University of Santiago de Compostela. Faculty of Economics. Econometrics*
Working Paper Series Economic Development. nº 63

Causality Tests, Interdependence and Model Selection: Application to OECD countries 1960-97

By M.Carmen GUISAN, eccgs@usc.es
University of Santiago de Compostela, Spain

Published 2003
www.usc.es/economet/eaa.htm

Abstract
This paper compares several methodologies for analysing unidirectional and bi-directional causality between Consumption and GDP in 25 OECD countries during the period 1960-95. For analysing unilateral causality a comparison is made between cointegration tests and joint regression on alternative explanatory variables, with 100% of correct results in the case of joint regression and lower percentages of success for cointegration approach. Bilateral causality is analysed comparing Granger´s test, a modified version of Granger´s test here suggested, TSLS, Hausman´s causality test and other approaches. The main conclusion is that the modified version of Granger´s test performs rather well and that Hausman´s test is very often useful for reinforcing the conclusions of multiple equations models with contemporaneous interdependence. Regarding the bilateral relationship between Consumption and GDP we conclude that there is a moderate degree of contemporaneous relation, with a high degree of dependence of Private Consumption on GDP and a lower dependence in the case of the reverse relation, because GDP is more dependent on supply side conditions than on demand side. This result is relevant for economic policies in less developed countries where very often emphasis is made more in the reverse relations than in the main ones.

JEL classification: C5, C52, E2, O57

1.- Introduction

In previous studies, such as Guisan(2001a) and Guisan(2002), the analysis of cointegration relationship between real Private Consumption and GDP in 25 OECD countries was performed, with results that show a low degree of success of cointegration tests for distinguishing causal regressions from spurious ones, due to several limitations of that approach.

For comparing those results with the regression approach for analysing unidirectional causality, section 2 presents the results that we can get with the same data by means of a joint regression approach, where the explained variable is related with two alternative variables, being one of them a causal explanatory variable and the other a spurious one. In the 100% of the cases the conclusions show that the own GDP is the causal explanatory variable and that the spurious variables have not effect or very low effect, and thus the method is very adequate for distinguish between casual and spurious relations.

* In colaboration with the Euro-American Association of Economic Development Studies

In section 3 we analyse bilateral direction of causality with Granger´s non contemporaneous causality test and a modified version of contemporaneous causality for this test here presented, and in section 4 bilateral direction is analysed following the Cowles Commission approach of TSLS and reinforcing its results with Hausman´s test of causality.

Finally in section 5 we present the main conclusions, which show that the type of bilateral direction of causality between Private Consumption and GDP may be in some cases of variable direction, following the approach of disequilibrium models analysed in Guisan(2001b), but that the main direction of causality is from GDP to Consumption.

GDP is usually the main explanatory variable for explaining Private Consumption, and so we can say that Consumption follows GDP. On the other side the growth of GDP depends on many other factors, mainly from the supply side, and Consumption is only one of the factors than contributes to the explanation of GDP by demand side. So there is a variable degree of contemporaneous interdependence among both variable, being the main direction of causality from GDP to Consumption.

2.- Unidirectional causality and regression analysis between Consumption and GDP

The empirical evidence shows that very often the analysis of regression, well in levels of by means of a mixed dynamic model, performs better than cointegration anaylisis for detecting unidirectional causality, so in the cases of the data used in Guisan(2002) for Private Consumption and Gdp in 25 OECD for the period 1960-95, we could find the following conclusions:

1) Linear correlation of C90i and GDP90i was higher than the linear correlation of C90i with GDP90j in all the cases but Luxembourg, with little difference between own correlation and foreign countries correlation.

2) In the regression of C90i as function of GDP90i and GDP90j the parameter of the own production resulted highly significant, both by LS and by GLS in cases of autocorrelation, while the parameter of foreign production resulted no significantly positive.

3) The null hypothesis for the foreign parameter usually was accepted. In 10 cases appeared a small and significant effect of foreign production with LS but this effect vanished in 7 out of the 10 regressions when the estimation by GLS was performed in order to have into account the autocorrelation.

4) In two cases, Norway with Iceland, and Norway with Canada, the estimated coefficient with own production was higher than with foreign production, although in both cases the statistic t was higher for the own estimated coefficient, in LS, but in both cases the foreign coefficient lost significance in the GLS estimation while the coeffecient of the own production was positive and highly significant in GLS having into account autocorrelation.

5) In one case, Switzerland with Sweden, both the estimated coefficient with foregin GDP and the t statistic resulted higher than the corresponding ones to own GDP, in the LS estimation. This anomalous result also disappeared with GLS estimation having into account

autocorrelation, and the coefficient of foreign GDP was not signicantly different from zero while the own coefficient was positive and highly significant.

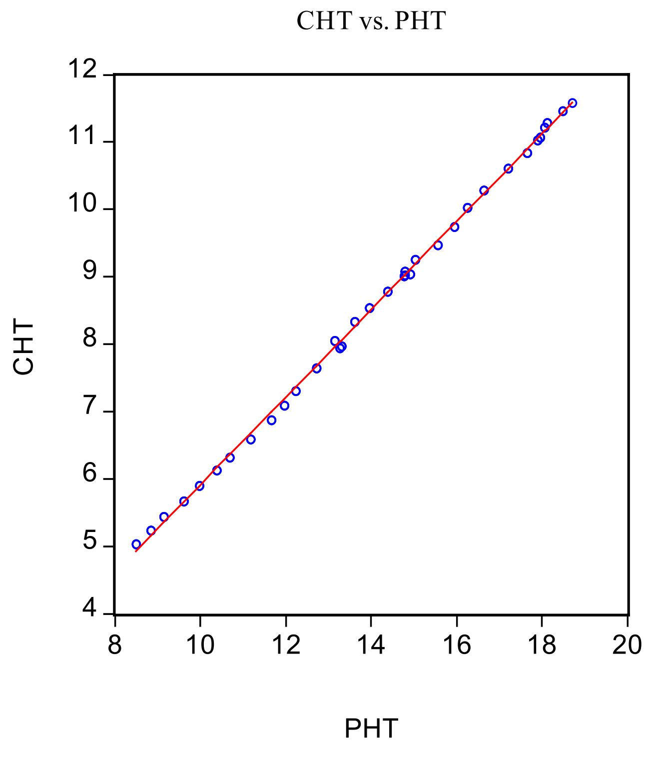
6) The results where very similar with a mixed dynamic model, where C90i, explaining this variable as a funcion of its own lagged value and the first differences of GDP90i and GDP90j. The results where favourable to the important positive impact of own GDP and the generally null effect of foreign GDP.

In comparison with the high degree of uncertainly and wrong conclusions of cointegration analysis for the analysis of causality between Consumption and GDP that we have shown in Guisan(2002), we can conclude that the supposed superiority of cointegration in comparison with regression should be questioned, and that the approach followed in this section with joint regression of the explained variable on the two rivals candidates to explanatory variables, usually functions adequately, both in levels or in the context of a mixed dynamic models.

Mixed dynamic models, on the other hand, perform usually better than first differences models, because it the latter is a particular case of the former for the case when the coefficient of the lagged variable is exactly equal to one.

In real world it happens very often that the coefficient of the lagged endogenous variable is statistically different of one, and in those cases mixed dynamic model usually is a better choice than the specification in first diffeences.

Graph 1 shows the high degree of linear correlation between Private Consumption by inhabitant, CHT, and GDP by inhabitant, PHT, in the group of 25 OECD countries during the period 1961-95.

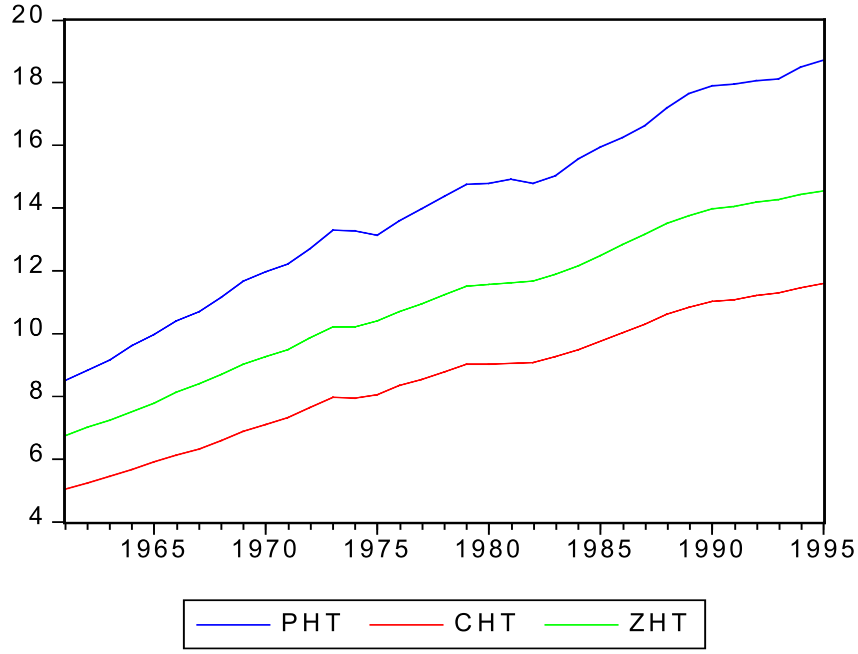


When we compare the evolution of both variables in each country we find small differences in the estimation of the parameter corresponding to production by inhabitant, PH. This difference is partly due to the different share of saving in family income but mainly it is due to the differences in public policies related with public consumption.

So in countries where there is a high degree of public expenditure on individual consumption of goods and services of Health and/or Education, there is usually a lower level of private consumption on those groups in comparison with countries of similar level of GDP by inhabitant, as we can see in Guisan and Arranz(2001).

Graph 2 present the evolution, in real terms at 1990 prices and exchange rates of Private Consumption by inhabitant, CH, total individual Consumption by inhabitant, ZH, including both private and public, and GDP by inhabitant, PH, in OECD countries.

Graph 2. Private Consumption, Individual Consumption and GDPH..
(thousands of dollars by inhabitant at 1990 prices and exchange rates)



It is really impressive to see the important increase in these three variables in OECD countries during the period 1961-95. The high level of production by inhabitant and consumption by inhabitant reached by this countries is not only due to increases in productivity by worker by mainly to the moderation in fertility rates, because the rate of growth of total GDP in OECD countries was not higher than world average, and many less developed countries have experienced similar, or even higher, rates of growth of production.

The main difference between the majority of OECD countries and world average has been the moderation in demographic growth, as we can deduced from the international comparisons made by Maddison(2001) and Guisan, Aguayo and Exposito(2001).

From those studies we can conclude that during the 20th century the average yearly rate of exponential growth of real GDP in Western Europe was 2.40%, while in the USA and Canada was 3.14% and world average was 2.97%. So the higher rates of growth of real GDP by inhabitant of these countries in comparison with world average, approximately 1.93% both in Western Europe, the USA and Canada, while world average was 1.56%, are due to the lower rates of demographic growth in the majority of OECD countries, with an exponential rate of yearly growth of population of 0.47% in Western Europe and 1.25% in the USA and Canada, both clearly below the world average of 1.40%.

Although we are not analysing here the main factors that influence the evolution of GDP by inhabitant, it is interesting to stand out this important feature of the process of economic development in OECD countries because it is usually ignored in the economic literature. A more detailed analysis of empirical results of time series macroeconometric models of supply and demanda, cross country models and international comparisons is presented in Guisan and Frias(2003).

3. Bilateral relationship with Granger´s causality test and a modified version of Granger´s test.

Here the estimations are performed with data expressed in purchasing power parities of 1990, PPPs, and per capita terms, and so we analyse the relation of Private Consumption by inhabitant en Gdp by inhabitant, with both variables measured in thousands of dollars at 1990 prices and PPPs.

The individual evolution of ChiPP for each country is presented in the graphs of the Annex, where we can see that although all the countries experienced important increases in this variable there are many differences among them.

1)Individual regressions with Granger´s test of causality

We use the command CAUSE of Micro-TSP version 7.2 of QMS:

CAUSE(2) Chipp Phipp

For i = at, au, ax, b ca, d e, fi f, gr, ho, ic ,ir it j, l, m, no nz, pt se, si tu uk u

This approach tests the joint nullity of the parameters, corresponding to lags of X in relation (1) and to lags of Y in relation (2), in the following VAR model:

(1) LS Y C Y(-1) Y(-2) X(-1) X(-2)

(2) LS X C Y(-1) Y(-2) X(-1) X(-2)

Results: The hypothesis Phi causes Chi, Chi=f(Phi), could be accepted only in 10 out of 25 countries. The reverse hypothesis Chi causes Phi, Phi=f(Chi), could be accepted only in 8 out of 25 countries. The consideration of different numbers of lags did not get to better results.

2) Individual regressions with a modified version of Granger´s test

A first modification to Granger test, maintaining this author´s approach of non contemporaneous relations is the following

(3) LS Chipp Chipp(-2) Phipp(-1) C

(4) LS Phipp Phipp(-2) Chipp(-1) C

Result: The causal relation Chi=f(Phi) is accepted in 23 countries, being the exceptions among 25 countries only Luxembour and Switzerland. The causal relation Phi=f(Chi) was accepted in 14 countries.

This modified version gives better results than the original version of Granger´s test because it avoids the high degree of multicollinearity corresponding to that test, and besides that it does not make redundant the information of the lagged explanatory variable in each equation. In this modified version the lagged value of the explained variable correspond to a delay higher than the lagged value of the explanatory variable.

3) Pooled estimation by LS with modified version of Granger´s test

With a sample of 25 OECD countries during the period 1962-97 the results of the pool estimation by LS lead to accept the bilateral relation between Chi=f(Phi) and Phi=f(Phi), as it can be seen in the following results of equations (3) and (4).

Table 1. Estimation of relation (3) with a pool of 900 observations

Dependent Variable: CH?PP
Method: Pooled Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 900

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.270471	0.028459	9.503885	0.0000
CH?PP(-2)	0.889787	0.015373	57.87975	0.0000
PH?PP(-1)	0.068288	0.008749	7.804894	0.0000

R-squared	0.987327	Mean dependent var	7.303589
Adjusted R-squared	0.987298	S.D. dependent var	2.688606
S.E. of regression	0.303009	Sum squared resid	82.35731
Log likelihood	-200.9473	F-statistic	34940.99
Durbin-Watson stat	0.709188	Prob(F-statistic)	0.000000

Table 2. Estimation of relation (4) with a pool of 900 observations

Dependent Variable: PH?PP
Method: Pooled Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 900

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.350105	0.048302	7.248224	0.0000
PH?PP(-2)	0.977932	0.015208	64.30486	0.0000
CH?PP(-1)	0.065368	0.026303	2.485220	0.0131

R-squared	0.988564	Mean dependent var	12.23753
Adjusted R-squared	0.988539	S.D. dependent var	4.713977
S.E. of regression	0.504669	Sum squared resid	228.4575
Log likelihood	-660.0746	F-statistic	38770.07
Durbin-Watson stat	0.668382	Prob(F-statistic)	0.000000

The results where similar under several approached, fixed effects modelts, correction of heteroskedasticity by White´s estimations of standard deviations, and other shown in the Annex. The presence of autocorrelation makes also interesting the estimation by GLS.

In a future revision of the paper we will present another estimations of the modified version of Granger´s test of causality, and as a provisional conclusion we think that the test has advantages on the original version, because the lags of the explanatory variable are more recent than those of the explained variable and thus the explanatory variable is not redundant.

4.- Bilateral contemporaneous relationship: TSLS and Hausman´s test of causality

For the moment the Hausman´s test of causality was applied to the USA and Mexico, with acceptance of interdependence in both cases, and in a forthcoming revision of this paper the results for the another 23 countries will be reported. Tables 3 to 6 present the results of TSLS estimation and Hausman´s causality test for the USA, while tables 7 to 12 present the results for Mexico.

Table 3

Dependent Variable: PHUPP
Method: Two-Stage Least Squares
Sample(adjusted): 1961 1997
Included observations: 37 after adjusting endpoints
Instrument list: CHUPP(-1) PHUPP(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PHUPP(-1)	0.986857	0.006684	147.6462	0.0000

D(CHUPP)	2.328931	0.485225	4.799690	0.0000
R-squared	0.996142	Mean dependent var		18.59539
Adjusted R-squared	0.996032	S.D. dependent var		3.338300
S.E. of regression	0.210280	Sum squared resid		1.547616
Durbin-Watson stat	1.700638			

Table 4
Dependent Variable: CHUPP
Method: Two-Stage Least Squares
Sample(adjusted): 1961 1997
Included observations: 37 after adjusting endpoints
Instrument list: CHUPP(-1) PHUPP(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CHUPP(-1)	1.008740	0.002711	372.1281	0.0000
D(PHUPP)	0.426130	0.088501	4.814965	0.0000
R-squared	0.998854	Mean dependent var		11.99393
Adjusted R-squared	0.998821	S.D. dependent var		2.658072
S.E. of regression	0.091264	Sum squared resid		0.291518
Durbin-Watson stat	1.675525			

Table 5
Dependent Variable: CHUPP
Method: Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CHUPP(-1)	1.005270	0.001454	691.1818	0.0000
D(PHUPP)	0.289440	0.053849	5.374994	0.0000
D(PHUPPF)	0.266861	0.061433	4.343969	0.0001
R-squared	0.999248	Mean dependent var		12.11943
Adjusted R-squared	0.999203	S.D. dependent var		2.582220
S.E. of regression	0.072910	Akaike info criterion		-2.319538
Sum squared resid	0.175422	Schwarz criterion		-2.187578
Log likelihood	44.75169	Durbin-Watson stat		1.071881

Table 6
Dependent Variable: PHUPP
Method: Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PHUPP(-1)	0.995096	0.001724	577.0895	0.0000
D(CHUPP)	0.688933	0.193453	3.561242	0.0011
D(CHUPPF)	1.017030	0.166877	6.094490	0.0000
R-squared	0.998737	Mean dependent var		18.76594

Adjusted R-squared	0.998660	S.D. dependent var	3.218030
S.E. of regression	0.117780	Akaike info criterion	-1.360340
Sum squared resid	0.457781	Schwarz criterion	-1.228380
Log likelihood	27.48612	Durbin-Watson stat	1.129317

Table 7
Dependent Variable: CHMPP
Method: Two-Stage Least Squares
Sample(adjusted): 1961 1997
Included observations: 37 after adjusting endpoints
Instrument list: PHMPP(-1) CHMPP(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CHMPP(-1)	0.994886	0.003414	291.4003	0.0000
D(PHMPP)	0.775867	0.127368	6.091520	0.0000

R-squared	0.993642	Mean dependent var	3.593790
Adjusted R-squared	0.993460	S.D. dependent var	0.594324
S.E. of regression	0.048064	Sum squared resid	0.080854
Durbin-Watson stat	1.241978		

Table 8
Dependent Variable: PHMPP
Method: Two-Stage Least Squares
Sample(adjusted): 1961 1997
Included observations: 37 after adjusting endpoints
Instrument list: PHMPP(-1) CHMPP(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PHMPP(-1)	1.005167	0.002421	415.1042	0.0000
D(CHMPP)	1.202590	0.196453	6.121506	0.0000

R-squared	0.996207	Mean dependent var	5.140972
Adjusted R-squared	0.996099	S.D. dependent var	0.977275
S.E. of regression	0.061038	Sum squared resid	0.130397
Durbin-Watson stat	1.263467		

Table 9
Dependent Variable: CHMPP
Method: Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CHMPP(-1)	0.995340	0.001995	498.8021	0.0000
D(PHMPP)	0.365891	0.102532	3.568555	0.0011
D(PHMPPF)	0.396998	0.100779	3.939297	0.0004

R-squared	0.995186	Mean dependent var	3.627193

Adjusted R-squared	0.994894	S.D. dependent var	0.566437
S.E. of regression	0.040474	Akaike info criterion	-3.496656
Sum squared resid	0.054059	Schwarz criterion	-3.364696
Log likelihood	65.93981	Durbin-Watson stat	0.601180

Table 10
Dependent Variable: CHMPP
Method: Least Squares
Sample(adjusted): 1963 1997
Included observations: 35 after adjusting endpoints
Convergence achieved after 14 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CHMPP(-1)	0.993001	0.005378	184.6573	0.0000
D(PHMPP)	0.383846	0.057168	6.714370	0.0000
D(PHMPPF)	0.394337	0.056646	6.961432	0.0000
AR(1)	0.737112	0.147299	5.004188	0.0000

R-squared	0.997098	Mean dependent var	3.662183
Adjusted R-squared	0.996817	S.D. dependent var	0.533777
S.E. of regression	0.030115	Akaike info criterion	-4.060406
Sum squared resid	0.028113	Schwarz criterion	-3.882652
Log likelihood	75.05710	Durbin-Watson stat	1.558899
Inverted AR Roots	.74		

Table 11
Dependent Variable: PHMPP
Method: Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PHMPP(-1)	1.004540	0.001770	567.4472	0.0000
D(CHMPP)	0.642882	0.170176	3.777753	0.0006
D(CHMPPF)	0.629233	0.176047	3.574232	0.0011

R-squared	0.996937	Mean dependent var	5.194176
Adjusted R-squared	0.996751	S.D. dependent var	0.935215
S.E. of regression	0.053307	Akaike info criterion	-2.945848
Sum squared resid	0.093774	Schwarz criterion	-2.813888
Log likelihood	56.02526	Durbin-Watson stat	0.677102

Table 12
Dependent Variable: PHMPP
Method: Least Squares
Sample(adjusted): 1963 1997
Included observations: 35 after adjusting endpoints
Convergence achieved after 17 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PHMPP(-1)	1.005242	0.004514	222.6965	0.0000
D(CHMPP)	0.658632	0.104009	6.332433	0.0000
D(CHMPPF)	0.669636	0.109025	6.142041	0.0000
AR(1)	0.711572	0.152533	4.665037	0.0001

R-squared	0.998047	Mean dependent var	5.249238
Adjusted R-squared	0.997858	S.D. dependent var	0.887690
S.E. of regression	0.041080	Akaike info criterion	-3.439392
Sum squared resid	0.052314	Schwarz criterion	-3.261638
Log likelihood	64.18935	Durbin-Watson stat	1.554701

Following Nakamura and Nakamura(1980), the significant values of the parameters corresponding to the reduced form estimations of the endogenous variables (indicated with the letter F of fitted at the end of their names), in the LS estimation of the structural equations is equivalent to accept Hausman´s causality. According to their analysis it is enough to get one of the coefficients significant, together with significance of both coefficients in TSLS estimation for evidence in favour of simultaneity and interdependence. In this cases the results confirm significant of all the relevant coefficients, both in the TSLS estimation and in the Hausman´s test, and so we can conclude that there is evidence in favour of contemporaneous bilateral relation.

Besides the methods here utilized there are another interesting specification tests between different theories and functional forms, as those used in Cancelo, Guisan and Frias, which usually lead to interesting conclusions and which we will applied also to the relationship between real Consumption and GDP in future studies.

5.- Conclusions

Some of the main conclusions from this paper are the following:

1) An adequate regression approach has more success for distinguishing causal relations from spurious ones than cointegration approach, so the emphasis on cointegration should be, in my opinion, diminished and the interest on other more realistic approaches should be fostered. In 100% of cases the adequate regression approaches got a good result while in the case of cointegration tests the results where too much inconclusive with false results in more than 50% of the cases in many options.

2) Granger´s test of causality present many problems of multicollinearity and redundant variables, because the effect of lagged values of explanatory variables with the same delay than the lagged values of the explained variables make the latter redundant in many cases. The causal relation between Consumption by inhabitant and Gross Domestic Product by inhabitant could only be accepted in 10 out of 25 OECD countries.

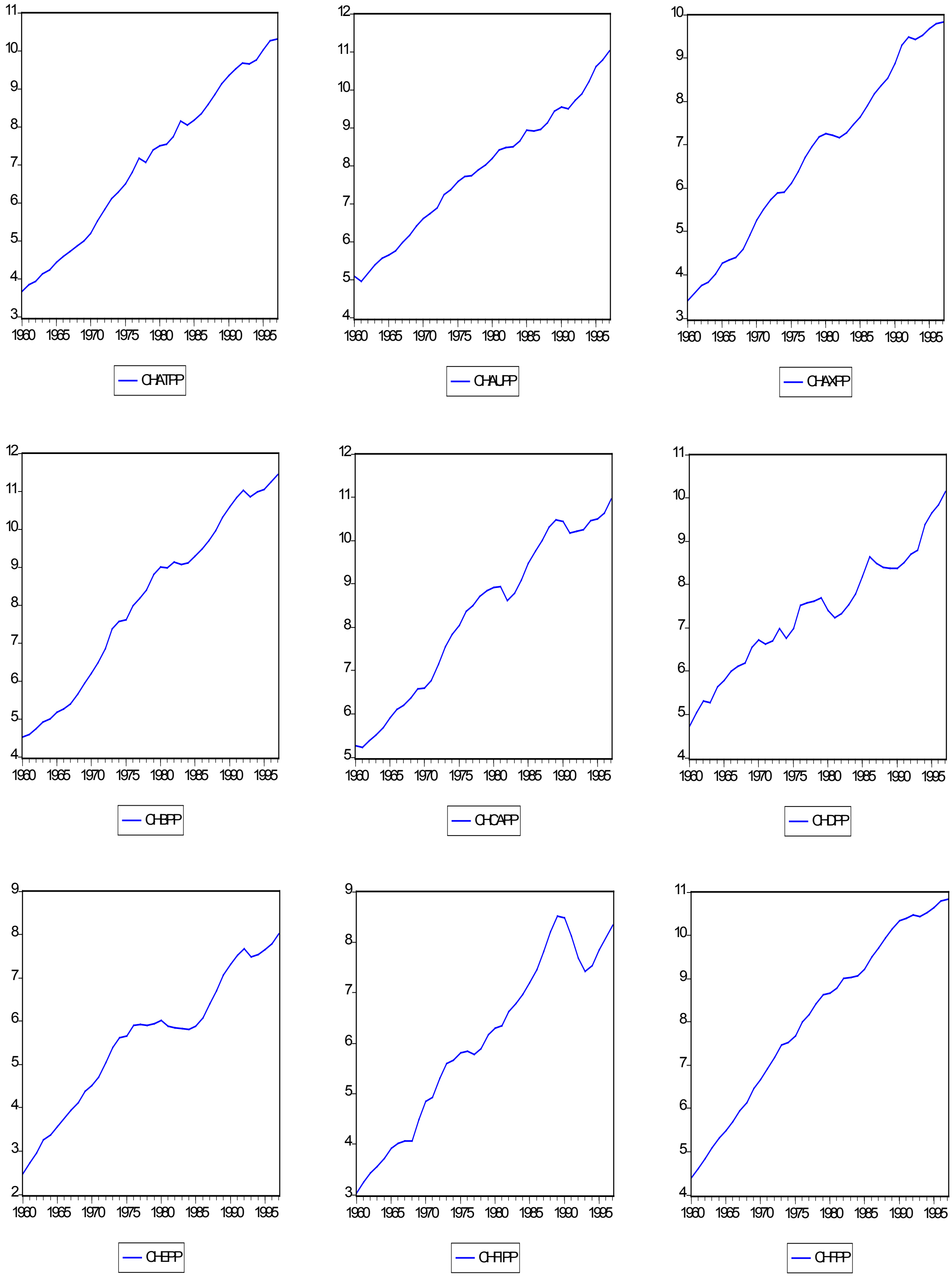
3) Granger´s test have interest, in spite of those unfortunate results, if we consider a modified version where the lagged values of explanatory variables have less delay than the lagged value of the explained variable. The results were much better with this approach, being accepted the causal relation between Consumption by inhabitant and Gross Domestic Product by inhabitant in 23 out of 25 OECD countries.

4) Although the modified version of Granger´s test seems to have very good results, the question is that contemporaneous relation also hold in macroeconomics, and the experience of TSLS and Hausman´s performed with these data and with another macroeconomic relations seems to give very goods results. In this paper we have presented those estimations and tests for the USA and Mexico showing evidence of bilateral contemporaneous relations in both countries between Consumption and GDP.

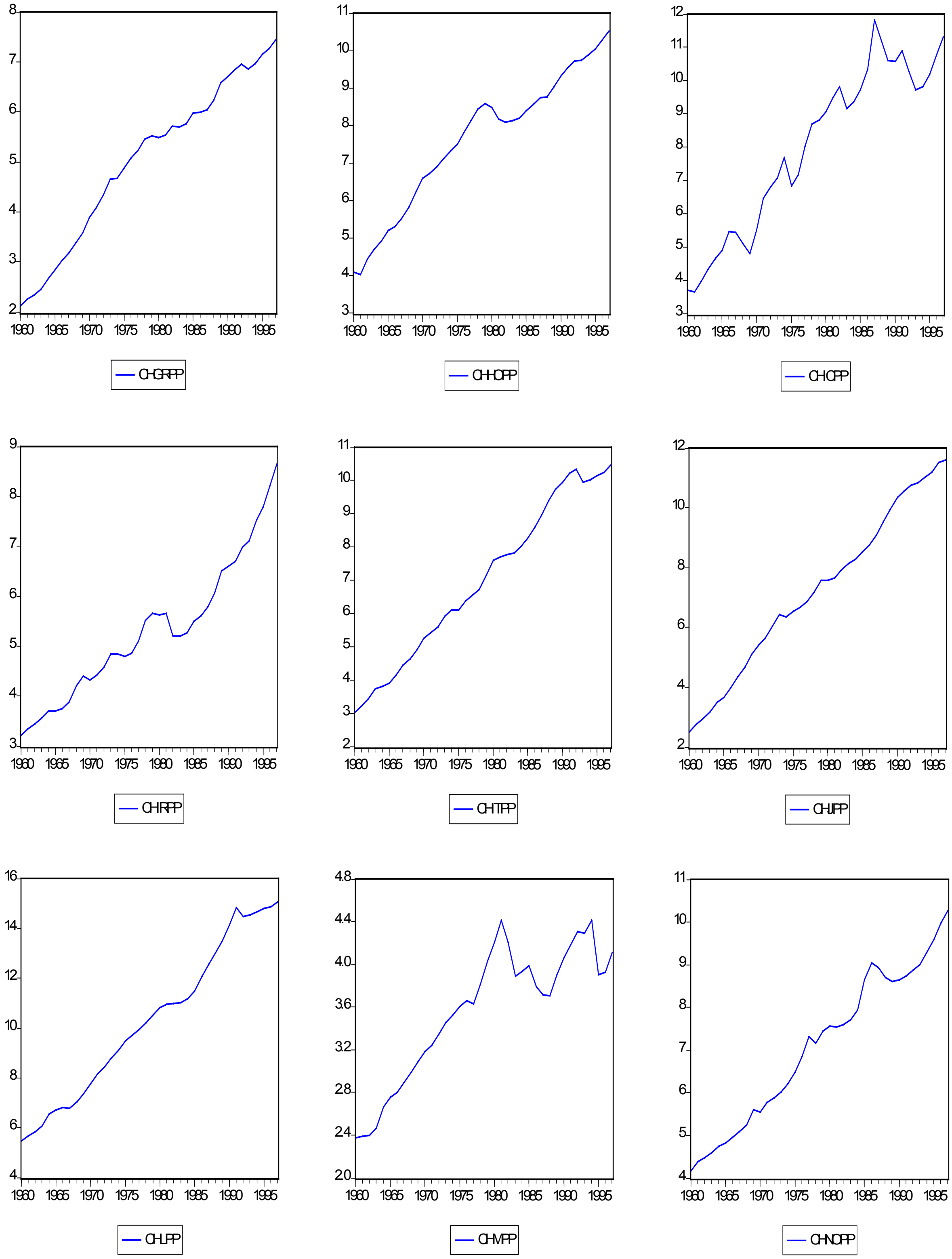
5) We would like to insist upon the empirical evidence that exists in favour of the relation between Consumption and GDP, with usually is very strong, and the the reverse relation, between GDP in Consumption usually is important but not so strong.

ANNEX.

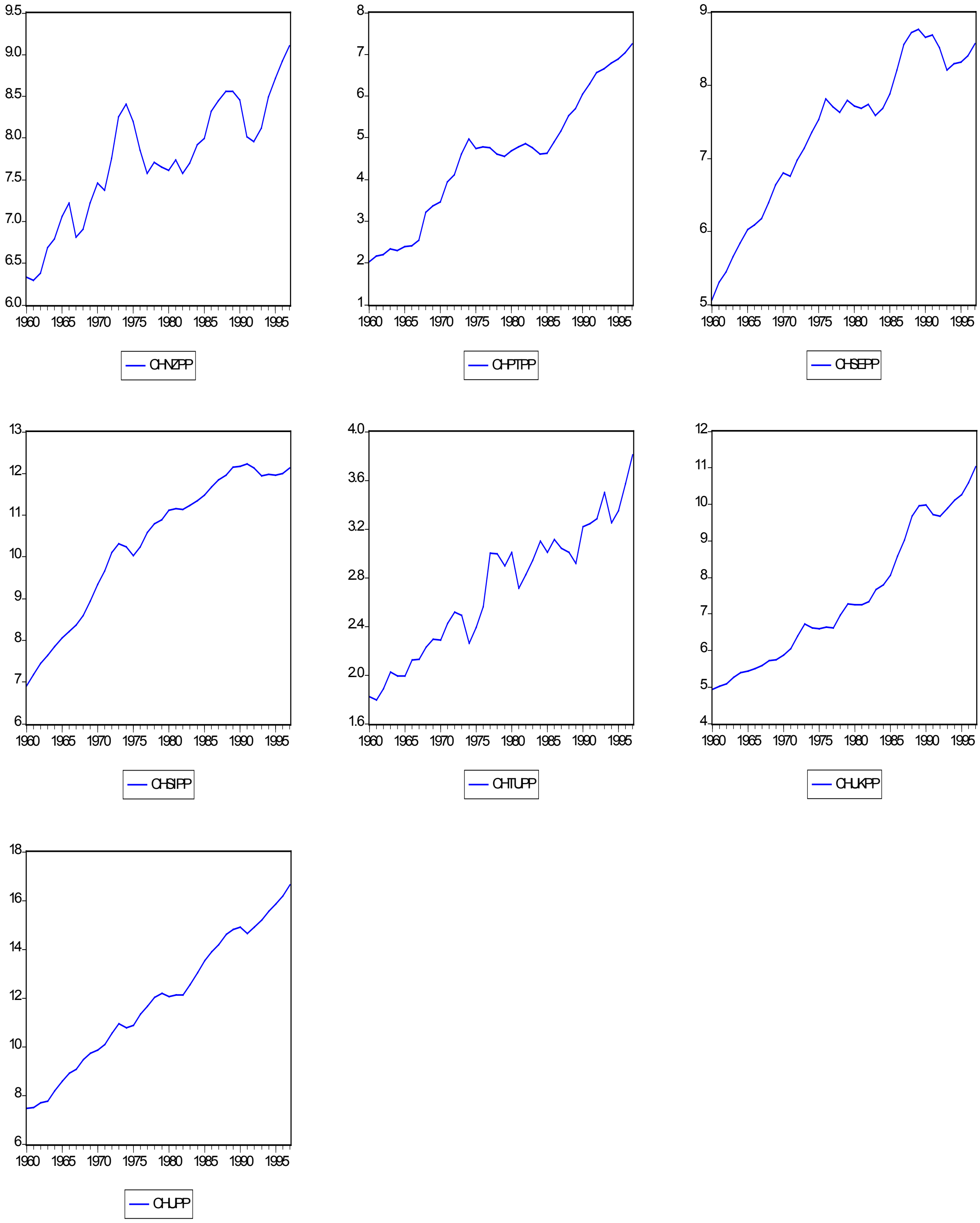
Graph A1. Evolution of Chipp of Austria, Australia, Germany, Belgium, Canada, Denmark, Spain , Finland and France (thousands of dollars by inhabitant at 1990 prices and PPPs)



Graph A2. Evolution of Chipp of Greece, Netherlands, Iceland, Irland, Italy, Japan, Mexico, Luxembourg, and Norway (thousands of dollars by inhabitant at 1990 prices and PPPs)



Graph A3. Evolution of Chipp of New Zealand, Portugal, Sweden, Switzerland, Turkey, United Kingdom and the USA (thousands of dollars by inhabitant at 1990 prices and PPPs)



Pooled estimated relations of the modified version of Granger´s causality test.

Table 13

Dependent Variable: CH?PP
Method: Pooled Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 900

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CH?PP(-2)	0.920960	0.015748	58.47988	0.0000
PH?PP(-1)	0.069844	0.009173	7.614456	0.0000
R-squared	0.986051	Mean dependent var		7.303589
Adjusted R-squared	0.986035	S.D. dependent var		2.688606
S.E. of regression	0.317721	Sum squared resid		90.65032
Log likelihood	-244.1213	F-statistic		63477.57
Durbin-Watson stat	0.665242	Prob(F-statistic)		0.000000

Table 14

Dependent Variable: CH?PP
Method: Pooled Least Squares
Date: 01/30/03 Time: 10:19
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 900

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CH?PP(-2)	0.714859	0.021244	33.64953	0.0000
PH?PP(-1)	0.155649	0.012489	12.46286	0.0000
Fixed Effects				
R-squared	0.990092	Mean dependent var		7.303589
Adjusted R-squared	0.989797	S.D. dependent var		2.688606
S.E. of regression	0.271577	Sum squared resid		64.38748
Log likelihood	-90.18068	F-statistic		3355.282
Durbin-Watson stat	0.761272	Prob(F-statistic)		0.000000

AT= 0.364789, AU=0.498824, AX=0.303098, B=0.654451, CA=0.335282, D=0.179278, E=0.476515, FI=0.166583,

F=0.498172, GR=0.569698, HO=0.486537, IC=0.622286, IR= 0.476733, IT=0.458443, J=0.594219, L=0.791435,

M=0.303924, NO=0.216283, NZ=0.451540, PT=0.489272, SE=0.130644, SI=0.450500, TU=0.290215, UK=0.455530,

U=0.942951

Table 15

Dependent Variable: CH?PP
Method: Pooled Least Squares

Date: 01/30/03 Time: 10:21
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 900
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.270471	0.027621	9.792165	0.0000
CH?PP(-2)	0.889787	0.018831	47.25074	0.0000
PH?PP(-1)	0.068288	0.010049	6.795607	0.0000

R-squared	0.987327	Mean dependent var	7.303589
Adjusted R-squared	0.987298	S.D. dependent var	2.688606
S.E. of regression	0.303009	Sum squared resid	82.35731
Log likelihood	-200.9473	F-statistic	34940.99
Durbin-Watson stat	0.709188	Prob(F-statistic)	0.000000

Table 16
Dependent Variable: CH?PP
Method: Pooled Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 900
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CH?PP(-2)	0.714859	0.027925	25.59911	0.0000
PH?PP(-1)	0.155649	0.016196	9.610630	0.0000
Fixed Effects				

R-squared	0.990092	Mean dependent var	7.303589
Adjusted R-squared	0.989797	S.D. dependent var	2.688606
S.E. of regression	0.271577	Sum squared resid	64.38748
Log likelihood	-90.18068	F-statistic	3355.282
Durbin-Watson stat	0.761272	Prob(F-statistic)	0.000000

AT—C	0.364789	IC—C	0.622286
AU—C	0.498824	IR—C	0.476733
AX—C	0.303098	IT—C	0.458443
B—C	0.654451	J—C	0.594219
CA—C	0.335282	L—C	0.791435
D—C	0.179278	M—C	0.303924
E—C	0.476515	NO—C	0.216283
FI—C	0.166583	NZ—C	0.451540
F—C	0.498172	PT—C	0.489272
GR—C	0.569698	SE—C	0.130644
HO—C	0.486537	SI—C	0.450500
		TU—C	0.290215
		UK—C	0.455530
		U—C	0.942951

Graph A4. Residuals of Chipp= f(Chipp(-2), Phipp(-1) c) with dummies for fixed effects

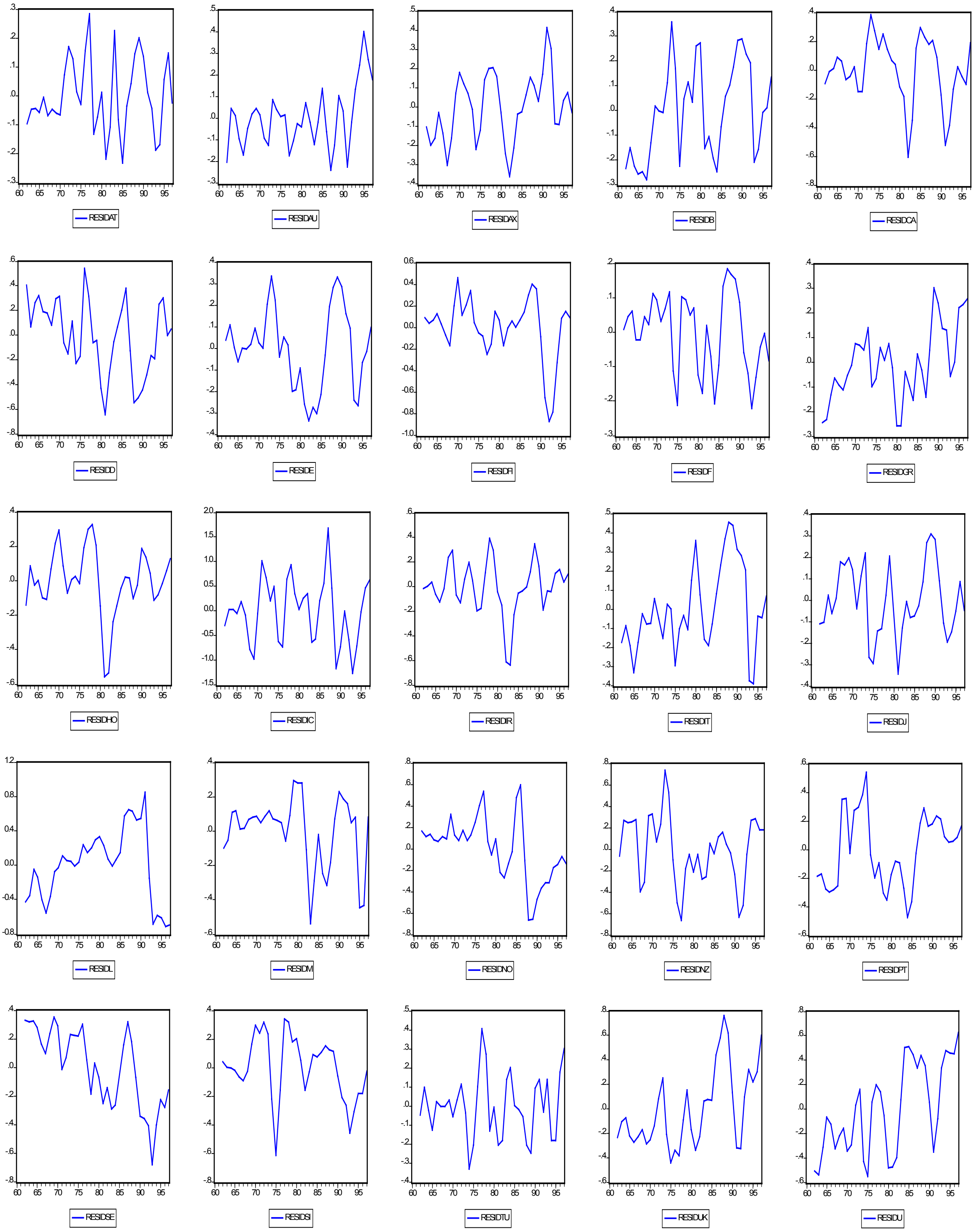

RESIDAT
RESIDAU
RESIDAX
RESIDB
RESIDCA
RESIDD
RESIDE
RESIDFI
RESIDF
RESIDGR
RESIDHO
RESIDIC
RESIDIR
RESIDIT
RESIDJ
RESIDL
RESIDM
RESIDNO
RESIDNZ
RESIDPT
RESIDSE
RESIDSI
RESIDTU
RESIDUK
RESIDU

Table 17

Dependent Variable: PH?PP
Method: Pooled Least Squares
Sample(adjusted): 1962 1997
Included observations: 36 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 900

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PH?PP(-2)	0.882452	0.023285	37.89810	0.0000
CH?PP(-1)	0.194468	0.039847	4.880371	0.0000
Fixed Effects				
R-squared	0.990171	Mean dependent var		12.23753
Adjusted R-squared	0.989878	S.D. dependent var		4.713977
S.E. of regression	0.474270	Sum squared resid		196.3654
Log likelihood	-591.9568	F-statistic		3382.366
Durbin-Watson stat	0.716832	Prob(F-statistic)		0.000000

AT--C	0.713260
AU--C	0.518577
AX--C	0.661852
B--C	0.497279
CA--C	0.650619
D--C	0.796803
E--C	0.411562
FI--C	0.714358
F--C	0.578479
GR--C	0.216323
HO--C	0.556269
IC--C	0.576719
IR--C	0.596296
IT--C	0.646894
J--C	0.836649
L--C	0.920928
M--C	0.056574
NO--C	0.965993
NZ--C	0.190126
PT--C	0.333095
SE--C	0.627151
SI--C	0.466072
TU--C	0.074754
UK--C	0.480681
U--C	0.485208

Table 18
Dependent Variable: PH?PP
Method: Pooled Least Squares
Sample(adjusted): 1962 1997

Included observations: 36 after adjusting endpoints
Number of cross-sections used: 25
Total panel (balanced) observations: 900
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PH?PP(-2)	0.882452	0.032777	26.92330	0.0000
CH?PP(-1)	0.194468	0.053342	3.645652	0.0003
Fixed Effects				
R-squared	0.990171	Mean dependent var		12.23753
Adjusted R-squared	0.989878	S.D. dependent var		4.713977
S.E. of regression	0.474270	Sum squared resid		196.3654
Log likelihood	-591.9568	F-statistic		3382.366
Durbin-Watson stat	0.716832	Prob(F-statistic)		0.000000

AT--C	0.713260	IR--C	0.596296
AU--C	0.518577	IT--C	0.646894
AX--C	0.661852	J--C	0.836649
B--C	0.497279	L--C	0.920928
CA--C	0.650619	M--C	0.056574
D--C	0.796803	NO--C	0.965993
E--C	0.411562	NZ--C	0.190126
FI--C	0.714358	PT--C	0.333095
F--C	0.578479	SE--C	0.627151
GR--C	0.216323	SI--C	0.466072
HO--C	0.556269	TU--C	0.074754
IC--C	0.576719	UK--C	0.480681
		U--C	0.485208

Table 19
Dependent Variable: CH?PP
Method: Pooled Least Squares
Sample: 1960 1997
Included observations: 38
Number of cross-sections used: 25
Total panel (balanced) observations: 925
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	36.66680	163.9594	0.223633	0.8231
PH?PP	0.429040	0.014588	29.41102	0.0000
AR(1)	0.998905	0.005156	193.7384	0.0000
R-squared	0.997455	Mean dependent var		7.219623
Adjusted R-squared	0.997449	S.D. dependent var		2.710532
S.E. of regression	0.136891	Sum squared resid		17.27762
Log likelihood	528.4085	F-statistic		180672.2
Durbin-Watson stat	1.718040	Prob(F-statistic)		0.000000

Table 20
Dependent Variable: CH?PP

Method: Pooled Least Squares
Sample: 1960 1997
Included observations: 38
Number of cross-sections used: 25
Total panel (balanced) observations: 925
Convergence achieved after 5 iterations
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PH?PP	0.422190	0.029242	14.43788	0.0000
AR(1)	0.967663	0.008743	110.6823	0.0000
Fixed Effects				
AT--C	3.053116			
AU--C	3.804686			
AX--C	3.227753			
B--C	4.456249			
CA--C	3.128095			
D--C	1.828795			
E--C	3.197968			
FI--C	1.765875			
F--C	3.850023			
GR--C	3.923081			
HO--C	3.887266			
IC--C	4.634091			
IR--C	1.600679			
IT--C	4.000311			
J--C	4.053200			
L--C	4.561874			
M--C	1.779524			
NO--C	1.157379			
NZ--C	3.022763			
PT--C	3.072097			
SE--C	1.361884			
SI--C	4.312579			
TU--C	1.622407			
UK--C	4.021677			
U--C	7.353286			

R-squared	0.997610	Mean dependent var	7.219623
Adjusted R-squared	0.997541	S.D. dependent var	2.710532
S.E. of regression	0.134404	Sum squared resid	16.22194
Log likelihood	557.5677	F-statistic	14419.23
Durbin-Watson stat	1.769355	Prob(F-statistic)	0.000000

Bibliography

Cancelo, M.T., Guisan, M.C. and Frias, I.(2001). Supply and Demand on Manufacturing Output in OECD Countries: Econometric Models and Specification Tests. *Applied Econometrics and Economic Development*. 2001, Vol. 1-2, pp. 7-42.[1]

Guisan, M.C. (2001a). “Causality and Dynamic Relations in Applied Econometrics”. *Applied Econometrics and Economic Development*. 2001-vol. 1. pp. 5-15.[1]

Guisan, M.C.(2001 b). Relaciones causales y modelos dinámicos. Chapter 2 of the book “*Crecimiento económico en los países de la OCDE 1. Modelos de crecimiento y empleo en Irlanda, Francia, España, Alemania, USA y Japón”*. Estudios Económicos nº 4. Asociación Hispalink-Galicia. Distribuye Mundi-Prensa. Madrid.[1]

Guisan, M.C. and Arranz, M.(2001). Consumption Expenditure on Health and Education: Econometric Models and Evolution of OECD countries in 1970-96. Working paper of the series *Economic Development,* n.50, edited by Euro-American Association of Economic Development Studies, free downloadable.[1]

Guisan, M.C. (2002). Causalidad y cointegración en modelos econométricos: Análisis econometríco de la relación entre le Consumo y el PIB en los países de la OCDE. Working paper of the series *Economic Development,* n.61, edited by Euro-American Association of Economic Development Studies, free downloadable.[1]

Guisan, M.C. and Frias, I.(2003), eds. *Econometric Models and International Development: Evolution of Agriculture, Industry, Trade, Transport and other Services in OECD and non-OECD countries.. Forthcoming.*[1]

Granger, C.W.J.(1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, Vol. 37, pp. 424-438.

Hausman, J.A.(1978). Specification tests in Econometrics. Econometrica Vol. 46.

Maddison, A.(2001). *“The World Economy. A Millennial Perspective”.* Development Centre Studies. OECD.

Nakamura, A. and Nakamura, M.(1981). On the Relationships among Several Specification Error Tests Presented by Durbin, Wu and Hausman. *Econometrica*, Vol. 49, n.6, pp.1583-88.

OECD(2000) and previous issues. National Accounts of OECD countries. OECD, Paris.

[1] Information about these publications on www.usc.es/economet/eaa.htm