FINANCIAL INTERDEPENDENCIES AND CAUSALITY IN THE EUROPEAN UNION

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RESUMEN/ABSTRACT
The main objectives of this paper are the study of foreign direct investment (FDI) among several UE countries, the appreciation of the interdependencies among them, the integration and co-integration of the FDI export series, in order to try to discover whose economies are the financial engines of the EU, the appreciation of the way of absorption of the FDI in the destiny countries of this money, the way that the economies found to regain the equilibrium after a foreign investment stimulus. In methodological terms the paper uses the VAR modelling theory, it optimizes the lag length, it uses the SURE method to estimate the parameters, it appreciates the IRF (functions), it uses the Granger causality and the Cholesky Variance Decomposition to study the degree of dependence or of independence of one economy against the others. Before this, it studies the stationarity, the integration and the co-integration of the series.

KEY WORDS: foreign direct investment, VAR modelling, causality, co-integration, international financing

1. INTRODUCTION AND MAIN OBJECTIVES

Before we enter more in the aim of this work dedicated to the study of the Foreign Direct Investment (FDI) it's convenient to define what this kind of investment is. The FDI is defined as an investment that involves a long term relationship that reflects an interest and long term duration of an entity from one economy into another different from that of the capital owner – the foreign direct investor. This investment requires that the foreign investor controls or at least has a significant influence in the enterprise of the other economy. Such an investment involves an initial transaction between the two entities and all the subsequent transactions between them and between the foreign filials, either incorporated or not.

Taking in account the definition of the OCDE a foreign direct investment enterprise is the one that through the foreign direct investment controls at least 10% of the shares or of the vote's privilege and in which the foreign enterprise has the management decision power.

With this work we try to study the relationships and inter-relationships among several countries of the western and central European Union (EU) – more precisely Portugal (P), Spain (S), France (F), United Kingdom (UK), Germany (G), and Italy (I) – departing from the capital exports of these countries – under the foreign direct investment (FDI) manner. In order to reach these objectives we use the Autoregressive Vector (VAR) and the Granger causality methodologies.

More deeply we can say that the main objectives of this work are: (1) to study the international capital movements, namely those that can be called Foreign Direct Investment (FDI); (2) to appreciate the interrelationships that can be detected in this way among the 6 economies of Europe; (3) to verify if we can detect causality links among some of the economies; (4) to see which are the more opened and the more closed economies at this level; (5) to see how acts the autoregressive vector methodology (VAR) and the causality theory in this kind of approaches.

In terms of structure the work begins to define his own objectives; the second part is relative to the methodologies used: the autoregressive vector and the Granger causality ones; the third part is dedicated to the presentation of the empirical data, its sources, and to the study of the stationarity and co-integration of the series; the fourth part shows the results obtained concerning either the autoregressive vector and causality methodologies or the interpretation of the results (the IRF functions and the Cholesky variance decomposition). It ends with a brief conclusion and a presentation of the main references consulted.

2. METHODOLOGICAL FRAMEWORK

2.1 AUTOREGRESSIVE VECTOR MODEL (VAR)

The autoregressive vector model is used frequently either to foresee the interrelated time series systems or to analyse the dynamic impact of the random errors on the variables' system. This model treats each endogenous variable of the system as a function of the past or lagged values of the endogenous variables in the system.

The mathematical expression of the autoregressive vector model can be the following $y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t$ (1-1), where y_t is a vector of k endogenous variables, x_t is a vector of d exogenous variables, A_1, A_2, ..., A_p and B are matrices of the parameters to be estimated and ε_t is a vector of innovations that can be contemporaneously correlated but that can not be correlated with their own past values and with all the variables of the second member of the equation.

It is frequent to consider the autoregressive vector (VAR) model without exogenous variables, x_t, or with these ones reduced to the c constants (the independent terms) reason why we can write the model as $y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + c + \varepsilon_t$ (1-2) where c is a vector of constant terms c_1, c_2,... c_k, A_i are squared matrices of the kxk type and ε_t is a vector of terms generated by a white noise process with the following proprieties:

$$E[\varepsilon_t] = 0 \qquad \forall t$$
$$E[\varepsilon_t \varepsilon'_t] = \begin{cases} \Omega & s = t \\ 0 & s \neq t \end{cases}$$

(1-3) where we assume that the covariance matrix Ω is positively definite.

These properties indicate that the ε's are not serially correlated (but can be contemporaneously correlated).
Adopting a first difference reformulation of a second order autoregressive vector this model is equivalent to $\Delta y_t = c + B_1 \Delta y_{t-1} + B_2 \Delta y_{t-2} + \ldots + B_{p-1} \Delta y_{t-p+1} - \pi y_{t-1} + \varepsilon_t$ (1-4) where the B's are functions of the A's, $\pi = I - A_1 - A_2 - \ldots A_p$ and Δ is the first difference operator.

The model doesn't pose great problems or difficulties of estimation of the model's parameters as the second member of each equation of the system has only lagged or pre-determined endogenous variables, reason why the ordinary least squares (OLS) method gives consistent estimates of the model's parameters. Besides this, even in the eventual case that the innovations ε_t are contemporaneously correlated, the OLS method gives consistent and equivalent estimates to those obtained with the GLS once all the equations have similar regressors. Following Johnston and Dinardo (p.325) we may say that there are two approaches to estimate the autoregressive vector model: (a) one, the direct estimation of the system (1-2) or of the alternative model (1-4); nevertheless, this way is only appropriated if all the eigenvalues of π are inferior to 1; and (b) another that is recommended when the variables y are not stationary; in this case we determine the number r of possible co-integrated vectors and then we estimate the system (1-4) restricting the π matrix to the r co-integrated variables.

An important element in the estimating process of an autoregressive vector model is the determination of the lag length p. To achieve this aim usually we compute some indicators that help in this task. Among these there is the determinant of the residual covariance that can be defined as $\left|\hat{\Omega}\right| = \left|\frac{1}{T-p}\sum \hat{\varepsilon}_t \hat{\varepsilon}'_t\right|$ (1-5) where p is the number of parameters of each equation of the autoregressive vector model. Another important indicator is the logarithm of the likelihood function *l* whose value, assuming a normal multivariate function, is given by the expression $l = -\frac{T}{2}\left\{k(1+\log(2\pi)) + \log\left|\hat{\Omega}\right|\right\}$ (1-6). Other useful indicators are the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC) whose mathematical expressions are: $AIC = -2l/T + 2nT$ (1-6) for the first one (AIC) and $SC = -2l/T + n\log(T)/T$ (1-7), for the second one (SC), where n=k(d+pk) is the total estimated number of parameters of the autoregressive vector model. These two criterions are used for model selection namely for the selection of the lag length to consider in the model. They recommend the choice of the lag length for which the values of the AIC and SC are the least.

To end this section let's refer one more criterion to select the lag length – the LR test (initials of Likelihood Ratio) that tests the hypothesis that the coefficients on the lag *l* are jointly nulls using the statistic $LR = (T-m)\left\{\log\left|\Omega_{l-1}\right| - \log\left|\Omega_l\right|\right\} \sim \chi^2_{k^2}$ (1-8) where m is the number of equation parameters under the alternative hypotheses. The test can be done like this: we begin by comparing the value of the modified LR statistic with the critical values at the level of significance of 5% beginning with the maximum possible lag and descending the lag length one unit each time until we obtain a rejection.

When we adjust an autoregressive vector model of order p_1 and we pretend to test the hypotheses that this order is $p_0<p_1$ we begin to write the logarithm of the likelihood function to maximize *l*, $l = c + \frac{n}{2}\ln\left|\hat{\Omega}^{-1}\right|$ (1-9) where n is the number of observations, and Ω^ is the estimated matrix of the residuals of the autoregressive vector equations, and the likelihood functions when we use p_0 and p_1 lags, respectively, as $l_0 = c + \frac{n}{2}\ln\left|\hat{\Omega}_0^{-1}\right|, \quad l_1 = c + \frac{n}{2}\ln\left|\hat{\Omega}_1^{-1}\right|$ (1-10). On these circumstances the LR test statistics can be written as $LR = -2(l_0 - l_1) = n\left[\ln\left|\hat{\Omega}_0^{-1}\right| - \ln\left|\hat{\Omega}^{-1}\right|\right] \& \chi^2_q$ (1-11), where q is the number of restrictions imposed by the null hypotheses determination. In general $q=k^2(p_1-p_0)$ with k the number of variables of the autoregressive vector model.

2.2 THE GRANGER CAUSALITY

It is worth to refer that correlation doesn't imply necessarily causality. There are many examples of very high correlations that are either spurious or that have no sense. The Granger (1969) approach to the question of knowing if "x (Granger) causes y" permits to investigate how much of the current value y can be explained by the past values of y and if when adding lagged values of x we can improve the explanation of the model. We can say that "y is Granger caused by x" if x helps in the prevision of y, or if the coefficients of the x lagged variables are statistically significant.

It's important to refer that the conclusion that "x is Granger cause of y" doesn't imply that y is the effect or the result of x, even when the Granger causality measures, in some aspects, the precedence.

The Granger causality implies the estimation of 2 regressions, or, in other words, implies the estimation of a bivariate regression like the following:

$$\begin{aligned} y_t &= \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \ldots + \beta_l x_{t-l} + \varepsilon_t \\ x_t &= \alpha_0 + \alpha_1 x_{t-1} + \ldots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \ldots + \beta_l y_{t-l} + u_t \end{aligned} \quad (1\text{-}12)$$

for all the possible pairs of values of the series (x,y) of the group. Sometimes we consider models like these ones but without independent terms ($\alpha_0=0$).

The Granger causality test is not but the F. Wald test for the joint hypotheses $\beta_1 = \beta_2 = \ldots = \beta_l = 0$ for each equation. The null hypotheses can be expressed as: H_{01}: 'x is not Granger cause of y', in the first equation, and $H0_2$: 'y is not Granger cause of x', in the second. The test statistic is given by

$$F = \frac{(SQEr - SQEnr)/m}{SQEnr/(n-k)} \quad (1\text{-}13)$$

a statistic that follows the F distribution with m and n-k degrees of freedom, where m is the number of lagged terms of Y and k is the number of parameters estimated in the regression without restrictions, SQEr is the sum of squared errors in the restraint regression (when the hypotheses H_0 is true) and SQEnr is a similar sum obtained with the unrestricted regression.

Some econometric software computes routinely the values of the F statistic in each one of the hypotheses and the minimum levels of significance that are needed to reject H_0 (usually identified by *Prob.*).

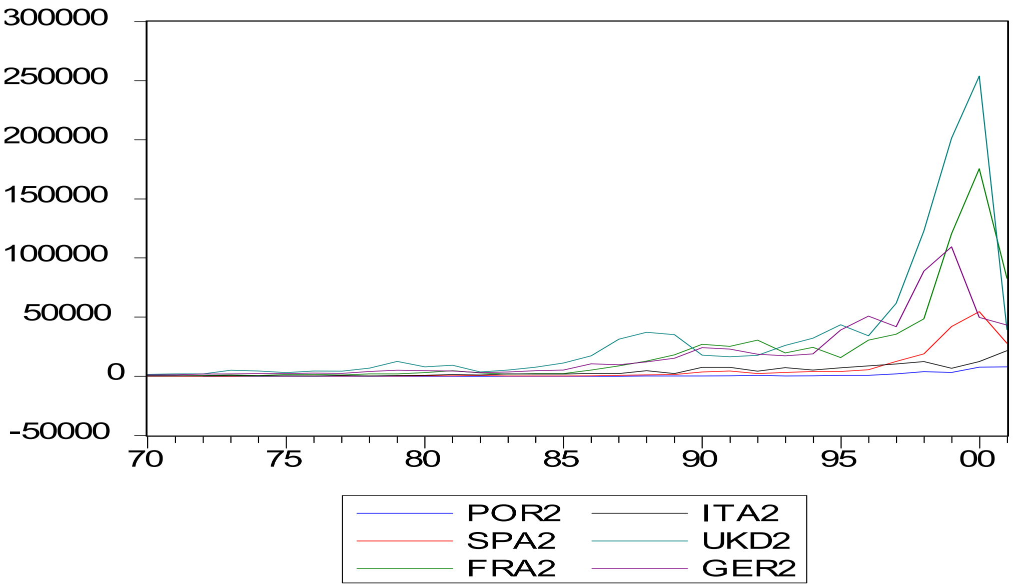
If in such a test we reject both null hypotheses then we say that between the two x and y variables there is a bilateral relationship, if only one of them is rejected we say that there is a unilateral relationship and if we don't reject none of them we say that there is an independent relationship. In more deeply terms there are four situations or cases in such an analysis: (1) Unidirectional causality of the foreign direct investments from the x economy to the y economy: when the estimated coefficients of the lagged Variables of the second economy (y), taken toghether, are statistically differents from zero and the estimated coefficients of the first lagged variable, x, in the second equation are not statistically different from zero. (2) Unidirectional causality of the foreign direct investments of the x economy to the y economy: when the set of coefficients of the lagged variable, y, in the first equation is not statístically different from zero and the set of coefficients of the lagged economy, x, in the second equation is not statistically different from zero. (3) *Feedback* or bilateral causality: when the sets of coefficients of the FDI of the two economies, x and y, are statistically different from zero in the two regressions. (4) Independence of the FDI originated on the x and y economies: when the sets of estimated coefficients of the y variable and of the x variable are not statistically different from zero in the two regressions.

3. CAPITAL EXPORTS AS FOREIGN DIRECT INVESTMENT

3.1 DATA BANK

As we said before the data that we are going to use is referred to the capital exports as foreign direct investment (FDI, outflows) of 6 countries of the European Union – Portugal, Spain, France, United Kingdom, Italy and Germany – of the years 1970 till 2001. The values used in the empirical application were extracted from a data bank of the United Nations Conference on Trade And Development (UNCTAD) and published in the *site* www.unctad.org/FDI; they are referred to the capital flows and include the *equity capital* (capital that is bought by the investor), the reinvested results (the part of the foreign direct investor on the profit or gain that are not distributed to the filials or results that are not sent to the foreign direct investor) and the loans borrowing among the enterprises (short or long term loans and the fund's loans among the mother and filials' enterprises. The *outflows* that we consider here are the net way outs of capitals from a country to another to lasting control of a firm. The monetary unity in which are expressed the values is the USA million dollar. The following figure shows the evolution of the FDI outflows over the 32 years of the period.

Graphic n. 2.1 – Capital Exports' Evolution (in 10^6 USA dollars)



Note: POR2-Portugal, SPA2-Spain, FRA2-France, ITA2-Italy, UKD2-United Kingdom, GER2-Germany. The Portuguese data from 2000 to 2001 are estimates done by UNCTAD.

3.2 NON STATIONARITY OF THE TIME SERIES – CORRELOGRAMS AND THE Q BOX-PIERCE, ADF AND PP TESTS

Either the correlograms of the total and partial autocorrelation functions, ACF and PACF, respectively, of the natural logarithms of the time series that are being studied or the Q Box-Pierce test clearly show the non stationarity of the original series when taken in levels. In the same sense point the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests – when testing the null hypotheses of the integration or non-stationarity of the respective series, in levels, we could not reject them. Once certified that the series are not stationary we apply the same tests to the first differences of the same series to confirm that all of them are already stationary, fact that is equivalent to say that the original series in levels are I(1).

3.3 COINTEGRATION OF THE SERIES – THE JOHANSEN TEST

The application of the Johansen test to appreciate the co-integration of the 6 series gave the following results:

Table n. 3.31 – Results of the Johansen test to appreciate cointegration

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.975996	154.7625	94.15	103.18	None **
0.759988	76.44243	68.52	76.07	At most 1 **
0.691838	46.47401	47.21	54.46	At most 2
0.595345	21.75430	29.68	35.65	At most 3
0.122771	2.755153	15.41	20.04	At most 4
0.000211	0.004432	3.76	6.65	At most 5

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

The LR test denotes the existence of 2 cointegrating equations at the 5% level of significance. It also permits to reject, in 2 cases, the hypotheses of the existence of a linear trend at the s. levels of 5% and 1%. This fact means that among these series there are a long term equilibrium relationship.

4. CAPITAL EXPORTS TO FOREIGN DIRECT INVESTMENT – EMPIRICAL APPLICATION

4.1 ESTIMATES OF THE AUTOREGRESSIVE VECTOR MODEL (VAR)

Following step by step everything that was said in the third section of this paper (when we spoke of the methodology framework) we obtained the estimates for each one of the components of the VAR model with 6 endogenous Variables– one for each exporting country (Portugal, Spain, France, United Kingdom, Italy and Germany) that are written in the table n. 4.1. Unhappily not all the series covered the period 1970-2001 reason why in the estimation process we only use the period 1974-2001 for the estimation process. For other reasons 7 other observations have to be excluded (the mi*ssing values*, related especially to the fact that the negative flows could not be converted in logarithms as happen for 3 times in the Portuguese case). Due to these facts the optimisation process of the lag length indicated the value of 1.

The variables of the VAR model were expressed in the first differences of the natural logarithms. As can be seen by the table n. 4.1 the estimated VAR model has 42 parameters resulting from the fact of having 6 endogenous variables by the same number of pre-determined ones more 6 constant terms c in the pre-defined VAR model. The values found for these parameters translate thus the relations and interrelations' network among the 6 capital exporting economies.

Table n. 4.1 Estimation of the VAR(1) model with 6 endogenous Variables

Sample(adjusted): 1974 2001
Included observations: 21
Excluded observations: 7 after adjusting endpoints
Standard errors & t-statistics in parentheses

	DLP	DLE	DLF	DLUK	DLI	DLG
DLP(-1)	-0.074502	-0.006705	-0.133861	-0.188842	0.131378	0.021746
	(0.24144)	(0.13419)	(0.11496)	(0.17754)	(0.13455)	(0.10811)
	(-0.30858)	(-0.04996)	(-1.16439)	(-1.06368)	(0.97643)	(0.20115)
DLE(-1)	0.705092	-0.055122	0.228890	0.015038	0.087416	0.076157
	(0.47328)	(0.26306)	(0.22536)	(0.34802)	(0.26375)	(0.21192)
	(1.48979)	(-0.20955)	(1.01568)	(0.04321)	(0.33143)	(0.35937)
DLF(-1)	0.053966	0.266972	-0.394063	-0.143895	-0.060200	-0.336927
	(0.47758)	(0.26545)	(0.22741)	(0.35118)	(0.26615)	(0.21384)
	(0.11300)	(1.00575)	(-1.73287)	(-0.40974)	(-0.22619)	(-1.57559)
DLUK(-1)	-0.072430	0.148914	0.167828	0.034453	-0.287839	0.063492
	(0.49560)	(0.27546)	(0.23598)	(0.36443)	(0.27619)	(0.22191)
	(-0.14615)	(0.54060)	(0.71118)	(0.09454)	(-1.04218)	(0.28612)
DLI(-1)	0.271013	0.011272	0.076890	-0.059939	-0.810538	0.024155
	(0.33276)	(0.18495)	(0.15845)	(0.24469)	(0.18544)	(0.14900)
	(0.81444)	(0.06094)	(0.48527)	(-0.24496)	(-4.37082)	(0.16212)
DLG(-1)	0.179212	0.701871	0.842340	0.647878	-0.180234	0.044613
	(0.57826)	(0.32141)	(0.27534)	(0.42522)	(0.32226)	(0.25892)
	(0.30991)	(2.18375)	(3.05922)	(1.52364)	(-0.55929)	(0.17230)
C	-0.061283	0.069310	-0.007167	0.022086	0.223237	0.100479
	(0.23466)	(0.13042)	(0.11173)	(0.17255)	(0.13077)	(0.10507)
	(-0.26116)	(0.53142)	(-0.06415)	(0.12800)	(1.70710)	(0.95632)
R-squared	0.215212	0.345618	0.506226	0.202413	0.596682	0.165508
Adj. R-squared	-0.121126	0.065169	0.294608	-0.139410	0.423831	-0.192131
Sum sq. Resids	10.59911	3.274359	2.403103	5.731155	3.291728	2.124986
S.E. equation	0.870103	0.483614	0.414307	0.639819	0.484895	0.389596
F-statistic	0.639869	1.232373	2.392173	0.592157	3.452008	0.462779

Log likelihood	-22.61831	-10.28450	-7.036211	-16.16235	-10.34005	-5.744756
Akaike AIC	2.820791	1.646143	1.336782	2.205938	1.651434	1.213786
Schwarz SC	3.168966	1.994317	1.684956	2.554112	1.999608	1.561960
Mean dependent	0.135095	0.168023	0.072634	0.028266	0.093872	0.091083
S.D. dependent	0.821757	0.500187	0.493295	0.599400	0.638812	0.356822
Determinant Residual		1.57E-05				
CoVARiance		-62.62051				
Log Likelihood		9.963858				
Akaike Information Criteria		12.05290				
Schwarz Criteria						

4.2 INTERPRETATION OF THE RESULTS

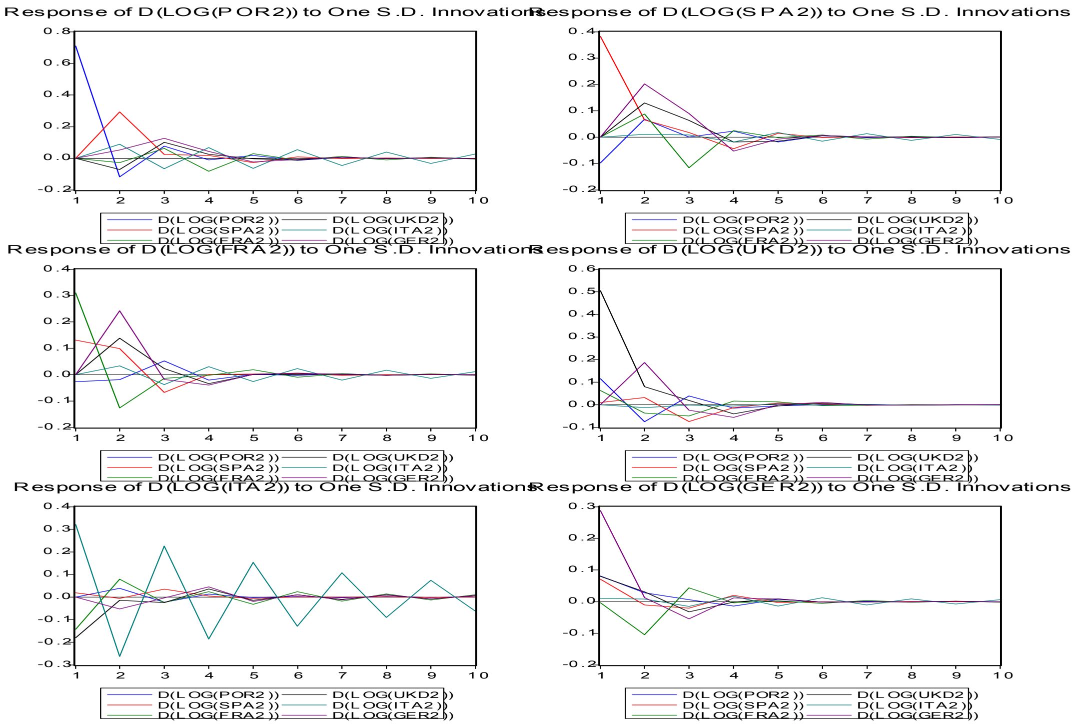
The direct interpretation of the VAR model is very complicated and most time conducts to poor conclusions. Instead of this in general this interpretation uses the impulse response function (IRF), or the error variance decomposition analysis.

4.2.1 IMPULSE RESPONSE FUNCTIONS – GRAPHICAL ANALYSIS

Let us see the shape of the IRF – the response of the different FDI or economies to impulses of size 1 standard deviation (s. d.).

The following illustration give us the evolution of the Foreign Direct Investment of the 6 economies – in IRF terms – to variations, shocks or unitary innovations (of one standard deviation) introduced in the error terms of the VAR model. From these graphics we can retain the quickly convergence of these functions, fact that, in some sense, translates the rapidity of absorption of the innovations by the six economies. It is worth to refer that the innovation absorption takes 5/6 years for all the economies; the only exception is the Italian one that is slower taking more then 10 years.

Illustration n. 4-1: Economical Response to Impulses of 1 s. d.



4.2.2 IMPULSE RESPONSE FUNCTIONS – NUMERICAL ANALYSIS

In order to short the size of this paper we don't put here the numerical values that support the graphics of the impulse response functions (IRF) to innovations introduced in the VAR model structure.

Following a methodology that other authors use – like, for instance, Goux (1996) – if we sum the values of the IRF obtained by each variable along the 10 years in analysis, we may say that the Portuguese FDI exports answer positively to innovations in the Spanish, British, Italian, and German economies and negatively to innovations or impulses in the French economy (FDI exports).

Doing the same thing for Spain we may say that the Spanish FDI exports answer positively to innovations in the French, British, Italian, German and Spanish and negatively to impulses in the Portuguese economy. The same analysis for France says that the French FDI exports answer positively to innovations in the economies of Spain, France, UK, Italy and Germany and answer negatively to innovations in the Portuguese economy. The British FDI exports answer positively to innovations in the economies of Portugal, France, UK and Germany, and negatively in the economies of Spain and Italy. The Italian FDI exports answer positively to innovations in the economies of Portugal, Spain and itself (Italy) and negatively in the economies of France, UK and Germany. And the German FDI exports answer positively to innovations in the economies of Portugal, Spain and Italy and negatively in the economies of France, Italy and itself (Germany).

4.2.3 CHOLESKY VARIANCE DECOMPOSITION

The values obtained with the Cholesky Variance Decomposition of the forecasting error show us how the variance of the forecasting errors of each one of the capital export investments (FDI) is explained by each one of the different economies considered in the analysis during a period of 10 years. The 1st group of columns is referred to the explanation of the capital exports' variations of the Portuguese economy. These values show (i) that Spain is the most important economy to explain the future variations of the Portuguese capital exports' – with values from 12.7% to 13.9%; (ii) that the importance of the other economies is nothing but residual with values that individually explain only from 0% to 4.2% of the future FDI variations; (iii) that the Portuguese economy explains between 100% in the 1st year and 75% in the 10th of its own variation, with values descending slowly; and that the standard errors of the forecasting vary from 0.71 to 0.83.

The 2nd group of values that is referred to the Spanish FDI show (i) that German is the most important economy to explain the future variations of the Spanish capital exports' – with values from 17% to 19%; (ii) that the following more important economies are the Portuguese – with values from 5 to 6% - and the German – with values from 3% to 8% – of the future FDI variations; (iii) that the Spanish economy explains from 57.8% to 94% of its own variation; (iv) that the standard errors (s. e.) of the forecasting vary from 0.39 to 0.51.

The 3rd group of values refers to the French capital exports'; the most important economies are, besides itself (with values varying from 48% to 84%), the German one (with values varying from 0% to 27%), the Spanish one (with values varying from 12% to 15%), and the British one (with values varying from 0% to 9%), and Italy (with values varying from 0% to 2.5%); the values of the s.e. vary from 0.34 to 0.49.

The 4th group of values refers to the United Kingdom capital exports; the values obtained show that the most important economies to explain the future variance of the British FDI exports are, besides itself (with values varying from 78% to 94%), Germany (with values varying from 0% to 11%), Portugal (from 5% to 6%), Spain (from 0% to 2%), and France (from 1% to 2%). The values of the s.e. vary from 0.52 to 0.58.

The 5th group of values refers to the Italian capital exports; the values show that the most important economies for the Italian one in terms of capital exports are besides itself (with values varying from 66% to 81%), the British one (from 9% to 21%), and the French one (from 8% to 13%) and the German (from 0% to 1%). The values of the s.e. vary from 0.39 to 0.63.

The last group of values refers to the German exports of capital; the economies that proved to be more important for the German economy are besides itself (with values varying from 70% to 82%), France (from 0% to 10%), the United Kingdom (from 6.3% to 6.9%), Portugal (from 6.2% to 6.5%), Spain (from 4.5% to 4.8%) and Italy (with values varying from 0% to 1%). The values of the s.e. vary from 0.31 to 0.35.

As the order of entrance of the variables influence the results we came to present we must say that the order of entrance of the variables considered is Portugal, Spain, France, United Kingdom, Italy and Germany.

4.3 CAUSALITY APPRECIATION

In the following we are going to see first the estimated VAR model of the Granger methodology, the estimation of the number of lags to include in the VAR model and later the economical interpretation of the results.

4.3.1 ESTIMATION OF THE MODEL AND OTHER CONSIDERATIONS

To appreciate the Grangerian (non) causality we begin to estimate a VAR model without independent terms with 6 Variables– Portugal, Spain, France, United Kingdom, Italy and German – in the first differences of the logarithms of the initials series given the integration of these original series (in level). Before this, however, we estimate the optimal lag, i. e., the one that minimises the Schwarz Criterion (SC) and Akaike Information Criterion (AIC) statistics. The lag length that proved to be optimal was the number 2. With these elements we estimated the VAR model whose elements can be seen in the Append, and we computed the values of the F statistics to test the Granger (non) causality as was referred in the section n. 2 when we exposed the respective methodology.

4.3.2 INTERPRETATION OF THE CAUSALITY RESULTS

As was referred in the section n. 2 now we are going to appreciate all the tests, one each time, and to classify the relationship between each two economies in terms of bilateral, unilateral and independent relationships. At the end we will interpret the results found.

(1) Unilateral Relationships
The values found show that there are 4 relationships of the unilateral type: one for Portugal-Spain, another for Germany-Spain, another for Germany-France and another for Spain-UK. Let us see them individually and let us see the causality test, too. The results permit us to conclude that the Portuguese and Spanish relationship is of the unilateral type, as was said in the precedent paragraph, and that the causality direction is from Spain to Portugal (al the level of significance, ls, of 0.5%). The test doesn't admit the opposite hypotheses, i. e., that this relationship is from Portugal to Spain (once the minimum level of significance (ls) to admit that hypothesis is 17.4% so greater than the level of significance (l.s.), 5%). The results say that the relationship between Spain and Germany, besides being of the unilateral type acts in the sense Germany to (->) Spain (ls=1.1%), the opposite hypothesis not being accepted. The relationship between Germany and France besides being unilateral acts from Germany to (->) France (ls=0.2%), the opposite hypothesis not being accepted.

The country that has more unilateral type relationships is Spain with 3 (with Portugal, Germany and the United Kingdom), followed by France with only one (with Germany) and Portugal with one (with Spain).

(2) Bilateral Type Relationships
At the level of significance of 5% there is only one bilateral type relationship. The granger causality tests used led to the rejection of the two following null hypothesis – H01: "The United Kingdom is not Granger cause of France" (ls=4.9%), and H02: "France is not Granger cause of the United Kingdom" (ns=1.5%) –, what means that both capital exporting sectors are interrelated as we should expect between two economies that are powerful and neighbours.

(3) Independence Relationships
The following relationships are of the independent type detected by the Granger (non)causality analysis: France – Portugal, United Kingdom – Portugal, Italy – Portugal, Germany-Portugal, France – Spain, Italy – Spain, Italy – France, Italy – United Kingdom, Germany – United Kingdom and Germany – Italy.

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As a synthesis we may say that the analysis of the Grangerian (non) causality theory applied to the capital exports for direct investment, authorises the following illations following a methodological approach adopted by Manso (2000):

Capítulo 7 That the more independent economies in terms of FDI exports are Italy with 5 relationships of this type (P, S, F, UK, G), followed by Portugal with 4 (I, F, G, UK), by the United Kingdom with 3 (P, I, G), by France with 3 (P, I, S), by Germany with 3 (UK, I, P), and by Spain with 2 (I, F).

Capítulo 8 That the more opened economies in terms of capital exporting for direct investment – those that have a greater number of the bilateral type – are only the United Kingdom and France with only one relationship.

Capítulo 9 That the economies that have a greater number of unilateral relationships are Spain with three (Portugal, UK, Germany), followed by Germany with 2 (with Spain, France) and Portugal, France and the U. Kingdom, all of them with only one relationship; what we came to write confirms the importance of Germany as the financial engine of the European Union – or at least for France and Spain – and also the importance of Spain as financial engine of Portugal at least during the last few years and for the United Kingdom.

Another Causality Methodology

Many critics are made to the Granger causality theory, the most important refers with the fact that it can only be done at the bilateral level; another is because it is very sensitive to the lag length considered in the analysis. Taking in account these objections we are going to try to interpret the multilateral relations among the 6 countries using another methodology.

In the appreciation of the multilateral relationships among the Portuguese, Spanish, French and British, Italian and German FDIs we are going to follow a methodology that uses some results obtained from the VAR model we estimated earlier – the Cholesky Variance Decomposition. The idea is that as this kind of variance decomposition gives the future influence of the exogenous or explicative variables on the endogenous or explained variables, then we can see here a sign of causality in the Granger causality sense; and the Cholesky variance Decomposition quantifies this causality.

For instance if we consider the 10th year after the current one we can say that the Portuguese FDI exports' innovations explain or influence 5.7% of Spanish FDI exports while the inverse, the Spanish FDI innovations explain 12.7% of the Portuguese FDI movements, so the intensity of the reaction is greater from Spain to Portugal than the inverse. The same table shows that the responsibility of Portugal to France and that of France to Portugal are the same, 1.8%, so both reactions are meaningful. The responsibility of Portugal to UK is 6.1% and the inverse is smaller (2.3%) and meaningful. The responsibility of Portugal to Italy is 0.6% and the inverse is 4.7%, so both meaningful, too. Finally the responsibility of Portugal to Germany is 6.3% and the inverse is smaller (3.1%), this one being meaningful. In the same way we can see that the responsibility of Spain is 13.3% for France (the inverse is 8.3%, so smaller), is 2.0% (so meaningful) for UK (the inverse is 8.1%, so greater), is 0.4% for Italy (the inverse is 0.6%, so both meaningful) and is 4.9% for Germany (the inverse is 19.5% so greater, the first being meaningful). Looking now for France we may say that the responsibility of this country is 2.4% for UK (the inverse is 8.8%, so greater and significant while the first one is not), is 7.5% for Italy (the inverse is 2.4%, so smaller and insignificant), is 10.5% for Germany (the inverse is 25.7%, so both meaningful). In what concerns the United Kingdom we may say that the responsibility of this country is 8.7% for Italy (the inverse is 0.1%, so smaller), and is 6.9% for Germany (the inverse is 11.4%, so greater, both being significant). In what concerns Italy we may say that the responsibility of this country is 1.1% for Germany and the inverse is 1.4%, so both small and insignificant.

If we omit the relations that have less than 5% and that we said to be insignificant because they are truly meaningful, we conclude there are bilateral relationships between Portugal and Spain, between Spain and France, between France and Germany and between the UK and Germany, this meaning that the relationship between these binomial countries are very strong and influence each other.

Using the same methodology we can also conclude that the relations between Portugal and UK, between Portugal and Germany, between Spain and UK, between France and UK, between France and Italy, and between UK and Italy are of the unilateral type in the senses Portugal to UK, Portugal to Germany, UK to Spain, Germany to Spain, UK to France, France to Italy and UK to Italy, respectively, this meaning that the FDIs of the countries referred earlier are in a certain sense Granger causes of the FDIs of the countries referred later.

The same methodology helps us to discover the independent relationships (when the levels of variance explained of the two relations are less than 5%): the results show that the Portuguese and French, that the Portuguese and the Italian, that the Spanish and the Italian and the Italian and the German are of this type.

These values show that the more independent FDIs are: Italy (with 3 relationships), Portugal (2), France, Spain and Germany (with 1 each one of them), the more opened are Spain, France and Germany (with 2 each one) and Portugal and UK (with one each one), and the ones that have more unilateral relationships are UK (4), Spain, France, Italy and Germany (each one with 2).

Comparison of the Two Causality Methodologies

Both causal methodologies agree that the relationship between Germany and Spain has the sense Germany→Spain, this meaning that the political and economical measures taken in Germany affect or influence the FDI exports of Spain, and both agree, too, that the relationships of Portugal~France, Portugal~Italy, Spain~Italy and Italy~Germany are of the independent type, this meaning that the political and economical measures taken in each one of the binomial countries are almost indifferent for the other country of the binomial. In the rest of the relationships the 2 methodologies give different results. Nevertheless we think that the results obtained by the Cholesky Variance Decomposition are more adequate or realistic than those obtained by the Granger methodology, reason why we can say that the true sense of the relationships are the following: relations of the unilateral type: UK→Italy, Portugal→UK, Portugal→Germany, UK→Spain, Germany→Spain, France→UK, and France→Italy; relations of the bilateral type: Portugal↔Spain, Spain↔France, France↔Germany, UK↔Germany; relations of the independent type: Portugal~France, Portugal~Italy, Spain~Italy and Italy~Germany. Of course there are still some conclusions that are surprising, this meaning that the Cholesky Variance decomposition used in the sense we are referring it is not perfect: that the case of the 2 results Portugal→UK, Portugal→Germany, which are very improbably.

5. CONCLUDING REMARKS

The analysis we came to present shows (i) that the logarithms of the time series of the foreign direct investment (FDI) of 6 countries of the EU – Portugal, Spain, France, United kingdom, Italy and Germany – are non stationary and are integrated of order 1, or I(1), as can be seen using the ADF and PP tests, and (ii) that, besides this, they are co-integrated, fact that means that among them there long term equilibrium relationships, as shows the Johansen test.

The estimated VAR model shows the type of relations and of interrelationships that exist among the 6 European capital exporting countries. The graphics of the IRF show a quick absorption period of 5/6 years, period that the economies take to absorb the innovations or impulses introduced in the dynamic structure of the VAR model and the pattern of this reaction.

The Granger (non)causality, shows that the more independent economies of these 6 that we are studying are Italy with 5 relationships, Portugal with 3, the United Kingdom with 3, France with 3, Spain with 2 and Germany with 2. Using the Cholesky Variance Decomposition of the forecasting error to study the causal relationships among these 6 countries conducts to results that are more realistic than the ones presented before and this methodology says that the true sense of the relationships are the following: of the unilateral type: UK→Italy, Portugal→UK, Portugal→Germany, UK→Spain, Germany→Spain, France→UK, and France→Italy; of the bilateral type: Portugal↔Spain, Spain↔France, France↔Germany, UK↔Germany; and of the independent type: Portugal~France, Portugal~Italy, Spain~Italy and Italy~Germany; some of these causality senses are surprising as is the case of the 2 following results: Portugal→UK and Portugal→Germany, which are very improbably.

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