2. Comparative Studies of OECD countries:

Econometric Models of Foreign Trade in OECD Countries

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Abstract

This article presents some econometric models which take into account both supply and demand sides as determinants of real Exports, including the important relationships existing between industrial development and external trade. The models focus on the positive role human capital plays in reducing external debt by fostering the evolution of exports and allowing the increase of imports necessary for industrial development. The analysis is performed with data of 25 OECD countries during the period 1960-97.

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1. Evolution of Exports in 25 OECD countries, 1960-97.

Trade has an important role in development as it is deeply related to industrial development, so countries with low levels of industry by inhabitant usually have low levels of national and foreign trade per capita, and very often they have problems of deficit in their balances of payments which lead to increasing external debt and difficulties in promoting development.

Foreign trade is particularly important for small countries, or for countries with low levels of production of raw materials. They need to sell goods and services to foreign countries in order to finance some intermediate goods and services necessary for their production, which are not produced in the country and have to be bought in international markets.

The positive impact of imports on economic development does not usually receive enough attention in many reports on economic policies for less developed countries. In our view it deserves more attention, as the empirical evidence shows that industry is essential for development, with positive impact on other sectors such as building and services.

Industrial development, on the other hand, is usually deeply related to both national and international trade. Large countries usually have a high level of national trade so they can acquire most of their intermediate inputs and machinery by producing them themselves, but small countries usually need to have a high level of foreign trade in order to improve their industrial development.

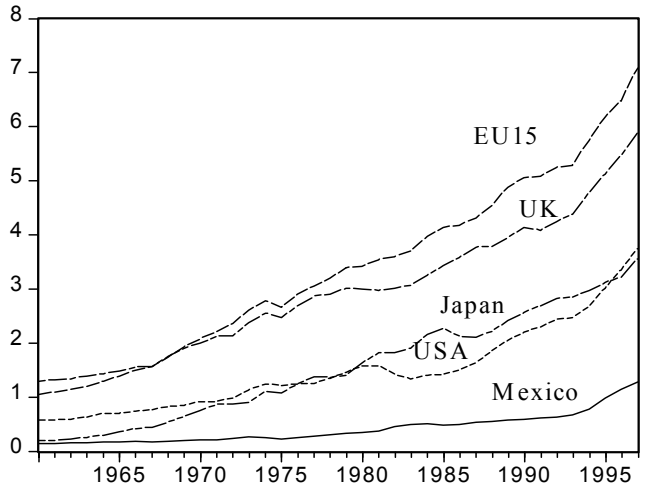
Graph 1 shows the evolution of Exports by inhabitant, in thousands of dollars, at the price levels and exchange rates of 1990, of the European Union, the USA, Japan, Mexico and the United Kingdom.

We can see the important increase in all cases, although we should note that the high level of EU15 is the sum of fifteen countries belonging to the European Union and includes not only extra-EU foreign trade but also intra-EU foreign trade.

If we analysed only foreign trade between the European Union and other areas, excluding intra-EU trade, we would see that foreign trade of the EU has a value by inhabitant very similar to that of the USA, because only about one half of EU total foreign trade is extra-EU.

Many theoretical and empirical studies have noted the important positive role of exports in economic growth, although many of them only emphasise its impact on the demand side. Actually, the impact on the supply side is also very important, as imports also have in many cases a positive role in economic growth.

Graph 1. Exports by inhabitant, thousands of $90



The increase in imports usually contributes to the improvement of industry, building and services, making available some intermediate goods which are needed to expand production in these sectors. This happens because many imported goods and services are complementary to internal production, and their positive impact on internal production usually overrides some negative effects due to substitution effects of other imported goods.

In Cancelo, Guisan and Frias(2001) we present a combined model for real Value-Added of Manufacturing in OECD countries, where the final effect of the increase of one unity both in imports and exports signifies a positive increase of industrial development.

The important positive impact of industry on other sectors explains that an increase of one unity in real Value-Added of Industry can increase the real Value-Added of Services by 0.8, as shown in the cross-country world model presented in Guisan, Aguayo and Exposito(2001). Similar conclusions have been reached by several authors with different approaches, although some studies on openness and on the role of foreign trade are inconclusive.

Table 1 shows the evolution of real exports by inhabitant of 25 OECD countries in the years 1960, 1975, 1985 and 1997, and there we can observe the high increases that have happened in all OECD countries during the period 1960-97.

Table 1. Real exports by inhabitant
(thousands of dollars at 1990 prices and exchange rates)

Country	1960	1975	1985	1997
Australia	0.825	1.659	2.339	4.844
Austria	1.169	3.423	6.360	11.08
Belgium	2.511	7.085	10.27	17.50
Canada	1.263	2.681	4.548	8.531
Denmark	2.314	4.771	7.448	11.87
Finland	1.607	3.171	5.728	10.64
France	0.853	2.538	3.835	6.722
Germany	1.208	3.020	5.084	6.882
Greece	0.127	0.607	0.970	1.711
Iceland	3.125	4.954	8.174	9.779
Ireland	0.829	2.373	4.932	17.07
Italy	0.550	1.913	3.036	5.906
Japan	0.190	1.074	2.266	3.559
Luxembourg	7.707	13.87	20.49	32.13
Mexico	0.138	0.225	0.481	1.276
Netherlands	2.352	6.013	8.173	13.75
New Zealand	1.426	2.190	3.102	4.547
Norway	2.466	5.233	8.526	16.16
Portugal	0.342	0.761	1.468	3.467
Spain	0.266	0.969	1.806	4.372
Sweden	2.043	4.675	7.087	12.87
Switzerland	3.706	6.985	10.73	13.77
Turkey	0.061	0.118	0.274	0.704
UK	1.290	2.465	3.435	5.877
USA	0.577	1.217	1.412	3.736
EU-15	1.045	2.664	4.139	7.091
OECD-25	0.754	1.805	2.689	4.853

Source: OECD National Accounts Statistics

The real value of exports has increased in the OECD countries, not only because of the increase of real Gross Domestic Product, GDP, but also because of the increase of the ratio Exports/GDP.

In all 25 OECD countries the ratio between Exports and GDP has evolved from 9.11% in 1960 to 13.57% in 1975, 16.73% in 1985 and 24.69% in 1997.

The European Union has higher levels of exports by inhabitant and higher ratios between exports and GDP due to the high level of intra-EU trade. Big countries, like the USA, have similar levels of internal trade inside its territory but this of course counts as national trade and not as foreign trade.

Mexico has experienced a high degree of openness to foreign trade, but its levels of exports by inhabitant are already very low. This country, as well as most Latin American countries, needs to increase foreign trade to foster industrial development.

The degree of openness of a country to foreign trade can be measured in absolute terms, by the value of exports by inhabitant, and it can also be measured in relative terms, by means of the ratio between Exports and Gross Domestic Product.

Generally the degree of absolute openness depends positively on the degree of development of the country and negatively on the size of the country, as big countries have usually more opportunities for internal trade than smaller ones.

The degree of relative openness to foreign trade depends on several factors:

1) The size of the country, with generally a greater need for openness in small countries.

2) The increase of industry, with generally a greater need for openness in countries which are increasing their level of industrialisation.

3) The distance to other markets, with more trade when the distance is small and/or the cost of transport is low.

4) Trade barriers, trade increases when these barriers are lowered or disappear.

5) The degree of development. In countries with very low levels of Gdp by inhabitant even low levels of exports by inhabitant imply a relatively high ratio. If Gdph increases faster than Exports by inhabitant the ratio between Exports and Gdp can diminish with development.

Graphs 2 to 5 present the degree of openness measured by the ratio between real Exports and real GDP, at 1990 prices and exchange rates. We consider the following groups according to the value of ratio Exports/GDP in 1997.

Group 1.- Countries with ratio higher than 0.40: Luxembourg, Ireland, Belgium, Netherlands, Austria, Norway and Sweden.

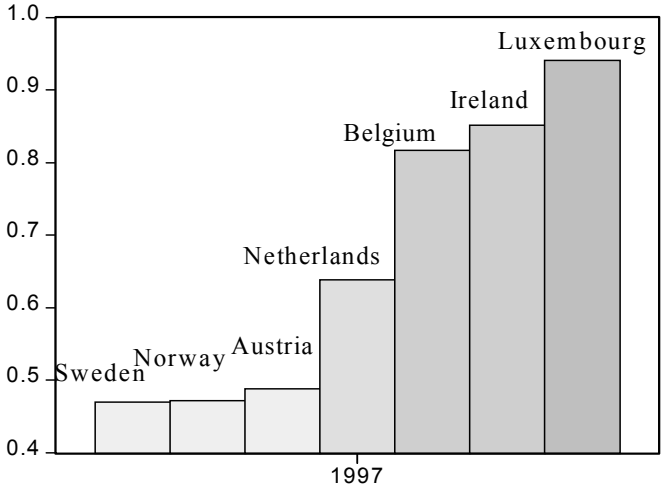
Group 2.- Countries with ratio between 0.34 and 0.40: New Zealand, United Kingdom, Spain, Germany, France and Italy.

Group 3.- Countries with ratio between 0.26 and 0.33: Portugal, Switzerland, Canada, Denmark, Mexico and Iceland.

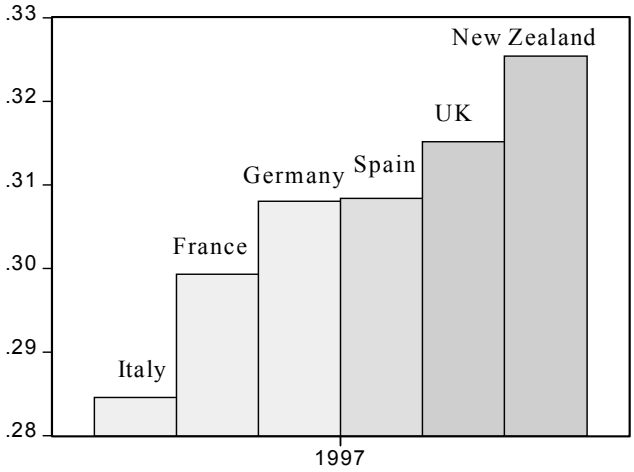
Group 4.- Countries with ratio below 0.25: Australia, Turkey, Greece, USA and Japan

These graphs show that the USA and Japan, despite being countries with high levels of absolute openness have a low level of relative openness in comparison with smaller countries and in comparison with countries with lower levels of Gdp by inhabitant.

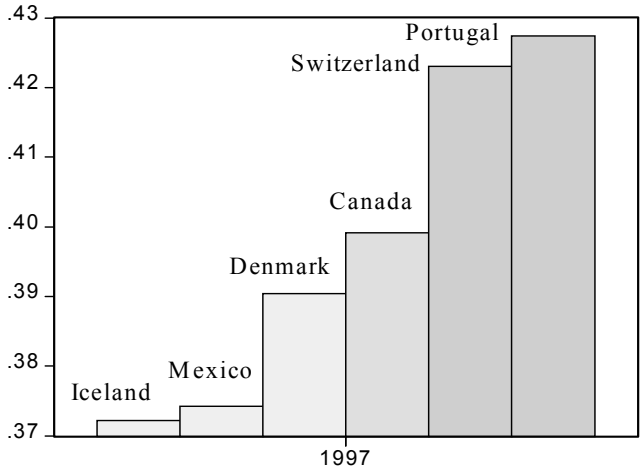
Graph 2. Ratio Exports/GDP in countries of group 1



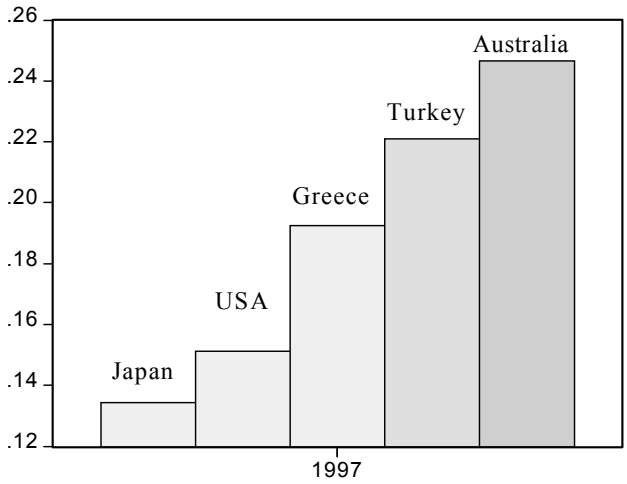
Graph 3. Ratio Exports/GDP in countries of group 2



Graph 4. Ratio Exports/GDP in countries of group 3



Graph 5. Ratio Exports/GDP in countries of group 4



2. Econometric Model for Exports in OECD countries 1960-97

In section 1 we have seen that there are important differences in exports by inhabitant, both in the time series of a country or in a cross-section of countries.

In this section we present an econometric model that explains the real value of exports as a function of some factors from the demand and the supply sides, estimated with a pool of 925 observations of 25 OECD countries in the period 1961-97.

Usually econometric models of exports focus on the demand side, with two main explanatory variables: the level of external demand, with a positive effect on exports, and the relative price of the country in relation with the external market.

Our approach includes other relevant variables such as the level of GDP of the country as a variable that represents the supply side and has a positive effect, the level of private consumption of the country, as a variable that represents internal demand and has a negative effect on exports, and a variable related with the educational level of the population, as a measure of the changes in quality of production and organisation.

The variables included in Model 1 are the following:

$EXP90_{it}$= Exports of goods and services of country i in year t, in billions of dollars at the price levels and exchange rates of 1990.

$DEXT_{it}$ = External Demand, measured by the sum of the real value of GDP in the other 24 OECD countries in year t, in B$90.

$GDP90_{it}$ = Internal Supply, measured by the real value of GDP in country i and year t, in B$90.

IPR_{it} = Index of Prices Ratio, measured by the ratio between the external index of prices of exports of each country and the external index of exports of the USA.

TYR_{it}/TYR_{Ut} = ratio between the average years of schooling of adult population of each country in comparison with the corresponding value of this variable in the USA. This variable is an indicator of relative quality of production and socio-economic organisation.

The Index of prices ratio is measured by the ratio between the index of external prices of exports of each country, IPEXX, and that variable in the USA:

(1) $$IPR_{it} = IPEXX_{it}/IPEXX_{Ut}$$

The index of external prices of exports of a country is the ratio between the index of internal prices of exports, IPINX, and the index of the exchange rate, the index of the exchange rate being the ratio between the exchange rate in year t, ER_{it}, and the same variable in the base year. The base year is 1990 in this case.

(2) $IPEXX_{it} = IPINX_{it} / IER_{it,}$ where $IER_{it} = ER_{it}/ER_{io}$

As the exchange rate is in units of currency in each country by US$, the variable IER is equal to unity for the USA and in that country the index of external prices is equal to the index of internal prices.

Relation (2) has an important role in explaining the international variations of the exchange rate, as shown in several models such as those analysed in Guisan(2003).

Model 1 is a dynamic log-linear model, expressed in the form of a mixed dynamic model, including among the explanatory variables, besides the lagged value of the dependent variable, the increases in the natural logarithms of DEXT, GDP90, and IPR, as

well as the indicator of changes in quality, measured by the educational distance in relation with the USA.

Model 1.
Mixed dynamic model for log(EXP90)

Dependent Variable: LOG(EXP90?)
Method: Pooled Least Squares
Sample(adjusted): 1961 1997
Included observations: 37 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 925
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(DEXT?))	1.021635	0.121969	8.376172	0.0000
D(LOG(GDP90?))	1.442267	0.184443	7.819566	0.0000
D(LOG(C90?))	-0.983835	0.199605	-4.928901	0.0000
D(LOG(IPR?))	-0.091943	0.025175	-3.652152	0.0003
D(LOG(TYR?/TYRU))	0.322314	0.094902	3.396301	0.0007
LOG(EXP90?(-1))	1.003198	0.000742	1351.375	0.0000

R-squared	0.998803	Mean dependent var	3.517324
Adjusted R-squared	0.998797	S.D. dependent var	1.473892
S.E. of regression	0.051125	Sum squared resid	2.402023
Log likelihood	1440.967	F-statistic	153409.3
Durbin-Watson stat	1.773522	Prob(F-statistic)	0.000000

The model performs very well: the goodness of fit is high, all the coefficients are significantly different from zero and have the adequate signs, and the lagged value of the explained variable has a coefficient near one.

The hypothesis of homogeneity of parameters between individual countries is tested in Guisan(2003) with satisfactory results, and the model shows good forecasting accuracy as we shall see in the next section, where we compare this model with other

interesting models of foreign trade, in relation with predictive capacity.

3. Econometric Models for Manufacturing Exports

In this section we present two econometric models for manufacturing exports in OECD countries with a sample of 11 countries in the period 1975-90, using the indices of prices elaborated by Cancelo(1996) and published in Cancelo and Guisan(2001).

Model 2 relates the exponential rate of yearly growth of real exports of sector 10 (Manufacturing), which is equal to the difference between log of XR10 and log of its lagged value XR10L=XR10(-1), with the following explanatory variables:

Log(Q10/Q10L), exponential rate of growth of Q10, where Q10 is the real value of Manufacturing Value-Added in billions of dollars at the price levels and exchange rates of 1990.

Log(PRI10/PRI10L), exponential rate of growth of prices, where PRI10 is the International Price Ratio of sector 10, calculated as follows.

$$PRI10_j = \frac{IPXI10_j}{IPXG10_j} \quad ; \quad IPXG10_j = \sum_{i=1,i\neq j}^{10} IPX10_i \frac{XR10_i}{\sum_{i=1,i\neq j}^{10} XR10_i}$$

Log(DEXT/DEXTL), exponential rate of growth of external demand, where DEXT for country j is calculated, in billions of dollars at the price levels and exchange rates of 1990, as follows:

$$DEXT_j = \sum_{i=1,i\neq j}^{10} \frac{X_{ij}}{\sum_{i=1}^{10} X_{ij}} PIB90_i$$

where: Xij = Exports of goods and services from country j to country i, and GDP90i = Gross Domestic Product of country, both variables at 1990 prices and exchange rates.

LOG(NE3/N3L), exponential rate of growth of the percentage of active population with second cycle secondary studies complete or superior educational level.

Model 2.
LS estimation of the exponential rate of growth of XR10

LS // Dependent Variable is LOG(XR10/XR10R) Sample: 1975 1990 Included observations: 165				
Variable	Coefficient	Std. Error	t-Statistic	prob.
LOG(Q10/Q10R)	0.654030	0.086386	7.571028	0.0000
LOG(PRI10/PRI10R)	-0.264720	0.068575	-3.860275	0.0002
LOG(DEXT/DEXTR)	0.659224	0.117188	5.625375	0.0000
LOG(NE3/NE3R)	0.779364	0.145619	5.352092	0.0000
R-squared	0.993762	Mean dependent var		0.053791
Adjusted R-squared	0.993653	S.D. dependent var		0.072345
S.E. of regression	0.056073	Akaike info		-5.739743
Sum squared resid	0.540796	Schwarz criterion		-5.667686
Log likelihood	259.3642	F-statistic		39.76954
Durbin-Watson stat	1.521495	Prob(F-statistic)		0.000000

Model 3 presents the relation between the log of XR10 and the same explanatory variables of model 2, which are not expressed in exponential rates but in levels. Model 3 also includes an intercept and the lagged value of the explained variable.

Both models present good results, although Model 2 shows better forecasting accuracy.

Model 3.
LS estimation for log XR10.

LS // Dependent Variable is LOG(XR10) Sample: 1975 1990 Included observations: 176				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.333233	0.119509	-2.788343	0.0059
LOG(Q10)	0.020026	0.007859	2.548168	0.0117
LOG(DEXT)	0.037321	0.017021	2.192600	0.0297
LOG(PRI10)	-0.247913	0.050998	-4.861189	0.0000
LOG(NE3)	0.048028	0.016794	2.859828	0.0048
LOG(XR10R)	0.960375	0.012945	74.19058	0.0000
R-squared	0.995573	Mean dependent var		4.057490
Adjusted R-squared	0.995442	S.D. dependent var		0.994489
S.E. of regression	0.067137	Akaike info criterion		-5.368530
Sum squared resid	0.766264	Schwarz criterion		-5.260445
Log likelihood	228.6975	F-statistic		7645.590
Durbin-Watson stat	1.615829	Prob(F-statistic)		0.000000

Table 3 presents the forecasting accuracy of Model 1, based on the individual regressions for each country, in comparison with Models 2 and 3.

Although Model 1 is a simplified version of this approach to exports equation, with less detailed information than model 2 and 3, we can see that in spite of its higher simplicity Model 1 performs almost equally to Model 2 regarding the root of mean square forecasting error, in percentage of the true mean of the explained variable, %RMSE, and both models perform better than model 3.

Table 3.
Forecasting accuracy for real exports 1991-1992

Model	Dep. Variable	%RMSE
1	EXP90	4.996
2	XR10	3.430
3	XR10	7.386

The variables utilised in these models are presented in Cancelo and Guisan(2001) and in Guisan(2003) where other interesting relations concerning the relationship between exports, imports, external trade prices and exchange rates are analysed.

4. Conclusions

The main conclusions of this article point to the comparison between a simplified version of exports equation, Model 1, which, under general circumstances, has goodness of fit and an accuracy of predictions as good as the more elaborated version, Model 2, and better than the more elaborate version Model 3.

In comparison with other approaches to Exports equation, based mainly on demand side, our models have the added feature of taking into account both demand and supply sides, and they take into account the important role of education, not only directly in the equation, by means of the variable Tyr in Model 1 and NE3 in Models 2 and 3, but also indirectly.

The indirect effect of education on Exports is highly positive and comes through the variables GDP in Model 1 and Q10 in Models 2 and 3. Both variables are highly sensitive to the educational level of population, as it is shown in Cancelo, Guisan and Frias(2001).

Another conclusion is that the mixed dynamic specification of Model 1, and the first difference specification of Model 2, show better results than the equation in levels of Model 3.

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[2] Information about these publications, at: http://www.usc.es/eaa.htm