Forecasting the Trade Flow of Denmark

Stéphanie Vincent Lyk-Jensen[1]

Danmarks TransportForskning

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1. Introduction

This paper presents the modeling of a gravity equation in order to forecast trade flows of goods in and out of Denmark, including transit goods. This analysis is part of a research project where the objective is to establish the future flow of goods for Denmark as well as the node points in order to be able to optimize public investments. In order to fulfill this goal a cross-ministerial coordination group- “Danmark, godsstrømme og væksregioner i EU” has been established, with the participation of the Danish Ministry of Transport, the Danish Ministry of Environment and the Danish Ministry of Economic and Business Affairs.

The paper only focuses on the construction of a foreign trade model (a gravity equation) that will be used for setting up scenarios for the future flow of goods from and to Denmark. It is expected that the enlargement of EU and the integration of the new members, economic growth and other factors will influence the flows of goods and have to be part of the scenario analysis. The principle of forecasting the trade flows of Denmark consists in obtaining growth rates based on the gravity equation prediction and scenarios for future development taking into account for example economic growth and integration processes. These growth rates will then be introduced into a traffic model for freight (Senex). This will provide a forecast for the allocation of trade flows by mode and route choice.

The gravity equation is estimated by using panel data for Western countries. For Eastern and Central European countries some adjustments are necessary to take into account the specific trade patterns of the Central and Eastern countries, as well as the availability of time series data.

We compare different methods of estimation of the gravity equation used in previous studies and propose a robust estimation of a dynamic gravity equation. Examples of the forecasting method are presented for illustration.

Section 2 presents the different econometric approaches used to estimate the gravity equation. The empirical specification of the gravity equation and the data used are presented in Section 3, while Section 4 shows the empirical results. The last section concludes the paper.

2. Econometric approaches for estimating gravity equations

The capacity of gravity models for explaining the trade flows between countries has largely been verified empirically and they therefore constitute efficient tools.

Gravity models are based on Linnemann’s analysis (1966), according to which the size of the trade flows is explained by three factors reflecting the potential supply of the exporting country, the potential demand of the importing country and the commercial flow resistance between the parties. The gravity equation is obtained by replacing these three factors by the underlying variables, i.e., national income, population, distance and the existence of trade agreements. The economic foundation of the “classic “ gravity equation has often been criticized. Conclusions from Deardoff (1995) show that the gravity equation can be justified by standard international trade theory. Forecasting trade flows with the gravity equation consists in, as first step to estimate the coefficient of the so-called gravity variables in order to evaluate their explanatory power in the exchange explanation. A second step consists in applying these estimates to each country data. We present the different issues related to the estimation of the gravity equation.

2.1. Error component model (ECM)

We present the error component approach for a dynamic model and look at the different issues related to this approach. Dynamic models make it possible to capture gradual adjustment to changes in the explanatory variables.[2] A shock to the economy will thus affect more than one period. The ECM approach is used to estimate panel data. Three individual and independent shocks are modeled:

[2] This is relevant when modeling integration process for the EU candidate countries.

$$Y_{ijt} = \lambda Y_{ijt-1} + \beta X_{ijt} + u_{ijt},$$
$$u_{ijt} = \delta_t + \eta_{ij} + \varepsilon_{ijt}, \quad (1)$$

where, Y_{ijt} is the export from country i to country j at the time t. i =1,…N, j = 1,…,N and t = 1,…, T. Y is dimension (N x (N-1) x T). δ_t affects all observations for time period t, η_{ij} affects all observations for the trade flow between countries i and j, and ε_{ijt} affects only observations ijt. X is the matrix of explanatory variables and is organized as Y. β is a $(K \times 1)$ parameter vector with K the number of explanatory variables. No distinctions between import and export countries are made in (1). In the following the ε_{ijt} are assumed to be independent across all ij and t. Two possibilities are available in order to estimate a regression model having an error term consisting in several error components. The first is the Fixed effects model (FEM) and the second Random effects model (REM).

2.2. FEM vs. REM

FEM and REM are two conceptually different approaches. In FEM, the model is estimated conditionally on the error terms δ_t and η_{ij}, while in the REM the estimations are made unconditionally. One advantage of the FEM is that it is not necessary to assume that δ_t and η_{ij} are independent of the regressors as the model is estimated conditionally on them. The FEM will assume, that each country have different starting point, while REM assumes that countries have different variance for import and export.
It is generally more appropriate to use FEM than REM, when looking at macroeconomic issues for several reasons. First of all if the individual effects represents omitted variables, it is highly likely that these country-specific characteristics are correlated with the other regressors, as shown in Egger (2000), giving preference to FEM over REM. Egger's (2000) conclusion is supported by the Hausman χ^2-test[3], showing that the proper econometric specification of a gravity model in most applications would be one of fixed country and time effects.
Second it is also fairly likely that a typical macro panel will contain most of the countries of interest and thus, will be less likely to be a random sample from a much larger group of countries. Moreover, the types of effects analyzed by the gravity equation are more likely determined by historical, political and geographical facts than by random. We will not estimate a REM on our data.

2.3. Three-way model with time and country effects

The previous specification of the ECM does not distinguish between export and import country effects. This constitutes an important issue when forecasting trade flows between countries. Mátyás (1997) claims that the most natural representation of bilateral trade flows is a three-way specification with country and time effects. Two sets of dummies one for exporting countries and one for importing countries are added to the set of time dummies. It is this approach with specific fixed country and time effects, which is also used by Egger (2000) for a gravity equation based on a Heckscher-Olhin specification.
Equation (1) becomes:

$$Y_{ijt} = \lambda Y_{ijt-1} + \beta X_{ijt} + u_{ijt},$$
$$u_{ijt} = \delta_t + \alpha_i + \gamma_j + \varepsilon_{ijt}, \quad (2)$$

where η_{ij} is replaced by α_i, the fixed specific effect of exporting country i and γ_j the fixed specific effect of importing country j. The advantage of this approach is that an effect for export and import countries can be estimated. We have N dummies for export countries and N dummies for import countries, while the FEM estimates one dummy by trade flow Nx(N-1).

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[3] The Hausman χ^2 statistic is a misspecification test for the orthogonality of the random effects. A significant test statistic reveals correlation with the right-hand variables. In such a case the REM estimates are significantly inconsistent.

2.4. Dynamic vs. static model

The dynamic aspect is modeled by introducing a lagged variable for the trade flows as in equation (1). Since Y_{ijt} is a function of η_{ij}, Y_{ijt-1} is also a function of η_{ij} the errors are then correlated with an explanatory variable. The FEM approach estimates in fact the following equation[4] (3):

$$(Y_{ijt} - \overline{Y}_{ij.} - \overline{Y}_{.t} + \overline{Y}) = \lambda\left(Y_{ijt-1} - \overline{Y}_{ij.-1} - \overline{Y}_{.t-1} + \overline{Y}_{-1}\right) + \beta\left(X_{ijt} - \overline{X}_{ij.} - \overline{X}_{.t} + \overline{X}\right) + \left(\varepsilon_{ijt} - \overline{\varepsilon}_{ij.} - \overline{\varepsilon}_{ij.} + \overline{\varepsilon}\right), \quad (3)$$

where $\overline{Y}_{.t} = \sum_{ij=1}^{N(N-1)} Y_{ijt} / N$, $\overline{Y}_{ij.} = \sum_{t=1}^{T} Y_{ijt} / T$ and $\overline{Y} = \sum_{ij=1}^{N(N-1)} \sum_{t=1}^{T} Y_{ijt} / NT$. Equivalent expressions are computed for X_{ijt} and ε_{ijt}. $\sum_{t=1}^{T} \delta_t = 0$ and $\sum_{ij=N}^{N(N-1)} \eta_{ij} = 0$.The correlation between the errors terms and the transformed lagged variable is still relevant in (3). The least squares dummy variable estimator, with a full set of dummy variables (η_{ij}) generates a biased estimate of the coefficients. The order of the bias is 1/T (see Baltagi (1995)).

More generally, using dummy variables to estimate individual effects in a model including a lagged value of the dependent variable results in biased estimates when the dimension of the panel T is small. This means that a bias also exists when we introduce export and import dummies as in model (2). Judson and Owen (1999) show that when working with dynamic panel for period less than thirty years a GMM[5] estimation is required in order to correct for the bias. Our panel for the EU15 and EFTA countries encompasses 36 years, in this case we could perform a Least Square estimation (LS), both results are presented in Section 4.

2.5. The SAMGODS approach

The foreign trade model for SAMGODS, INREGIA and COWI (1999) is based on a FEM, which predicts the trade flows between Sweden and some selected countries. The SAMGODS gravity equation is the only dynamic modeling of the gravity equation we have found, the gravity equation formulation is based on Bergstrand (1989). The analysis is made for four types of goods and three groups of countries for the period 1972-1997. In some cases the forecasting approach is also based on a REM. A model is estimated for each group of countries (western European countries, eastern European countries and countries outside Europe), and within each group of countries, estimation is made for four types of goods: capital-intensive goods, labor-intensive goods, information-intensive goods, research and development goods. There are two trade flows for each country one for export from Sweden and one for import to Sweden. Hence, it turns out that the 2xN fixed effects parameters for each trade flows can also be interpreted as export and import country effects for the other countries. In our approach we rather want to include all the trade flows between the countries involved in the sample.

3. The empirical specification and data

3.1. The gravity equation

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[4] Dummies and variables that do not vary with time are not included as they disappear when averaging. As a consequence the coefficients of variables such as distance, common frontier or common language cannot be estimated, as they do not vary with time.

[5] Generalized Method of Moment. The principle of the GMM is to choose the parameter estimates so that the theoretical moment condition is satisfied as "closely" as possible. The theoretical relation that the parameters should satisfy are usually orthogonality conditions between some (possibly nonlinear) function of the parameters and a set of instrumental variables. The GMM estimator selects parameter estimates so that the sample correlations between the instruments and the function of parameters are as close to zero as possible, as defined by the criterion function. GMM is a robust estimator in that, unlike maximum likelihood estimation, it does not require information of the exact distribution of the disturbances. For more details see Davidson and McKinnon (1993).

We used the gravity model specification adopted by Egger (2000), which is associated with a Heckscher-Ohlin (H-O) model under product differentiation in order to avoid critique associated with the theoretical content of the gravity equation (see Deardoff, 1995). The gravity equation in Egger (2000) is based on Helpman and Krugman (1985) and Helpman (1987) with an endowment based 2x2x2 model, where one of the goods is differentiated and the other is homogeneous. The two factors of production are the stock of capital and the labor force (proxied by population, as in Egger (2002). In this framework the total volume of trade of each country can be defined as the sum of inter- and intra-industry trade volumes. We estimate a dynamic version of Egger (2000).
In our model all bilateral flows between the countries of interest are included in the sample. Contrary to the Swedish model, we do not look at different gravity equations for different types of goods but look at the total exports. The main reasons are that it is difficult to know the future structure of the growth within each commodity groups and it is usually difficult to collect data that match the specific country definition of commodity groups for all countries. This also reduces the probability of having trade flows equal to zero.
All variables are expressed in logarithms and in real prices. We use the value of export in real prices as the independent variables.[6]

The corresponding dynamic reduced form equation to estimate the volume of trade is:

$$Y_{ijt} = \beta_0 + \lambda Y_{ijt-1} + \beta_1 RELENDOW_{ijt} + \beta_2 GDPT_{ijt} + \beta_3 SIMILAR_{ijt}$$
$$+ \beta_4 DIST_{ij} + \beta_5 RER_{ijt} + D1_{ijt} + D2_{ij} + \alpha_i + \gamma_j + \delta_t + \varepsilon_{ijt}.$$

- Y_{ijt} is the log of country i's exports to country j in year t.
- β_0 is the constant.
- $RELENDOW_{ijt} = \left| \ln \frac{GDP_{jt}}{POP_{jt}} - \ln \frac{GDP_{it}}{POP_{it}} \right|$ is the per capita GDP differential between country i and j.
- $GDPT_{ijt} = \ln(GDP_{it} + GDP_{jt})$ is the overall economic space.
- $SIMILAR_{ijt} = \ln\left[1 - \left(\frac{GDP_{it}}{GDP_{it} + GDP_{jt}}\right)^2 - \left(\frac{GDP_{jt}}{GDP_{it} + GDP_{jt}}\right)^2\right]$, captures the relative size of two countries in terms of GDP.
- $DIST_{ij}$ is the log of the distance variable which is a proxy for transport costs.
- RER_{ijt} is the log of the real exchange rate between countries i and j at the time t.
- α_i and γ_j are the export and import country specific fixed effects.
- δ_t reflects the time effect for all countries.
- ε_{ijt} is the error term.

Dummy variables are also added to the equation. Among dummy variables it can be distinguished dummy variables varying with time $D1_{ijt}$ (**EU** if both countries involved in the trade flow at the year t are EU members, a dummy variable for Germany (**DEU91**) taking the value one before 1991 and zero after and a dummy variable for the Swedish devaluation in Sweden (**SWE93**)) and dummy variables that are stable in time $D2_{ij}$ (common language (**COMLG**), common frontiers (**CONTIG**)).

3.2. Interpretation of parameters and expected signs of the variables

[6] According to Fosgerau and Kveiborg (2004) converting production in fixed prices into weight measures does not constitute a problem as the relationship between the two is reasonably stable. As a consequence the growth rates obtained based on the gravitation equation can be used into the freight model Senex to forecast the variation in tons.

The sign of RELENDOW is not predictable a priori. According to the H-O theory, the sign should be positive, while according to the Linder Hypothesis it should be negative. According to the H-O theory the larger difference in endowment, the higher the volume of interindustry and overall trade, and the lower the share of intra-industry trade. According to Linder's hypothesis: countries with similar demand patterns will trade more intensively with each other. The parameter estimate should be negative.

A rise in country j's income, an appreciation of country j's currency, adjacency (common frontiers) and the presence of preferential trading arrangements (EU membership) should increase the trade flow from i to j. The larger the overall economic space (GDPT), the higher the total volume of trade. The more similar two countries in terms of GDP, the higher the share of intra-industry trade. Greater distance between these countries should reduce this flow.

The α and γ parameters represent respectively export and import parameters. Large parameters for importing countries (γ_j) indicate the openness of the economy as a import country. It shows both that there are no major administrative hurdles making foreign trade difficult and there are no financial obstacles requiring keeping import down. Export country effect parameters (α_i) show how efficient a given country is in exporting relative to the other countries in the sample, but also relative to its given size.

The stability of coefficients estimates across years will suggest that the gravity equation estimated is rather robust.

3.3. Computation of short-term and long-term elasticities

A dynamic formulation of the gravity equation both provides long term and short term elasticities.

The short-term elasticities of a change in an explanatory variable is directly interpreted by looking at the parameter β, as the model is formulated in logarithms[7]. In the long term the elasticity depends on the value of λ. If $\lambda<1$ then we can write:

$$Y_{ij} = \frac{1}{1-\lambda}(\beta X_{ij} + u_{ij})$$

The long-term elasticity for a change in an exogenous variable is given by $\frac{1}{1-\lambda}\beta$ and corresponds to the percentage variation in Y due to one percent change in one of the explanatory variables.

3.4. Data

The sample includes the 15 EU[8] and two EFTA countries[9] and nine Central and Eastern European countries[10]. Data are available for the period 1967-2002 for the Western European countries and from 1993 to 2002 for some of the Central and Eastern European countries. Three sub-samples have been created: a sample "EUEFTA" with only EU and EFTA countries for the period 1967-2002, a sample "EUEFTA+EAST" with both EU, EFTA and Eastern countries for the period 1993-2002 and a sample "EAST" with only Eastern countries for the period 1993-2002.

All variables are in constant prices and dollars with 1995 as the base year. Bilateral export data, GDP[11], population[12], GDP deflators and real exchange rates[13] are obtained from CHELEM database.[14]

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[7] For dummies variables the percentage change is given by $\exp(\beta)$ or can be approximated by $100 \times \beta$.

[8] Belgium and Luxembourg are estimated as a single country and Switzerland and Liechtenstein are also estimated as a single country.

[9] Switzerland and Norway.

[10] Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Russian Federation, Slovakia. Serbia and Montenegro is excluded from the sample "EUEFTA+EAST" as too many of its trade flows with EU countries where equal to zero in the period 1993-2002 but is included in the sample" EAST".

[11] The main sources are the World Bank, World development indicators 1997 and OECD National accounts.

[12] Countries' total population is reported in millions inhabitants, and measured in mid-year. These time series are from the US Census Bureau, The international Data Base, Washington, DC.

[13] Real exchange rates are computed in CHELEM as the general level of prices of each country, in comparison with the respective levels of the United States.

[14] Comptes Harmonisés sur les Echanges et L'Economie Mondiale, Harmonized Accounts on Trade and World Economy.

This database has been constructed by CEPII[15]. The data used for distance (as a proxy for transport costs) are available from the CEPII homepage[16]. The measure of bilateral distance is the great circle distance generally from capital to capital between the two trading countries.[17]

4. Empirical results

4.1. Results for Western Europe

We present results for the 3-way model and the FEM estimated by GMM and LS. The list of instruments used in the GMM estimation is Y_{ijt-2}, all the exogenous variables, and some first lagged exogenous variables. The basis for the estimation is Denmark as exporting and importing country and the year 1969.

Table 1: Estimation results for the Sample EUEFTA, with log of export as the dependent variable[18]

Variables [(a)]	**3-way LS**	**3-way GMM**	**FEM LS**	**FEM GMM**
CONST.	-1.7148***	-1.1231***	-4,2236***	-3.16***
	(0.4554)	*(0.4758)*	*(0.7861)*	*(0.8234)*
Log(export)(-1)	0.9335***	0.9506***	0.86***	0.8879***
	(0.0048)	*(0.0051)*	*(0.0086)*	*(0.0096)*
Relendow	0	0[(b)]	-0.0455**	-0.0437**
	-	-	*(0.0213)*	*(0.0221)*
GDPT	0.2011***	0.1459***	0.4103***	0.3129***
	(0.0393)	*(0.0407)*	*(0.0608)*	*(0.0633)*
SIMILAR	0.091***	0.0658***	0.2050***	0.1606***
	(0.0190)	*(0.0198)*	*(0.0281)*	*(0.0296)*
DIST	-0.0441***	-0.0335***	-	-
	(0.0059)	(0.0062)	-	-
RER	-0.03**	-0.0265**	-0.0354***	-0.0315**
	(0.0129)	*(0.0135)*	*(0.0129)*	*(0.0134)*
COMLG	0.0319***	0.0219***	-	-
	(0.0319)	*(0.0069)*	-	-
CONTIG	0.0264***	0.0203***	-	-
	(0.0264)	*(0.0061)*	-	-
DEU91	0.0155**	0.0125*	0.0249***	0.0213***
	(0.0067)	*(0.0067)*	*0.0072*	*(0.0072)*
SWE93	-0.0418*	-0.0393*	-0.0446**	-0.0415*
	(0.0228)	*(0.023)*	*(0.0220)*	*(0.0222)*
EU	0.0272***	0.0209***	0.0640***	0.0530***
	(0.0054)	*(0.0056)*	*(0.0067)*	*(0.0069)*
Hansen's J statistic [(c)]		5.63 χ^2 (3)		2.45E-06 χ^2 (2)
No. of observations	8160	8160	8160	8160
No. of bilateral flows	240	240	240	240
Adj. R^2	0.9926	-	0.9928	-
Durbin-Watson Statistic	2.3262	2.366	2.2670	2.346
LR-X χ^2 (15)[(d)]		234.08		-
LR-M χ^2 (15)[(d)]		84.18		-
LR-T χ^2 (34)[(d)]		2371.74		-
Time Stability Test [(e)] χ^2 (5)		8.0693		12.34

Notes:

(a) Standard Errors in parentheses. Estimations are made by using the White Heteroskedasticity Consistent Covariance.

[15] Centre d'Etudes Prospectives et d'Information Internationale.

[16] http://www.cepii.fr/anglaisgraph/bdd/distances.htm

[17] For Germany, as the capital is not populated enough to represent the economic center, Essen replaces Berlin.

[18] Country and time effects are not reported

(b) Wald Test for H_0: $\beta_1 = 0 \sim \chi^2(1)$. Wald test= 0.000684, we accept H_0.

(c) Hansen's J statistic is the GMM objective function evaluated at the GMM estimate and is formed by multiplying the Eviews J-Statistic by the sample size. Under the null hypothesis of correct specification (the overidentifying restrictions are valid). The J-statistic is asymptotically χ^2(r) with r equal to the number of overidentifying restrictions. Hence, we do not reject the over identifying restrictions.

(d) See Davidson and McKinnon (1993) p 618.

(e) We did not do a test for stability of the parameters for each year, however we have tested that the parameters estimated for two sub-samples (1967-1993 and 1994-2002) were equal. We are doing a dummy variable test (see Green (1997 pages 212-213), testing that the parameters of Y_{ijt-1}, SIMILAR, GDPT, RER and EU are the same in the two periods. The critical value of $\chi^2(5)=11.07$.

*** Significant at 1 per cent; ** Significant at 5 per cent; * Significant at 10 per cent.

4.1.1. Interpretation of the elasticities results

Table 2: Long-term elasticities

Variable	Definition	3-way GMM	FEM GMM
RELENDOW	Per capita GDP differential between country i and j	0	-0.39
GDPT	The overall economic space	2.9618	2.7909
SIMILAR	The relative size of two countries in terms of GDP.	1.3365	1.4322
DIST	Distance between country i and country j	-0.6815	-
RER	Real exchange rate between country i and country j	-0.5384	-0.2805

For GDPT, the total volume of trade should be higher the larger the overall economic space. In the long-term, an increase of 1% of the sum of GDP of the two trading countries (i and j) will result in an increase of 2.96% of the export from country i to country j, according to the estimate of the 3-way model. This is in line with the fact that trade usually grows faster than the economy.

The long-term elasticities produced by the two approaches (3-way and FEM) lead to comparable long-terms estimations.[19] Variables such as distance, common language and common frontiers are excluded from the FEM estimation and the 3-way model is imposing $\eta_{ij} = \alpha_i + \gamma_j$. The sign of RELENDOW in the FEM approach is negative and fits with the Linder's hypothesis according to which countries with similar demand patterns will trade more intensively with each other.

4.1.2. Predicting trade flows

In order to forecast trade flows for EU and EFTA countries we will use the results from the 3-way model as they provide us with countries effects and make the approach more intuitive and results seem to be more stable over time (cf. time stability tests).

The exports from Denmark (DNK) to France (FRA) for the year 2002 can be computed using the 3 way-model the following way:

$$Y_{ijt} = -1.1235 + 0.9507 Y_{ijt(-1)} + 0.1459 GDPT_{ijt} + 0.0658 SIMILAR_{ijt}$$
$$- 0.0335 DIST_{ij} - 0.0265 RER_{ijt} + 0.0209 EU_{ijt} - 0.071 \gamma_{FRA} - 0.1760 year 2002$$

See Graph 1 for the comparison of the observed and estimated volume of export from Denmark to France in million USD 1995 for the period 1969-2002. We will then use the above equation for forecasting trade flows, where we will insert the forecast for GDP, population and other variables for the next 15/20 years. In the basis scenario, time effects (Graph 2) will be replaced by the sample average. Graph 3 and Graph 4 represent the country effects.

[19] Similar results are obtained by adding USA, Canada, New Zealand, Japan and Australia to the EUEFTA sample.

4.2. Results for Eastern and Central Europe

The exercise of forecasting trade flows for Eastern countries is not an easy task and the period for which data are available has been a period of radical changes for these countries. It has not been possible to estimate a consistent model for the period 1993-2002 including the eastern countries.
Gravitation models have recently been used to forecast trade potentials between EU members and the Eastern countries, see Fontagnié and Pajot (1999) among others.
In this kind of approach two gravity equations are estimated: one for export from country i to country j and one for import from country j to country i. The endogenous variables are $Y^{X}{}_{ijt}$ the exports from country i to country j and $Y^{M}{}_{ijt}$ the imports of country i coming from country j (with $Y^{M}{}_{ijt} = Y^{X}{}_{jit}$). These equations are estimated on the sample EUEFTA for the period 1967-2002. The estimated models are then used to explain the theoretical level of exports and imports between the countries i (EU and EFTA) and countries j (Central and Eastern countries). It has to be noticed that the export and import equations estimated are a restricted version of the 3-way model estimated for the eastern countries, where $\lambda_j = 0$ for the export equation and $\alpha_j = 0$ for the import equation. They are in fact a 2-way GMM estimations. An alternative to this approach could be to use the results of the model estimated with both import and export country effects (3-way GMM approach) and choose the most appropriated fixed import and export effects for the Eastern countries, by comparing their size and the openness of their economy with the EU and EFTA countries (see Graph 3 and Graph 4).

The basis for the export equation is DNK and year 1994.[20]

$$Y^{X}{}_{ijt} = -0.2981 + 0.9558 Y_{ijt_{(-1)}} + 0.0662 GDPT_{ijt} + 0.0281 SIMILAR_{ijt}$$
$$- 0.0277 DIST_{ij} + 0.0239 EU_{ijt} + 0.0183 COMNLG_{ij} + 0.0175 CONTIG_{ij} + \alpha_i + \delta_t .$$

The basis for the import equation is DNK and year 1994. [21]

$$Y^{M}{}_{ijt} = 0.1729 + 0.9688 Y_{ijt_{(-1)}} + 0.0253 GDPT_{ijt} - 0.0343 DIST_{ij} + 0.024 EU_{ijt}$$
$$+ 0.0113 COMNLG_{ij} + \gamma_i + \delta_t .$$

The idea was to use this kind of approaches to forecast the trade flows for Eastern countries once they are fully integrated and behave as EU countries. The result is that the equation applied to Eastern data provides a good forecast of the trade flows and instead of an expected overestimation it gives an underestimation in the beginning but at the end of the sample the forecast is very close to the observed value. The good fit of the model for Eastern countries is mainly due to the dynamic formulation of the model.

5. Conclusion

For EU EFTA countries growth rates will be computed by using the 3-way GMM model. For the Eastern countries they will be based on the results from the export and import equations estimated on the EUEFTA sample for the period 1967-2002. Based on the gravity model, bilateral directional growth rates will be computed. These growth rates will take into account projections of economic growth in each country, as well as the prospects for economic integration within the enlarged EU. As for previous EU candidates the macro-economic performances of the candidate countries measured by their GDP per head and their capacity for attracting foreign direct investment are expected to be an important element for determining the future trade flows of the new EU members.
The next step of the project consists in introducing these growth rates into the freight transport model Senex. The Senex model will then provide a forecast for the allocation of trade flows by mode and route choice, by replacing the current growth factors of the Senex model with the growth factors obtained from the gravity model for the different scenario alternatives. It will then be possible to visualize on the map of Denmark the consequences of the future flow of goods for mode and route choice.

[20] All the parameters are significant at 1%.

[21] All the parameters are significant at 1%.

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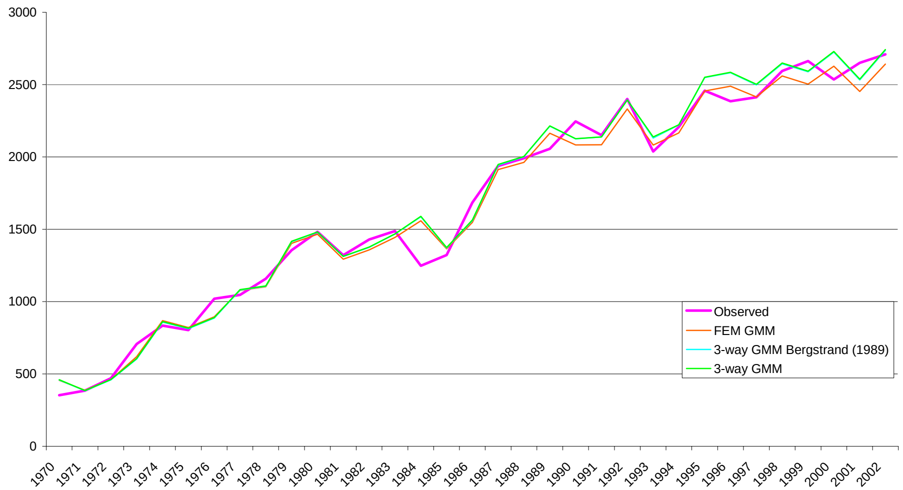
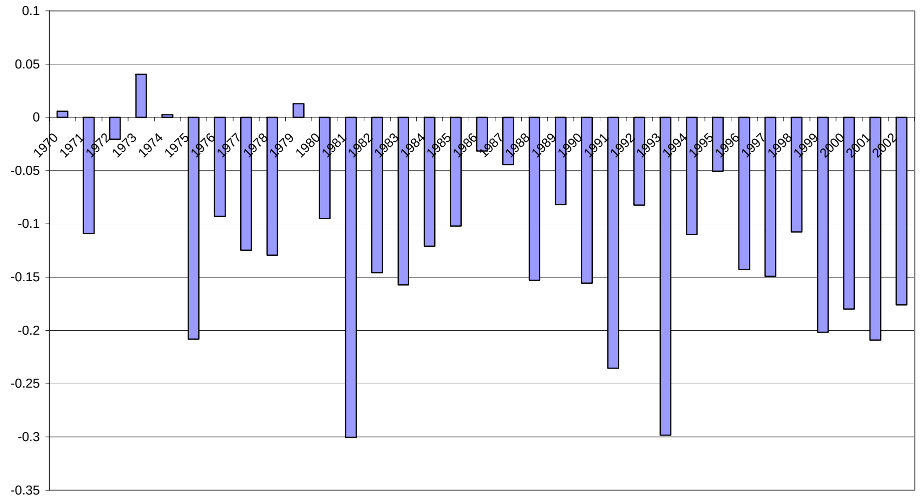
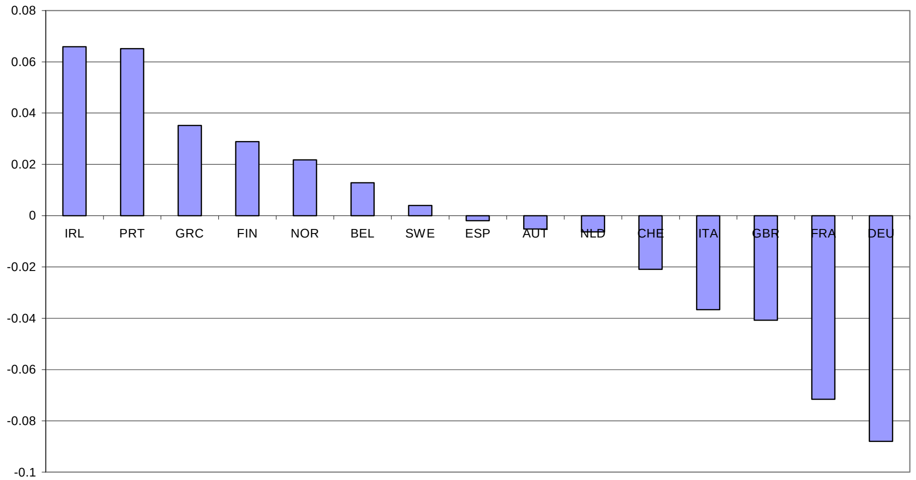
Graph 1: Export from Denmark to France (1995 million USD)



Graph 2: Time effect (delta t), basis 1969



Graph 3: Importing country effects (gamma j), DNK=Basis



Graph 4: Exporting country effects (alpha i), DNK=Basis