Danmarks Statistik
MODELGRUPPEN

Arbejdspapir*

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Manufactured exports – a panel estimation

Resumé:

This paper presents a panel estimation of Danish manufactured exports. The Armington model is first estimated based on 20 OECD countries that are the major trading partners. The estimated long run price elasticity ranges between -1.4 and -1.6 depending on the methods, and the short run demand (price) elasticity is close to +0.6(-0.6). Including Eastern European countries marginally reduces the price elasticities and marginally increases the demand elasticity. There is also an attempt to use country specific Danish export prices based on bilateral unit values. A further scrutiny of the bilateral unit values is required before making inferences.

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1. Introduction

Trade elasticities - the response of traded quantities to changes in prices - have always received a great deal of attention. In a macro-modeling exercise, the size of trade elasticities influence the effects of policy experiments on trade patterns, welfare and factor returns, cf. Hillberry and Hummels (2013).

In ADAM, the sizes of the foreign trade elasticities are important for the crowding out properties of the model. If the foreign trade elasticities are high, the response of exports and imports to a change in prices would be high, and the speed of adjustment to the long run equilibrium after a demand or supply shock will be quick. If the foreign trade elasticities are high, the necessary change in the terms of trade and real wages will also be smaller, hence the impact on consumption will be smaller, cf. Kristensen (2008) and Rasmussen (2010).

The estimates for the long run price elasticities on the macro level lie somewhere between -2 and -4 for Danish manufactured exports, cf. Jensen and Knudsen (1992), Kongsted (1998) and Sisay (2009). However, price elasticities tend to be quite sensitive to changes in model specification even when similar data, methods and sample periods are used. The estimating framework can also be influenced by measurement issues, unobserved effects and endogeneity problems, which could influence the size of the elasticities. In ADAM, the long term price elasticity for manufactured exports has long been estimated around -2. This value has been maintained in a series of model group papers, see e.g. Sisay (2009). It has always been argued in the model-group that when the data is allowed to speak freely, the best estimate for Danish manufactured exports is in the neighborhood of -2. This value has often met critics from users of the model, deemed low for Danish exports.

The empirical evidence on trade price elasticities provides a wide range of estimates. Via (2011) provides a review of long-term price elasticities for imports and exports for a number of OECD countries including Denmark, see appendix Ia-Ib. The long-term import price elasticities range between 0.5 and 2 with a median approximately 1. The highest reported long-term export price elasticity is approximately 2.5 with a median of 1.2, see appendix for detail. Erkel-Rousse and Mirza (2002) provide a similar review of the empirical literature (see appendix Ic). They also try to reconcile the difference between the high level of elasticity suggested by the theory and the low values reported in the empirical literature. They attribute the differences to misspecification, measurement error and endogeneity problems. They provide estimates for import price elasticities ranging from 1 to 7, which is a broad range. Their approach relies on bilateral trade flows and unit value indices. Feenstra, Obstfeld and Russ (2012) simultaneously estimate macro elasticity between home and import goods and micro elasticity between foreign sources of imports using import demand equations for various goods. The former is estimated in the neighborhood of unity (which is in line with the estimates in ADAM) and the median estimate for the latter is 3.1. They also use bilateral unit values and trade flows. The magnitude of the Armington elasticity has always been subjected to debate and the empirical evidence is inconclusive.

In this paper, we consider a panel data approach for estimating the export price elasticities in ADAM. Such analysis has previously been made in Kristensen (2000). This paper builds on the previous study with a new dataset for export markets, cf. Sisay (2012). The new data provides the opportunity to look at the old debate on price elasticity from a panel data perspective. A panel data have a number of advantages over a time-series or cross-section data, one important advantage is the possibility for controlling omitted variables. A panel data contains more degrees of freedom and more sample variability and provides a more accurate inference of model parameters. A panel data also provides a micro foundation for aggregate data analysis, see Hsiao (2007).

A popular approach for modeling exports is based on Armington (1969) model, see e.g. Kongsted (1998), Nielsen (2002) and ADAM (2012). Here too we apply the Armington model in a panel approach. The next section presents the econometric framework, section 3 give a brief account of the dataset, section 4 presents the results and section 5 concludes.

2. The econometric framework

Exports in ADAM are modelled using the Armington model. The model assumes that products are imperfect substitutes and relates market shares to relative prices. The long term relation can be written as:

$$\log\left(\frac{fE_{it}}{fEe_{it}}\right) = k + \beta \cdot \log\left(\frac{pe_t}{pee_{it}}\right) + u_{it}, \quad t = 1,2,\dots,T \;\&\; i = 1,2,\dots,N \qquad (1)$$

fE_{it} Danish exports to partner *i* at time *t* in fixed prices
fEe_{it} imports of partner *i* at time *t* in fixed prices
pe_t Danish export prices at time *t*
pee_{it} import prices of partner *i* at time *t*
β long term price elasticity
k constant, scaling of the market share
u_{it} error term

The model *(1)* deserves some considerations. The model may appear restrictive because it assumes a single slope coefficient, β and a single intercept, k. We can allow for the slope and intercept terms to vary across cross section units. A test of a single slope and intercept vis-à-vis non-constant coefficients can also be carried out.

The model *(1)* assumes the same Danish export prices for all partners. The presence of different transportation costs, among others, implies different partners pay different prices for Danish goods. One remedy is to augment *(1)* with a variable for transport costs. Getting a measure of transport costs is often difficult, the popular approach in the literature is to use physical distance between countries as a proxy for transport costs. A second alternative is to look for the actual prices partners pay for Danish goods. This requires the presence of bilateral prices between Denmark and trading partners. We will present estimation results using bilateral unit values from the detailed ITCS database.

From an econometric point of view, the estimation of *(1)* requires that the error in each time period be uncorrelated with the explanatory variable(s) in the same time period. This assumption is too strong for a panel data. In fact, a panel data with its variation over time and cross section provides ways for dealing with unobserved effects. The model can also be augmented with control variables such as time dummies, dummies for common boarder, language, etc.

Finally, the model *(1)* is a long-term relation between market share and relative prices, it can be transformed to an error correction form, which is more informative as it distinguishes between short-run and long-run elasticities. Thus, *(1)* can be re-written in an error correction form as:

$$\begin{aligned}\mathrm{Dlog}(fE_{it}) = {} & \alpha_1 \cdot \mathrm{Dlog}(fEe_{it}) + \alpha_2 \cdot \mathrm{Dlog}\left(\frac{pe_t}{pee_{it}}\right) \\ & -\gamma \cdot \left[\log\left(\frac{fE_{it-1}}{fEe_{it-1}}\right) + \beta \cdot \log\left(\frac{pe_{t-1}}{pee_{it-1}}\right) + \alpha_3 \cdot \log(D_i)\right] \\ & +c_i + k + u_{it}\,, \qquad t = 1,2,\dots,T \;\&\; i = 1,2,\dots,N \qquad (2)\end{aligned}$$

Where D_i is the physical distance between Denmark and partners and c_i is the unobserved effect.

Equation *(2)* can be estimated in various ways: pooled OLS, random effect, fixed effect, dummy variable regression, and first difference. In the following, we give a very brief account of the different techniques, see Wooldridg (2002) for detailed discussion.

The first method – pooled OLS – is the simplest of all. It puts the unobserved effect, c_i, in the error term and assumes no correlation between the composite error term, c_i+u_{it}, and the explanatory variables. This assumption has to hold for the OLS estimation of *(2)* to be consistent. The random effect method (RE), like pooled OLS, puts c_i in the error term, but assumes a more restrictive assumption than pooled OLS. The RE approach assumes strict exogeneity, i.e. no correlation between the composite error term and the lagged, leaded or current values of the explanatory variables. The RE exploits the serial correlation in the composite error term to obtain a consistent estimate in a generalized least square framework.

The whole point of using a panel data is to allow the unobserved effect, c_i, to be correlated with the explanatory variables. The fixed effect (FE) approach allows c_i to be explicitly correlated with the explanatory variables. One drawback of FE analysis is that we cannot include time constant observables such as distance as explanatory variables, because we cannot distinguish their effects from the time constant unobservable, c_i. One alternative to this is to allow time-constant observables to interact with time dummies, this gives the effects of time-constant observables on the dependent variable over time. The FE approach estimates *(2)* by transforming the equation so that the unobserved effect c_i is eliminated. The FE transformation (also called the within transformation) subtracts from *(2)* the time-average of the equation for each cross section unit. Since c_i is time-constant, it will be dropped in the transformation. However, this transformation also drops time constant observables such as distance, and this is one of the drawbacks of FE estimators.

An alternative transformation to eliminate c_i is to take the first differences of *(2)* with in each cross section. This method also eliminates c_i together with any other time constant observables. We now have T-1 time periods for each cross section. This method is called the first difference (FD) estimation.

All the above techniques assume that c_i is unobservable. Traditional approaches to FE estimation view c_i as parameters to be estimated. One possibility of estimating c_i is to define a dummy variable for each cross section and run pooled OLS. This approach is called the dummy variable regression.

The choice between random effect and fixed effect approach hinges on whether c_i and the explanatory variables are correlated. The test suggested by Hausman (1978) can be used to test this assumption. We will report this together with the different estimators in the subsequent sections.

3. The data

The data for Danish exports to partner countries is taken from Statistics Denmark's *StatBank*. The market data comes from two sources: before 1990 data for partners' import is taken from the OECD *International Trade and Competitiveness Indicators* (ITCI), and from 1990 onwards partners import is taken from the OECD *International Trade by Commodity Statistics* (ITCS). This is because the productions of ITCI data have been discontinued by OECD, and in recent periods export market and market price indices in ADAM have been constructed using detailed trade statistics data from ITCS, see DSI231112. The market data covers the period 1976 to 2012 for 20 OECD countries[1], which are the major Danish trading partners. The data for Eastern European countries is available beginning the 1990s. The distance measures are taken from Jon Haveman's website, a standard source for gravity equations.[2] The distance is measured from capital city to capital city.

4. Estimation result

a. Basic model

We first consider the 20 major trading partners. Table 1 presents the estimation result for equation *(2)* using the different estimation techniques for panel data. The sample covers the period 1976-2012.
The different approaches yield very close estimates for the short term demand elasticity (α_1) and the short term price elasticity (α_2). The former (latter) is in

[1] The OECD countries are Australia, Austria, Belgium, Canada, Germany, Spain, Finland, France, Great Britain, Ireland, Iceland, Italy, Japan, Netherland, Norway, New Zealand, Portugal, Sweden, Switzerland and United States. The data for Belgium before 1993 includes Luxembourg.

[2] http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/Data/Gravity/dist.txt

the vicinity of 0.60 (-0.60). The estimated long term price elasticities range between -1.4 and -1.6. The FE long term elasticity is slightly lower than the other two, but has the highest error correction coefficients. With the exception of the coefficient to distance and intercept terms, all parameters are highly significant [with a p-value = 0.000]. The coefficient for distance and the constant cannot be estimated using FE methods as they are eliminated in the FE transformation. These coefficients are estimated but insignificant under pooled OLS and RE methods.

Table 1. Panel estimation result for manufactured exports, basic model[3]

Variable	Coeff.	Pooled OLS	RE	FE
Dlog(fE)				
Dlog(fEe)	α_1	0.600 [0.044]	0.603 [0.043]	0.612 [0.044]
Dlog(pe/pee)	α_2	-0.591 [0.063]	-0.591 [0.062]	-0.591 [0.063]
$\log(fE_{-1}/\widehat{fE}_{-1})$	γ	0.127 [0.016]	0.149 [0.017]	0.204 [0.021]
$\log(pe_{-1}/pee_{-1})$	β	-1.607 [0.027]	-1.538 [0.028]	-1.431 [0.031]
$\log(D_i)$	α_3	-0.023 [0.006]	-0.026 [0.008]	-
C_i		-	-	-
	k	0.008 [0.005]	-0.007 [0.006]	-

Heteroskedasticity and autocorrelation robust standard errors are given in square brackets.
The sample covers the period T=1976-2012 and countries N = 20.
Adj. R-square .322 (pooled OLS), .320 (RE), .336 (FE).
Note: $\log(\widehat{fE}) = \log(fEe) - \beta \cdot \log\left(\frac{pe}{pee}\right)$

Hausman test - H_o :RE vs H_1:FE, Chisq(4) = 22.41, p-value = [0.000]
F-test of C_i, β=C_i, β_i: F(75,640) = 1.587, P-value = [.002]
F-test of C, β=C_i, β: F(19,715) = 1.831, P-value = [.020]

The presence of unobserved effects makes the pooled OLS estimates biased. This leaves us with the RE and FE estimates, and the choice between the two depends on whether the unobserved effect, c_i, and the explanatory variables are correlated. If the two are correlated the FE is consistent and RE is inconsistent. Hausman (1978) provides a formal test based on the differences between the RE and FE estimates. A statistically significant difference is interpreted as evidence against the null hypothesis that the RE is the preferred model. The test statistics from table 1 shows that the null of RE is rejected, i.e. FE is the preferred method. Hence, the long term elasticity of -1.43 and the error correction coefficient of 0.20 are the consistent estimates.

The FE method estimates a common slope coefficient for all cross section units by eliminating the unobserved effect. Table 1 reports an F-test for the hypothesis that the slope coefficients are constant and for the hypothesis that both the slopes and intercepts are constant. The former is rejected and there is some evidence for the latter that both the slopes and intercepts are constant.

[3] German imports are corrected to account for the re-unification of Germany, see AMB120797.

Given that a constant slope and intercept is rejected, manufactured exports can be estimated in each individual market, cf. table 2. Such exercise is cumbersome, nevertheless informative. The adjustment coefficients are restricted to 0.2 to ensure uniformity, which is approximately equal to the unrestricted estimates average, appendix II reports the unrestricted estimates.

Table 2. Manufactured exports in individual markets, restricted estimation

Country/ Dlog(fE)	Dlog(fEe), α_1	Dlog(pe/ pee) ,α_2	log(fE$_{-1}$/ $\widehat{fE}_{-1}$),γ	log(pe$_{-1}$/ pee$_{-1}$),β	Const.	SE	R2	DW(1)
AUS	0.525	-0.583	-0.200	1.057	-0.020	0.130	0.298	2.166
	(2.092)	(2.543)	(-)	(2.105)	(0.578)			
AUT	0.710	-0.673	-0.200	2.626	-0.005	0.054	0.657	1.030
	(5.621)	(1.793)	(-)	(4.733)	(0.364)			
BEL	0.542	-0.788	-0.200	1.170	-0.005	0.058	0.324	1.968
	(2.680)	(2.419)	(-)	(1.752)	(0.351)			
CAN	0.474	-0.496	-0.200	1.237	-0.018	0.138	0.247	1.814
	(1.410)	(2.168)	(-)	(2.263)	(0.569)			
CHE	0.629	-0.726	-0.200	2.501	0.020	0.083	0.236	1.111
	(1.964)	(1.639)	(-)	(2.156)	(0.942)			
DEU	0.467	-1.165	-0.200	2.956	0.011	0.059	0.720	0.796
	(3.914)	(4.276)	(-)	(7.246)	(0.699)			
ESP	0.687	-0.642	-0.200	0.957	-0.007	0.082	0.622	1.602
	(5.820)	(2.359)	(-)	(3.242)	(0.360)			
FIN	0.722	-0.733	-0.200	0.999	0.031	0.044	0.833	1.348
	(10.154	(4.086)	(-)	(3.773)	(2.795)			
FRA	0.744	-0.515	-0.200	1.193	-0.020	0.045	0.713	1.235
	(6.345)	(2.166)	(-)	(4.985)	(1.575)			
GBR	0.721	-0.745	-0.200	1.879	-0.013	0.062	0.706	2.366
	(4.351)	(4.354)	(-)	(5.362)	(0.887)			
IRL	0.571	-0.783	-0.200	0.817	-0.049	0.129	0.267	1.297
	(2.607)	(2.045)	(-)	(0.920)	(1.427)			
ISL	0.692	-0.897	-0.200	1.500	0.065	0.097	0.690	1.979
	(7.016)	(4.351)	(-)	(4.102)	(3.888)			
ITA	0.678	-0.338	-0.200	1.009	-0.005	0.060	0.587	2.038
	(6.653)	(1.633)	(-)	(1.903)	(0.474)			
JPN	0.508	-0.427	-0.200	2.172	0.005	0.079	0.585	2.057
	(3.360)	(2.693)	(-)	(4.940)	(0.252)			
NLD	0.417	-0.708	-0.200	1.821	0.008	0.048	0.655	1.990
	(2.609)	(3.727)	(-)	(6.639)	(0.528)			
NOR	0.374	-0.454	-0.200	0.902	0.032	0.045	0.535	1.521
	(3.843)	(2.552)	(-)	(4.140)	(2.791)			
NZL	0.046	-0.240	-0.200	1.246	0.041	0.295	0.031	2.233
	(0.082)	(0.406)	(-)	(0.996)	(0.611)			
PRT	0.975	-0.635	-0.200	3.325	-0.025	0.093	0.733	1.929
	(6.035)	(1.694)	(-)	(5.639)	(1.183)			
SWE	0.659	-0.623	-0.200	1.126	0.009	0.038	0.813	1.273
	(9.211)	(4.286)	(-)	(5.803)	(0.977)			
USA	0.645	-0.717	-0.200	1.511	0.004	0.103	0.548	1.713
	(2.603)	(3.887)	(-)	(3.512)	(0.161)			

T-values are given in parentheses. The sample covers 1976-2012. The adjustment coefficients are restricted to 0.2, all other parameters are estimated freely.

Note: $\log(\widehat{fE}) = \log(fEe) - \beta \cdot \log\left(\frac{pe}{pee}\right)$.

The weighted mean[4] of the estimated long term price elasticities is equal to -1.73, which is not far from the panel estimates. Generally, the estimated coefficients in each market have the appropriate magnitude and sign, however, the results should be interpreted with caution. For example, the estimated coefficients for exports to New Zealand are insignificant. But the lack of significant relationship might not be surprising given that New Zealand is one of the least important OECD market for Danish goods. The estimated coefficients for exports to Germany are relatively larger, one might be suspicious of a spurious regression given that the R^2 is high and the DW statistics is low. It might after all be a good idea to stick to the panel estimates that are more robust.

Yet another alternative is to use a dummy variable regression. A dummy variable regression reproduces the FE estimates reported in table 1 together with individual intercept coefficients for each country, see appendix III. Most of the country specific effects are insignificant and interpreting every c_i is also not straightforward. Generally, the panel estimation (table 1) is the parsimonious representation of Danish manufactured exports and is the preferred result.

We can also see that the coefficient to distance (a proxy to transportation cost) is insignificant both in the pooled OLS and RE estimation. Distance is a time-invariant variable, and it makes more sense to include it in a long run relation than in a short run relation. Appendix IV presents estimation results for the long-run relation *(1)* including distance. The distance coefficient is significantly estimated in the pooled OLS and has the appropriate negative sign, whereas the RE estimate is insignificant. The negative sign indicates that the more distant the trading partner is, the smaller is the import from Denmark. Overall, it is not easy estimating a significant coefficient for distance. A preliminary scrutiny of the data provides some explanation. Trade has been increasing with partners that are far away, e.g. North America, owing, in part, to the declining transportation costs, which is in contrast with a permanent negative distance effect.

b. Expanding the trading partners

Danish exports to Eastern European and BRIC countries have been growing in recent periods. This will have consequences for the pattern of trade and the trade elasticities. The lack of data inhibits us from including BRIC countries. Table 3 below presents the estimation result for manufactured exports including Eastern European countries.

The sample now consists of the 20 major OECD countries, Eastern European countries (Hungary, Poland, Czech Republic, Estonia, Slovenia & Slovakia), and other OECD countries (Greek & Turkey). Data for Eastern European countries is available partly, beginning the 1990s only, see table 3. The basic result from table 1 is maintained in table 2. All parameters with the exception

[4] The individual elasticities are weighted by the share of each partner from the total Danish exports, and the value -1.73 is the time average of the weighted elasticties for the sample period 1976-2012.

of distance and intercept coefficients are significant. Now the long-term and short-term price elasticities are marginally smaller and the short term demand elasticity is marginally larger. Eastern European countries import from Denmark is more likely to be driven by demand than by relative prices, which is a reflection of their recent fast economic growth record.

Table 3. Panel estimation result for manufactured exports, expaned market

Variable	Coeff.	Pooled OLS	RE	FE
Dlog(fE)				
Dlog(fEe)	α_1	0.630 [0.040]	0.630 [0.039]	0.626 [0.039]
Dlog(pe/pee)	α_2	-0.500 [0.067]	-0.500 [0.065]	-0.493 [0.065]
log($fE_{-1}/\widehat{fE}_{-1}$)	γ	0.170 [0.016]	0.216 [0.018]	0.264 [0.020]
log(pe_{-1}/pee_{-1})	β	-1.254 [0.027]	-1.236 [0.028]	-1.223 [0.030]
log(D_i)	α_3	-0.041 [0.007]	-0.055 [0.011]	-
C_i		-	-	-
	k	0.014 [0.006]	-0.015 [0.007]	-

Heteroskedasticity and autocorrelation robust standard errors are given in square brackets. The sample covers 28 trading partners and the period 1976-2012 for the 20 major OECD partners and Turkey, 1990-2012 for Greek, 1993-2012 for Hungary and Slovenia, 1995-2012 for Poland, 1997-2012 for Czech Republic and Estonia, and 1998-2012 for Slovakia.
Adj. R-square .316 (pooled OLS), .311 (RE), .350 (FE).
Note: $\log(\widehat{fE}) = \log(fEe) - \beta \cdot \log\left(\frac{pe}{pee}\right)$

Hausman test - H_o :RE vs H_1:FE, Chisq(4) = 30.99, p-value = [0.000]
F-test of C_i, β=C_i, β_i: F(75,640) = 2.493, P-value = [.00]
F-test of C, β=C_i, β: F(19,715) = 2.693, P-value = [.000]

c. Alternative export prices: bilateral unit values

One of the limitations in equation *(2)* is that a single export price for all partners is assumed. One remedy was to include a distance variable as a measure of transport and other costs. But estimating a significant coefficient for distance is difficult in a short term relation. Alternatively bilateral unit values can be used as a surrogate for prices. The OECD ITCS-database provides values and quantities of exports and imports between OECD countries. From these we can construct unit values for Danish exports to partner countries or for partners' import from Denmark using the methodology described in DSI231112. Particularly, the latter are of interest because values of imports include cost, insurance and freight, and thus account for transport and other costs. Appendix V presents the estimation result using bilateral unit values for partners' import in place of '*pe*' in equation *(2)*. In this case there is no need to include a measure of distance. The estimated price elasticities are small and in some occasions insignificant. The short term demand elasticity is significantly estimated.

This section sheds light on the use of bilateral unit values. Due to the preliminary nature of the unit values we abstain from making any conclusion, and suggest a further scrutiny of the unit values. If such data is available, it can be used to make analysis of the kind Feenstra, Obstfeld and Russ (2012) and Erkel-Rousse and Mirza (2002) carried out using bilateral trade flows. Such analysis for Denmark can have a significant value.

5. Conclusion

This paper applied a panel estimation to Danish manufactured exports. The Armington equation in an error correction form is applied to a data consisting of 20 OECD countries that are the major Danish trading partners. The estimated long-term price elasticities lie between -1.4 and -1.6 and the short term demand and price elasticities are estimated in the vicinity of +0.6 and -0.6, respectively. The large degree of freedom in panel data produces a more accurate estimate of the model parameters. Alternatively, the export equation can be estimated in each individual market, the average estimated results are not far from the panel estimates. Expanding the market by including Eastern European countries reduces the price elasticities in favor of higher short term demand elasticity. There has also been an attempt to use country specific Danish export prices based on bilateral unit values from the OECD ITCS-database. The results are encouraging but premature and a further development of the unit values is required.

Literature

ADAM (2012). A model of the Danish economy. Statistics Denmark.

Armington, P. S. (1969). "A Theory of Demand for Products Distinguished by Place of Production", International Monetary Fund Staff Papers, Vol. 16, pp. 159 – 178.

Erkel-Rousse, H. and Mirza, D. (2002). "Import Price Elasticities: Reconsidering the Evidence", The Canadian Journal of Economics, Vol. 35, No. 2, pp. 282-306.

Feenstra, R. C., Obstfeld, M. and Russ, K. N. (2012). In Search of the Armington Elasticity, working paper.

Finansredegørelse (2014). Finansministeriet.

Hausman, Jerry A., (1978). "Specification Tests in Econometrics," Econometrica 46, pp. 1251-1272.

Hillberry, R. and Hummels, D. (2013). Handbook of Computable General Equilibrium Modeling SET, Vols. 1A and 1B, Chapter 18 – Trade Elasticity Parameters for a Computable General Equilibrium Model, Volume 1, Pages 1213–1269.

Hsiao C. (2007) "Panel data analysis – advantages and challenges", TEST, Volume 16, Issue 1, pp 1-22.

Jensen, L. S., and Knudsen, D. (1992). 'Multivariat Analyse af Udenrigshandelens Priselasticiteter', in Symposium i Anvendt Statistik, Aarhus, Denmark: UNI-C, pp. 413-428 (in Danish).

Kongsted, H. C. (1998). "Modelling Price and Quantity Relations for Danish Manufacturing Exports", Journal of Business and Economics Statistics, Vol. 16, pp. 81-91.

Kristensen, T. M. (2000). Paneltilgang til eksportrelationer - foreløbige resultater. Modelgruppepapirer, Danmarks Statistik [TMK141200, in Danish].

Kristensen, T. M. (2008). ADAM april 2008 – analyse af parameterfølsomheder. Modelgruppepapirer, Danmarks Statistik [TMK201008, in Danish].

Nielsen , H. B. (2002). 'An I(2) Cointegration Analysis of Price and Quantity Formation in Danish Manufactured Exports', Oxford Bulletin of Economics and Statistics, Vol. 64, pp. 449 – 471.

Rasmussen, J. N. (2010). ADAM december 2009 – analyse af parameterfølsomheder. Modelgruppepapirer, Danmarks Statistik [JNR220610, in Danish].

Sisay, D. (2009). New export aggregation and re-estimation, Model group paper, Statistics Denmark [DSI300609].

Sisay, D. (2009). Export Market and Market Price Indices - trade statistics data, Model group paper, Statistics Denmark [DSI231112].

Via, A. (2011). "Estimating Price Elasticities in International Trade: is the empirical evidence beyond proof?", Department of Economics and Statistics, University of Calabria.

Wooldridge Jeffrey. M. (2002) Econometric analysis of cross section and panel data, The MIT Press, Cambridge, Massachusetts.

www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/Data/Gravity/dist.txt

Appendix

Appendix Ia. Long run price elasticities estimates of Import demand

Author(s)/ Country	Houthakker-Magee (1969)	Armington (1970)	Taplin (1973)	Stern et al. (1976)	Gylfason (1978)	Goldstein-Khan (1980)	Senhadji (1998)	Johnson, Marquez (2000)
Austria	-	-1.37	-	-1.32	-1.21	-0.82	-1.37	-
Belgium	-1.02	-1.11	-0.65	-0.83	-2.57	-0.48	-3.40	-
Canada	-1.46	-1.30	-1.59	-1.30	-	-0.20	-1.21	-
Denmark	-1.66	-1.26	-0.85	-1.05	-	-0.42	-0.27	-
France	-	-1.53	-0.39	-1.80	-0.46	-	-0.37	-
Germany	-0.24	-1.42	-0.61	-0.88	-1.36	-0.25	-0.18	-0.06
Italy	-0.13	-1.42	-1.03	-1.03	-0.32	-0.45	-0.37	-0.40
Japan	-0.72	-1.47	-0.81	-0.78	-	-	-0.40	-0.30
Netherlands	-	-1.13	-0.02	-0.68	-1.65	-	-	-
Norway	-	-1.19	-1.20	-1.19	-	-	-1.70	-
Switzerland	-0.84	-1.35	-1.10	-1.22	-	-	-1.69	-
Sweden	-0.79	-1.30	-0.76	-0.79	-	-0.84	-0.14	-
U.K	-0.21	-1.38	-0.22	-0.65	-	-	-0.02	-0.60
U.S.A	-1.03	-1.73	-1.05	-1.66	-1.12	-1.12	-0.44	-0.30

Source: Via (2011)

Appendix Ib. Long run price elasticities estimates of export demand

Author(s)/ Country	Basevi (1973)	Samuelson (1973)	Stern et al. (1973)	Goldstein-Khan (1978)	Gylfason (1978)	Amano (1981)	Senhadji Montenegro (1998)	Johnson, Marquez (2000)
Austria	-	-1.21	-0.93	-	-	-	-0.24	-
Belgium	-	-1.14	-1.02	-1.57	-	-	-	-
Canada	-0.59	-1.10	-0.79	-	-	-0.33	-	-
Denmark	-	-1.06	-1.28	-	-	-	-0.23	-
France	-	-1.28	-1.31	-1.33	-	-0.34	-0.04	-
Germany	-1.68	-1.12	-1.11	-0.83	-0.38	-0.29	-	-0.30
Italy	-0.72	-1.29	-0.93	-3.29	-1.91	-0.30	-0.16	-0.90
Japan	-2.38	-1.04	-1.25	-	-2.13	-0.81	-1.38	-1.00
Netherlands	-2.39	-1.07	-0.95	-2.72	-0.88	-	-	-
Norway	-	-1.16	-0.81	-	-	-	-0.94	-
Switzerland	-	-1.51	-1.01	-	-	-	-0.17	-
Sweden	-1.92	-	-1.96	-	-	-	-0.28	-
U.K	-0.71	-1.28	-0.48	-1.32	-0.32	-0.08	-0.38	-1.60
U.S.A	-1.44	-1.13	-1.41	-2.32	-0.62	-0.32	-0.90	-1.50

Source: Via (2011)

Appendix Ic. Previous papers that estimate price elasticities at the industry level

Authors	Level of aggregation	Period	Export ing Countries	Importing Countries	Trade Flows	Type of equation	Import Price indicator	Level of desaggregation	Price-elasticities levels
Grossman [1982]	11 'homogeneous' commodity groups selected from 7-digit SITC data	1968-1978 (quarterly)	Less Developed or Industrial Countries	USA	Multilateral	Import equation with cross-price elasticities	multilateral unit values	by group of commodities	US price elasticities: 1 to 9 ; Non-US price-elasticities take more usual values.
Marquez & McNeilly [1988]	3 commodity groups: Food, Raw Materials and Manufactures	1973-1984 (quarterly)	Less Developed Countries	Canada, Germany, Japan, UK, US	Bilateral	Bilateral import equation	multilateral import prices	by country and industry	More (less) than unity for manufactures (food and raw materials)
Bergstrand [1989]	1-Digit SITC data	1965, 1966, 1967	16 OECD countries and Switzeland	16 OECD countries and Switzeland	Bilateral	Gravity equation model	aggregate wholesales price index for importers and exporters	by industry	Large range of coefficients (from 0.1 to 11). Most parameters are statistically insignificant
Greenhalgh, Taylor and Wilson [1994]	36 industries, Cambridge Econometric database (CE)	1954-1985 (annual)	UK	Industrial and part of LDCs	Multilateral	Import share equation	aggregate import price index	by industry	Between 0.0 and 2.5
Ioannidis & Schreyer [1997]	2-digit ISIC data	1975-1994 (annual)	10 exporting OECD countries	Industrial and part of LDCs	Bilateral	Mean bilateral export share equation	mean import bilateral prices	by industry	Between 0.0 and 1.8
Anderton [1998]	2-digit ISIC data	1970-1987 (annual)	UK and Germany	Industrial and part of LDCs	Bilateral	Bilateral import equation	bilateral import prices	by industry and importing country	UK: around unity; Germany: less than unity
Head & Mayer [1999]	2-digit Eurostat database	1986-1995 (annual)	12 EC countries	12 EC countries	Bilateral	Gravity equation model	price index at industry level	by industry	average price-elasticity around unity.
Crozet & Erkel-Rousse [1999]	2 categories : consumer goods and *other* goods	1994-1997 (annual)	4 EC countries	4 EC countries	Bilateral	Gravity-like eq. model, including a quality *proxy*	bilateral unit values	by group of commodities (consumer or *other*)	average price-elasticity above unity.
This study	3-4 digit ISIC data	1972-1994 (annual)	17 or 12 OECD countries (depending on specification)	17 or 12 OECD countries (depending on specification)	Bilateral	Gravity-like eq. model	bilateral unit values	pooled and by industry	Between 1 and 7, depending on degree of differentiation of goods produced in the industry

Source: Erkel-Rousse and Mirza (2002)

Appendix II. Manufactured exports in individual markets, unrestricted estimation

Country/ Dlog(fE)	Dlog(fEe), α_1	Dlog(pe/ pee), α_2	log(fE$_{-1}$/ $\widehat{fE}_{-1}$), γ	log(pe$_{-1}$/ pee$_{-1}$), β	Const.	SE	R2	DW(1)
AUS	0.626 (2.516)	-0.511 (2.271)	-0.449 (3.283)	0.934 (2.797)	-0.089 (1.770)	0.126	0.432	1.905
AUT	0.570 (4.726)	-0.249 (0.694)	0.000 (0.005)	-324.099 (0.618)	-0.008 (0.650)	0.048	0.476	1.639
BEL	0.516 (2.570)	-0.944 (2.758)	-0.117 (1.898)	1.812 (1.596)	0.007 (0.425)	0.058	0.437	2.268
CAN	0.475 (1.375)	-0.497 (2.125)	-0.198 (2.143)	1.243 (1.890)	-0.018 (0.522)	0.140	0.305	1.818
CHE	0.415 (1.421)	-0.997 (2.479)	-0.002 (0.035)	94.691 (0.927)	0.007 (0.347)	0.073	0.266	1.830
DEU	0.418 (3.589)	-1.142 (4.380)	-0.057 (0.809)	5.172 (1.780)	0.010 (0.684)	0.056	0.539	1.047
ESP	0.694 (5.804)	-0.640 (2.330)	-0.274 (2.429)	0.896 (2.417)	-0.016 (0.682)	0.083	0.565	1.499
FIN	0.727 (9.757)	-0.709 (3.491)	-0.223 (2.659)	0.969 (2.706)	0.033 (2.497)	0.045	0.832	1.313
FRA	0.710 (6.066)	-0.629 (2.571)	-0.060 (0.657)	2.497 (2.013)	-0.010 (0.732)	0.044	0.647	1.557
GBR	0.771 (4.605)	-0.768 (4.528)	-0.312 (3.856)	1.710 (4.004)	-0.015 (1.025)	0.061	0.633	2.237
IRL	0.590 (2.105)	-0.797 (1.960)	-0.188 (1.802)	0.862 (0.898)	-0.047 (1.152)	0.131	0.462	1.311
ISL	0.696 (7.255)	-0.802 (3.849)	-0.395 (3.453)	1.125 (4.019)	0.115 (3.433)	0.094	0.714	1.762
ITA	0.669 (7.595)	-0.239 (1.318)	-0.649 (5.068)	0.780 (4.012)	-0.058 (3.233)	0.051	0.733	1.538
JPN	0.480 (2.938)	-0.427 (2.656)	-0.150 (1.448)	2.542 (2.705)	0.002 (0.067)	0.080	0.413	2.181
NLD	0.416 (2.540)	-0.710 (3.619)	-0.198 (3.131)	1.829 (3.979)	0.008 (0.516)	0.049	0.533	1.996
NOR	0.362 (3.520)	-0.477 (2.524)	-0.168 (2.139)	0.975 (2.723)	0.030 (2.398)	0.046	0.478	1.562
NZL	0.278 (0.497)	-0.506 (0.877)	-0.541 (3.322)	1.201 (2.127)	0.010 (0.154)	0.280	0.260	1.977
PRT	0.919 (5.132)	-0.540 (1.352)	-0.120 (1.125)	3.782 (1.488)	-0.028 (1.297)	0.094	0.517	2.021
SWE	0.658 (9.260)	-0.625 (4.331)	-0.311 (3.356)	1.055 (3.481)	0.011 (1.223)	0.037	0.802	1.148
USA	0.634 (2.524)	-0.713 (3.820)	-0.255 (2.618)	1.430 (2.588)	0.004 (0.148)	0.104	0.525	1.602

T-values are given in parentheses. The sample covers 1976-2012.

Note: $\log(\widehat{fE}) = \log(fEe) - \beta \cdot \log\left(\frac{pe}{pee}\right)$.

Appendix III. Dummy variable regression

Variable	Coeff.	Dummy variable regression
Dlog(fE)		
Dlog(fEe)	α_1	0.612*** [0.044]
Dlog(pe/pee)	α_2	-0.591*** [0.063]
$\log(fE_{-1}/\widehat{fE}_{-1})$	γ	0.204*** [0.021]
$\log(pe_{-1}/pee_{-1})$	β	-1.431*** [0.031]
C(AUS)		-0.039** [0.019]
C(AUT)		0.020 [0.018]
C(BEL)		-0.010 [0.017]
C(CAN)		-0.030* [0.017]
C(CHE)		0.028* [0.017]
C(DEU)		0.032* [0.017]
C(ESP)		-0.021 [0.018]
C(FIN)		0.022 [0.017]
C(FRA)		-0.020 [0.017]
C(GBR)		0.003 [0.017]
C(IRL)		-0.071*** [0.019]
C(ISL)		0.067*** [0.017]
C(ITA)		0.004 [0.017]
C(JPN)		0.026 [0.018]
C(NLD)		0.008 [0.017]
C(NOR)		0.004 [0.018]
C(NZL)		0.005 [0.017]
C(PRT)		0.040** [0.018]
C(SWE)		0.002 [0.017]
C(USA)		0.009 [0.018]

* indicates significance at 10% level,** at 5% and *** at 1%.
Heteroskedasticity and autocorrelation robust standard errors are given in square brackets. The sample covers the period T=1976-2012 and countries N = 20. Adj. R-square 0.337.

Appendix IV. Manufactured exports, long run relation

The long term relation is given as:

$$\log\left(\frac{fE_{it}}{fEe_{it}}\right) = k + \beta \cdot \log\left(\frac{pe_t}{pee_{it}}\right) + \alpha \cdot \log(D_i) + C_i + u_{it}$$

Variable	Coeff.	Pooled OLS	RE	FE
log(fE/ fEe)				
log(pe/pee)	β	-0.882***	0.966***	0.970***
		[0.053]	[0.042]	[0.042]
log(D)	α	-0.045***	-0.047	-
		[0.015]	[0.063]	
C_i		-	-	-
	k	0.012	-0.002	-
		[0.012]	[0.041]	

* indicates significance at 10% level,** at 5% and *** at 1%.
Heteroskedasticity and autocorrelation robust standard errors are given in square brackets. The sample covers the period T=1976-2012 and countries N = 20.
Adj. R-square .270 (pooled OLS), .270 (RE), .590 (FE).
Hausman test - H_o :RE vs H_1:FE, Chisq(4) = 1.7232, p-value = [0.189]

Appendix V. Estimation result for manufactured exports, bilateral unit values

Variable	Coeff.	Pooled OLS	RE	FE
Dlog(fE)				
Dlog(fEe)	α_1	0.700***	0.693***	0.661***
		[0.060]	[0.060]	[0.061]
Dlog(pe/pee)	α_2	-0.046	-0.052	-0.100**
		[0.041]	[0.042]	[0.044]
$\log(fE_{-1}/\widehat{fE}_{-1})$	γ	0.130**	0.141***	0.204***
		[0.023]	[0.024]	[0.029]
$\log(pe_{-1}/pee_{-1})$	β	-0.236	-0.318*	-0.721***
		[0.025]	[0.027]	[0.040]
	k	0.002	-0.002	-
		[0.006]	[0.006]	

* indicates significance at 10% level,** at 5% and *** at 1%.
Heteroskedasticity and autocorrelation robust standard errors are given in square brackets.
The sample covers the period 1991-2012 and the 20 major OECD partners.
Adj. R-square .280 (pooled OLS), 0.280 (RE), 0.292 (FE).
Note: $\log(\widehat{fE}) = \log(fEe) - \beta \cdot \log\left(\frac{pe}{pee}\right)$

Hausman test - H_o :RE vs H_1:FE, Chisq(4) = 20.01, p-value = [0.000]
F-test of C_i, β=C_i, β_i: F(75,640) = 2.873, P-value = [.000]
F-test of C, β=C_i, β: F(19,715) = 1.371, P-value = [.136]