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INDUSTRY, FOREIGN TRADE AND DEVELOPMENT: ECONOMETRIC MODELS OF EUROPE AND NORTH AMERICA, 1965-2003

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Abstract

We compare several econometric models of Western Europe, Central Europe, the United States, Canada and Mexico in order to analyze the impact of foreign trade and industry on development from demand and supply sides. It is important to notice that the positive effects of foreign trade are more due to the role of imports from the supply side than to the effect of exports from the demand side, although both are relevant. The main benefit from increasing exports is usually to increase the capacity to import intermediate inputs and other goods and services which are necessary to foster domestic production of goods and services. Many studies have shown the positive effects of exports but very few have focused on the positive role of imports, and this study contributes in this regard. On the other hand the analysis of industrial contribution to the non industrial sectors is twofold: directly providing intermediate and capital goods to non industrial sectors and indirectly increasing exports and the capacity to import foreign inputs which contribute to increase domestic production.

JEL codes: C51, F1, L6, L8, O52, O52. O54

Keywords: Industry, Foreign Trade, Development, Europe, America

1. Introduction

Both in developed and developing countries there is a frequent misunderstanding of the role of foreign trade in development, which may lead to wrong economic policies. Here we emphasize the important role of imports to foster domestic production. The expansion of foreign trade with exports of goods and services is

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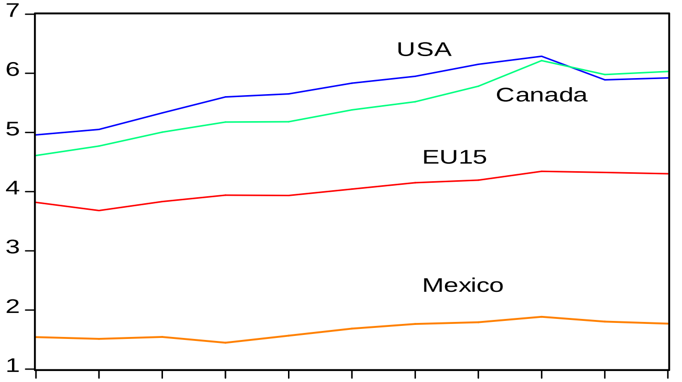
usually convenient in order to increase the capacity to import. Here we analyze direct and indirect effects of foreign trade on non-industrial production and the final effect on real Gdp.

Section 2 presents estimations of econometric models for North America, which show the positive effects of foreign trade and industrial development on non-industrial sectors. Section 3 analyzes similar relationships in two groups of European Union Countries: countries which belonged to EU15 before the 2004 enlargement and the five Central European countries which joined the EU after 2004 Enlargement: Poland, Hungary, Czech Republic, Slovakia and Slovenia. Finally section 4 presents the main conclusions.

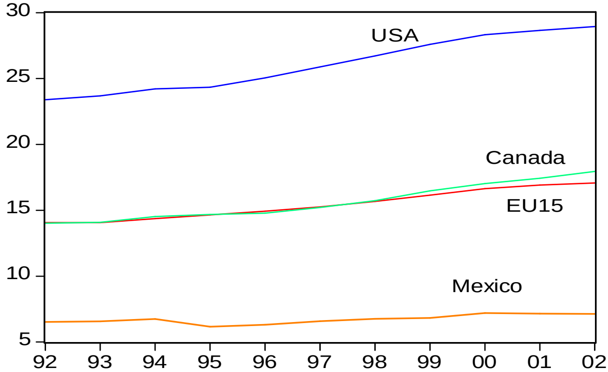
2. Data and models of North America

2.1. Evolution for the period 1992-2002. Graphs 1 and 2 present, respectively, the evolution of Industrial and Non-Industrial real Value-Added per inhabitant, in thousand dollars at 2000 prices of the three North American countries and the average of the fifteen countries belonging to the European Union before the Enlargement of year 2004.

Graph 1. Real Value-added of Industry
(thousand $ per inhabitant at 2000 prices)



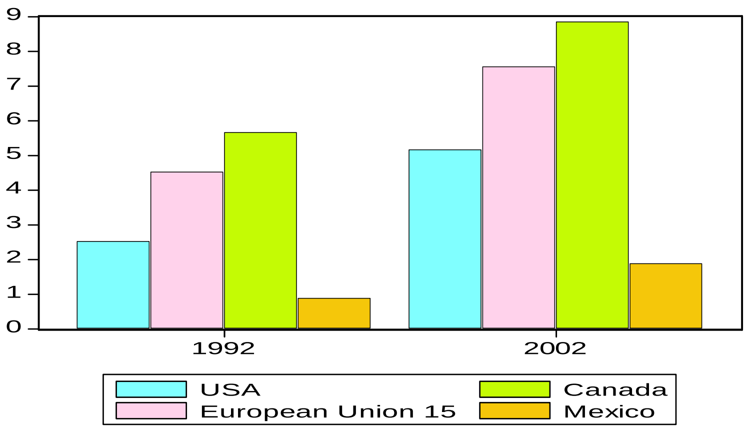
Graph 2. Real Value-Added of Non-Industrial sectors (thousand $ per inhabitant at 2000 prices)



Notes: Own elaboration from OECD statistics. For the European Union and Canada values are expressed in dollars accordingly to exchange rates and in the case of Mexico accordingly to purchasing power parities to avoid underestimation.

Graph 3 presents the value of Imports per inhabitant of the three NAFTA countries in comparison with the European Union in the years 1992 and 2002, expressed in thousand dollars at 2000 prices and exchange rates.

Graph 3. Imports per inhabitant (dollars at 2000 prices)



We notice that in all the cases there was an increase of this variable, and the country with the most outstanding values is Canada. In the case of the European Union imports are inclusive not only of abroad purchases of goods and services but also of internal trade among the 15 EU countries. The comparison of external trade of EU15 countries gives an average per inhabitant close to the United States. In Guisan and Cancelo(2002) we analyze several factors which explain the differences in foreign trade per inhabitant of OECD countries.

Table 1 presents the situation of the three North-American countries in comparison with the EU15 average for years 1992 and 2002, for industrial and non-industrial real Value-Added per inhabitant.

Table 1. Industrial and Non-Industrial real Value-Added and Gdph (thousand dollars per inhabitant at 2000 prices)

	Industrial		**Non-Industrial**		**Gdp per capita**	
Country	**1992**	**2002**	**1992**	**2002**	**1992**	**2002**
Canada	4.61	6.03	14.02	17.95	18.63	23.98
Mexico	1.54	1.77	6.52	7.14	8.06	8.91
USA	4.96	5.92	23.39	28.95	28.35	34.87
EU-15	3.82	4.30	14.07	17.07	17.89	21.37

Note: Elaborated from OECD(2006). Data for Canada and the European Union in dollars at exchange rates and for Mexico in dollars at purchasing power parities (in order to avoid underestimation).

2.2. Econometric models of demand and supply in the United States: the role of industry and foreign trade

Here we present the results of two econometric models estimated for the USA, previously published for the period 1965-1998 by Guisan and Exposito(2006), here updated with data for the period 1966-2001.

We follow the disequilibrium approach of Guisan(2005) which has into account not only demand side, and supply side of primary inputs, but also inter-sector relationships from supply side of intermediate inputs. The aim of this approach is to show the importance of inter-sector relationships and the positive role of foreign trade not only from the demand side but also from the supply side. As it has been very clearly pointed out by Klein(1983) it is very important to have into account all the factors which are relevant to explain macro-economic growth and development.

Model 1 has 9 equations and Model 2 has 11. Data for the variables in the USA are included in the Annex. Data source is OECD(2006) and own elaboration. All the variables are measured in Billion dollars at 1990 prices.

Equations (1) to (8) are common for both models and equation (9) is different for each model: Model 1 includes equation (9a) and Model 2 equations (9c) (10) and (11).

$$CP= f\ (D(RFI, CP(-1)) \qquad (1)$$

$$GCF = f(\ D(SUR), GCF(-1)) \qquad (2)$$

$$CE = f(D(GDP), CE(-1)) \qquad (3)$$

$$RFI = CE+Z1 \qquad (4)$$

$$SUR = GDP - CE - Z2 \qquad (5)$$

$$D(RFI) = RFI - RFI(-1) \qquad (6)$$

$$D(SUR) = SUR - SUR(-1) \qquad (7)$$

$$D(GDP) = GDP - GDP(-1) \qquad (8)$$

CE is Compensation of Employees, CP Private Consumption, GCF Gross Capital Formation, GDP Gross Domestic Product, RFI Real Family Income, SUR is Gross Operating Surplus, Z1 is the Family Income different from Compensation of Employees, and Z2 is Net

Taxes on Production and Imports (Taxes less Subsidies). D(X) means the first difference of X, and X(-1) is the lagged value of X.

Model 1 is a demand side model, where real GDP is explained by the identity:

$$GDP^{d} = CP + G + GCF + EXP - IMP \quad (9a)$$

Where C is Private Consumption, G is Public Consumption, GFC is Gross Capital Formation (the sum of Gross Fixed Capital Formation (GFCF) and the Increase in Stocks (IS). IS indicates the intermediate inputs or finished goods produced in one year which are expected to be sold in the next year. The variables of foreign trade, EXP and IMP, include Exports and Imports of goods and services.

Model 2 is a supply side model, where GDP is explained by GDP^{s2} when it is the minimum of the following disequilibrium relation:

$$GDP = \min (GDP^{d}, GDP^{s1}, GDP^{S2}) \quad (9b)$$

where GDP^{d} represents demand side (equation 9a) GDP^{s1} represents supply side of primary inputs (given by a production function when the available stock of physical capital may be fully utilized), and GDP^{s2} represents supply side of intermediate inputs, based on Input-Output inter-sectoral relationships, where we express non manufacturing real Value-Added as a function of real Value-Added of domestic manufacturing and Imports. We could disaggregate the inter-sector relationships in a more detailed model but the simplification here adopted is enough for the purposes of this study.

We assume that in this case the minimum of relation (2) is given by GDP^{s2}, because the experience shows that highly industrialized countries like the United States, usually do not have problems from the stock of capital side, as they may increase KA when the economic conditions are proper for that. Thus in model (2) the equations which explain real GDP are:

$$GDP = QM + QNM \quad (9c)$$

$$QNM = F\ (D(QM), D(IMP), D(EXP), QNM(-1) \quad (10)$$

For simplification we assume that QM=real GDP of Manufacturing, and IMP (Imports) is explained by equation 11, although in a more detailed study we should have into account the role of profits and incentives to investment on manufacturing and other variables:

$$QM = f\ (QM(-1), D(IMP), D(EXP)) \quad (11)$$

The sign of the coefficient of the first difference of Imports will be positive if the positive impact of supplementary Imports is higher than the negative impact of substitutive Imports, and usually expected to be positive. The coefficient of Exports is usually positive because foreign demand contributes to the expansion of manufacturing. In a more detailed model we would add relationships showing the positive impact of industrial production, on Exports of goods, as seen in Guisan and Cancelo(2002) and other studies, as well as the positive impact of Exports of goods and services on the capacity to increase Imports.

Model 1 is an interdependent system which was estimated by Two Stage Least Squares (TSLS), while Model 2 is a recursive system estimated by Least Squares (LS). As Model 2 leads to better forecast than Model 1, we here present only the results of the estimation by LS. In Guisan and Exposito(2001) and (2006) both estimations are presented for the previous version of the model.

The equations (1) to (3), (10) and (11) are initially expressed in the form of mixed dynamic models, which are usually quite convenient because they may present several advantages in comparison with other dynamic model specifications, as it is explained in Guisan(2006) and other studies: 1) good results of co-integration tests, in comparison with models in levels or in first differences. 2) More simplicity for estimation and interpretation of coefficients than Error Correction Models with similar quality of forecasting results. In spite of these advantages the mixed dynamic model did not perform well in the equation 1 for Private Consumption, as seen in the Annex, and here we present the equation in first differences which seems to be preferable in this case.

Equation 1 shows that a unit increase in Real Family Income leads to an increase of 0.77 in CP. Equation 2 shows that in absence of increase of the Surplus, the Investment, given by the Gross Fixed Capital Formation, GFCF, shows a trend to remain equal to its lagged value but a unity increase in operating surplus leads to a similar or slightly higher increase in investment. Equation 3 shows that Compensation of Employees is very alike to the previous year unless there is an increase in real GDP. For each 100 dollars of increase in real GDP the expected average increase in CE is 57.99.

Equation 1. Private Consumption in first differences

Dependent Variable: D(CP). Method: Least Squares. Sample: 1965 2001

Variable	Coeff.	Std. Error	t-Statistic	Prob.
D(RFI)	0.778480	0.071664	10.86294	0.0000
Adjusted R-squared for CP	0.996825	Mean dependent var		97.9081
Adjusted R-squared for D(CP)	0.052456	S.D. dependent var		56.8030
S.E. of regression	55.29309	Akaike info criterion		10.8898
Sum squared resid	110063.7	Schwarz criterion		10.9333
Log likelihood	-200.461	Durbin-Watson stat		1.7094

Note: For comparison of the goodness of fit with the models in the Annex we have into account Adjusted R-sq. for CP, which is comparable to those of the mixed dynamic model and the model in levels, and not for D(CP).

Equation 2. Gross Capital Formation, mixed dynamic model

Dependent Variable: GFCF. Method: Least Squares. Sample: 1965 2001

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SUR)	1.094717	0.189744	5.769434	0.0000
GCF(-1)	1.003895	0.011220	89.47633	0.0000
R-squared	0.977847	Mean dependent var		921.0684
Adjusted R-squared	0.977214	S.D. dependent var		374.3205
S.E. of regression	56.50405	Akaike info criterion		10.95904
Sum squared resid	111744.8	Schwarz criterion		11.04612
Log likelihood	-200.7422	Durbin-Watson stat		1.575993

Equation 3. Compensation of Employees in USA
Dependent Variable: CE. Method: Least Squares. Sample: 1965 2001

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP)	0.579919	0.053703	10.79870	0.0000
CE(-1)	1.002496	0.003052	328.4781	0.0000

R-squared	0.998754	Mean dependent var	2881.008
Adjusted R-squared	0.998718	S.D. dependent var	834.8436
S.E. of regression	29.89225	Akaike info criterion	9.685614
Sum squared resid	31274.14	Schwarz criterion	9.772691
Log likelihood	-177.1839	Durbin-Watson stat	1.673533

Equation 10. Real GDP of Non-Manufacturing Sectors in USA
Dependent Variable: QNM. Method: Least Squares. Sample: 1965 2001

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(QM)	0.752426	0.203149	3.703815	0.0008
D(IMP)	0.597799	0.192720	3.101902	0.0039
D(EXP)	-0.507500	0.232687	-2.181038	0.0364
QNM(-1)	1.021066	0.002256	452.6004	0.0000

R-squared	0.999046	Mean dependent var	3841.203
Adjusted R-squared	0.998959	S.D. dependent var	1116.706
S.E. of regression	36.02684	Akaike info criterion	10.10821
Sum squared resid	42831.78	Schwarz criterion	10.28236
Log likelihood	-183.0019	Durbin-Watson stat	1.797746

Equation 11. Real GDP of Manufacturing, GLS AR(1)
Dependent Variable: QM. Method: GLS. Sample: 1965 2001

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QM(-1)	0.986480	0.009618	102.5686	0.0000
D(IMP)	0.673593	0.177830	3.787839	0.0006
D(EXP)	0.146409	0.244845	0.597965	0.5541
AR(1)	0.381132	0.194547	1.959069	0.0589

R-squared	0.989697	Mean dependent var	934.4350
Adjusted R-squared	0.988731	S.D. dependent var	269.5760
S.E. of regression	28.61640	Akaike info criterion	9.650276
Sum squared resid	26204.75	Schwarz criterion	9.826223
Log likelihood	-169.7050	Durbin-Watson stat	1.932816

The goodness of fit, with reference to the explained variable in levels, is very high in all the equations.

The coefficients of equation 10 are significantly different from zero, with the expected signs. An increase of 100 dollars in QM implies an increase of 75 dollars in QNM. An increase of 100 dollars in Exports and Imports, implies on average an increase of approximately 9 dollars in QNM. While Imports has a positive coefficient of 0.59, Exports shows a negative coefficient of -0.50, but this does not mean that Exports are useless, really they are necessary to increase the capacity to import, because Imports depend strongly on the value of Exports, and the final effect is positive.

Equation 11 shows the positive effect of Imports on QM. The equation has been estimated by Generalized Least Squares, GLS, due to the effect of some missing variables which provokes autocorrelation of the random shock. The analysis of the estimations allow us to measure other direct and indirect effects of foreign trade on the increase of real Gross Domestic Product: 1) Direct effect of 100 dollars of increase in Exports and Imports on QM, which amounts to 82 dollars, 2) Indirect effect, which implies also an additional effect of 49 dollars on QNM (indirect effect of foreign trade through the increase of QM) having into account that the coefficient of D(QM) in equation 10 is 0.597.

Total effect of Foreign Trade on GDP in the model of the USA: The combination of direct and indirect effects on QM and QNM gives a total effect of 82 dollars in QM and 58 dollars in QNM, which sum up to an increase of 140 dollars in real GDP as consequence of an increase of 100 dollars in Exports and Imports.

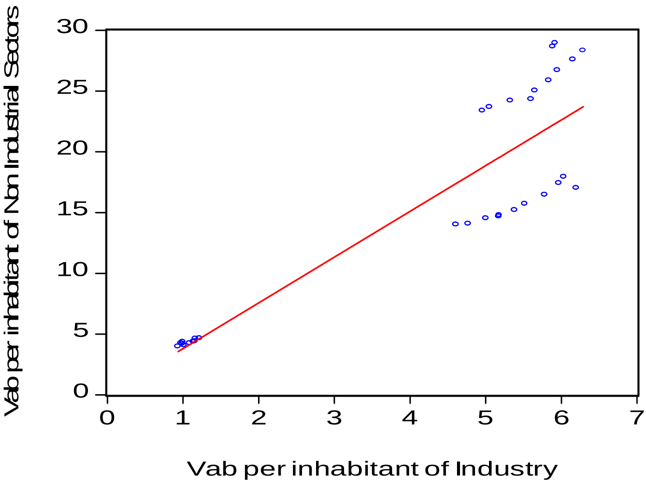
It is very important to conclude that the volume of foreign trade is relevant and not only the trade balance. If we only consider the demand side to explain Gdp, as in the relation (9a), it would seem that a similar increase in Exports and Imports would have a null effect on economic growth and development, but really it is not so, and the consideration of relations (9b), (9c), 10 and (11) allow us to have into account the positive effect of foreign trade level.

As seen in the Annex, the study by Guisan and Exposito (2001) and (2006) shows that the forecasting capacity for the USA was better with the supply side model, which has into account the positive effects of industry and imports on non industrial real value-added.

2.3. Pool of NAFTA countries.

Graph 4 shows the important positive impact of industrial development on non industrial sectors in the three North American countries or NAFTA countries. The values of Mexico are very low in comparison with Canada and the United States. It is noticeable that non industrial development is higher in the United States than in Canada in spite of similar levels of industrial development. Several factors explain this difference, and a more disaggregate study of Canadian production at sectoral level will show some of the causes.

Graph 4. Industrial and non Industrial Sectors in NAFTA



The following tables present the estimation of equations which related Industrial and Non-Industrial real Value-Added with foreign trade for the pool of the three NAFTA countries. Although it may be some degree of heterogeneity of parameters we do not analyze it in this moment and present the pooled estimation as representative of the three North American countries to the effects of analyzing the effect of industry and foreign trade on non industrial value-added. The high goodness of fit is an indicator of some degree of homogeneity of coefficients in the three countries.

Equation 10: Pool of NAFTA. Non Industrial real Value-Added, 1993-2002
Dependent Variable: QNIH
Method: Pooled Least Squares Sample(adjusted): 1993 2002
Number of cross-sections used: 3 Total panel observations: 30
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QNIH(-1)	1.017965	0.003406	298.8678	0.0000
D(QIH)	0.170514	0.429598	0.396915	0.6947
D(IMPH)	0.397339	0.281994	1.409031	0.1707
D(EXPH)	-0.142676	0.245222	-0.581824	0.5657

R-squared	0.999561	Mean dependent var	15.49877
Adjusted R-squared	0.999511	S.D. dependent var	9.223023
S.E. of regression	0.204023	Sum squared resid	1.082256
Log likelihood	7.264092	F-statistic	19745.87
Durbin-Watson stat	1.426132	Prob(F-statistic)	0.000000

Note: the estimated coefficients are referred to as a1, a2, a3 and a4 in this study.

Equation 11: Pool of NAFTA. Industrial real Value-Added, 1993-2002
Dependent Variable: QIH
Method: Pooled Least Squares. Sample(adjusted): 1993 2002
Number of cross-sections used: 3. Total panel 29
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QIH(-1)	0.997083	0.007613	130.9797	0.0000
D(IMPH)	0.265145	0.106206	2.496515	0.0192
D(EXPH)	0.188931	0.074629	2.531616	0.0177

R-squared	0.998232	Mean dependent var	4.220914
Adjusted R-squared	0.998095	S.D. dependent var	2.175880
S.E. of regression	0.094957	Sum squared resid	0.234439
Log likelihood	28.70970	F-statistic	7337.920
Durbin-Watson stat	1.491006	Prob(F-statistic)	0.000000

Note: the estimated coefficients are referred to as b1, b2 and b3 in this study.

Data are expressed in thousand dollars per inhabitant at 2000 prices and exchange rates. The source of data is OECD(2006) and own elaboration from this source. QIH is industrial real value, QNIH is non industrial real value, and IMPH and EXPH are Imports and Exports. All the variables are expressed in per capita terms, in thousand dollars per inhabitant at 2000 prices and exchange rates.

The small time dimension of the pool, with only 10 observations for each country, is probably one cause of the non significance of the coefficient of D(QIH). It is important to notice that the fact that this coefficient is not significantly different from zero do not imply that it is null. The interval of confidence for the parameter of this variable is approximately (-0.69; 1.03) which means that there is more evidence in favor of a positive value than a negative one. The uncertainty of the result should not be confused with evidence in favor of nullity. It is important to re-estimate the model with a larger sample, but for the moment we interpret the result having into account that there is evidence supporting a positive impact of industry on equation 10 in spite of some degree of uncertainty.

Total effect of foreign trade on Gdp in the pool of 3 NAFTA countries: The total effect of an increase of 100 dollars in exports and imports on QI00H is 45.4 (sum of coefficients b2 and b3 in the equation 2, multiplied by 100) and there is also a direct effect of 33.4 on QNI00H (sum of coefficients a2 and a3 of equation 10 multiplied by 100), and besides there is an indirect effect of the increase in QI00H on QNI00H (given by the product of 45.4 by the coefficient of D(QI00H) in equation 10 (0.1705) which amounts to 7.7. The total on real Gross Domestic Product per inhabitant is 86.5.

One recommendation to avoid uncertainty is to get a wider sample for more years and/or more countries and the evidence in favor of a positive impact of industry will increase. Besides we would analyze with more detail the particular circumstances of the economic sectors in Canada, country which does not show a value of non-industrial value-added per inhabitant so high as the USA in spite of its high values of industrial production and imports capacity. May be also that the demand side for some types of services is not so high in Canada. We hope to analyse this question in a future study.

2.4. Estimations for Canada

The following tables present the estimated equations for QNI and QI in Canada.

Equation 10: Non-Industrial rela Value-Added in Canada, 1993-2002
Dependent Variable: QNIH
Method: Least Squares. Sample(adjusted): 1993 2002

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QNIH(-1)	1.023259	0.007799	131.2035	0.0000
D(QIH)	0.559981	1.095947	0.510956	0.6276
D(IMPH)	-0.021204	0.359292	-0.059015	0.9549
D(EXPH)	-0.067253	0.461800	-0.145633	0.8890

R-squared	0.979658	Mean dependent var	15.78925
Adjusted R-squared	0.969486	S.D. dependent var	1.349545
S.E. of regression	0.235740	Akaike info criterion	0.237001
Sum squared resid	0.333440	Schwarz criterion	0.358035
Log likelihood	2.814997	Durbin-Watson stat	1.237504

Equation 11. Industrial Production in Canada, 1993-2002
Dependent Variable: QIH
Method: Least Squares. Sample(adjusted): 1993 2002

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QIH(-1)	0.994895	0.007359	135.1914	0.0000
D(IMPH)	0.129539	0.113545	1.140859	0.2915
D(EXPH)	0.280790	0.117982	2.379944	0.0489

R-squared	0.978078	Mean dependent var	5.504351
Adjusted R-squared	0.971815	S.D. dependent var	0.483398
S.E. of regression	0.081155	Akaike info criterion	-1.941587
Sum squared resid	0.046103	Schwarz criterion	-1.850811
Log likelihood	12.70793	Durbin-Watson stat	1.811451

The effects of Imports and Exports on QNI seems almost null in equation 10 of Canada, what imply few transformation of imports for goods addressed to the domestic market, while it appears that

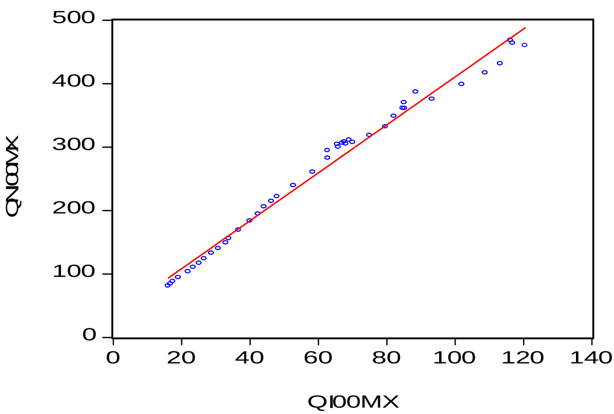
Exports have a positive effect on equation 11 by the demand side, fostering industrial production addressed to the United States and other foreign markets. The positive effect of exports on industrial production also contributes to increase real value-Added of non industrial sectors.

Total effect of foreign trade on real Gdp of Canada: Even if we consider null the direct effect of foreign trade in equation 10 of Canada, we may conclude that an increase of 100 dollars in Imports and Exports per inhabitant will have on average a positive effect of 40 dollars in industrial real value-added per inhabitant, and a positive indirect effect of 22.4 dollars for the effect of this increase on non-industrial real value-added (product of 40 by the coefficient of QI00CAH in equation 10 of Canada which is 0.5599). The total effect of foreign trade on real Gdp in the model of Canada accordingly to these estimations is 62.4 dollars.

2.5. Estimations for Mexico

Graph 5 presents the relationships between non-industrial and industrial real value-added in Mexico for the period 1960-2002.

Graph 5. Non-Industrial and Industrial real value-added, Mexico 1960-2002 (billion dollars at 2000 prices and exchange rates)



The following equations show the positive effect of imports and industrial production in non industrial real value-added of Mexico, as well as the positive impact of imports on industrial real value-added. Data sources is OECD(2006) and back issues of National Accounts Statistics and data are expressed in billion dollars at 2000 prices and exchange rates.

Equation 10. Non Industrial real Value-Added: Mexico 1962-2002
Dependent Variable: QNI
Method: Least Squares. Sample(adjusted): 1962 2002

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QNI(-1)	1.013846	0.005210	194.5820	0.0000
D(QI)	2.345701	0.314935	7.448205	0.0000
D(IMP)	0.376032	0.106784	3.521437	0.0012
D(EXP)	-0.494034	0.114257	-4.323873	0.0001
AR(1)	0.603735	0.140500	4.297061	0.0001
R-squared	0.999058	Mean dependent var		271.3021
Adjusted R-squared	0.998953	S.D. dependent var		112.8430
S.E. of regression	3.650909	Akaike info criterion		5.541679
Sum squared resid	479.8489	Schwarz criterion		5.750651
Log likelihood	-108.6044	Durbin-Watson stat		1.961059

Equation 11: Industrial real Valued Added: Mexico 1962-2002
Dependent Variable: QI
Method: Least Squares. Sample(adjusted): 1962 2002

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QI(-1)	1.008100	0.009128	110.4385	0.0000
D(IMP)	0.268025	0.033627	7.970533	0.0000
D(EXP)	0.013890	0.060500	0.229590	0.8197
AR(1)	0.458028	0.151695	3.019410	0.0046
R-squared	0.996304	Mean dependent var		62.92236
Adjusted R-squared	0.996004	S.D. dependent var		29.88335
S.E. of regression	1.889032	Akaike info criterion		4.202474
Sum squared resid	132.0323	Schwarz criterion		4.369651
Log likelihood	-82.15071	Durbin-Watson stat		2.221563

These equations show very clearly that there has been a positive impact of foreign trade on industrial development on non-agrarian value-added in Mexico during the last decades of the 20th century. We should notice that although some imports are substitutive of domestic production many other goods and services imported are complementary inputs to favour the development of some industries and non-industrial real value-added.

Total effect of foreign trade in the Model of Mexico: The effect of an increase of 100 dollars in imports and exports on industrial real valued-added amount to 28 dollars, and the effect on non-industrial real value-added is equal to: 63+37-49=51 (being 63 the result to multiply 27, the effect of an increase of 100 dollars in Imports in equation 11, by the coefficient of industry in equation 10, which has an estimated value of 2.3457). The total effect on real Gdp is of 79 dollars.

Some interesting suggestions to foster industrial development per inhabitant in Mexico are presented in Guisan, Exposito and Malacon(2002) and other studies there cited, among others. It is important to develop industrial policies addressed not only to foreign markets but also to the domestic market.

3. European Union

3.1. Pool of 14 European countries belonging to EU15.

The countries included in the pool are: Austria, Belgium, Denmark, France, Finland, Germany, Greece, Netherlands, Ireland, Italy, Portugal, Spain, Sweden and the United Kingdom, as to say all the countries which belonged to the European Union previously to the 2004 Enlargement, but Luxembourg which has been excluded due to the particular features of this small country. The period of estimation for the pool is 1993-2003. Data are expressed in billion dollars at 2000 prices and exchange rates).

In the case of Luxembourg the development of non industrial sectors is very high due to institutional location of public and financial activities and other services addressed to the European market.

The variables included in the equations are:

EXP = Exports of goods and services
IMP = Imports of goods and services
QI = real value-added of industrial sectors
QNI = real value-added of non-industrial sectors.

In graph 6 we may notice that Germany, the country of this sample with the highest levels of QIH (industrial real value-added per inhabitant), show relatively low values of QNIH (non-industrial real value-added per inhabitant) in comparison with the other EU countries. One explanation might be that some industries in Germany have a low degree of outsourcing what implies that activities related with services developed internally in the industry account for value-added in the sector and not in the Services sector. It is convenient to analyze the causes of this difference in a future study.

Graph 6. Industrial and non-industrial real Value-Added in 14 EU countries, 1992-2003 (thousand dollares per inhabitant at 2000 prices)

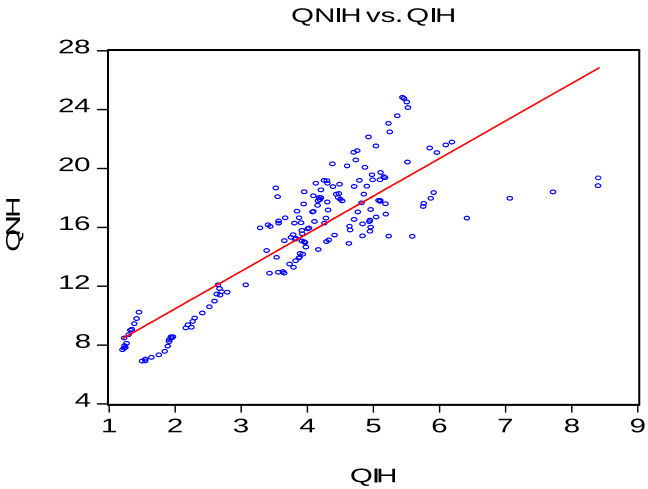


Table 3 shows the correlation coefficients between the following variables QNI, QI, IMP and EXP expressed in per capita terms.

Table 3. Correlation coefficients in the EU pool, 1992-2003

	QNIH	QIH	IMPH	EXPH
QNIH	1	0.8473	0.5702	0.6006
QIH	0.8473	1	0.6613	0.7172
IMPH	0.5702	0.6613	1	0.9872
EXPH	0.6006	0.7172	0.9872	1

We may notice a high degree of correlation between EXPH and IMPH, because the import capacity of a country is highly related with its capacity to export. Both Imports and exports show a high correlation coefficient with industrial development, because usually the higher the industrial development the higher the export capacity and the import capacity for a given country, as seen in Guisan and Cancelo(2002) and other studies. There is also a high degree of correlation between industrial and non-industrial real value-added.

The following equations show the positive effect of industry and foreign trade on the economic growth of European Union countries.

Equation 10: Non Industrial real value-added: Pool of 14 EU countries
Dependent Variable: QNI. Method: Pooled Least Squares
Sample: 1993 2003. Number of cross-sections used: 14
Total panel (unbalanced) observations: 139
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QNI(-1)	1.014516	0.005360	189.2675	0.0000
D(QI)	0.313947	0.200799	1.563485	0.1203
D(IMP)	0.098486	0.085851	1.147168	0.2534
D(EXP)	0.194078	0.094472	2.054354	0.0419
AR(1)	0.793069	0.109746	7.226403	0.0000

R-squared	0.999904	Mean dependent var	429.5053
Adjusted R-squared	0.999900	S.D. dependent var	438.6475
S.E. of regression	4.381806	Sum squared resid	2553.630
F-statistic	276561.9	Durbin-Watson stat	1.796531
Prob(F-statistic)	0.000000		

Note: this estimation was performed including a multiplicative variable given by the product of a dummy for Germany and D(QI00), which showed a significant negative value, indicating that the coefficient of D(QI00) in this equation is lower for this country.

Equation 11. Industrial real value-added: Pool of 14 EU countries
Dependent Variable: QI. Method: Pooled Least Squares
Sample: 1993 2003. Number of cross-sections used: 14
Total panel (balanced) observations: 154
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QI(-1)	0.984177	0.005973	164.7631	0.0000
D(IMP)	0.144268	0.053068	2.718561	0.0073
D(EXP)	0.215275	0.058765	3.663351	0.0003

R-squared	0.999351	Mean dependent var	109.4590
Adjusted R-squared	0.999343	S.D. dependent var	120.0573
S.E. of regression	3.077586	Sum squared resid	1430.202
F-statistic	116341.9	Durbin-Watson stat	1.681837
Prob(F-statistic)	0.000000		

The coefficients of foreign trade are positive in both equations In equation 10 ser find that the coefficients of imports and industry do not show a significant value and that there is autocorrelation, which may be due to the effect os some missing explanatory variables or to other problems related with the specification of the equations. In any case there is not evidence against the positive effect of QI on QNI.

We have a case of uncertainty with some degree of evidence in favor of a positive effect. The estimated effect of Imports on equation 10 shows a value almost null, which seems too much low to be realistic, and we think that the equation should be re-estimated with a larger sample, both in the pool and at country level, because in several EU countries the effect of Imports on non-industrial production is clearly positive.

Total effect of foreign trade on real Gdp in the pool of 14 EU countries: A increase of 100 dollars in Imports and Exports imply a direct effect of 36 dollars in industry and 29 dollars in non-industrial sectors, beside there is an indirect effect of 11 dollars on non-industrial sectors due to the increase of industry. The estimated total effect is of 76 dollars.

3.2. Estimation for Spain, 1971-2003

Here we estimate at country equations 10 and 11 to analyze the evolution of Spain for a larger period, 1971-2003.

Equation 10: Non industrial real value-added: Spain 1971-2003
Dependent Variable: QNI
Method: Least Squares. Sample(adjusted): 1971 2003

Variable	Coefficient	Std. Error	t-Statistic	Prob.
QNI(-1)	1.017076	0.003046	333.9145	0.0000
D(QI)	1.196024	0.288758	4.141964	0.0003
D(IMP)	0.556936	0.151986	3.664384	0.0010
D(EXP)	-0.318525	0.154720	-2.058726	0.0486
R-squared	0.998908	Mean dependent var		320.6777
Adjusted R-squared	0.998795	S.D. dependent var		85.45182
S.E. of regression	2.965945	Akaike info criterion		5.125481
Sum squared resid	255.1080	Schwarz criterion		5.306876
Log likelihood	-80.57043	Durbin-Watson stat		1.965793

Equation 11. Industrial real value-added: Spain 1971-2003
Dependent Variable: QI
Method: Least Squares. Sample(adjusted): 1972 2003

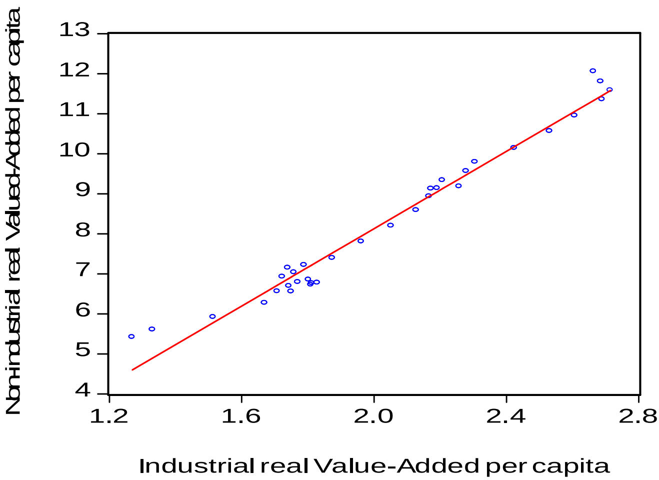
Variable	Coefficient	Std. Error	t-Statistic	Prob.
QI(-1)	0.999421	0.010798	92.55668	0.0000
D(IMP)	0.303752	0.080501	3.773289	0.0008
D(EXP)	0.001881	0.100734	0.018671	0.9852
AR(1)	0.537993	0.167181	3.218027	0.0033
R-squared	0.992322	Mean dependent var		80.21702
Adjusted R-squared	0.991499	S.D. dependent var		17.63657
S.E. of regression	1.626071	Akaike info criterion		3.926679
Sum squared resid	74.03498	Schwarz criterion		4.109896
Log likelihood	-58.82686	Durbin-Watson stat		1.980129

Equation 10 presents interesting results accordingly to the expected signs and significance of coefficients, and with a high positive estimated effect of industry on non-industrial production. Equation 11 shows a positive impact of imports on industrial production and almost null direct effect of exports on industrial production. This feature of the Spanish economy suggest that industrial production depends more on factors related with supply side (here represented by imports) than on demand side (here represented by exports), although both variables are necessary to improve economic development because the capacity of the country to import must be mainly based on expanding its capacity to export.

Total effect of foreign trade on real Gdp of Spain: An increase of 100 dollars in Imports and Exports imply a direct effect increase of 30.4 dollars on QI in equation 11, a direct effect of 24.4 dollars on QNI in equation 10 and an indirect effect of the increase of QI on QNI, given by the product of 30.4 and the coefficient of D(QI) in equation 10 (1.1960) which amount to 36.4. The total effect is 91.2

Graph 7 shows the positive relation between of non-industrial real value-added per inhabitant and industrial development. The real value-added of industry in Spain should be increased in order to reach both a direct effect on non-industrial real value-added and an indirect effect fostering exports and the capacity to import.

Graph 7. Industrial and non-industrial value-added: Spain 1970-2003 (thousand dollars per inhabitant at 2000 prices and exhange rates)



3.3. Model of 5 Central European Countries (CC5): Poland, Hungary, Czech Republic, Slovakia and Slovenia.

Graph 8 shows the evolution of real Gdp per inhabitant in CC5 countries in comparison with Austria, Ireland and Spain.

Graph 8. Real Gdp per inhabitant in 5 Central (CC5) and 3 Western countries, 1950-2002 (thousand US dollars at 1990 prices and PPPs)

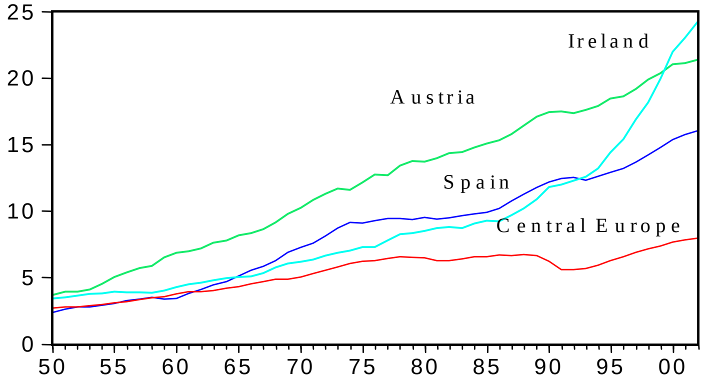


Table 3 presents the evolution of real Gdp per inhabitant for the period 1950-2000.

Table 3. Real GDP per inhabitant in Central Europe, Western Europe and the USA (thousand dollars at 1990 prices and PPPs)

Country	1950	1960	1970	1980	1990	2000
Czech R.	3.561	5.199	6.585	8.137	8.689	8.837
Hungary	2.480	3.649	5.028	6.307	6.471	7.131
Poland	2.447	3.218	4.428	5.740	5.115	7.228
Slovakia	3.347	4.887	6.190	7.649	8.168	8.736
Slovenia	2.410	3.742	5.700	9.158	8.848	10.456
CC5 countries	2.723	3.781	5.064	6.476	6.226	7.679
Spain	2.397	3.437	7.291	9.524	12.210	15.367
Austria	3.706	6.864	10.246	13.746	17.459	21.030
Ireland	3.446	4.279	6.200	8.541	11.825	21.981
Western Europe	4.594	6.930	10.297	13.226	15.988	18.910
USA	9.597	11.328	15.030	18.575	23.221	29.403

Source: Maddison(2001) and own elaboration.

Equations 10 and 11, for the variables in dollars per inhabitant, estimated by Guisan, Aguayo and Carballas(2004) show a positive effect of industrial real value added and imports on non industrial production and also the positive effect of imports on industrial production.

Equation 10: Non-industrial real value-added per inhabitant: Pool of CC5

Dependent Variable: QNIH				
Method: Pooled Least Squares. Sample: 1991 2002				
Included observations: 12. Number of cross-setion 5. Total panel 60				
White Heteroskedasticity-Consistent Standard Errors&Covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
QIH	1.210453	0.374636	3.231007	0.0021
IMPH	0.134133	0.057350	2.338863	0.0231
Fixed Effects				
PL--C	1386.112	HU--C	1803.568	
CZ--C	1018.652	SK--C	1146.928	
SI—C	2081.220			
R-squared	0.908232	Mean dependent var		3577.002
Adjusted R-squared	0.897843	S.D. dependent var		1041.665
S.E. of regression	332.9372	Sum squared resid		5874901.
Log likelihood	-429.8920	F-statistic		87.42361
Durbin-Watson stat	0.306032	Prob(F-statistic)		0.000000

Source: Guisan and Aguayo(2004). The model includes fixed effects for Poland (Pl), Hungary (Hu), Czech Republic (Cz), Slovaquia (Sk) and Slovenia (Si)

Equation 11. Industrial real valued added per inhabitant: pool CC5

Dependent Variable: QIH				
Method: Least Squares. Sample 1992-2002. 5 countries.				
Included observations: 55				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
QIH(-1)	0.995254	0.009390	105.9958	0.0000
D(IMPH)	0.167857	0.037223	4.509442	0.0000
R-squared	0.966309	Mean dependent var		1.409597
Adjusted R-squared	0.965673	S.D. dependent var		0.450651
S.E. of regression	0.083494	Akaike info criterion		-2.092394
Sum squared resid	0.369478	Schwarz criterion		-2.019400
Log likelihood	59.54084	Durbin-Watson stat		2.382319

Source: Guisan and Aguayo (2004).

The estimations did not show a significant effect of exports, beyond its important and necessary role to increase the capacity to finance imports.

Total effect of foreign trade on real Gdp per inhabitant in the pool of five Central European Countries (CC5): The estimated direct effect of an increase of 100 dollars in Imports and Exports per inhabitant is 16.8 on QIH and 13.4 on QNIH. Besides there is an indirect effect that the increase in QIH has on QNIH (16.8 multiplied by 1.21) which amounts to 20.3. The total effect has been 50.5.

The low levels of industrial development and the lack of enough freedom of trade seem to be the main causes explaining the relatively slow development of CC5 countries during the period 1950-1990, in comparison with Austria, Ireland, Spain and other countries with better industrial and foreign trade policies.

4. Conclusions

The models here estimated show the great importance of inter-sector relationships at macroeconomic level, and the positive role that industrial development and imports usually have to improve economic development. We have found a positive coefficient for industrial real value-added in the equation of non-industrial real value-added with an estimated value close to 1 in several cases (for example 0.75 for the United States and 1.19 for Spain) which implies a very positive effect of industry on other production sectors.

Regarding the role of foreign trade we have found a positive impact of Imports and Exports on industrial and non-industrial real value-added, with the following estimated effects of an increase of 100 dollars in Imports and Exports on real Gross Domestic Product: 50 dollars in CC5 countries, 62 in Canada 79 in Mexico, 76 in the pool of 14 European Union countries, 86 in the pool of 3 NAFTA countries, 91 in Spain and 140 in the USA. All these values are estimated in dollars at 2000 prices but in the case of the USA where they are expressed at 1990 prices.

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Annex at the journal website

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Annex: Data for section 2.2: Model of the United States 1965-2001.

Table A1. Variables of the demand model in United States, 1964-2001.

year	cp	rfi	gfci	sur	gdp	z1	z2	g	sal
1965	1664	1772	537	768	2789	250	500	574	-10
1970	2021	2214	554	627	3224	245	629	686	-45
1975	2335	2569	558	693	3587	355	680	691	28
1980	2715	2898	720	757	4205	271	823	753	34
1985	3176	3474	902	986	4793	546	880	871	-172
1990	3648	4166	943	1169	5490	852	1007	979	-80
1995	4135	4636	1242	1354	6190	948	1147	965	-111
1996	4266	4734	1344	1432	6413	956	1202	972	-125
1997	4418	4868	1502	1490	6700	946	1288	985	-152
1998	4630	5131	1665	1552	6989	969	1274	1000	-266
1999	4859	5265	1780	1603	7278	911	1321	1031	-372
2000	5070	5503	1880	1655	7553	924	1319	1062	-458
2001	5195	5608	1714	1664	7573	1000	1301	1103	-474

Source: Elaboration from OCDE. National Accounts Statistics. Billion $ of 1990.

Table A2. Manufacturing and Non-Manufacturing Value-added and Foreign Trade

obs	qm	qnm	imp	exp	qmh	qnmh	imph	exph	pop
1965	551	2238	147	137	2837	11518	754	704	194.3
1970	610	2614	232	186	2975	12749	1130	909	205.0
1975	671	2916	235	263	3107	13500	1089	1217	215.9
1980	815	3391	323	358	3576	14888	1419	1571	227.7
1985	898	3895	509	337	3768	16333	2135	1412	238.4
1990	1032	4458	629	548	4130	17836	2515	2194	249.9
1995	1237	4953	902	792	4644	18597	3388	2972	266.3
1996	1267	5146	1013	888	4702	19098	3759	3296	269.4
1997	1335	5364	1154	1002	4897	19672	4230	3673	272.6
1998	1390	5599	1288	1023	5040	20293	4667	3708	275.8
1999	1457	5821	1435	1058	5222	20859	5144	3790	279.0
2000	1526	6027	1624	1160	5410	21364	5757	4113	282.1
2001	1435	6138	1580	1098	5037	21550	5548	3856	284.8

Notes: Data elaborated from OECD National Accounts Statistics, expressed in billion dollars at 1990 for the variables cp, rfi, gfci, sur, gdp, z1, z1, g, sal, qm, qnm, imp and exp. Data in dollars of 1990 per inhabitant for manufacturing, non-manufacturing,imports and exports: qmh qnmh, imph, exph, and data of population in million people. The model has been estimated with annual data for the period 1965-2001.

Forecasting capacity of the two models for the USA: 1999-2001

Table A3 presents the static and dynamic forecasts of QNM in supply model, and of real GDP both in supply and demand models, with the model estimated by Guisan and Exposito(2001) and (2006) with the sample of the United Statis for 1965-1998, with estimation by least squares for the supply model and by TSLS (Two Stage Least Squares) for the demand model. The QNM forecast with the dynamic model in 1999 is very good with a forecasting error of only 0.1%. The error for GDP in the dynamic model is also only 0.1% in the supply model and 0.3% in the demand model.

Both models present good forecasts, because supply and demand have evolved closely related one to each other, but the results support the view of a higher impact from the supply side of relation (9b). Usually economic policies may easily foster demand when there are not supply restrictions, but the opposite is usually more difficult, particularly in countries with restrictions to expand domestic supply and/or a very limited capacity to import and this also happens in developed countries. The Root of Mean Square Error of forecasts was 0.67% in supply model and 1.77% in demand model. This measure also supports the supply model.

Table A3. Static and Dynamic forecasts post-sample

Variable	Forecast	1999	2000	2001
QNM	Actual value	5821	6027	6138
	Supply side Static	5844	6087	6044
	Supply side Dynamic	5844	6110	6128
GDP	Actual value	7278	7553	7573
	Supply side Static	7301	7613	7479
	Supply side Dynamic	7301	7636	7563
	Demand side Static	7166	7490	7749
	Demand side Dynamic	7166	7355	7547

Source: Guisan and Exposito (2006). Note: Billion dollars at 1990 prices.

Estimation of the equation of Private Consumption in the United States

Although the mixed dynamic model usually lead to better results than the estimation of models in levels or firs difference, in the equation for CP in the USA in the period 1965-2001 the mixed dynamic model showed underestimation of the coefficient of D(RFI). For this reason it has been preferable to choose another specification of the dynamic relationship of Private Consumption (CP) with Real Family Income (RFI). In section 2.1 we have presented the equation in first differences and in this annex we also include the estimation of the Consumption equation in levels.

Private Consumption in levels with AR(1), USA

Dependent Variable: CP				
Method: Least Squares. Sample(adjusted): 1965 2001				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	66.58551	103.8568	0.641128	0.5257
RFI	0.893733	0.026908	33.21436	0.0000
AR(1)	0.712762	0.130822	5.448330	0.0000
R-squared	0.997089	Mean dependent var		3119.465
Adjusted R-squared	0.996918	S.D. dependent var		991.2846
S.E. of regression	55.03163	Akaike info criterion		10.93130
Sum squared resid	102968.3	Schwarz criterion		11.06191
Log likelihood	-199.2290	F-statistic		5823.424
Durbin-Watson stat	1.783307	Prob(F-statistic)		0.000000

The comparison of this equation with the model in first differences of section 2.2 shows that both equations provide a good estimation. The Adjusted R-squared values must be compared with reference to the same variable in both models (CP for example in both cases). We have calculated The R-squared for CP in the model in first differences, by means of 1-SSE(CP)/SST(CP), which resulted equal to 0.996825 and thus slightly higher to the valued of this statistic for the equation in levels. They are very alike because the Sum of Squares of Residuals (SSE) is very similar and the SST (sum of squares of the deviation of CP to its mean) is the same in both cases.

We may prefer equation in first differences, in this case, because the adjusted R-squared of CP is higher, the Akaike and Schwarz criterion are very alike to the equation in levels, and besides the equation in first differences does not present the problem of autocorrelation.

The following tables show an underestimation of the coefficient of RFI in the mixed dynamic model for this sample.

Equation for CP in the USA: mixed dynamic models. LS estimation
Dependent Variable: CP
Method: Least Squares. Sample: 1965 2001

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RFI)	0.326922	0.107419	3.043430	0.0044
CP(-1)	1.021009	0.004274	238.8964	0.0000
R-squared	0.998229	Mean dependent var		3145.743
Adjusted R-squared	0.998179	S.D. dependent var		1003.113
S.E. of regression	42.81008	Akaike info criterion		10.40396
Sum squared resid	64144.59	Schwarz criterion		10.49104
Log likelihood	-190.4733	Durbin-Watson stat		1.203174

Equation for CP in the USA: mixed dynamic models. GLS estimation
Dependent Variable: CP
Method: Least Squares. Sample(adjusted): 1966 2001

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RFI)	0.254876	0.087952	2.897911	0.0066
CP(-1)	1.022897	0.004510	226.7963	0.0000
AR(1)	0.423785	0.161193	2.629053	0.0129
R-squared	0.998454	Mean dependent var		3186.897
Adjusted R-squared	0.998360	S.D. dependent var		985.1552
S.E. of regression	39.89200	Akaike info criterion		10.28988
Sum squared resid	52515.27	Schwarz criterion		10.42184
Log likelihood	-182.2179	Durbin-Watson stat		1.703899

The presence of autocorrelation is probably due to a problem of specification (missing variables or other problems). In this case the equation selected in section 2.2 seems to be preferable.