a quota system and a tariff system. There are two separate sets of trade arrangements for EU rice imports: import duties and import quotas.

Import duties: Transitional import duty arrangements are in place, subsequent to agreements concluded with the EU's main supplier countries (the USA, India, Pakistan and Thailand). The negotiations were conducted after the 2003 CAP reform. Under these agreements, the new import arrangements provide for the introduction of fixed duties. Agreement has also been reached on a reduction of the duties. The EU rice tariff regime is summarized in table 1 from 1998 to 2007. [2] The table shows that the EU reduced import tariffs on rice over the past ten years. Moreover, before 2005 the EU imposed the same tariff for all exporters - or the difference of tariff rates was not great; but in recent years, the EU has followed tariff discrimination. For example, in 2007 in addition to the special RTAs with the USA and

[2] Source: DEFRA (2006), p. 4.

Thailand, the tariff rates on rice in the husked were 69.51 (Euro/1000 kg) for ACP countries and 211 (Euro/1000 kg) for other countries (table 1).

Table 1: EU imports tariff by type of rice (Euro/1000 kg)

	Rice in the husk (*paddy rice* or *rough rice*)		*Semi-milled or wholly-milled rice* (whether or not polished or glazed)	
HS code	1006 10		1006 30	
	Erga omnes	Preferential tariff quota	*Erga omnes*	Preferential tariff quota
Year	Third country duty	ACP	Third country duty	ACP
1998	270.5	*Na*	533	*Na*
1999	250.7	*Na*	477.69	*Na*
2000	230.8	*Na*	455	*Na*
2001	211	*Na*	416	*Na*
2002	211	*Na*	416	*Na*
2003	211	*Na*	416	*Na*
2004	211	*Na*	360.14	*Na*
2005	211	69.51	175	38.36
2006	211	69.51	145	38.36
2007	211	69.51	145	38.36

Source: the *Export Helpdesk* online service, provided by the EC (http://exporthelp.europa.eu/)

Na = not available.

Import quotas: Various preferential quota arrangements exist for rice imports: the GATT quota, ACP quota, EBA quota and some regional trade agreements with exporter countries such as Thailand (table 2)[3].

[3] Source: EU Commission Regulation (1998, 2002, 2003) and DEFRA (2006), p 5.

i. **GATT quota:** In the context of the GATT negotiations, the EU has agreed to two separate duty-free quotas of 63,000t and 13,500t for milled/semi-milled rice and quotas of rice in the husk (EU Commission Regulation, 1998).

ii. **ACP/OCT quota:** Reduced-duty rate quotas of 125,000t (husked) also exist for imports of rice from the African, Caribbean and Pacific (ACP) countries. Rice imports originating in the Overseas Countries and Territories (OCT) are exempt from customs duties under a quota of 35,000t (husked), of which 25,000t are reserved for the Netherlands Antilles and Aruba and 10,000t for the least developed OCT. These imports take place under the ACP States and the OCT cumulation arrangements (EU Commission Regulation, 2003).

iii. **Everything But Arms (EBA):** Under the Everything But Arms Agreement, the EU granted duty-free access to its market to imports from the LDCs for all goods except arms and munitions. However, special arrangements apply for three sensitive products, including rice. Full liberalization will apply from 2009. A duty-free quota, based on previous exports to the EU, was opened from the marketing year 2002-2003 (2,895t) and will be increased by 15% each year until 2008/09 (6,694t), when all tariffs and quotas will be removed (EU Commission Regulation, 2002).

Tariff agreement on Thai rice: On September 5th 2005, the EC presented an agreement on the tariffs applying to rice imports to Member States from Thailand. This measure provides for an adjustment of tariffs applied to semi-milled and milled rice every six months, depending on actual imports and the reference import price, so that they fall within the range of Euros 145-175 per ton (EC press, 2005).

Table 2: Rice import quotas imposed by the EU

Year	Agreement	Quota
1995	GATT	duty-free quotas of 63,000t (*Semi-milled /milled*) duty-free quotas of 13,500t (*husked*)
2003	ACP	duty- rate quotas 125,000t (*husked*) (ACP direct route) duty-rate quotas 35,000t (*husked*) (OCT route)
2003	EBA	duty-free quota 2,895t and will be increased by 15% each year until 2008/09 (6,694t) when all tariffs and quotas will be removed

Source: EU Commission Regulation (1998, 2002, 2003)

As it can be seen in table 2, the types of quota are not the same, nor are quotas generally imposed on large exporting countries - with the exception of the ACP quota. In this paper, we follow the Armington procedure to calculate the elasticities of substitution and changes in market access; however, this method alone cannot account for the effects of quotas. Furthermore, neither exporting countries nor the kinds of rice usually studied benefit from duty-free quotas. Our study focuses on the implications of tariffs.

3. The Armington model

3.1. Overview of the model

Armington (1969) proposed to distinguish products from different suppliers in a market. Using a two-stage budgeting method, he supposed in the first stage that a buyer (or importing country) determines the total quantity to buy to maximize the utility, and in the second-stage, allocates shares of the total quantity to individual suppliers (or exporting countries) in order to minimize the costs. In the first-stage equation, he specifies the total demand for both foreign and domestic products as the dependent variable.

Armington (1969) specifies the CES form for the utility function, which he maximizes, subject to a budget constraint:

$$\textbf{Max} \quad U = \left[\sum_{i=1}^{m} b_i q_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \qquad (i = 1, \ldots, m) \tag{1}$$

$$\text{S.t.: } E = \sum_{i=1}^{m} p_i q_i \qquad (\sigma \neq 1, \quad \textstyle\sum_i b_i = 1, \quad b_i \in [0,1] \forall i) \tag{2}$$

where, E is the total expenditure on imports, U is the utility, p_i is the price of imported good from source i, q_i is the quantity of imports from source i, b is the parameter that gives the weight associated with particular commodity, and σ is the elasticity of substitution between import sources. Thus, if equation (1) is maximized subject to equation (2), we obtain the demand function for q_i.

$$q_i = \left(\frac{1}{p_i} \right) b_i^{\sigma} \left(\frac{p_i}{P} \right)^{1-\sigma} E \tag{3}$$

$$\text{With } P = \sum_i \left(b_i^{\sigma} \; p_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \tag{4}$$

where P is calculated with *Stone's price index*.[4] Therefore, we can write equation (3) in logarithmic form (equation 5) and estimate it to calculate the elasticity of substitution between the sources (σ):

$$\ln(p_i.q_i) = \sigma \ln(b_i) + (1-\sigma)\ln\left(\frac{p_i}{P}\right) \quad (5)$$

The Armington model has been widely used for international trade analysis because this simple linear specification is consistent with utility maximization and because it economizes degrees of freedom in empirical applications (Sarris, 1983; Alston et al., 1990; Ito et al., 1990; Duffy et al., 1990; Yang and Koo, 1993; Davis and Kruse, 1993; Kapuscinski and Warr, 1999; Surry et al., 2001; Xu, 2002; Gallaway et al., 2003 and Saito, 2004).

Suppose now that an importing country imposes a different tariff rate on each import source, such that the utility function is maximized, subject to a new budget constraint:

$$E = \sum_{i=1}^{m} (p_i + t_i)\, q_i \quad (6)$$

where p_i is the price of the imported good from source i, and t_i is the tariff rate of imported good from source i. Consequently, the new Armington equation is:

$$\ln((p_i + t_i)\, q_i) = \sigma \ln(b_i) + (1-\sigma)\ln\left(\frac{p_i + t_i}{P^*}\right) \quad (7)$$

where P^* is calculated with the *Stone's price index*, explicitly including tariffs.[5]

3.2. Respecification with non-homothetic CES utility function

In 1969, Armington presented his model and used it to analyze trade in chemical products under the assumption that there were no major trade restrictions. In his example, suppliers of chemicals, including the domestic suppliers, sell in a market with no major barriers. Namely, the buyer (or the importing country) only considers relative prices among the products from different suppliers (or exporting countries). The Armington model also assumes that goods imported from different countries (or regions) create different consumer utilities, which is to say that the elasticities of substitution among the goods imported from different places are not infinite.

[4] The Stone's price index is $\ln P = \Sigma_j w_j \ln p_j$, in which w is the expenditure share of the source in the total imports.

[5] The Stone's price index including tariffs is $\ln P^* = \Sigma_j w_j \ln(p_j + t_j)$.

Furthermore, the Armington model is based on the CES utility function. This functional form is homothetic. It implies that the size of the market, as measured by expenditure, does not affect each exporting country's relative market share, the result being that expenditure elasticities are identical and unitary. This assumption, although making the specification easier, may also be too restrictive for empirical research. If a good is differentiated so that each product yields different utility, an increase in the buyer's budget may not be allocated in the same proportion to all products. A relatively high proportion would probably be allocated to the higher quality or more preferred products, other factors remaining constant (Yang and Koo, 1993).

Pishbahar and Huchet-Bourdon (2007) calculate the Armington elasticities for two types of rice imported by the EU using this Armington model and then using a model based on a non-homothetic utility function. They show that a non-homothetic model yields more consistent estimated elasticities. The more flexible forms are important: they are more reliable than the Armington elasticities when utilized in the kind of CGE models widely used in many countries and in institutions such as the World Bank to estimate the term of trade effect or the implied tariff equivalent of the RTAs.

In other words, the Armington model is set up with non-homothetic preferences.

$$U = \left(\sum_i b_i . (q_i - \mu_i)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \qquad (8)$$

$(\sigma \neq 1, \quad (q_i - \mu_i) \geq 0, \quad \sum_i b_i = 1, \quad b_i \in [0,1] \forall i)$

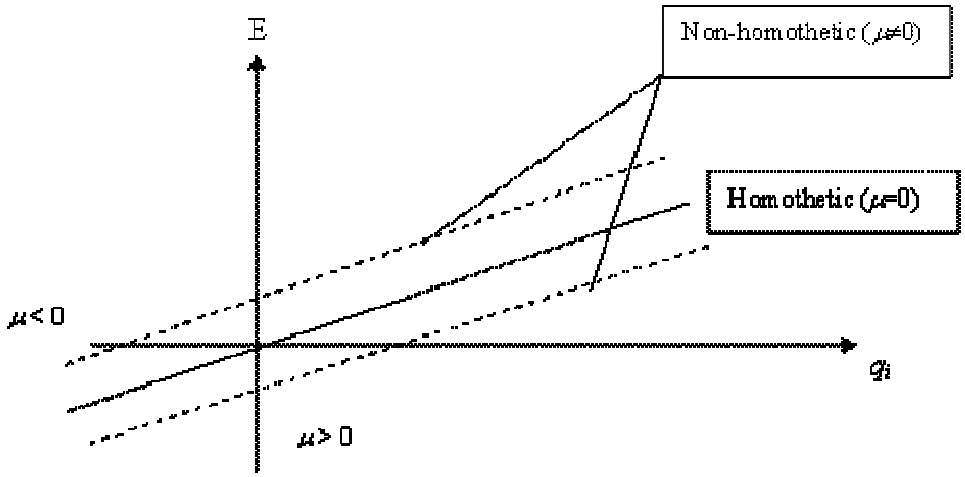
The novelty in specifying preferences is the influence of the non-homothetic parameter μ_i. When $\mu_i = 0$ for all i, then equation (8) is identical to equation (1), i.e. U is a homothetic CES function with an elasticity of substitution (σ). Additionally, the condition of $q_i - \mu_i \geq 0$ is required because consumption must be positive.

If μ_i is positive, it is interpreted as a subsistence level requirement, consumers having to buy at least μ_i of good i, first allocating a fraction of their budget to meet the minimum-consumption requirement. In this case, the Engel curves are straight lines shifted below the origin by a positive constant (figure 1). If μ_i is negative, then the Engel curves are shifted above the origin, implying that consumers buy the commodity if income exceeds a certain level. In neither case ($\mu_i > 0$, or $\mu_i < 0$) does the slope of the Engel curves depend on the non-

homothetic parameter, even though the elasticity of total consumption ($p_i q_i$) with respect to total income (E) still does.

As in the homothetic CES function, the elasticity of substitution between the q_i - μ_i is constant.

Figure 1: Engel curves



Thus, by using the Lagrangean function to maximize the non-homothetic utility function (equation 8), subject to expenditure function (equation 2), the procedure generates the following import demand function:

$$q_i = \left(\frac{1}{p_i}\right)\left(\frac{b_i^{\sigma} p_i^{1-\sigma}}{P^{1-\sigma}}\right)\left(E - \sum_r p_r \mu_r\right) + \mu_i \qquad (9)$$

With: $P = \sum_i \left(b_i^{\sigma} p_i^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$

We can write an alternative form of the Armington equation simply as:

$$p_i.q_i = b_i^{\sigma}\left(\frac{p_i}{P}\right)^{1-\sigma}\left(E - \sum_r p_r \mu_r\right) + \mu_i p_i \qquad (10)$$

There is no empirical evidence on μ_i in the context of trade. As a result, to take into consideration this dimension (μ_i), we need more information, or we have to use non-linear estimates. In this research, equation (10) is estimated with nonlinear estimation.

Now, if we consider the import tariff, the new Armington equation is:

$$(p_i + t_i)\, q_i = b_i^{\sigma} \left(\frac{p_i + t_i}{P} \right)^{1-\sigma} \left(E - \sum_r (p_r + t_i)\, \mu_r \right) + \mu_i\, (p_i + t_i) \qquad (11)$$

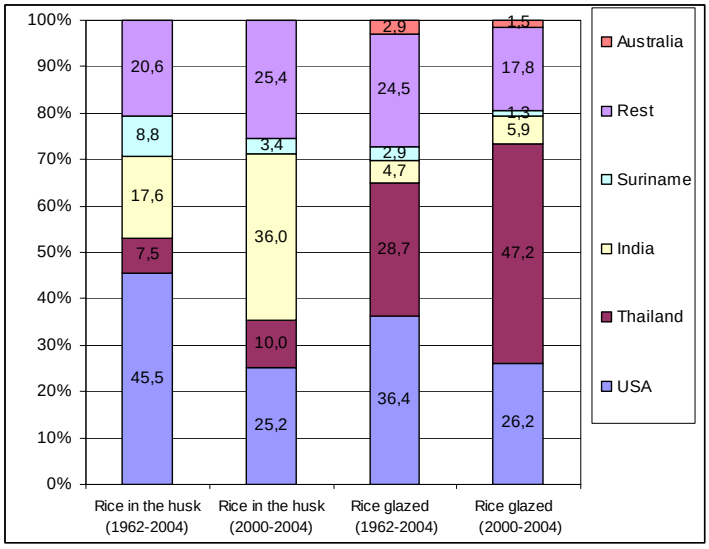
In section 5, we report the estimated original Armington model (equations 5 and 7) and the non-homothetic Armington model (equations 10 and 11), in the both cases, with and without a tariff rate for two types of rice. Then we compare the results.

4. Data

The prices and the quantities of imports are collected from the United Nation Commodity Trade Statistics (Comtrade) over the 43 years from 1962 to 2004 and deflated using the GDP deflator index series from the International Financial Statistics (IFS). The EU's rice imports are studied over the entire period.[6] The unit price (p_i) is in USA dollars (\$), and the unit import (q_i) quantity is in kilograms (*kg*). The Comtrade database relies on the Standard International Trade Classification (SITC) with 4-digit codes. This system attributes two 4-digit codes for rice: the code of 0421 is for 'rice in the husk', and the code of 0422 is for 'rice, glazed or polished'. For both types of rice, we consider all import sources and select the principal sellers (the sources of import) to the EU(15) during the 1962-2004 period. The EU's tariff rates are collected from the Export Helpdesk online service provided by the European Commission (EC) since they are unavailable in the Comtrade database. The tariff data from the EC database relies on the Harmonized System (HS) with 6-digit codes. The HS classifies the rice in four subgroups. Allowing ourselves some flexibility, we choose to account for the tariff on rice in the husk (with 1006 10 HS code) in the same way as for rice in the husk (with 0421 SITC code), and for semi-milled/milled rice glazed or polished (with 1006 30 HS code) as for rice glazed or polished (with 0422 SITC code).

[6] In this study, the European Union contains 15 countries: *Belgium, France, Germany, Italy, Luxembourg, The Netherlands, Denmark, Ireland, United Kingdom, Greece, Portugal, Spain, Austria, Finland* and *Sweden*.

Figure 2: The average share of rice imported by the EU(15) (1962-2004 and 2000-2004)



Source: Commodity Trade Statistics of UN (Comtrade)

Figure 2 shows the average share of the leading exporters to the market of the EU(15) for both kinds of rice in the two periods, 1962-2004 and 2000-2004. Principal sellers are those having the highest average import share in the EU each year over the period. The principal exporters of rice in the husk to the EU are the USA, India, Thailand and Suriname. Other countries are accounted for in the rest-of-the-world group, labelled 'Rest'. The USA have the largest share in the EU market over the entire period. Namely, the EU imported 45.5% of rice in the husk from the USA, 17.6% from India, 8.8% from Suriname and 7.5% from Thailand. However, the average share of these countries in the EU market has changed from 2000 to 2004. More precisely, the average shares of India and Thailand have increased to 36% and 10% respectively, while the average shares of the USA and Suriname have decreased.

Similarly, for rice glazed or polished the primary sources of imports to the EU are the USA (36.4%), Thailand (28.7%), India (4.7%), Suriname (2.9%) and Australia (2.9%) over the 1962-2004 period. In recent years, the average shares of the USA, Australia and Suriname have decreased, while the shares of Thailand and India have increased.

Therefore, data show a shift in the import sources of the EU. In other words, the EU imported more in recent years from South Asia than from the USA or the African countries. Perhaps the greater stability in policies and economic situations, in addition to the higher quality of rice imported from Thailand and India, due to the cheaper price of this product in those countries, are the reasons of this change in the EU market.

5. Estimated results

5.1. Does including a tariff in the estimation alter estimated substitution elasticities?

The suppliers of rice to the EU market are in competition with each other, and the specific supplier's behaviour is not independent from the behaviour of other suppliers in the market. As a result, the demand equations for all individual products from different suppliers must be estimated simultaneously in a system. The seemingly unrelated regression analysis originally developed by Zellner is appropriate.

Two types of Armington models (based on different utility functions), with and without the inclusion of an import tariff, are estimated over the period 1962-2004, and the results obtained are reported in tables 3 to 6. Table 3 shows the estimated results of the original Armington models (with and without tariffs included, respectively equations 5 and 7), and table 4 shows the non-homothetic Armington models (with and without tariffs, respectively equations 10 and 11) for rice, glazed or polished. The same estimated models for rice in the husk are reported in tables 5 and 6. To estimate the models with tariffs, we use the 1998 tariff rates for the years before 1998, deflating them with the GDP deflator index from the IFS.

As shown in table 3 for rice, glazed or polished, the elasticities of substitution (σ) in the original Armington model are 1.22 when a tariff is not included in the estimation and 2.44 when it is. The elasticities are significantly different from zero at the 5% level. For rice in the husk, they are 0.92 and 1.24 respectively (table 5).

Then, with a non-homothetic CES utility function, the estimated σ are equal to 0.99 when a tariff is not included and 1.22 when it is. These estimations too are significantly different from zero at the 5% level (table 4). Table 6 shows the same results for *rice in the husk (*σ being equal to 0.87 and 0.99, respectively without and with the tariff inclusion in the estimation). In table 4, μ_i is significantly different from zero at the 5% level in three cases without tariffs; it is positive for Australia and negative for India and the rest of the world. However, it is significantly negative for the USA and Thailand when tariffs are included. In table 6 too, the μ_i values are significant and negative for two sources (the USA and the rest of the world).

Table 3: The elasticity of substitution (σ) in original Armington model - Rice glazed or polished

Import Sources	Without tariff (equation 5)		With tariff (equation 7)	
	σ	t value	σ	t value
USA *Thailand* *India* *Suriname* *Australia* *Rest of the world*	1.22*	9.86	2.44*	9.75

***** denotes significance at the 5% level.

Note: Results after correction of autocorrelation.

Table 4 - Armington model with a non-homothetic CES utility function - Rice glazed or polished

Import Sources	Without tariff (equation 10)				With tariff (equation 11)			
	σ	t value	μi	t value	σ	t value	μi	t value
USA			-13099608	-1.15			-123000000*	-1.92
Thailand			-8754672	-0.72			-140000000*	-2.07
India	0.99*	9072.5	-15851191*	-5.44	1.22*	3.90	-13241248	-1.36
Suriname			2939671	1.38			-8296966	-1.26
Australia			9978440*	2.80			1974123	0.30
Rest of the world			-114000000*	-3.56			-822477	-0.02

***** denotes significance at the 5% level.

Note: Results after correction of autocorrelation.

Table 5: The elasticity of substitution (σ) in original Armington model - Rice in the husk

Import Sources	Without tariff (equation 5)		With tariff (equation 7)	
	σ	t value	σ	t value
USA *India* *Suriname* *Thailand* *Rest of the world*	0.92*	(8.63)	1.24*	(7.03)

* denotes significance at the 5% level.

Note: Results after correction of autocorrelation.

Table 6 - Armington model with a non-homothetic CES utility function - Rice in the husk

Import Sources	Without tariff (equation 10)				With tariff (equation 11)			
	σ	t value	μi	t value	σ	t value	μi	t value
USA			-468000000*	-3.31			-637000000*	-3.74
India			440083	0.11			-1214620	-0.48
Suriname	0.87*	13.01	-22238814	-0.94	0.99*	39.07	-33591858	-1.22
Thailand			-40018186	-1.94			16705515	1.88
Rest of the world			-268000000*	-3.96			-489000000*	-4.48

* denotes significance at the 5% level.

Note: Results after correction of autocorrelation.

At this stage in our study, three remarks can be made. First, including tariffs (even a fixed-rate tariff) can well change the results of the Armington model. In other words, ignoring the tariff may lead to underestimation of the elasticity of substitution, and the results may be biased. Secondly, the estimations with a non-homothetic CES function show that estimates of σ depend on the subsistence-level requirements (μ_i). It is particularly worthwhile to consider non-homothetic preferences. If we estimate the model ignoring μ_i, the results may turn out to be biased. Thirdly, we can observe that μ_i, when significant, is negative. We have already mentioned that if μ_i is negative, then the Engel curves are shifted above the origin, implying that consumers buy (import) the commodity if income exceeds a certain level, in other words

under that level of expenditure, there is no import of rice, i.e. the consumers prefer the domestic market (see figure 1).

5.2. Simulation: discriminating tariff and change in market shares

Before 2004 (prior to the last CAP reform), the EU imposed a common tariff on the entire group of rice exporters and it was approximately between 25% and 50% of the import price (table 1).[7] According to the EBA Agreement, the EU intends to reduce or remove the tariff for some rice exporting countries from 2009 onwards (particularly for LDCs in the EBA schedule such as Suriname and Guyana). ACP countries also benefit a tariff reduction. It is clear that with tariff discrimination (or trade barriers), the relative prices change and consequently market access of rice exporters will change. The degree of change in the import and market accesses depends on the substitution elasticity and the tariff variations.

Thus, in order to forecast the changes in the market access of large rice exporters to the EU, we use the estimated Armington models over the period 1962-2004 developed in the previous section to simulate five cases of discriminating tariffs with different rates. In this prospective, we use the price level in 2004 and build five scenarios:

i. Without any tariff on imports. We use the price level of the last year, 2004.

ii. We assume that the EU puts a 25% tariff on the exports of developed countries (which here are the USA and Australia).[8]

iii. Similar to the second scenario, but we increase the tariff to 50%. [9]

iv. The EU imposes a 25% tariff on all exporters, except the LDCs (here Suriname).

v. Similar to the fourth scenario, but we increase the tariff to 50%.

[7] Nevertheless, since the price of rice is not the same for each trading partner, this tariff represented from 25% to 50% of the import price (depending on the type of rice, the source and the period under consideration).

[8] The tariff rates equal 262 $/1000 kg and 448 $/1000 kg, respectively for *rice in the husk* and *rice glazed or polished* which represent 25% of the imported prices. We choose this scenario because this percentage is the minimum weight of the tariff on rice imports. It can be compared to the tariff analysis in the following scenario (iii), corresponding to the double and the maximum tariff weight.

[9] The tariff rates equal 524 $/1000 kg and 869 $/1000 kg, respectively for *rice in the husk* and *rice glazed or polished* which represent 50% of the imported prices.

The results of these scenarios are reported in tables 7 and 8 for rice glazed or polished and in tables 9 and 10 for the rice in the husk. We mention both the imported quantity (tons) and the market accesses (or import shares) (%) for exporters in each table.

Table 7: Forecast of the quantity of imports (tons) and the import shares (%) based on original Armington model (equation 5) - Rice glazed or polished

The import source	Scenario I	Scenario II	Scenario III	Scenario IV	Scenario V
	Imports (tons)				
USA	88305.7	71083.9	60203.4	84399.5	81848.3
Thailand	88517.0	93626.1	99115.1	84601.5	82044.3
India	5137.5	5434.0	5752.6	4910.2	4761.8
Suriname	10754.1	11374.8	12041.7	13505.6	16371.0
Australia	6446.1	5189.0	4394.7	6161.0	5974.8
Rest of the world	89253.7	94405.3	99940.0	112089.5	135871.4
	Import shares (%)				
USA	**30.62**	25.29	21.39	27.61	25.04
Thailand	30.69	33.31	**35.22**	27.68	25.10
India	1.78	1.93	**2.04**	1.61	1.46
Suriname	3.73	4.05	4.28	4.42	**5.01**
Australia	**2.24**	1.85	1.56	2.02	1.83
Rest of the world	30.95	33.58	35.51	36.67	**41.57**

Table 8: Forecast of the quantity of imports (tons) and the import shares (%) based on non-homothetic CES utility function (equation 10) - Rice glazed or polished

The import source	Scenario I	Scenario II	Scenario III	Scenario IV	Scenario V
	Imports (tons)				
USA	79340.3	63940.2	53671.5	75818.0	73469.4
Thailand	118283.0	121533.6	124783.2	105536.7	97038.8
India	5358.2	6169.1	6979.7	4274.7	3552.3
Suriname	11086.9	11490.9	11894.8	13051.8	15016.5
Australia	8671.1	8931.2	9104.6	8925.2	9094.6
Rest of the world	151416.8	161525.3	171630.9	200580.3	249738.3
	Import shares (%)				
USA	**21.21**	17.12	14.20	18.57	16.40
Thailand	31.61	32.53	**33.01**	25.86	21.66
India	1.43	1.65	**1.85**	1.05	0.79
Suriname	2.96	3.08	3.15	3.20	**3.35**
Australia	2.32	2.39	**2.41**	2.19	2.03
Rest of the world	40.47	43.24	45.40	49.14	**55.76**

As shown in these tables, Australia and the USA reach their maximum market shares under scenario I (i.e. without changes in relative import prices). With the other scenarios, market access of the USA decreases. The USA obtain the minimum market access in the third scenario with 21.39% and 14.20% for *rice glazed or polish* and 17.8% and 14.29% for *rice in the husk* respectively with original and non-homothetic Armington model. The changes of market access of other developed countries (Australia) are similar. Conversely, the Suriname in the case of fifth scenario (i.e. free access to the EU market only for the LDCs) displays the maximum increase in its share of the EU market.

Table 9- Forecast of the quantity of imports (tons) and the import shares (%) based on original Armington model (equation 5) - Rice in the husk

The import source	Scenario I	Scenario II	Scenario III	Scenario IV	Scenario V
	Imports (tons)				
USA	182581.6	155809.0	137646.2	175167.8	170334.6
Thailand	253709.2	266039.5	278114.5	243407.2	236691.2
India	11265.8	11813.4	12349.6	10808.4	10510.2
Suriname	78385.7	82195.2	85925.9	92407.7	106331.7
Rest of the world	238488.9	250079.5	261430.0	281151.0	323514.8
	Import shares (%)				
USA	23.9	20.3	17.8	21.8	20.1
Thailand	33.2	34.7	35.9	30.3	27.9
India	1.5	1.5	1.6	1.3	1.2
Suriname	10.3	10.7	11.1	11.5	12.5
Rest of the world	31.2	32.7	33.7	35.0	38.2

Table 10: Forecast of the quantity of imports (kg) and the import shares (%) based on non-homothetic CES utility function (equation 10) - Rice in the husk

The import source	Scenario I	Scenario II	Scenario III	Scenario IV	Scenario V
	Imports (Tons)				
USA	244528.4	185449.8	146081.0	244942.4	245227.0
Thailand	228483.8	232474.8	236466.8	184653.6	155434.0
India	88621.9	90208.1	91794.7	73936.4	64146.3
Suriname	166568.3	168749.5	170931.2	171311.5	176055.7
Rest of the world	257971.5	297085.1	336207.6	343027.9	428101.9
	Import shares (%)				
USA	24.8	19.0	14.9	24.1	22.9
Thailand	23.2	23.9	24.1	18.1	14.5
India	9.0	9.3	9.4	7.3	6.0
Suriname	16.9	17.3	17.4	16.8	16.5
Rest of the world	26.2	30.5	34.3	33.7	40.0

Comparing tables 7 and 8, and then 9 and 10, the original Armington model shows a larger market access than the non-homothetic model for Suriname for both types of rice. Although the estimated market accesses according to the two models (original and non-homothetic) are different, the direction of changes in the two models is the same. Consequently, in the trade policy reforms, paying attention to the relative import prices is very important. Moreover, this simulation shows that although a preferential tariff could increase market access of the LDCs, this increase is not great. Particularly, this is observed with the two last scenarios (IV and V) which better represent the situation in 2009. The supply side problems (i.e. domestic dilemmas in LDCs such as poor infrastructures, weak technology and small capacity production) could not allow the LDCs to reap the benefits of preferential tariffs.

6. Conclusion

The Armington model is very well-known for trade analysis of agricultural products. The Armington elasticities are particularly important for CGE models since they influence the outcomes of policy shocks introduced to these models. Therefore, it is important to measure right estimations of Armington elasticities. The size of the Armington elasticities could have a large effect on the terms of trade or the implied tariff equivalent of regional trade agreements.

This paper seeks to analyze the substitution elasticities between the large exporters of rice to the EU and to consider the changes in their market accesses. In addition, we attempt to respond to the following questions: First: Does the inclusion of import tariffs in the specification lead to different estimated Armington elasticities? Second: When a discriminating tariff is introduced, what happens to the market access of large rice exporters to the EU, especially the LDCs)?

Thus, we present the Armington model derived from a CES utility function, and then a non-homothetic CES utility functional form, which is more flexible. We also calculate the Armington elasticities and the market accesses of large rice exporters to the EU.

Our empirical findings, as applied to the import demand for rice of the EU, lead to the following conclusions. 1. The assumption of homotheticity is valid only for specific cases. 2. Ignoring the import tariff when estimating Armington elasticities may cause them to be underestimated. 3. It is worthwhile considering non-homothetic preferences. Ignoring tariffs and subsistence-level requirements (μ_i) when estimating the model may also lead to biased results.

Adding to these conclusions, the simulation findings demonstrate that in spite of a large difference between import tariff rate of Suriname and other countries (scenario V), its market access would not change greatly. This problem may be caused by the small production capacity and weak technology in LDCs (supply side problems). It shows the weak capacity of such a country to compete with developed countries such as the USA. It could demonstrate how difficult it is for a LDC to increase its market access, and in so doing, to increase its development level. This could also reflect the situation in 2009: even if the LDCs will have free access to the EU rice market, their market access will not increase so largely.

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