TRADE OF QUALITY DIFFERENTIATED GOODS AND IMPORT ELASTICITIES.

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1. Introduction

Import demand analyses are popular among trade economist because of their relevance for many macroeconomic and industrial issues, as country and sectoral performances; the evolution of trade balance and currency behaviour. Since Armington (1969) the literature relies on a traditional approach. It is on the representative consumer and on product homogeneity. The only difference between the competing goods is their country of origin. This description of goods is not realistic: since Lancaster (1979), many contributions have underlined the relevance of product differentiation. Trade empirical literature has suggested that product differentiation is important at the sectoral and bilateral level, with countries producing only some among various product specifications and buying abroad the others. The literature also suggests that quality based differentiation seems to prevail over not-quality based differentiation. (Greenaway *et al.*, 1994; Fontagné *et al.*, 1998; Aturupane *et al.*, 1997; Hu and Ma, 1999). This evidence should be taken into consideration when studying import demand, because it implies that factors different from price and income influence the choice of the consumer. It also suggests that the representative consumer hypothesis is not adequate.

The objective of this paper is face these issues. We derive individual import demand functions, accounting for quality differentiation, to study the reactions of imports to activity variable and prices. Then, we derive national elasticities and analyse the policy implications of trading quality-differentiated goods. Finally, we study the impacts on the econometrics of import demand. The plan of this paper is the following. In Section 2, we present the traditional way of dealing with import demand. Section 3 introduces the issue of product differentiation.

Section 4 and Section 5 derive respectively individual and national import demand with quality differentiation. Section 6 studies the econometrics of import demand when quality matters. Finally, Section 7 summarises the main results. Appendix A shows the details of the constrained maximisations reported in the Sections 2 and 4.

2. Import Demand with Homogeneous Products.

The traditional approach to empirical analyses of import demand dates back to Armington (1969): a representative consumer chooses whether to buy an imported or a national good. They are not perfect substitutes, because of their different national origin.[1]. The representative consumer maximises his utility, according to a budget constraint to obtain demand functions in term of imported good price; domestic good price and demand for the other good. The parameter on the latter variable, called Activity Variable, gives a measurement of the reaction of imports to national economic performances. At the aggregate level the elasticities to activity variable and cross prices have been assumed positive and that to own prices negative, because we can exclude the possibility of dealing with inferior goods or complementarity issues. Empirical evidence has confirmed these assumptions.

The economy is divided in sectors, each including only goods satisfying similar needs. We analyse the problem of the consumer at the sectoral level, otherwise we could not say that the consumer chooses between competing goods. The consumer allocates the total income I in different shares to buy goods belonging to the different sectors: $I = I_1 + I_2 + ... + I_n$. The utility function U(·) translates the sub-utility associated to the sectors, $u_{i,}$ in a general utility level for the consumer: $U = U[u_1(\cdot), u_2(\cdot), u_3(\cdot), ... u_n(\cdot)]$[2]. We study how the consumer divide the income allocated to a sector between the domestic and the imported goods[3], according to the maximisation of the relevant sub-utility function respect to the sectoral budget constraint. In our sector only two countries compete, each producing a homogeneous good. Homogeneity allows referring the representative consumer hypothesis. Our maximisation problem is:

$$\begin{aligned} &Max\ \ u \\ &s.t.\, I \geq p_m m + p_d d \end{aligned}$$

with p_m being the price of imported good, p_d being the price of domestic good, m being the quantity of the imported good and d being the quantity of the domestic good. Following Clarida (1996) and Ogaki (1992) utility is addi-log[4]. a and b are positive, determine the form of the indifference curve and the Marginal Rate of Substitution between the goods[5]:

$$u = \frac{d^{(1-a)}}{(1-a)} + \frac{m^{(1-b)}}{(1-b)} \qquad 1$$

The constrained maximisation[6] gives $d = m^{\frac{b}{a}} (\frac{p_m}{p_d})^{\frac{1}{a}\frac{1}{b}}$ and

$$m = d^{\frac{a}{b}} (\frac{p_d}{p_m})^{\frac{1}{b}} \qquad 2$$

Import demand depends on the domestic demand and the price ratio. If we take a logarithmic[7] transformation[8], of 2, we get:

$$\tilde{m} = \frac{a}{b}\tilde{d} + \frac{1}{b}\tilde{p}_d - \frac{1}{b}\tilde{p}_m \qquad 2'$$

The parameter associated to the activity variable and the one associated to relative prices depend on β and are correlated. This is a classical by-product of similar maximisation exercises. The curvature parameters, α and β, influences the import demand function because they determine the Marginal Rate of Substitution and the optimal bundle is chosen where the Marginal Rate of Substitution is equal to the slope of the budget constraint. Log-linearity allows a simpler recognition of the elasticities to the import prices:

$$\frac{\partial \tilde{m}}{\partial \tilde{p}_m} = -\frac{1}{b}, \qquad 3$$

to the domestic prices

$$\frac{\partial \tilde{m}}{\partial \tilde{p}_d} = \frac{1}{b} \qquad 4$$

and to the activity variable:

$$\frac{\partial \tilde{m}}{\partial \tilde{d}} = \frac{a}{b} \qquad 5$$

Elasticities to the activity variable and to cross prices are positive, while elasticity to the own prices is negative. Given the RCH, these are the national sectoral elasticities. Our sectoral elasticities depend on the parameters α and β, which could be different in the various sectors. That implies different sectoral elasticities. Aggregate elasticities are weighted averages of the sectoral ones. Changes in the weights of the different sectors in national trade modify the national elasticities. This has two implications. First, long-term analyses require testing for change in the structure of the national economy, which could imply non-constant parameters. Studying and identifying these changes can help understanding the behaviour of the relevant elasticities. Second, any consideration of long-term national competitiveness based on the estimated reaction of imports to relative prices can give wrong suggestions, because it does not consider the impact of future changes in the shares of various sectors. Sectors with a high price elasticity are more sensitive to foreign competition, suggesting potential competitive problems in presence of higher national inflation. But along their development path, countries change their comparative advantages and their product mix, even according to foreign competition towards the sectors where they are more efficient. This process limits the competitive pressure caused by high elasticities to prices.

3. Product Differentiation.

There is a strong evidence of countries importing and exporting goods belonging to the same sector. That is not consistent with the traditional Heckescher-Ohlin representation of trade and has been often interpreted has a paradox. Subsequently this Intra-Industry Trade has been accepted as a different typology of trade and its existence has been explained by reference to product differentiation. (Lancaster, 1980; Krugman, 1981; Helpman, 1981).

According to Lancaster (1979), a good is a bundle of characteristics, including location; country of origin; and other features. Under this setting a sector is a group of products consisting of the same characteristics, or a group of firms producing goods that share the same characteristics. Differentiation depends on the goods having different combinations of characteristics and the consumers have heterogeneous preferences over them. If two goods have a different proportion of included characteristics, without any of them two having a greater amount of all the characteristics, they are similar or horizontally differentiated. If one of them have a greater amount of all the characteristics, it is qualitatively better than the other, and will probably cost more. We refer to this situation talking of vertical differentiation.

Every sector includes homogeneous, quality differentiated and similar products, but we only concentrate on quality differentiation and log linearity allows doing that without any loss of generality. Our choice depends on the higher weight of quality differentiation respect to horizontal differentiation in the international trade of many countries. This result has been shown by various studies including Greenaway et al. (1994) for the United Kingdom; Fontagné et al. (1998) for the European Union; Aturupane et al (1997) for trade between EU and Central and Eastern Europe Countries); Hu and Ma (1999) for China and finally by Chiarlone (1999) for Italian trade with EU 15 and G7 countries.

4. Individual Import Demand with Quality Differentiated Products

To include quality we modify the setting described in Section 0. Vectors of characteristic c_d and c_m, define our goods according to Lancaster (1979). The quality level of domestic and imported goods, $q_d = q_d(c_d)$ and $q_m = q_m(c_m)$[9] are positive function of the vectors of included characteristics c_d and c_m,: $\frac{\partial q_d}{\partial c_d} > 0$ and $\frac{\partial q_m}{\partial c_m} > 0$. Finally, higher quality goods give a higher utility level, for given quantity. Higher quality goods include a greater quantity of all the characteristics, which implies higher production costs and higher prices. Prices could also change for reasons not dependent on quality, as shocks to overall price level, cost of intermediate and raw materials. We account for these factors with the exogenous variable g. We write prices as $p_d = p_d(g_d, c_d)$ and $p_m = p_m(g_m, c_m)$. Their relation with characteristics and other shocks is positive : $\frac{\partial q_d}{\partial g_d} > 0$; $\frac{\partial q_d}{\partial c_d} > 0$ and $\frac{\partial p_m}{\partial g_m} > 0$; $\frac{\partial p_m}{\partial c_m} > 0$.

For given income, the positive relationship between price and quality implies a trade off between quantity and quality. The net effect on utility depends on two factors. First, the quantity reduction caused by the purchase of the higher quality good, which depends on the price of the goods. Second, the impact of the higher quality on utility, which varies across consumers. We model it with a quality preference parameter γ, that measures the utility value of quality. It varies with individual income, across sectors and along time. Utility function is:

$$u = \frac{d^{(1-\alpha)} q_d^{\gamma}}{(1-\alpha)} + \frac{m^{(1-\beta)} q_m^{\gamma}}{(1-\beta)} \qquad 6$$

The constrained maximisation gives[10] $d = m^{\frac{\beta}{\alpha}} (\frac{q_d}{q_m})^{\frac{\gamma}{\alpha}} (\frac{p_m}{p_d})^{\frac{1}{\alpha}}$ and

$$m = d^{\frac{\alpha}{\beta}} (\frac{q_m}{q_d})^{\frac{\gamma}{\beta}} (\frac{p_d}{p_m})^{\frac{1}{\beta}} \qquad 7$$ [11]

The activity variable and the prices influence demand functions. Their impact depends on α and β. Respect to the homogenous case, also relative quality (q_m/q_d)[12] matters. Import demand increases with quality of imported goods and decreases with quality of domestic good, net of price effects. The contemporaneous dependence of import demand on prices and qualities[13] requires considering their correlation. Let's write the impact of quality on import as $k_m = (\frac{q_m}{q_d})^{\frac{\gamma}{\beta}}$. It depends positively on γ and negatively on β. $\frac{\partial k_m}{\partial \gamma}$ gives the importance of γ:

$$\frac{\partial k_m}{\partial g} = \frac{1}{b}\left(\frac{q_m}{q_d}\right)^{\frac{g}{b}} \ln\left(\frac{q_m}{q_d}\right). \qquad 8$$

When $q_m > q_d$, and κ_m is >1, quality contributes to increase demand for import. If this is the case, with α, β q_m and q_d positive, the derivative is positive: if γ grows, import demand increases, for given quality differences. If $q_d > q_m$, and $\kappa_m < 1$, quality contributes to reduce import demand. In this case the derivative is negative, meaning that increases in γ further reduce import demand, for given quality differences. It shows that the importance of quality differences grows when preference for quality is bigger. Finally, when γ=0, κ_m =1, which means that the impact of quality is nil if the preference for quality is nil.

If we refer to the usual logarithmic transformation, 7 becomes:

$$\tilde{m} = \frac{a}{b}\tilde{d} + \frac{g}{b}\tilde{q}_m - \frac{g}{b}\tilde{q}_d + \frac{1}{b}\tilde{p}_d - \frac{1}{b}\tilde{p}_m \qquad 7'$$

Elasticity to scale variable is equal to homogeneous product case:

$$\frac{\partial \tilde{m}}{\partial \tilde{d}} = \frac{a}{b} \qquad 9$$

As for elasticity to prices, we consider changes in prices related to quality and changes caused by other reasons. As for quality, we refer to changes in the included characteristics:

$$\frac{\partial \tilde{m}}{\partial c_m} = -\frac{1}{b}\frac{\partial \tilde{p}_m}{\partial c_m} + \frac{g}{b}\frac{\partial \tilde{q}_m}{\partial c_m} \qquad 10a$$

and

$$\frac{\partial \tilde{m}}{\partial c_d} = \frac{1}{b}\frac{\partial \tilde{p}_d}{\partial c_d} - \frac{g}{b}\frac{\partial \tilde{q}_d}{\partial c_d} \qquad 10b$$

A change in the amount of characteristics impacts positively on the prices and on the quality of the goods, which have opposite effects on import. The net effect on import depends on the effective change in prices and quantity and on the value of γ.

The derivative of m to g_m and g_d gives the reaction of imports to shocks to prices independent by quality. It is unambiguously positive for g_d and negative for gm:

$$\frac{\partial \tilde{m}}{\partial g_m} = -\frac{1}{b}\frac{\partial \tilde{p}_m}{\partial g_m} \qquad 11a$$

and

$$\frac{\partial \tilde{m}}{\partial g_d} = \frac{1}{b}\frac{\partial \tilde{p}_d}{\partial g_d} \qquad 11b$$

We divide 11a and of 11b δp_m and δp_m. and multiply them for δg_m and δg_d:

$$\frac{\partial \tilde{m}}{\partial p_m} = -\frac{1}{b} \qquad 11'a$$

and

$$\frac{\partial \tilde{m}}{\partial p_d} = \frac{1}{b} \qquad 11'b$$

The impact of shocks to prices not dependent on quality is equal to the elasticity to prices emerging in the homogeneous goods case.

We want to obtain the reaction of imports to domestic and foreign prices. Let's consider a general shock to prices. For the sake of simplicity assume that d is constant. We can write:

$$d\tilde{m} = -\frac{1}{b}\frac{\partial \tilde{p}_m}{\partial g_m} - \frac{1}{b}\frac{\partial \tilde{p}_m}{\partial c_m} + \frac{g}{b}\frac{\partial \tilde{q}_m}{\partial c_m} \qquad 12a$$

and

$$d\tilde{m} = \frac{1}{b}\frac{\partial \tilde{p}_d}{\partial g_d} + \frac{1}{b}\frac{\partial \tilde{p}_d}{\partial c_d} - \frac{g}{b}\frac{\partial \tilde{q}_d}{\partial c_d} \qquad 12b$$

Reaction of imports to prices depends on the value of γ; the effective impact of change in the characteristics on prices and the relative frequency of shocks depending either on quality or not. That suggests varying reactions of import demand to prices. If shocks do not depend on quality the reaction of demand to prices would be equal to the homogeneous goods case. As much shocks to prices depends on quality, as lower the reaction of demand to prices will be, because of the contemporaneous opposite variation of qualities and prices.

Let's write 12a as $d\tilde{m} = -\frac{1}{b}d\tilde{p}_m + \frac{g}{b}d\tilde{q}_m$ and 12b as $d\tilde{m} = \frac{1}{b}d\tilde{p}_d - \frac{g}{b}d\tilde{q}_d$ and divide them by δp_m and : δp_d. We get:

$$\frac{d\tilde{m}}{d\tilde{p}_m} = -\frac{1}{b} + \frac{g}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m} \qquad 13.a$$

and

$$\frac{d\tilde{m}}{d\tilde{p}_d} = \frac{1}{b} - \frac{g}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d} \qquad 13b$$

If the shock to prices depends only on g, 13a and 13b reduce to $-\frac{1}{b}$ and $\frac{1}{b}$, as in the homogeneous case. Otherwise, $\frac{g}{b}$ >0, $\frac{d\tilde{q}_m}{d\tilde{p}_m}$ >0 and $\frac{d\tilde{q}_d}{d\tilde{p}_d}$ >0 imply $\frac{g}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m}$ >0 and $\frac{g}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d}$ >0. The reaction of import demand to prices in presence of quality differentiation is not greater than in presence of only homogeneous goods, in absolute value. The preference for quality can be different in the various sectors. Consequently, in the sectors with a high γ the reduction of the reaction of imports to prices is bigger than in those with a low preference for quality.

5. National Import Demand with Quality Differentiated Products

Given quality differentiation the representative consumer hypothesis is not useful anymore. Let's assume the existence of consumers of type P with wealth wP and consumers of type R with wealth w^R. They respectively have quality preferences γ^P and γ^R, with $w^P<w^R$ and $\gamma^P<\gamma^R$. National population is composed by a percentage τ^P of consumers of type P and a percentage τ^R of consumers of type R, with $\tau^P+\tau^R=1$.

The log-linear demand functions for groups P and R are:

$$\tilde{m}^P = \frac{a}{b}\tilde{d} + \frac{g^P}{b}(\tilde{q}_m - \tilde{q}_d) + \frac{1}{b}(\tilde{p}_d - \tilde{p}_m) \qquad \text{14a}$$

and

$$\tilde{m}^R = \frac{a}{b}\tilde{d} + \frac{g^R}{b}(\tilde{q}_m - \tilde{q}_d) + \frac{1}{b}(\tilde{p}_d - \tilde{p}_m) \qquad \text{14b}$$

National import demand is the sum of individual import demands:

$$M = \sum_p m^p + \sum_r m^r \qquad \text{15}$$

Elasticity to scale variable of the two groups is the same:

$$\frac{\partial \tilde{m}^P}{\partial \tilde{d}} = \frac{\partial \tilde{m}^R}{\partial \tilde{d}} = \frac{a}{b} \qquad \text{16}$$

The reaction of national demand for imports to change in domestic demand (D) is a weighted average of the elasticities of the two groups and is not influenced by γ:

$$\frac{\partial \tilde{M}}{\partial \tilde{D}} = t^P \frac{a}{b} + t^R \frac{a}{b} = (1-t^R)\frac{a}{b} + t^R \frac{a}{b} = \frac{a}{b} \qquad \text{17}$$

Reaction of import demand to prices depends on as showed in 13a and 13b:

$$\frac{d\tilde{m}^j}{d\tilde{p}_m} = -\frac{1}{b} + \frac{g^j}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m} \qquad j = P,R \qquad \text{13'a}$$

and

$$\frac{d\tilde{m}^j}{d\tilde{p}_d} = \frac{1}{b} - \frac{g^j}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d} \qquad j = P,R \qquad \text{13'b}$$

For given price and quality variations, $\frac{g^P}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m} < \frac{g^R}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m}$ and $\frac{g^P}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d} < \frac{g^R}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d}$. That implies, without taking absolute values that $\frac{d\tilde{m}^R}{d\tilde{p}_m} > \frac{d\tilde{m}^P}{d\tilde{p}_m}$ and $\frac{d\tilde{m}^R}{d\tilde{p}_d} < \frac{d\tilde{m}^P}{d\tilde{p}_d}$. Demand of imports of group R reacts to prices more than demand of imports of group P, implying that the relative weight of the two groups in national population affects national reaction to prices, which is a weighted average of those of the two groups.

As for own prices, we can write $\frac{d\tilde{M}}{d\tilde{p}_m} = t^P\frac{d\tilde{m}^P}{d\tilde{p}_m} + t^R\frac{d\tilde{m}^R}{d\tilde{p}_m}$. If we use 13'a we write: $\frac{d\tilde{M}}{d\tilde{p}_m} = -\frac{1}{b} + t^P\frac{g^P}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m} + t^R\frac{g^R}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m} = -\frac{1}{b} + (1-t^R)\frac{g^P}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m} + t^R\frac{g^R}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m}$. Given that $\gamma^P<\gamma^R$:

$$\frac{\partial\left(\frac{d\tilde{M}}{d\tilde{p}_m}\right)}{\partial t^R} = -\frac{g^P}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m} + \frac{g^R}{b}\frac{d\tilde{q}_m}{d\tilde{p}_m} > 0 \qquad \text{18a}$$

18 a shows that reaction to p_m is as less negative as higher the weight of group R.

As for cross prices, let's write $\frac{d\tilde{M}}{d\tilde{p}_d} = t^P\frac{d\tilde{m}^P}{d\tilde{p}_d} + t^R\frac{d\tilde{m}^R}{d\tilde{p}_d}$. Using 13'b we can write: $\frac{d\tilde{M}}{d\tilde{p}_d} = \frac{1}{b} - t^P\frac{g^P}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d} - t^R\frac{g^R}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d} = \frac{1}{b} - (1-t^R)\frac{g^P}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d} - t^R\frac{g^R}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d}$. Given that $\gamma^P<\gamma^R$:

$$\frac{\partial\left(\frac{d\tilde{M}}{d\tilde{p}_d}\right)}{\partial t^R} = \frac{g^P}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d} - \frac{g^R}{b}\frac{d\tilde{q}_d}{d\tilde{p}_d} < 0 \qquad \text{18b}$$

18 b shows that reaction to pd is as less positive as higher the weight of group R.

These results point to the importance of income distribution, when dealing with vertical differentiation and import demand. If national growth raises per-capita income and the weight of the richer groups of the population, it reduces the impact of price variations on imports. That could cause a time variation pattern for price elasticities. At the same time, we could expect that richer countries, with higher weight of richer groups, react less negatively to own prices and less positively to cross prices, in vertical differentiated sectors.

From a policy perspective it has interesting implications. Rich countries, facing lower reaction of imports to prices, can move domestic productions towards high quality-high price goods without neither a strong increase in imports (associated with a deterioration of their trade balance) nor competitive problems for companies. This result depends on the fact that consumers, with a strong preference for quality, would not dramatically switch expenditure towards imports. On the other hand poor countries, whose population has a higher proportion of poor consumers, could be facing a constraint. A move towards high quality-high price goods could imply a switch of consumption towards imports, given the lower preference for quality of their consumers, causing a deterioration of their trade balance and competitive problems for the firms, unless they can produce the higher quality at a lower price.

6. Impacts on Estimations

One of the main limits of the estimations of import demand is the overlooking of quality. The correct function to be estimated, when product differentiation matters is:

$$\tilde{M} = q_1 \tilde{D} + q_2(\tilde{q}_m - \tilde{q}_d) + q_3(\tilde{p}_m - \tilde{p}_d) + e \qquad 19$$

with the following expected signs $\theta_1>0$ $\theta_2>0$ and $\theta_3<0$ and ε being the disturbance term.

If we would be able to measure quality, then we could estimate the true relationship. In this case, θ_2 includes a measure of the national quality preference, which is different for different consumers and in different sectors. Consequently, θ_2 can not be constant. It changes with the consumer's wealth, the population composition and the sectors involved. One of the fundamental hypothesis in traditional econometric estimates could fail, requiring testing for parameter variability and structural breaks and robust estimation procedure.

If we cannot measure quality, because of missing proxies, we have a missing variables mis-specification. We estimate:

$$\tilde{M} = q_1 \tilde{D} + q_3(\tilde{p}_m - \tilde{p}_d) + u \qquad 20$$

The new error term $n = q_2(\tilde{q}_m - \tilde{q}_d) + e$ which includes a measure of the missing variable, is correlated with the stochastic regressors. That causes bias and inconsistency.

The extent of distortion can be measured. Let's call the included variables $\mathrm{X} = \{\tilde{d}, (\tilde{p}_m - \tilde{p}_d)\}$. We can write 19 and 20 in a compact way:

$$M = X\Theta + q_2(\tilde{q}_m - \tilde{q}_d) + e \qquad 19'$$

$$M = X\Theta + n \qquad 20'$$

The Ordinary Least Squares estimation of Θ from 20' is:

$$E(\Theta) = \Theta + q_2\left[(\mathrm{X}'\mathrm{X})^{-1}\mathrm{X}'(\tilde{q}_m - \tilde{q}_d)\right] \qquad 21$$

The bias is the product between q_2, the coefficient on the excluded variable in the true regression and $\left[(X'X)^{-1}X'(\tilde{q}_m - \tilde{q}_d)\right]$ the vector of coefficients, in the following regression: $(\tilde{q}_m - \tilde{q}_d) = f_1 d + f_2(\tilde{p}_m - \tilde{p}_d)$. According to our specification discussed earlier $f_2 \geq 0$ and $f_1 \leq 0$ [14]. From 20 and 21 we get $E(\hat{q}_1) = q_1 + q_2 * f_1$ and $E(\hat{q}_3) = q_3 + q_2 * f_2$. Given that $q_1 > 0$, $q_2 * f_1 \leq 0$, $q_3 < 0$ and $q_2 * f_2 \geq 0$, we obtain:

$$E(\hat{q}_1) \leq q_1 \qquad 22$$

and:

$$\left|E(\hat{q}_3)\right| \leq \left|q_3\right| \qquad 23$$

Overlooking quality variables cause an underestimate of the parameter associated to the activity variable and, in absolute value, of the parameter associated to relative prices.

7. Conclusions

Import demand is one of the more investigated fields of international trade. The usual hypothesis of product homogeneity is not consistent with the evidence of product differentiation. This paper has tried to fill this gap, deriving import demand functions, which include quality differentiation and evaluating any difference respect to the traditional case.

Quality differentiation does not affect elasticity to activity variable. On the other hand, the reaction of imports to prices decreases in absolute value, because changes in quality contrast the pure impact of price variations. We show that the more shocks to prices depends on quality, the lower is the reaction of import demand to prices will be.

At the aggregate level, quality differentiation suggests the relevance of national income and of its distribution. In countries with a higher weight of richer people, imports react less to prices. National growth, if it implies a bigger share of rich people, reduces the reaction of imports to prices. It implies that moving towards high prices-high quality productions should be harder for poor countries because of its adverse impact on their trade balance.

As for the econometrics of import demand, our analysis suggests a problem of non-constancy for the parameters to be estimated and that not including proxies for quality implies an underestimate of the parameters associated with income and relative prices.

References

Armington, P.S. (1969) A theory of demand for products distinguished by place of production. IMF Staff Papers 26: 159-178.

Aturapane, C., S. Djankov, B. Hoekman (1997). Determinants of Intra-Industry Trade between East and West Europe. CEPR Discussion Paper 1721.

Boylan ,T.A., M.P. Cuddy, and J.O. Muircheartaigh (1980). The Functional Form of the Aggregate Import Demand Equation A comparative analysis of three European Countries. Journal of International Economics 10: 561-565.

Chiarlone, S. (1999) Import demand functions: the impact of product differentiation, parameter non-constancies and model selection. University of Ancona, Unpublished PhD Dissertation.

Davis, G. C. (1995). Product Differentiation and Representative Agent Import Demand Systems: A Reconsideration and Reconciliation. Canadian Journal of Agricultural Economics 43: 149-164.

Dixit, A. D. and J. E. Stiglitz (1977). Monopolistic Competition and Optimum Product Diversity. American Economic Review 67: 297-308.

Fontagné, L., M. Freudenberg, N. Péridy (1998). Intra-Industry Trade and the Single Market: Quality Matters. CEPR Discussion Paper 1959.

Goldstein, M. and M. S. Khan (1985). Income and Price Effects in Foreign Trade, in R. Jones, P. Kenen, Handbook of International Economics. Amsterdam: North Holland.

Greenaway, D., R. Hine and C. Milner (1994). Country Specific Factors and the Pattern of Horizontal and Vertical Intra-Industry Trade in the UK. Weltwirtschaftliches Archives 130: 77-99.

Greene, W.H. (1993). Econometric Analysis, Macmillan, New York: Macmillan.

Helpman, E (1985). Income and Price effects in Foreign Trade, in R. Jones, P. Kenen, Handbook of International Economics. Amsterdam: North Holland.

Helpman, E. and P. Krugman (1986). Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy. Cambridge Massachusetts: The MIT Press.

Houthakker, H. S. (1960). Additive Preferences. Econometrica 28: 244-257.

Hu, X.. and Y. Ma (1999). International Intra-Industry Trade of the China. Weltwirtschaftliches Archives 135: 82-101.

Khan, M. S. and K. Ross (1977). The Functional Form of the Aggregate Import Demand Equation. Journal of International Economics 7: 149-160.

Krugman, P. R. (1981) Intra-Industry Specialisation and the gains from Trade. Journal of political Economy 89: 959-973.

Lancaster, K. (1979). Variety, Equity and Efficiency. New York: Columbia University Press.

Lancaster, K. (1980). Intra-Industry Trade Under Perfect Monopolistic Competition. Journal of International Economics 10: 151-175.

Sinha D. (1997). Determinants of Import Demand in Thailand. International Economic Journal 11: 73-83.

Appendix

In this appendix, we solve the maximisation problem in the more general setting. The results are valid for the restricted cases presented in the paper.

$$Max\ U = \frac{d^{(1-a)}q_d^g}{(1-a)} + \frac{m^{(1-b)}q_m^q}{(1-b)} \quad \text{subject to: } I \geq p_m m + p_d d \qquad \text{A.1}$$

The Lagrange function for this problem is:

$$L = \frac{d^{(1-a)}q_d^g}{(1-a)} + \frac{m^{(1-b)}q_m^q}{(1-b)} + l\,(I - p_m m - p_d d) \qquad \text{A.2}$$

The derivative respect to *d* and to *m* are our first order conditions (FOC hereafter):

$$\frac{\partial L}{\partial m} = \frac{(1-b)m^{-b}q_m^q}{(1-b)} - l p_m = 0 \qquad \text{A.3}$$

$$\frac{\partial L}{\partial d} = \frac{(1-a)d^{-a}q_d^g}{(1-a)} - l p_d = 0 \qquad \text{A.4}$$

We solve A.4 respect to λ: $l = d^{-a}q_d^g p_d^{-1}$; we substitute for λ in A.3: $m^{-b}q_m^q = d^{-a}q_d^g p_m p_d^{-1}$ and solve it for *m:*

$$m = d^{\frac{a}{b}}\left(\frac{q_m^q}{q_d^g}\right)^{\frac{1}{b}}\left(\frac{p_d}{p_m}\right)^{\frac{1}{b}} \qquad \text{A.5}$$

and for *d*:

$$d = m^{\frac{b}{a}}\left(\frac{q_d^g}{q_m^q}\right)^{\frac{1}{a}}\left(\frac{p_m}{p_d}\right)^{\frac{1}{a}} \qquad \text{A.6}$$

Second Order Conditions requires the determinant of the Bordered Hessian to be positive.

$$H^B = \begin{bmatrix} 0 & p_m & p_d \\ p_m & -bm^{-b-1}q_m^q & 0 \\ p_d & 0 & -ad^{-a-1}q_d^g \end{bmatrix} \qquad \text{A.9}$$

The determinant is:

$$\Delta = -\left[-\left(p_d^2 bm^{-b-1}q_m^q\right) - \left(p_m^2 bd^{-a-1}q_d^g\right)\right] = p_d^2 bm^{-b-1}q_m^q + p_m^2 bd^{-a-1}q_d^g > 0 \qquad \text{A.10}$$

The determinant is positive, then the values satisfying our FOCs are the constrained maximum of the utility function.

Notes

[1] Goldstein and Khan (1985) offer a valid review of this literature. They extensively discuss all the problem related to choice of the correct explanatory variables, including the issues of relative price specifications and correct activity variable, which we will not discuss.

[2] U(·) is increasing in all its arguments and weakly separable. This assumption is common in the literature (Dixit and Stiglitz, 1977).

[3] We don't use under-script, but we refer to a single sector. Thus, when we speak of Consumer Income, we refer to the share allocated to that sector and when we speak of Utility, we refer to the Sub Utility associated to the goods belonging to that sector.

[4] See Houthakker (1960) for details of the addi-log function.

[5] Marginal Rate of Substitution is equal to minus the ratio of the marginal utilities, which depend on α and β.

[6] We present the details of this maximisation in the Appendix A.

[7] ~ means we are taking logarithms.

[8] Khan and Ross (1977), Boylan et *al*. (1980) and Sinha (1997) show for different countries, using the Box-Cox methodology, that the log-linear specification couldn't be rejected in favour of the linear one. We can see Goldstein and Khan (1985) for more references of log-linear analyses of import demand.

[9] The quality of a good can go from 1 to infinite, to allow simpler analyses when switching to logarithms, without loss of generality.

[10] The usual constrained maximisation is presented in the Appendix A.

[11] If $q_m = q_d$, the goods are of the same quality and our results reduce to those of Section 2.

[12] If $\frac{q_m}{q_d} > 1$ we say that there is a quality advantage for the imported good.

[13] The prices and the quality depend on the c_i. There is a correlation that should be taken into account in empirical estimations. We come back to this point in Section 6.

[14] It depends on the inverse relationship between quality of imported goods and demand of national goods.