

Re-estimating International Elasticity of Substitution – A Preliminary Study of Quality Effect on Trade

Thannaletchimy Thanagopal, Pierre Le Mouel, Arnaud Fourgeyrollas, Paul Zagamé

ABSTRACT

Trade in quality has become a dominant economic phenomenon in Europe since the 1990s (Fontagné, Freudenberg, Peridy, 1998). Increasingly, European countries trade in similar products which vary in quality and variety, making quality an important determinant of trade within these countries. This paper, thus, attempts to quantify the effect of quality in trade within Europe. In particular, the study attempts to re-estimate import elasticities of substitution between the same good coming from different origins while accounting for the varying quality of the product. These estimates are then used to quantify the impact of quality on trade within these countries. The paper concludes that quality is important for trade, especially for differentiated goods rather than homogeneous ones.

Keywords: Trade, quality, import price elasticity, elasticity of substitution, competitiveness, disaggregated sectoral analysis

Authors

Thannaletchimy Thanagopal, Université Paris 1 with SEURECO-ERASME, Université Paris I Panthéon-Sorbonne, 9 Rue Châteaudun, 75009 Paris, France. Email: thannaletchimy.thanagopal@erasme-team.eu

Pierre Le Mouel, Université Paris 1 with SEURECO-ERASME, Université Paris I Panthéon-Sorbonne, 9 Rue Châteaudun, 75009 Paris, France. Email: pierre.le-mouel@erasme-team.eu

Arnaud Fourgeyrollas, Université Paris 1 with SEURECO-ERASME Université Paris I Panthéon-Sorbonne, 9 Rue Châteaudun, 75009 Paris, France. Email: arnaud.fougeyrollas@erasme-team.eu

Paul Zagamé, Université Paris 1 with SEURECO-ERASME, Université Paris I Panthéon-Sorbonne, 9 Rue Châteaudun, 75009 Paris, France. Email: paul.zagame@erasme-team.eu

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1. Introduction

Europe has been characterized as a region which largely trades in quality since the 1990s (Fontagné, Freudenberg, Peridy, 1998). Increasingly, European countries are trading the same variety of good which varies from other competing countries in terms of product quality. Given this dominant trade phenomenon, a study of the implications of a R&D policy becomes all the more important and interesting. The first step in so doing requires us to develop econometric models that make use of elasticity of substitution. Several authors such as Cox and Harris (1985), Brown (1987) and Shiells and Reinert (1993) confirm that the values of elasticities of substitution have a significant role on the quantitative and qualitative results of analyses performed on the basis of multinational models. Thus, the need to correctly estimate these elasticities that allow us to further study the quantitative implications of an innovation policy becomes all the more important.

This article attempts to re-estimate these generally under-estimated international elasticities of substitution using an import market share equation and a quality measure, so as to reconcile these estimations with those of the ‘new’ trade theory. The ‘new’ trade theory demonstrates that import price elasticities tend to coincide with the theoretical elasticities of substitution, which are often above one, in industries producing large varieties of products (Krugman and Helpman, 1985). By accounting for these quality effects, we show that the elasticities of substitution increase and become superior to one. In addition, we are also able to show the impact of improving product quality on trade.

2. Theoretical model

The model used in this study follows the model from Crozet and Erkel-Rousse’s paper (2004) entitled “Quality Matters” which was based on a trade model developed by Erkel-Rousse (1997, 2002).¹

We consider an import market share function, denoted as $mshare_{kijl't}$, which looks at imports m between exporter i and importer j for a particular sector k over time t as a fraction of imports m between j and the competitors of the exporter country, denoted as I' . This fraction of imports between i and j over imports between I' and j is a function of four key variables namely relative prices denoted as $price_{kijl't}$, relative quality denoted as $know_{kijl't}$, number of varieties represented by $emp_{ijl't}$ and the distance variable denoted as $dist_{ijl't}$.

The equation to be estimated is given in log terms below:

$$\begin{aligned} \log(mshare_{kijl't}) &= -(e_p - 1) \log(price_{kijl't}) + e_q \log(know_{kijl't}) + e_g(emp_{ijl't}) \\ &\quad - e_d \log(dist_{ijl't}) + fixed\ effects + intercept + u_{kijl't} \end{aligned}$$

where $mshare_{kijl't} = \frac{M_{kijt}}{\sum_{i' \in I'} M_{kii'jt}}$

$$price_{kijl't} = \frac{p_{kijt}}{\overline{p_{kii'jt}}}$$

$$emp_{ijl't} = \frac{emp_{kijt}}{\overline{emp_{kii'jt}}}$$

$$know_{ijl't} = \frac{know_{kijt}}{\overline{know_{kii'jt}}}$$

The variables $\overline{p_{kii'jt}}$, $\overline{emp_{kii'jt}}$ and $\overline{know_{kii'jt}}$ stands for the average import prices, average employment and average knowledge originating for the set of i ’s competitors I' .

¹ For an in-depth treatment of this model, consult “Trade Performances, Product Quality Perceptions, and the Estimation of Trade Price Elasticities” (2004), Mathieu Crozet and Erkel-Rousse (Review of International Economics), 12(1), pg 108-129

$mshare_{kijl't}$ reflects the import share of goods from a particular sector k originating from an exporter country i to an importer country j over time, t . $price_{kijl't}$ reflects the relative import price of a good k coming from country i to country j . $emp_{ijl't}$ reflects the relative employment of a sector in the importer country. It is indicative of the level of varieties available in the importer country. $know_{ijl't}$ reflects the relative quality of the importer good. Finally, $dist_{ijl't}$ reflects the relative distance between the trading partners i and j relative to the distance between the importer country and its trading competitors (to j). This variable is added together with the intercept as an invariant factor that affects the relative import market share. Distance, according to Anderson and Marcouiller (1999) and Rauch (1999) may be added to control for barriers to trade that are not accounted for through the relative prices.

We are interested in estimating the elasticity of substitution represented by e_p as well as the relative quality elasticity between the various varieties of good k , denoted by e_q . Due to several mismeasurements that could arise in the data especially for the price variable, it might be that e_p does not exactly equal to theoretical elasticity of substitution.

Intuitively, this model suggests that exporters can attempt to procure a greater market share via two channels: they can lower their prices relative to those of their competitors or they can enforce their relative strength through the differentiation channel, that is, by either increasing the number of varieties offered or improving the quality of their product relative to that of their competitors. Note that the coefficient of the price factor in the model is strictly negative since we assume that the elasticity of substitution, $e_p > 1$.

To study these relationships between imports and price and quality, we consider the data for a group of 11 European countries over the periods of 1990 to 2003 for a total of 20 manufacture goods sectors. The data is largely compiled from various sources. In particular, the data on import trade flows disaggregated over sectors is obtained from the January 2012 revised version of the WIOD (World Input-Output Database). The data on employment was taken partly from WIOD and revised with information from CHELEM and Eurostat. To represent prices, we use import price indices that are taken from the CEPII database. These price indices have been transformed to correspond to the nomenclature of our sectors. Likewise, the distance data is also obtained from CEPII. The distance is measured in kilometers between the major cities of the partners and the information on the country-city pair can be found in the Appendix. Finally, the quality data is constructed using data on direct R&D expenditures, taken from OECD and Eurostat, as well as indirect R&D expenditures which are measured using patent citations in other sectors.

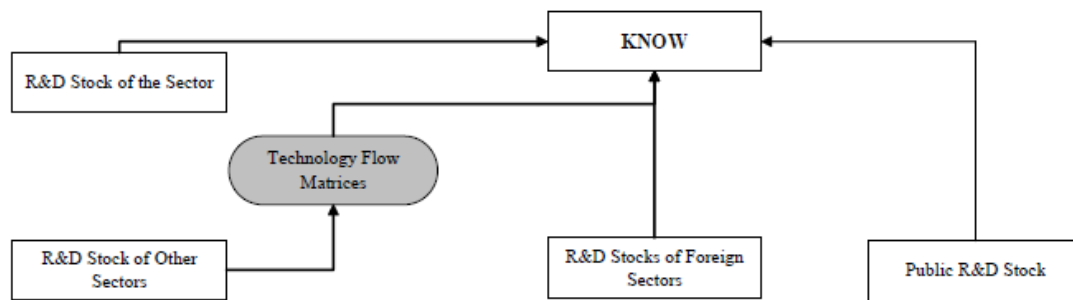
We understand that the quality of the product can influence the demand of the product from the point of view of the consumer. If the consumer prefers a higher quality product, he is still willing to pay for it despite its higher price. Thus, ignoring the quality aspect of a product leads to an underestimation of the trade price elasticity since it generates a positive correlation between import price indices and the value of manufactures imports.

Our study differs from others in the way in which product quality is represented. As quality is unobservable, we need a proxy to represent the effect of quality on prices. The proxy that we use to represent the quality of a product is known as the knowledge variable. The knowledge variable attempts to capture both the direct and indirect R&D expenditure on a particular sector. Using these expenditures, we are able to correlate the quality of the output with the amount spent on improving the output via innovation. Our paper is unique in presenting quality of the product being represented by the accumulation of R&D expenditures and other knowledge spillovers. In addition, this proxy aims to show the link between how the knowledge of producing one product has increasing returns on the knowledge required to produce another product. In this way, the quality variable, which is a demand side variable for the consumers, is derived from the supply side variable for the producers, that is, the technological know-how.

The construction of the knowledge variable is slightly complex. We use the value of R&D expenditures in a particular sector as well as the R&D expenditures in other sectors. We convert the

R&D expenditures from other sectors via technology flow matrices. These matrices were constructed under the methodology developed by Johnson for the OECD with sectoral differentiation (Johnson, 2002). Figure 2.1 charts the construction of the knowledge variable as a quality proxy.

Figure 2.1: Constructing the Knowledge Variable



Source: Chevalier et al, 2006

The knowledge variable considers the quality of the imported good. Thus, if the quality of the imported good is high, then this will increase imports coming into the country. So, we expect a positive coefficient when regressing quality proxy in the gravity equation.

The list of countries considered, as well as, the list of the sectors included are provided in the Appendix.

3. Main Estimation Results

The main estimation results are provided in the tables in this section namely Tables 3.1, 3.2 and 3.3. Table 3.1 depicts the results of our regressions on pooled data. We perform two main regressions methodologies – Ordinary Least Squares (OLS) and Instrumental Variables (IV). Our panel data is disaggregated across trading partners and sectors. Given such high level of disaggregation, we add controls in the pooled regressions to account for sectoral and country-specific heterogeneity. We perform simple OLS and IV regressions with and without fixed effects to account for temporal effects in the data.

The IV regression is performed using the lagged price indices as instruments for prices. This instrument is selected in an attempt to redress endogeneity that might be present in the import price indices.

Table 3.2 reports the results for all the specific sectors considered in the model. We run simple OLS with fixed effects regression for each sector and present the results in this table. By performing regressions on each particular sector, we are able to eliminate the presence of sectoral heterogeneity across the data.

Table 3.3 provides the results for country-specific estimations. Similarly, we run simple OLS with fixed effects regressions for each importing country and present the results in this table. This allows us to account for importer specific effects on the data.

Table 3.1: Pooled Results

Estimation Method	Without quality adjustment				With quality adjustment			
	OLS	OLS	2SLS	2SLS	OLS	OLS	2SLS	2SLS
$1 - e_p$	-0.11***	-0.11***	-0.15***	-0.17***	-0.60***	-0.81***	-0.91***	-0.19***
e_p	1.11	1.11	1.15	1.17	1.60	1.81	1.91	1.19
e_q	-	-	-	-	1.18	1.15	1.21	1.19
e_g	0.65*	0.22*	0.65*	0.22*	0.61*	0.22*	0.61**	0.22*
e_d	-0.44**	-0.09**	-0.43**	-0.10***	-0.41**	-0.11***	-0.40**	-0.12***
Constant	10.38***	8.90***	10.33*	8.86***	8.71***	7.59***	8.40**	7.22***
Fixed effects	Yes	No	Yes	No	Yes	No	Yes	No

R^2	17.22	10.50	17.54	13.73	15.04	16.32	16.16	17.54
Observations	26320	26320	26320	26320	26320	26320	26320	26320

Note: *, **, *** refers to significance testing under 10%, 5% and 1% significance level

Based on the results from Table 3.1, we observe that the relative price indicator has a negative relation which is often significant to the import share. This is because the relative price we consider is the price of import good relative to the price of the competitor's good. So if the price of the importer good from j is higher than the average price of the importer good from I 's, i 's competitors, then consumers would prefer to buy from i 's competitors given that both goods are identical (no quality effects intervening) thereby reducing the import share coming from i . Thus, the relationship between relative price and imports is negative.

As predicted, adjusting for quality decreases the price coefficients given by $(1-e_p)$ under all the estimations, and hence increasing the elasticity of substitution e_p to above 1, thereby correcting the under-estimation bias.

When accounting for quality, many authors readdress this bias and obtain relatively higher trade price elasticities, generally superior to 1, which is in line with the theoretical elasticities of substitution. Notably, work by Hummels (1999), Erkel-Rousse and Daniel Mirza (1999), Erkel-Rousse and Le Gallo (2002) and Crozet and Erkel-Rousse (2004) have proven that trade price elasticities do increase significantly, often above 1, when corrected for quality effects. Thus, our pooled results conforms to past work thereby confirming the notion that import price elasticities are under-estimated and should be above unity.

The quality proxy is highly significant according to the results above. Indeed, an improvement in the quality of products from the exporting countries (proxied by the knowledge variable) does lead to higher exports from these countries. Notably, the regressions with fixed effects display higher coefficients for quality than those for the regressions without fixed effects. As the model for fixed effects is recommended to account for within effects coming from the countries as well as from the sectors, we choose to consider these higher coefficients which are significant and above unity.

The variety effect is positively significant in all regressions. This is because the variety proxy helps to control for the effect of varieties on consumer preferences. According to Acemoglu and Ventura (2002), the variety proxy captures the effect of varieties on export potential because the number of employees employed in a particular sector is proportional to number of varieties that sector produces. Thus, an exporting country with a higher export potential (proxied by higher employment) tends to export increasing varieties of goods in relation to its competitors. This means that the importing country j prefers to import more goods from i rather than its competitors I' so as to provide higher varieties of the same good k in its country for its consumers.

We also note that the coefficient of the variety proxy falls with the addition of the quality proxy. This decline is due to the fact that without the quality proxy, the variety variable captures part of the effect of vertical differentiation. With quality effect, the effects are then differentiated. This is in line with empirical finding that support this negative relationship between quality and variety. Indeed, firms make a trade-off between quality and variety of their products. An exporter that improves his product quality can choose to reduce his product variety and vice versa. According to Krugman (1980), the parameter relative to the variety proxy should equal unity. Unfortunately in our case, the coefficient of the variety variable does not approach unity. This could be due to the weak proxy. Thus, we should analyze the role of variety in import trade and in determining international elasticities of substitution with care.

Distance, as expected, varies negatively and significantly with trade flows. As longer distances increase transportation costs, countries tend to trade more with neighboring countries. Thus, distance between trading partners is another significant variable in determining trade flows. Under this regression, we did not constrain the coefficients of both price and distance to be the same. This is because the results were much more robust without the constraint. Nevertheless, the role of

distance remains the same in reducing trade across countries when distance between trading partners rises.

Table 3.2: Bilateral Results

Sector	Name	Initial e_p	Adjusted e_p	e_q	Product Differentiation by Rauch	Product Differentiation by OMSP	Estimated Classification
1	Agriculture	0.097	1.414	1.529	HOM	HOM	HOM
5	Refined Oil	0.050	1.549	1.632	HOM	HOM	HOM
8	Ferrous and Non-Ferrous Metals	0.154	1.360	1.559	HOM	HOM	HOM
9	Non-metallic mineral products	0.026	1.390	1.647	HOM	HOM	HOM
10	Chemicals	1.006	1.339	2.442	DIF	HOM	DIF
11	Metal Products	1.007	1.355	1.381	DIF	HOM	HOM
12	Agricultural and Industrial Machines	1.014	1.067	2.043	DIF	DIF	DIF
13	Office Machines	0.032	1.048	3.448	DIF	DIF	DIF
14	Electrical Goods	1.037	1.019	2.795	DIF	DIF	DIF
15	Transport Equipment	1.038	1.035	2.740	DIF	DIF	DIF
16	Food, Drink and Tobacco	0.053	1.524	1.719	HOM	HOM	HOM
17	Textiles, Cloth and Footwear	1.003	1.546	1.262	DIF	HOM	HOM
18	Paper and Printing Products	1.037	1.452	1.516	DIF	HOM	HOM
19	Rubber and Plastic	1.025	1.340	1.491	DIF	HOM	DIF
20	Other Manufactures	0.027	1.623	1.947	DIF	DIF	HOM

According to Table 3.2, all the sectors show an elasticity of substitution higher than 1 with quality adjustments. These values were obtained by running the regressions using OLS estimator with fixed effects even though the results were robust for the IV regression. In fact, most of these sectors had an initial lower estimate of the elasticity of substitution which increased with the quality adjustment. This simply shows that adjusting for quality helps to correct for the downward bias in estimating the elasticities of substitution.

The two columns of Table 3.2 entitled Product Differentiation, record the type of product classification, be it homogenous (HOM) or differentiated (DIF). This product classification is based

on Rauch's calculations (1996) as well as the work of Oliveira-Martins, Scarpetta and Pilat (OMSP, 1996) on STAN sectors. However, the sectoral classification in our case differs slightly from that of STAN sectors since there are more sectors under STAN. As such, we had to regroup certain sectors such that they conform to the calculations performed by Rauch and OMSP. Given this limitation, it is possible that some sectors though they seem to produce differentiated products have relatively higher elasticities of substitution that correspond to those of the homogeneous sectors. For instance, the Other Manufactures sector, despite being categorized as a sector that produces highly differentiated products according to both Rauch and OMSP classifications, portrays an elasticity of substitution that is high, in line with the elasticities of substitution corresponding with homogeneous products. As such, keeping in mind these shortfalls, we have created our own classification of the sectors using our estimations and this is presented in the last column of Table 3.2.

The industries with low product differentiation have relatively higher elasticities of substitution when compared to the industries with high product differentiation. Under the OMSP classification, most industries classified as non-industrialized sectors or sectors producing highly homogeneous products, display relatively higher elasticities of substitution, which range between 1.340 and 1.549. The sectors with high product differentiation or largely industrialized sectors had relatively lower elasticities of substitution ranging between 1.019 and 1.340 with the exception of the Other Manufactures sector which display a high elasticity of substitution of 1.623.

These results do not display the same results in terms of magnitude where earlier studies recorded the range for homogenous sectors to be between 3.5 and 6 while for the differentiated sectors to be between 3.5 and 4.0. Nevertheless, these results are in line with the sectoral results derived by a similar study performed by Erkel-Rousse and Mirza (2002). Notably, sectors that produce differentiated and industrialized products tend to display lower elasticities of substitution as shown above. With the exception of Other Manufactures sector, the results coincide with past empirical work that proved that industries producing homogenous and non-industrialized products tend to have higher elasticities of substitution than industries producing differentiated and industrialized products due to the higher substitutability among homogeneous goods.

Now, we consider the role of quality innovation on import of these products. Most of the coefficients found produce a highly positive and significant effect of quality on imports. Thus, an improvement in the quality of exporting goods relative to those of the competitors leads to an increase in its export share. A 1% increase in relative product quality leads to higher export share varying between 1.26% and 3.45%. The sectors that display relatively high coefficients for quality are largely the sectors producing highly differentiated products namely Chemicals, Agricultural and Industrial Machines, Office Machines, Transport Equipment and Paper and Printing Products. These industrialized sectors have large scope for product differentiation. Thus, quality improvements are more useful in these sectors than in the homogeneous product sectors such as Agriculture.

Table 3.3: Import Price Elasticity by Importing Country

Importing Country	Initial e_p	Adjusted e_p
DE (Germany)	0.986	1.181
DK (Denmark)	1.044	1.961
ES (Spain)	1.029	2.691
FI (Finland)	0.986	1.325
FR (France)	1.028	1.183
IE (Ireland)	1.086	4.266
IT (Italy)	1.050	3.244
NL (Netherlands)	1.009	2.039
NO (Norway)	1.026	1.743

Sweden (SE)	1.012	1.737
UK (United Kingdom)	1.087	1.667

We, now, proceed to look at the elasticities of substitution from the point of view of the importing country given quality adjustments. The results are consolidated based on the OLS with fixed effects regression. The results are robust across the estimation methods which add more credibility to our results.

Out of the sample of 11 countries, all of them display an elasticity of substitution superior to 1 after being adjusted for quality effects of their products. In fact, the elasticities of substitution were often insignificant prior to the adjustment for most countries like Germany, France and Spain. Adjusting for quality not only raises the elasticities but it also restores the significance to the elasticities. Overall, all the countries in the sample improve their elasticities of substitution when they have been adjusted for quality effects.

According to Table 3.3, richer countries tend to display lower elasticities of substitution as opposed to our intuition which suggests that richer countries usually have higher import price elasticities. According to Imbs and Méjean (2010), rich countries tend to import goods that are not substitutable, while the reverse is true for large developing countries. Hence, these richer countries like Germany and France tend to display lower import price elasticities compared to relatively poorer countries like Spain and Italy.

In addition, the importance of specialization of industries also determines the elasticities. Since the service industry is exempted from this study, it might bias the ‘true’ elasticities of substitution for some importing countries that focus more on service trade rather than goods trade like Ireland. Also, domestic consumers may prefer imports from other trading partners that are not included in this study so it might bias the estimation of elasticity of substitution for some countries like Spain which trades intensively with Switzerland and Russia. We also do not consider the role of re-exports in these regressions. Thus, these results neglect the role of some countries like Ireland that serve as gateway to Europe markets for non-European products. Thus, these results need to be consulted with these shortfalls in mind that might bias the estimation of the ‘true’ elasticities of substitution.

From the point of view of the importing country, if this country has a high elasticity of substitution, it means that the consumers in this country have a strong preference for its domestic goods. The idea is that for a small increase in average price of its competitors, an importer is able to raise its market share via a large proportion because its consumers will substitute away from the higher priced competitor goods towards the lower priced domestic good. From the results in Table 3.3, we notice that importer countries that can procure higher domestic market share relative to its foreign competitors are Ireland, Italy and Spain.

Table 3.4: Quality elasticity by Exporting Country

Exporting Country	e_q
DE	1.419
DK	10.302
ES	8.048
FI	1.630
FR	1.375
IE	2.174
IT	5.320
NL	3.796
NO	2.839
SE	2.346
UK	1.808

Table 3.4 shows the impact of an increase in the market share between i and j due to a 1% increase in the product quality of the exporting good from i (represented as 1% deviation from the standard error of the regressions). The results presented above are the mean values calculated from the impact of product quality on each of the 15 sectors. The quality impacts are generally high implying that the impact on market share is higher than proportionate for a 1 unit deviation in the standard error for the quality variable. The range of impact lies between 1.4 and 10.3 deviation units. All exporting countries, thus, benefit from quality innovation with countries like Denmark, Spain and Italy benefiting more from it than others.

4. Conclusion

Overall, the paper proves that elasticities of substitution are often under-estimated and that correcting for this biasness through quality effects can help to 'correctly' estimate the 'true' values of import price elasticities. These elasticities tend to conform to the 'new' trade theory elasticities of substitution in that they are always superior to one and tend to be equal in industries producing large varieties.

When looking at the sectoral results, accounting for sectoral heterogeneity becomes all the more important as different sectors have different elasticities of substitution. In particular, sectors which produce highly homogeneous goods tend to have high elasticities of substitution due to the higher substitution effect among these goods. Highly differentiated goods sectors have lower elasticities of substitution with the exception for Other Manufactures sector. These sectors also have wider scope for innovation, thus they display higher relative quality elasticities as opposed to the homogeneous goods sectors.

On closer look at the various importers, we deduced that richer countries tend to have lower import price elasticities as these countries tend to import goods that are more differentiated and hence less substitutable with domestically produced product from the same sector. In addition, we also deduced that countries with higher import price elasticities are countries with stronger preference for their domestic products namely Ireland, Italy and Spain.

In considering the role of product quality in influencing market share, we note that the impact of quality across all countries and sectors is positively significant and higher than unity. When looking at exporting countries, we conclude that improving the quality of a product by 1 unit deviation in standard error can contribute to an average increase in the export share of an exporter ranging between 1.4 and 10.3 standard deviation units. This result suggests that a policy aimed at improving the quality of a product allows the exporter to have an edge over its competitors.

These results could serve as a policy foundation wherein policy makers can simulate the various competitiveness policies in various exporting markets on which they have an advantage so as to increase their market share in that market and henceforth increase their economic growth which is more of a result of greater exports than as a result of higher consumption. Thus, a further study on this phenomenon as well as an extension of all forms of trade (service and goods trade) can prove to yield interesting policy implications.

Appendix

Theoretical Treatment of Import Market Share Model

The model takes into account the preferences of the consumer through a Spence-Dixit-Stiglitz sub-utility function, U_{kj} , which weighs the consumer's preferences between domestic and imported goods from different origins.

Given there are $I \geq 2$ countries involved in trading with each other and i refers to the exporting country while j refers to the importing country and k refers to the differentiated product that is

traded. A representative consumer in the importing country j aims to maximize his Spence-Dixit-Stiglitz sub-utility function subject to his budget constraint:

$$U_{kj} = \left[\sum_{i=1}^I \sum_{v=1}^{n_{kj}} \alpha_{kij} y_{vij}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

Where y_{vij} stands for the total demand for variety v addressed to the producer of country i , n_{kj} reflects the number of varieties originating from country i . σ is the elasticity of substitution between domestic and imported goods from different origins. Here, the preference parameter is noted as α which corresponds to the quality of the product that is imported. In other words, these preference parameters stem from the national differences in terms of technological knowledge incurred through externalities as well as own R&D investment of a particular country.

In terms of the supply side, the producer solves for the profit maximization problem to obtain a price expression as seen below:

$$p_{kij} = c_{ki}(1 + t_{kij}) \frac{\epsilon_{kij}}{(\epsilon_{kij} - 1)}$$

Where c_{ki} represents the production cost per unit related to producing the good k in the exporting country i and ϵ_{kij} corresponds to the price elasticity of demand for the variety (k, i) in the importer country j .

Following closely to the model developed, we rewrite the trade equation by manipulating the sub-utility equation and the price expression to derive the following where E_{kj} refers to the share of country j 's national revenue allocated to the consumption of product k :

$$M_{kij} = n_{ki} p_{kij} y_{kij} = \left(\frac{p_{kij}}{p_{kj}} \right)^{1-\sigma} \left(\frac{n_{kj} \alpha_{kij}^{\sigma}}{\sum_{i'=1}^I n_{ki'} \alpha_{ki'j}^{\sigma}} \right) E_{kj}$$

Expressing the total imports M between i and j with respect to the imports between j and the competing exporters i' results in an import market share expression shown below where n refers to the number of varieties:

$$\frac{M_{kij}}{M_{ki'j}} = \left(\frac{p_{kij}}{p_{ki'j}} \right)^{1-\sigma} \left(\frac{n_{ki}}{n_{ki'}} \right) \left(\frac{\alpha_{kij}}{\alpha_{ki'j}} \right)^{\sigma}$$

The log-transformation of this equation (through transforming it into growth rate and then integrating) leads to the derivation of the testable import market share equation which we see below. We have transformed the above equation including some other variables so as to parallel the import market share equation from our reference paper.

$$\begin{aligned} \log(mshare_{kijl't}) &= -(e_p - 1) \log(price_{kijl't}) + e_q \log(know_{kijl't}) + e_g(emp_{ijl't}) \\ &\quad - e_d \log(dist_{ijl't}) + fixed\ effects + intercept + u_{kijl't} \end{aligned}$$

$$\text{where } mshare_{kijl't} = \frac{M_{kijt}}{\sum_{i' \in I'} M_{ki'jt}}$$

$$\begin{aligned} price_{kijl't} &= \frac{p_{kijt}}{p_{ki'jt}} \\ emp_{ijl't} &= \frac{emp_{kijt}}{emp_{ki'jt}} \\ know_{ijl't} &= \frac{know_{kijt}}{know_{ki'jt}} \end{aligned}$$

List of European Countries

Germany, DE	Italy, IT
Denmark, DK	Netherlands, NL
Spain, ES	Norway, NO

<i>Finland, FI</i>	<i>Sweden, SE</i>
<i>France, FR</i>	<i>United Kingdom, UK</i>
<i>Ireland, IE</i>	

List of Sectors

<i>NEMESIS Sectoral Index</i>	<i>Sectoral Description</i>
1	<i>Agriculture</i>
2	<i>Coal and Coke</i>
3	<i>Oil and Gas Extraction</i>
4	<i>Gas Distribution</i>
5	<i>Refined Oil</i>
6	<i>Electricity</i>
7	<i>Water supply</i>
8	<i>Ferrous and Non-Ferrous Metals</i>
9	<i>Non Metallic Mineral Products</i>
10	<i>Chemicals</i>
11	<i>Metal Products</i>
12	<i>Agricultural and Industrial Machines</i>
13	<i>Office Machines</i>
14	<i>Electrical Goods</i>
15	<i>Transport Equipment</i>
16	<i>Food, Drink and Tobacco</i>
17	<i>Textiles, Cloth and Footwear</i>
18	<i>Paper and Printing Products</i>
19	<i>Rubber and Plastic</i>
20	<i>Other Manufactures</i>

Distance measured across major cities of partner countries (in kilometers)

Country, 2-letter Country Code	City from which distance is measured
Germany, DE	Essen
Denmark, DK	Copenhagen
Spain, ES	Madrid
Finland, FI	Helsinki
France, FR	Paris
Ireland, IE	Dublin
Italy, IT	Rome
Netherlands, NL	Amsterdam
Norway, NL	Oslo
Sweden, SE	Stockholm
United Kingdom, UK	London

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