# INTERDEPENDENCIES IN THE EUROPEAN UNION CAPITAL EXPORTING MARKETS

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**Abstract**

The main objectives of this paper goes from the study of foreign direct investment (FDI) among six countries belonging to the EU, to the appreciation of the interdependencies among these economies, to the integration and co-integration of the capital export series, in order to try to discover whose economies are the financial engines of the EU – in capital export terms –, to the appreciation of the way of absorption of the invested capitals in the destiny countries of these money, to the way that the economies found to regain the equilibrium after a foreign investment stimulus.

In methodological terms the paper uses the Autoregressive vector (VAR) modelling theory; among other things it optimizes the lag length, it uses the SURE method to estimate the parameters, it appreciates the IR functions, decomposes the variance in the Cholesky way and uses the Granger causality to study the degree of dependence or of independence of one economy against the others. Before this, nevertheless, it studies the stationarity, the integration and the co-integration of the series using specific tests.

**Keywords: foreign direct investment, VAR modelling, causality, integration, co-integration, economical dependence**

JEL Classification: C32, F21,F37, G15

## 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 inter-relationships 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

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + B x_t + \varepsilon_t \qquad (1\text{-}1)$$

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 $\varepsilon_t$ 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

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + c + \varepsilon_t \qquad (1\text{-}2)$$

where c is a vector of constant terms $c_1$, $c_2$,... $c_k$, $A_i$ are squared matrices of the kxk type and $\varepsilon_t$ is a vector of terms generated by a white noise process with the following proprieties:

$$E[\varepsilon_t] = 0 \quad \forall t$$
$$E[\varepsilon_t \varepsilon'_t] = \begin{cases} \Omega & s = t \\ 0 & s \neq t \end{cases} \tag{1-3}$$

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

$$\Delta y_t = c + B_1 \Delta y_{t-1} + B_2 \Delta y_{t-2} + \ldots + B_{p-1} \Delta y_{t-p+1} - \pi y_{t-1} + \varepsilon_t \tag{1-4}$$

where the B's are functions of the A's, $\pi$=I-$A_1$-$A_2$-...$A_p$ 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 $\varepsilon_t$ are contemporaneously correlated, the OLS method gives consistent and equivalent estimates to those obtained with the GLS once all the equations have similar regressors[1]. 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

[1] E-Views (v. 4) Manual, pp. 501,...

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

$$\left|\hat{\Omega}\right| = \left|\frac{1}{T-p}\sum \hat{\varepsilon}_t \hat{\varepsilon}'_t\right| \qquad (1\text{-}5)$$

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

$$l = -\frac{T}{2}\left\{k(1+\log(2\pi)) + \log\left|\hat{\Omega}\right|\right\} \qquad (1\text{-}6)$$

Other useful indicators are the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC) whose mathematical expressions are:

$$AIC = -2l/T + 2nT \qquad (1\text{-}6)$$

for the first one (AIC) and

$$SC = -2l/T + n\log(T)/T \qquad (1\text{-}7)$$

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

$$LR = (T-m)\left\{\log\left|\Omega_{l-1}\right| - \log\left|\Omega_l\right|\right\} \sim \chi^2_{k^2} \qquad (1\text{-}8)$$

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***

$$l = c + \frac{n}{2}\ln\left|\hat{\Omega}^{-1}\right| \qquad (1\text{-}9)$$

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

$$l_0 = c + \frac{n}{2}\ln\left|\hat{\Omega}_0^{-1}\right|, \qquad l_1 = c + \frac{n}{2}\ln\left|\hat{\Omega}_1^{-1}\right| \qquad (1\text{-}10)$$

On these circumstances the LR test statistics can be written as

$$LR = -2(l_0 - l_1) = n\left[\ln\left|\hat{\Omega}_0^{-1}\right| - \ln\left|\hat{\Omega}^{-1}\right|\right] \sim \chi_q^2 \qquad (1\text{-}11)$$

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:

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

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 $\beta_1 = \beta_2 = ... = \beta_l = 0$ for each equation. The null hypotheses can be expressed as:

$H_{01}$: ‘x is not Granger cause of y’, in the first equation, and

$H_{02}$: ‘y is not Granger cause of x’, in the second.

The test statistic is given by

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

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 Variablesof

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.

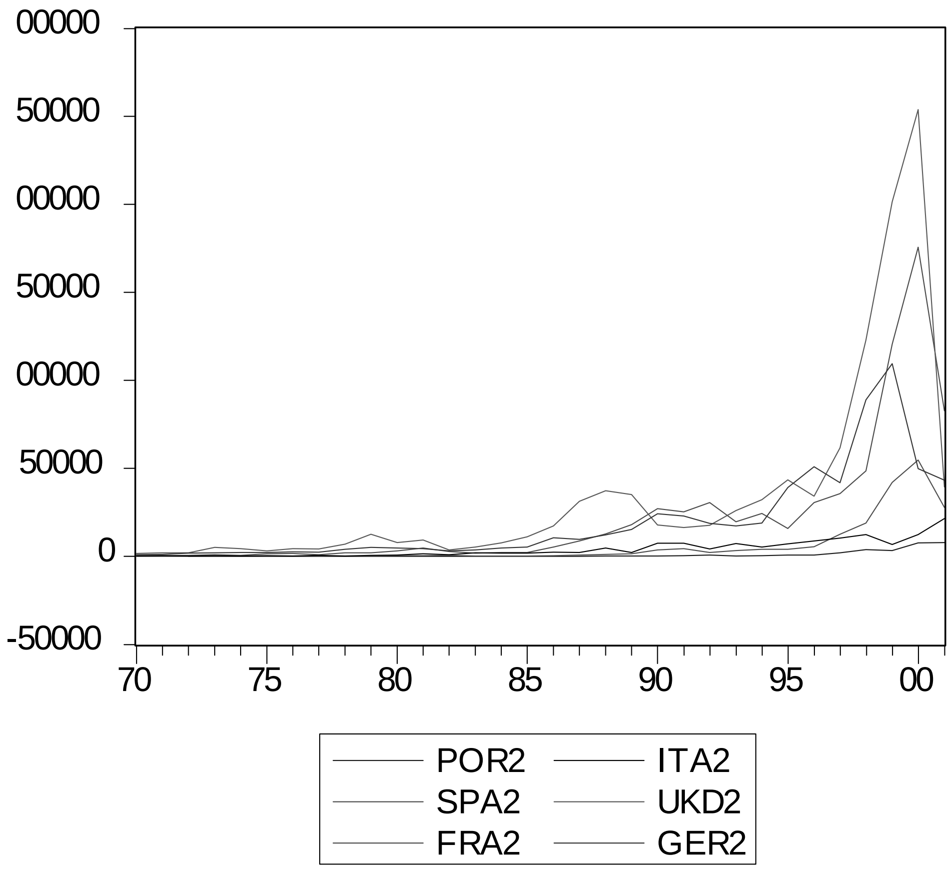
4) Independence of the FDI originated on the x and y economies: when the sets of estimated coefficients of the y variable and of the x variable are not statistically different from zero in the two regressions.

## 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 exists a long term equilibrium relationship.

The output of the software E-Views (v. 4) also shows the following results:

***Table n. 3.1 – Johansen Test to appreciate cointegration***

Unnormalized Cointegrating Coefficients:

| LOG(POR2) | LOG(SPA2) | LOG(FRA2) | LOG(ITA2) | LOG(GER2) | LOG(UKD2) |
|---|---|---|---|---|---|
| -0.111498 | -0.621011 | 0.102781 | 0.100648 | 0.459928 | 0.545677 |
| -0.239733 | 0.113774 | -0.394367 | -0.009972 | 1.047735 | -0.287185 |
| 0.189295 | -0.418643 | -0.096867 | 0.048905 | 0.609883 | -0.211612 |
| -0.088400 | -0.234237 | 0.368074 | 0.250456 | -0.138638 | -0.182603 |
| -0.025889 | -0.269427 | 0.738185 | -0.491751 | 0.448407 | -0.374290 |
| 0.222691 | 0.141105 | 0.185688 | 0.271167 | -0.904822 | -0.051100 |

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

| LOG(POR2) | LOG(SPA2) | LOG(FRA2) | LOG(ITA2) | LOG(GER2) | LOG(UKD2) | C |
|---|---|---|---|---|---|---|
| 1.000000 | 5.569687 | -0.921816 | -0.902685 | -4.124976 | -4.894034 | 56.81333 |
| | (0.72372) | (0.32626) | (0.24109) | (0.46627) | (0.64033) | |
| Log likelihood | -23.46048 | | | | | |

Normalized Cointegrating Coefficients: 2 Cointegrating Equation(s)

| LOG(POR2) | LOG(SPA2) | LOG(FRA2) | LOG(ITA2) | LOG(GER2) | LOG(UKD2) | C |
|---|---|---|---|---|---|---|
| 1.000000 | 0.000000 | 1.443484 | -0.032547 | -4.351155 | 0.719607 | 16.00535 |
| | | (0.44777) | (0.30617) | (0.74502) | (0.49879) | |
| 0.000000 | 1.000000 | -0.424674 | -0.156227 | 0.040609 | -1.007892 | 7.326799 |
| | | (0.09363) | (0.06402) | (0.15579) | (0.10430) | |
| Log likelihood | -8.476268 | | | | | |

Normalized Cointegrating Coefficients: 3 Cointegrating Equation(s)

| LOG(POR2) | LOG(SPA2) | LOG(FRA2) | LOG(ITA2) | LOG(GER2) | LOG(UKD2) | C |
|---|---|---|---|---|---|---|
| 1.000000 | 0.000000 | 0.000000 | -0.059781 | -0.529594 | -1.308438 | 13.42178 |
| | | | (0.27280) | (0.90028) | (0.74877) | |
| 0.000000 | 1.000000 | 0.000000 | -0.148215 | -1.083696 | -0.411240 | 8.086887 |
| | | | (0.07864) | (0.25953) | (0.21585) | |
| 0.000000 | 0.000000 | 1.000000 | 0.018867 | -2.647456 | 1.404965 | 1.789815 |
| | | | (0.23082) | (0.76176) | (0.63356) | |
| Log likelihood | 3.883588 | | | | | |

Normalized Cointegrating Coefficients: 4 Cointegrating Equation(s)

| LOG(POR2) | LOG(SPA2) | LOG(FRA2) | LOG(ITA2) | LOG(GER2) | LOG(UKD2) | C |
|---|---|---|---|---|---|---|
| 1.000000 | 0.000000 | 0.000000 | 0.000000 | -0.372389 | -1.576258 | 14.10216 |
| | | | | (1.61751) | (1.87569) | |
| 0.000000 | 1.000000 | 0.000000 | 0.000000 | -0.693939 | -1.075247 | 9.773758 |
| | | | | (0.55633) | (0.64513) | |
| 0.000000 | 0.000000 | 1.000000 | 0.000000 | -2.697069 | 1.489488 | 1.575089 |
| | | | | (1.32887) | (1.54098) | |
| 0.000000 | 0.000000 | 0.000000 | 1.000000 | 2.629673 | -4.480024 | 11.38123 |
| | | | | (3.97059) | (4.60436) | |
| Log likelihood | 13.38316 | | | | | |

Normalized Cointegrating Coefficients: 5 Cointegrating Equation(s)

| LOG(POR2) | LOG(SPA2) | LOG(FRA2) | LOG(ITA2) | LOG(GER2) | LOG(UKD2) | C |
|---|---|---|---|---|---|---|
| 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | -1.998304 | 14.74045 |
| | | | | | (0.16239) | |
| 0.000000 | 1.000000 | 0.000000 | 0.000000 | 0.000000 | -1.861720 | 10.96319 |
| | | | | | (0.09539) | |
| 0.000000 | 0.000000 | 1.000000 | 0.000000 | 0.000000 | -1.567221 | 6.197955 |
| | | | | | (0.18907) | |
| 0.000000 | 0.000000 | 0.000000 | 1.000000 | 0.000000 | -1.499698 | 6.873885 |
| | | | | | (0.23319) | |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 1.000000 | -1.133345 | 1.714033 |
| | | | | | (0.08893) | |
| Log likelihood | 14.75852 | | | | | |

## *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 following 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. 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. 3.1 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 CoVARiance | | 1.57E-05 | | | | |
| Log Likelihood | | -62.62051 | | | | |
| Akaike Information Criteria | | 9.963858 | | | | |
| Schwarz Criteria | | 12.05290 | | | | |

## 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

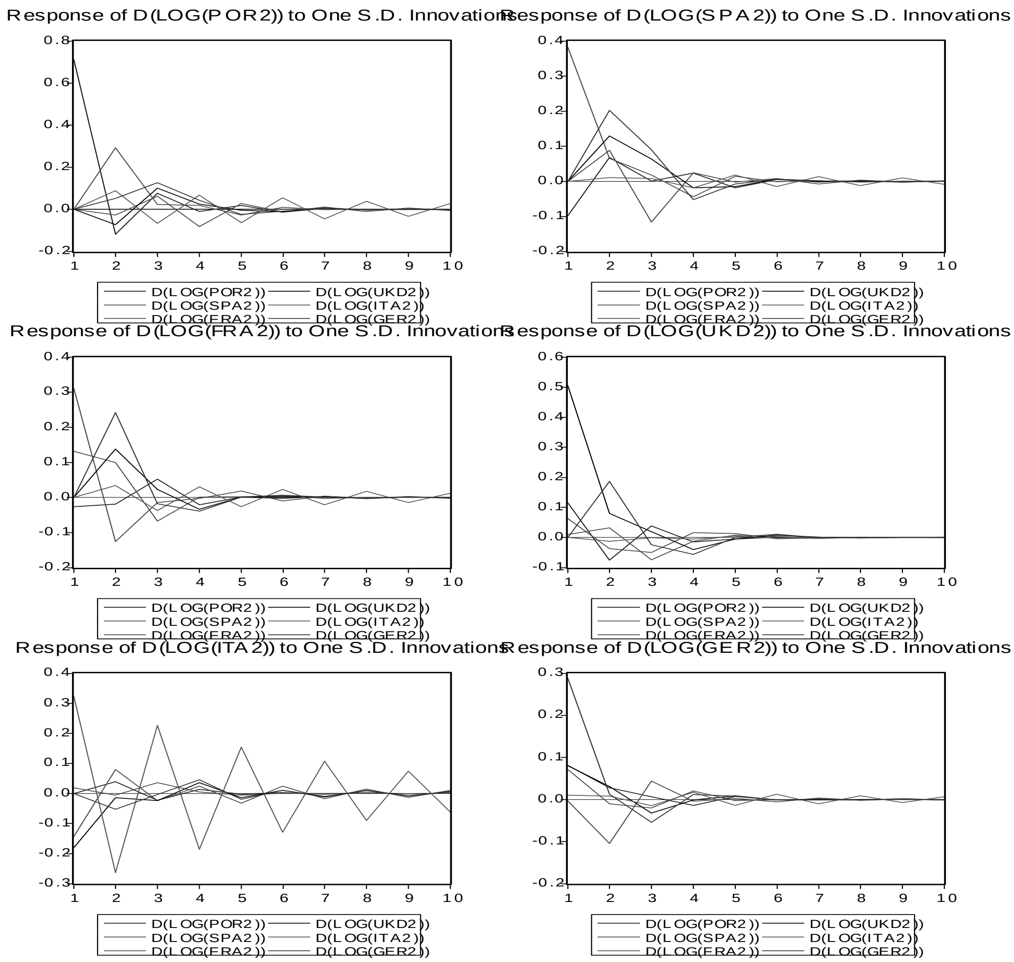
Let us see the shape of the two types of IRF, one the response of the economies to impulses of 1 dp, and another, the response of economies to impulses of 1 dp +/- 2 standard errors.

***(1) – Response of Economies to Impulses of 1 DP – Combined Graphics***

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 VARmodel.

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.

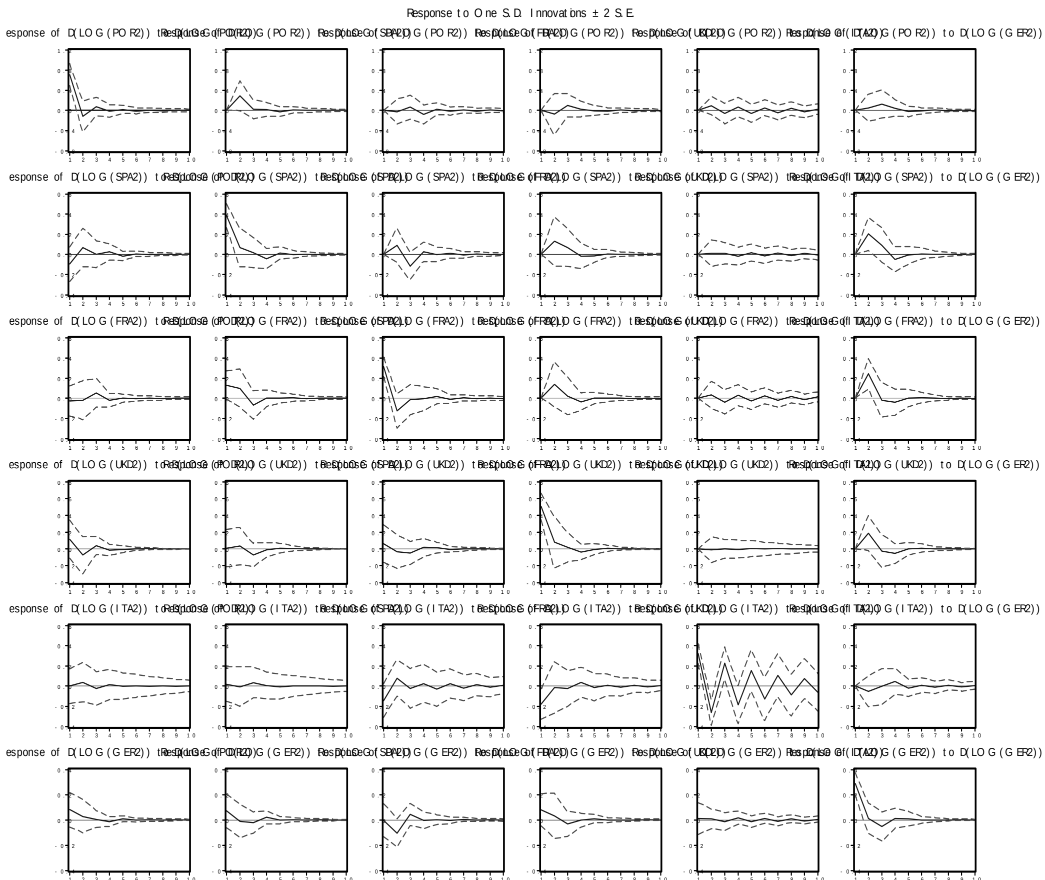
***Illustration n. 4-1: Economical Response to Impulses of 1 dp***



### *(2) Economical Response to Impulses of 1 Standard Deviation +/- 2 standard Errors – Multiple Response Graphics*

The following illustration shows the response pattern or the absorption rhythm of each one of the six economies – in foreign direct investment terms – to innovations or impulses of size 1 s.d. +/- 2 s.e.. For instance the 6 graphics of the first line give us the answer of the Portuguese economy to innovations or impulses introduced either in the own Portuguese economy or the others.

***Illustration n. 4-2: Economical Responses to Impulses of 1 s.d. +/- s.e.***



### 4.2.2 Impulse Response Functions – Numerical Analysis

Append to this paper we can find the numerical values that support the graphics referring the 6 economies' responses to innovations introduced in the VAR model structure.

### 4.2.3 Cholesky Variance Decomposition

Annex to this paper too we can find the values obtained with the variance decomposition using the Cholesky method. In it we can see how the variance of each one of the series is decomposed during a period of 10 years. The first group of columns is referred to capital exports of the Portuguese economy. These values show that the standard errors vary from 0.71 to 0.83, that the first value (0.71) is explained only by the Portuguese economy, that of those values of the standard errors the Portuguese economy explains between 75% and 100%, with values descending slowly, that Spain is the second more important economy to explain the variations in the Portuguese economy – with values from 12.7% till 13.9% – and that the importance of the other economies is nothing but residual with values that vary from 0% till 4.2%.

The second group of values shows that the explanation of the Spanish capital export variance is dependent of itself between 57.8% and 94%, that it is followed by Germany with values from 17 till 19%, by France with values between 3 and 8%, and Portugal with values from 5% to 6%.

The third group of values refers to the French capital exports; the most important economies are, besides itself, the German one, the Spanish one and the United Kingdom one.

The fourth group of values refers to the United Kingdom capital exports; the values obtained show that the most important economies are themselves followed by Germany, Portugal, Spain and France.

The fifth 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 itself, the English one, and the French one.

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 beside itself, France, the United Kingdom, Portugal and Spain.

## 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 VAR Model and other Considerations

To appreciate the Grangerian (non) causality we begin to estimate na 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 non stationarity 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. The results of the application of this test given by the E-Views (v.4) software can be seen in the table n. 4.3.1:

***Table n. 4.3.1: Appreciation of the Causality direction in the FDI – Granger Test***

Pairwise Granger Causality Tests
Sample: 1970 2001
Lags: 2

| Null Hypothesis: | Obs | F-Statistic | Probability |
|---|---|---|---|
| DLE does not Granger Cause DLP | 18 | 7.86718 | 0.00577 |
| DLP does not Granger Cause DLE | | 2.00824 | 0.17377 |
| DLF does not Granger Cause DLP | 18 | 0.22785 | 0.79936 |
| DLP does not Granger Cause DLF | | 2.37427 | 0.13215 |
| DLUK does not Granger Cause DLP | 18 | 0.49762 | 0.61910 |
| DLP does not Granger Cause DLUK | | 0.91677 | 0.42417 |
| DLI does not Granger Cause DLP | 18 | 2.02683 | 0.17132 |
| DLP does not Granger Cause DLI | | 1.52280 | 0.25458 |
| DLG does not Granger Cause DLP | 18 | 2.88789 | 0.09167 |
| DLP does not Granger Cause DLG | | 0.71595 | 0.50702 |
| DLF does not Granger Cause DLE | 29 | 1.18907 | 0.32181 |
| DLE does not Granger Cause DLF | | 0.85845 | 0.43643 |
| DLUK does not Granger Cause DLE | 29 | 2.88043 | 0.07565 |
| DLE does not Granger Cause DLUK | | 3.75935 | 0.03799 |
| DLI does not Granger Cause DLE | 29 | 0.79267 | 0.46413 |
| DLE does not Granger Cause DLI | | 0.45559 | 0.63944 |
| DLG does not Granger Cause DLE | 29 | 5.44789 | 0.01120 |
| DLE does not Granger Cause DLG | | 0.29378 | 0.74808 |
| DLUK does not Granger Cause DLF | 29 | 3.43883 | 0.04862 |
| DLF does not Granger Cause DLUK | | 4.99550 | 0.01535 |

| | | | |
|---|---|---|---|
| DLI does not Granger Cause DLF | 29 | 0.19735 | 0.82222 |
| DLF does not Granger Cause DLI | | 1.61335 | 0.22009 |
| DLG does not Granger Cause DLF | 29 | 8.09953 | 0.00205 |
| DLF does not Granger Cause DLG | | 0.90353 | 0.41848 |
| DLI does not Granger Cause DLUK | 29 | 1.20154 | 0.31818 |
| DLUK does not Granger Cause DLI | | 0.64687 | 0.53257 |
| DLG does not Granger Cause DLUK | 29 | 2.49749 | 0.10343 |
| DLUK does not Granger Cause DLG | | 0.28709 | 0.75298 |
| DLG does not Granger Cause DLI | 29 | 0.86895 | 0.43217 |
| DLI does not Granger Cause DLG | | 0.01775 | 0.98242 |

### 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***

There are 4 relationships of the unilateral type: one for Portugal-Spain, another for Portugal-Germany, another for Germany-Spain and a last one for Germany- France. Let us see them individually and let us see the causality sense, 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%).

The results permits to conclude that the unilateral relationship between Portugal and Germany has the sense Germany to Portugal (ls=9.2%); however, the significance level required to reject the null hypothesis is too high. The test doesn't admit the opposite hypothesis, i. e., that this relationship has the sense Portugal -> Germany (the minimum level of significance to admit this hypothesis is 50.7%).

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 is not accepted (the ls required to admit it is 74.8%).

The relationship between Germany and France besides being unilateral acts from Germany to (->) France (ls=0.2%). The opposite hypothesis is not accepted (the ls required to admit it is 41.8%).

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

***(2) Bilateral Type Relationships***

The tests used let 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.

The tests used let to the rejection of the two following null hypothesis – H01: "The United Kingdom is not Granger cause of Spain" (ls=7.6%), and H02: "Spain is not Granger cause of the United Kingdom" (ls=3.8%) –, what means that the capital exporting sectors of Spain and United Kingdom are also interrelated and influence each other.

Thus the country that has more relationships of the bilateral type is that of the United Kingdom, followed by France and Spain.

***(3) Independence Relationships***

The following relationships are the ones of the independence type detected by the Granger (non)causality analysis: France – Portugal, United Kingdom – Portugal, Italy – Portugal, France – Spain, Italy – Spain, Italy – France, Italy – United Kingdom, Germany – United Kingdom, Germany – Italy.

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

- That the more independent economies in terms of capital exports are Italy with 5 relationships of this type (P, S, F, UK, G), followed by

Portugal with 3 (I, F, UK), by the United Kingdom with 3 (P, I, G), by France with 3 (P, I, S),by Spain with 2 (I, F) and by Germany with 2 (UK, I).

- That the more opened economies in terms of capital exporting for direct investment – those that have a greater number of the bilateral type – are the United Kingdom with two (with France and Spain), France with one (with the UK) and Spain with one too (with the UK).
- That the economies that have a greater number of unilateral relationships are Germany with 3 (with P, S, F) and Spain with one (Portugal); what we came to write confirms the importance of Germany as the financial engine of the European Union – or at least for 3 of the 6 countries included in our study – and also the importance of Spain as financial engine of Portugal at least during the last few years.

## 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 sectors. 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 causality, or preferable, 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; it also shows that the more opened economies – those that have a greater number of bilateral relationships – are the United Kingdom with 2, France with one and Spain with one too, and that the economies that have a greater number of unilateral relationships are Germany with 3 and Spain with one, results that attest the great importance of German financial centre at least for 3 of the 6 economies (of the EU) of the study and the great importance of the financial centre of Madrid for the Portuguese economy at least during the last few years.

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## ANNEX

### *Table n. A3.1: IR Functions – Table of the values*

| | | | Response of DLP: | | | |
|---|---|---|---|---|---|---|
| Period | DLP | DLE | DLF | DLUK | DLI | DLG |
| 1 | 0.710436 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| | (0.10962) | (0.00000) | (0.00000) | (0.00000) | (0.00000) | (0.00000) |
| 2 | -0.117083 | 0.293966 | -0.027146 | -0.071001 | 0.089066 | 0.051633 |
| | (0.15392) | (0.14815) | (0.12394) | (0.20341) | (0.08927) | (0.13626) |
| 3 | 0.076413 | 0.023842 | 0.063011 | 0.100043 | -0.066059 | 0.126542 |
| | (0.09340) | (0.09704) | (0.12038) | (0.11440) | (0.10199) | (0.13975) |
| 4 | -0.010181 | 0.018584 | -0.082236 | 0.025411 | 0.067469 | 0.043640 |
| | (0.06205) | (0.06862) | (0.09332) | (0.07574) | (0.09641) | (0.08245) |
| 5 | 0.018530 | -0.026688 | 0.028285 | -0.003810 | -0.063341 | -0.023708 |
| | (0.04061) | (0.04555) | (0.05924) | (0.04925) | (0.08740) | (0.05172) |
| 6 | -0.013248 | 0.009771 | -0.011604 | -0.012044 | 0.054622 | -0.007151 |
| | (0.03042) | (0.03119) | (0.04104) | (0.03109) | (0.08027) | (0.03028) |
| 7 | 0.005228 | -0.001323 | 0.011965 | 0.007216 | -0.046089 | 0.007228 |
| | (0.02328) | (0.02203) | (0.03286) | (0.02278) | (0.07278) | (0.02115) |
| 8 | -0.002337 | 0.001038 | -0.009905 | -0.003044 | 0.038989 | -0.002560 |
| | (0.01851) | (0.01681) | (0.02731) | (0.01747) | (0.06510) | (0.01511) |
| 9 | 0.001781 | -0.000907 | 0.006699 | 0.002898 | -0.032814 | 0.002562 |
| | (0.01522) | (0.01374) | (0.02260) | (0.01431) | (0.05799) | (0.01138) |
| 10 | -0.001234 | 0.000184 | -0.004987 | -0.002877 | 0.027429 | -0.003084 |
| | (0.01269) | (0.01134) | (0.01901) | (0.01201) | (0.05156) | (0.00911) |
| | | | Response of DLE: | | | |
| Period | DLP | DLE | DLF | DLUK | DLI | DLG |
| 1 | -0.097534 | 0.382634 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| | (0.08484) | (0.05904) | (0.00000) | (0.00000) | (0.00000) | (0.00000) |
| 2 | 0.067633 | 0.065415 | 0.088345 | 0.129483 | 0.010769 | 0.202216 |
| | (0.09561) | (0.09554) | (0.08630) | (0.12223) | (0.06568) | (0.08179) |
| 3 | 0.000969 | 0.017985 | -0.115919 | 0.064068 | 0.008628 | 0.089530 |
| | (0.06567) | (0.07482) | (0.06901) | (0.09244) | (0.05308) | (0.08476) |
| 4 | 0.023563 | -0.044207 | 0.025058 | -0.017970 | -0.018459 | -0.052153 |

| Period | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|
| | (0.03873) | (0.05055) | (0.04912) | (0.06301) | (0.04495) | (0.06218) |
| 5 | -0.018511 | 0.014554 | -0.001904 | -0.014813 | 0.017476 | -0.007459 |
| | (0.02336) | (0.03014) | (0.03556) | (0.03297) | (0.04263) | (0.04356) |
| 6 | 0.005685 | -0.000969 | 0.008167 | 0.006258 | -0.015089 | 0.006517 |
| | (0.01441) | (0.01835) | (0.02378) | (0.01957) | (0.03903) | (0.02720) |
| 7 | -0.001867 | 0.001748 | -0.007365 | 0.000352 | 0.013477 | 0.001808 |
| | (0.00965) | (0.01036) | (0.01655) | (0.01121) | (0.03441) | (0.01552) |
| 8 | 0.001729 | -0.001942 | 0.003527 | 0.000586 | -0.011779 | -0.000747 |
| | (0.00690) | (0.00732) | (0.01105) | (0.00748) | (0.03011) | (0.00844) |
| 9 | -0.001171 | 0.000704 | -0.002065 | -0.001401 | 0.009975 | -0.001099 |
| | (0.00525) | (0.00481) | (0.00847) | (0.00531) | (0.02617) | (0.00513) |
| 10 | 0.000547 | -0.000106 | 0.001783 | 0.000985 | -0.008368 | 0.001029 |
| | (0.00408) | (0.00369) | (0.00680) | (0.00419) | (0.02260) | (0.00369) |

Response of DLF:

| Period | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|
| 1 | -0.027056 | 0.131049 | 0.310689 | 0.000000 | 0.000000 | 0.000000 |
| | (0.07370) | (0.07075) | (0.04794) | (0.00000) | (0.00000) | (0.00000) |
| 2 | -0.018949 | 0.098857 | -0.125692 | 0.138496 | 0.033321 | 0.242687 |
| | (0.09584) | (0.09534) | (0.08636) | (0.11204) | (0.06757) | (0.07482) |
| 3 | 0.052672 | -0.067422 | -0.014404 | 0.023308 | -0.037991 | -0.018099 |
| | (0.07017) | (0.06993) | (0.07428) | (0.09460) | (0.05977) | (0.08535) |
| 4 | -0.020587 | 0.000479 | -0.002720 | -0.033609 | 0.030162 | -0.039166 |
| | (0.03336) | (0.04097) | (0.05756) | (0.04341) | (0.05258) | (0.06508) |
| 5 | 0.001743 | 0.002202 | 0.018763 | 0.000498 | -0.026217 | 0.001638 |
| | (0.01964) | (0.02642) | (0.03727) | (0.02816) | (0.04299) | (0.04179) |
| 6 | -0.002296 | 0.004478 | -0.009894 | 0.002420 | 0.023485 | 0.006208 |
| | (0.01458) | (0.01798) | (0.02087) | (0.01922) | (0.03921) | (0.02635) |
| 7 | 0.002900 | -0.002631 | 0.003688 | 0.002580 | -0.020085 | 0.001108 |
| | (0.01119) | (0.01134) | (0.01541) | (0.01179) | (0.03545) | (0.01322) |
| 8 | -0.001419 | 0.000229 | -0.003188 | -0.002616 | 0.016787 | -0.002816 |
| | (0.00811) | (0.00768) | (0.01238) | (0.00877) | (0.03127) | (0.00882) |
| 9 | 0.000557 | 6.70E-05 | 0.003022 | 0.001336 | -0.014052 | 0.001518 |
| | (0.00659) | (0.00606) | (0.01021) | (0.00641) | (0.02749) | (0.00544) |
| 10 | -0.000405 | 6.42E-05 | -0.002277 | -0.001000 | 0.011767 | -0.001054 |
| | (0.00548) | (0.00491) | (0.00839) | (0.00525) | (0.02422) | (0.00437) |

Response of DLUK:

| Period | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|
| 1 | 0.115438 | 0.010032 | 0.063257 | 0.505454 | 0.000000 | 0.000000 |
| | (0.11260) | (0.11117) | (0.11073) | (0.07799) | (0.00000) | (0.00000) |
| 2 | -0.075059 | 0.032094 | -0.036189 | 0.080112 | -0.012704 | 0.186660 |
| | (0.11048) | (0.11132) | (0.09949) | (0.15445) | (0.07616) | (0.10409) |
| 3 | 0.039126 | -0.074293 | -0.049023 | 0.019326 | -0.000809 | -0.023760 |
| | (0.05394) | (0.06964) | (0.06775) | (0.08688) | (0.05586) | (0.09647) |
| 4 | -0.015089 | -0.012501 | 0.016305 | -0.040066 | -0.005374 | -0.055552 |
| | (0.03434) | (0.04293) | (0.05524) | (0.04644) | (0.05415) | (0.05874) |
| 5 | -0.005032 | 0.007867 | 0.012585 | -0.004836 | 0.004431 | -0.000481 |
| | (0.01984) | (0.02945) | (0.03081) | (0.03288) | (0.04742) | (0.03680) |
| 6 | 0.000629 | 0.003661 | -0.004115 | 0.006795 | -0.002295 | 0.010631 |
| | (0.00992) | (0.01385) | (0.01728) | (0.01748) | (0.03969) | (0.02459) |
| 7 | 0.001722 | -0.002388 | -0.001569 | 0.000628 | 0.001621 | -0.000854 |
| | (0.00579) | (0.00835) | (0.01100) | (0.00884) | (0.03318) | (0.01235) |
| 8 | -0.000575 | -0.000131 | 0.000555 | -0.001087 | -0.001460 | -0.001390 |
| | (0.00321) | (0.00402) | (0.00704) | (0.00567) | (0.02807) | (0.00826) |
| 9 | -8.00E-05 | 0.000158 | 0.000278 | -0.000209 | 0.001198 | -0.000141 |
| | (0.00191) | (0.00216) | (0.00514) | (0.00318) | (0.02356) | (0.00409) |
| 10 | -1.15E-06 | 0.000162 | -3.15E-05 | 0.000290 | -0.000941 | 0.000451 |
| | (0.00102) | (0.00107) | (0.00383) | (0.00237) | (0.01966) | (0.00294) |

Response of DLI:

| Period | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|
| 1 | -0.000484 | 0.018852 | -0.142856 | -0.179884 | 0.321912 | 0.000000 |
| | (0.08640) | (0.08635) | (0.08343) | (0.07553) | (0.04967) | (0.00000) |
| 2 | 0.038951 | -0.005401 | 0.079498 | -0.014129 | -0.262755 | -0.051927 |
| | (0.09747) | (0.09830) | (0.09006) | (0.12679) | (0.06441) | (0.07623) |
| 3 | -0.023357 | 0.035466 | -0.023504 | -0.023599 | 0.225783 | -0.004105 |
| | (0.08377) | (0.07606) | (0.09833) | (0.08761) | (0.08073) | (0.08975) |
| 4 | 0.013466 | 0.005097 | 0.024341 | 0.036710 | -0.185661 | 0.045453 |
| | (0.07543) | (0.06642) | (0.09523) | (0.07448) | (0.09464) | (0.06445) |
| 5 | -0.002121 | -0.005559 | -0.032089 | -0.014147 | 0.154449 | -0.019419 |
| | (0.06519) | (0.06032) | (0.08353) | (0.06727) | (0.10276) | (0.04204) |
| 6 | 0.002570 | 0.000399 | 0.024363 | 0.009451 | -0.129122 | 0.010523 |
| | (0.05622) | (0.05155) | (0.07279) | (0.05342) | (0.10652) | (0.03654) |
| 7 | -0.003074 | -0.000452 | -0.017747 | -0.010502 | 0.107569 | -0.012015 |
| | (0.04795) | (0.04330) | (0.06396) | (0.04366) | (0.10650) | (0.03132) |
| 8 | 0.002174 | 0.001394 | 0.014862 | 0.009157 | -0.089414 | 0.011187 |
| | (0.04052) | (0.03647) | (0.05565) | (0.03687) | (0.10372) | (0.02603) |
| 9 | -0.001500 | -0.001280 | -0.012664 | -0.007139 | 0.074350 | -0.008816 |
| | (0.03411) | (0.03062) | (0.04807) | (0.03096) | (0.09899) | (0.02192) |
| 10 | 0.001241 | 0.000956 | 0.010443 | 0.005849 | -0.061839 | 0.007156 |
| | (0.02861) | (0.02553) | (0.04142) | (0.02592) | (0.09298) | (0.01886) |

Response of DLG:

| Period | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|
| 1 | 0.081294 | 0.070974 | -0.003434 | 0.080131 | 0.010174 | 0.288110 |
| | (0.06827) | (0.06621) | (0.06530) | (0.06411) | (0.06289) | (0.04446) |
| 2 | 0.028081 | -0.010755 | -0.104267 | 0.031322 | 0.008230 | 0.012854 |
| | (0.06559) | (0.06641) | (0.05695) | (0.09058) | (0.03929) | (0.06094) |
| 3 | 0.006417 | -0.020506 | 0.043457 | -0.032203 | -0.015256 | -0.054074 |
| | (0.03249) | (0.04189) | (0.04286) | (0.04945) | (0.03582) | (0.05781) |
| 4 | -0.013805 | 0.019829 | -0.004346 | -0.001578 | 0.016743 | 0.011648 |
| | (0.01923) | (0.02467) | (0.03320) | (0.02670) | (0.02611) | (0.03958) |
| 5 | 0.007261 | -0.002910 | 0.002466 | 0.008780 | -0.014180 | 0.008264 |
| | (0.01161) | (0.01456) | (0.01921) | (0.01648) | (0.02205) | (0.02898) |
| 6 | -0.001641 | 2.16E-05 | -0.005718 | -0.001636 | 0.012166 | -0.001767 |
| | (0.00849) | (0.00942) | (0.01289) | (0.00959) | (0.01989) | (0.01312) |
| 7 | 0.000947 | -0.001127 | 0.003775 | -1.39E-05 | -0.010596 | -0.000900 |
| | (0.00567) | (0.00600) | (0.00817) | (0.00693) | (0.01777) | (0.00885) |
| 8 | -0.000928 | 0.000778 | -0.001903 | -0.000900 | 0.009020 | -0.000463 |
| | (0.00444) | (0.00427) | (0.00656) | (0.00441) | (0.01570) | (0.00423) |
| 9 | 0.000534 | -0.000142 | 0.001437 | 0.000972 | -0.007555 | 0.000998 |
| | (0.00353) | (0.00324) | (0.00528) | (0.00350) | (0.01390) | (0.00305) |
| 10 | -0.000255 | -1.60E-05 | -0.001254 | -0.000636 | 0.006316 | -0.000717 |
| | (0.00294) | (0.00265) | (0.00443) | (0.00281) | (0.01232) | (0.00225) |

Ordering: DLP DLE DLF DLUK DLI DLG

## *Table n. A4.1 – Cholesky VARiance Decomposition*

Decomposition of the VARiance of DLP:

| Period | S.E. | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|---|
| 1 | 0.710436 | 100.0000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.788176 | 83.45309 | 13.91071 | 0.118626 | 0.811478 | 1.276950 | 0.429146 |
| 3 | 0.813624 | 79.19633 | 13.14000 | 0.711088 | 2.273422 | 1.857523 | 2.821634 |
| 4 | 0.822373 | 77.53543 | 12.91296 | 1.696013 | 2.320786 | 2.491300 | 3.043517 |

| Period | S.E. | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|---|
| 5 | 0.826282 | 76.85388 | 12.89539 | 1.797187 | 2.301006 | 3.055420 | 3.097116 |
| 6 | 0.828449 | 76.47797 | 12.84194 | 1.807416 | 2.310121 | 3.474168 | 3.088388 |
| 7 | 0.829897 | 76.21535 | 12.79743 | 1.821904 | 2.309630 | 3.770476 | 3.085209 |
| 8 | 0.830884 | 76.03502 | 12.76717 | 1.831785 | 2.305483 | 3.981706 | 3.078826 |
| 9 | 0.831571 | 75.91007 | 12.74623 | 1.835253 | 2.302895 | 4.130852 | 3.074697 |
| 10 | 0.832049 | 75.82295 | 12.73157 | 1.836733 | 2.301441 | 4.234770 | 3.072533 |

Decomposition of the VARiance of DLE:

| Period | S.E. | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|---|
| 1 | 0.394869 | 6.101039 | 93.89896 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.479951 | 6.115399 | 65.41613 | 3.388172 | 7.278374 | 0.050347 | 17.75158 |
| 3 | 0.506270 | 5.496461 | 58.91766 | 8.287617 | 8.142744 | 0.074291 | 19.08123 |
| 4 | 0.512670 | 5.571343 | 58.19941 | 8.320899 | 8.063586 | 0.202082 | 19.64268 |
| 5 | 0.513779 | 5.677126 | 58.02862 | 8.286383 | 8.111930 | 0.316906 | 19.57903 |
| 6 | 0.514177 | 5.680560 | 57.93914 | 8.298787 | 8.114186 | 0.402538 | 19.56479 |
| 7 | 0.514416 | 5.676599 | 57.88648 | 8.311577 | 8.106695 | 0.470802 | 19.54785 |
| 8 | 0.514571 | 5.674323 | 57.85318 | 8.311287 | 8.101962 | 0.522920 | 19.53633 |
| 9 | 0.514677 | 5.672510 | 57.82960 | 8.309483 | 8.099375 | 0.560268 | 19.52876 |
| 10 | 0.514750 | 5.671006 | 57.81312 | 8.308314 | 8.097432 | 0.586535 | 19.52359 |

Decomposition of the VARiance of DLF:

| Period | S.E. | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|---|
| 1 | 0.338280 | 0.639689 | 15.00771 | 84.35260 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.468564 | 0.496958 | 12.27341 | 51.16148 | 8.736483 | 0.505720 | 26.82595 |
| 3 | 0.478950 | 1.685072 | 13.72846 | 49.05693 | 8.598486 | 1.113218 | 25.81783 |
| 4 | 0.483113 | 1.837748 | 13.49299 | 48.21835 | 8.934925 | 1.483905 | 26.03208 |
| 5 | 0.484199 | 1.830812 | 13.43462 | 48.15252 | 8.895009 | 1.770418 | 25.91662 |
| 6 | 0.484941 | 1.827455 | 13.40207 | 48.04690 | 8.870298 | 1.999532 | 25.85375 |
| 7 | 0.485395 | 1.827611 | 13.37996 | 47.96289 | 8.856549 | 2.167022 | 25.80596 |
| 8 | 0.485713 | 1.826072 | 13.36247 | 47.90442 | 8.847857 | 2.283634 | 25.77555 |
| 9 | 0.485930 | 1.824572 | 13.35053 | 47.86548 | 8.840706 | 2.365222 | 25.75349 |
| 10 | 0.486080 | 1.823514 | 13.34229 | 47.83811 | 8.835670 | 2.422363 | 25.73805 |

Decomposition of the VARiance of the DLUK:

| Period | S.E. | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|---|
| 1 | 0.522410 | 4.882870 | 0.036879 | 1.466191 | 93.61406 | 0.000000 | 0.000000 |
| 2 | 0.567721 | 5.882532 | 0.350814 | 1.647833 | 81.25855 | 0.050071 | 10.81020 |
| 3 | 0.576801 | 6.158922 | 1.998849 | 2.318711 | 78.83260 | 0.048704 | 10.64222 |
| 4 | 0.581437 | 6.128439 | 2.013323 | 2.360522 | 78.05524 | 0.056473 | 11.38601 |
| 5 | 0.581686 | 6.130690 | 2.029898 | 2.405315 | 77.99551 | 0.062229 | 11.37635 |
| 6 | 0.581853 | 6.127272 | 2.032686 | 2.408931 | 77.96419 | 0.063749 | 11.40318 |
| 7 | 0.581866 | 6.127879 | 2.034281 | 2.409552 | 77.96088 | 0.064522 | 11.40289 |
| 8 | 0.581871 | 6.127870 | 2.034250 | 2.409600 | 77.95987 | 0.065151 | 11.40326 |
| 9 | 0.581873 | 6.127843 | 2.034248 | 2.409612 | 77.95951 | 0.065574 | 11.40321 |
| 10 | 0.581874 | 6.127821 | 2.034249 | 2.409603 | 77.95926 | 0.065836 | 11.40323 |

Decomposition of the VARiance of DLI:

| Period | S.E. | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|---|
| 1 | 0.395915 | 0.000149 | 0.226734 | 13.01950 | 20.64332 | 66.11030 | 0.000000 |
| 2 | 0.486366 | 0.641472 | 0.162574 | 11.29896 | 13.76352 | 72.99359 | 1.139891 |
| 3 | 0.538943 | 0.710237 | 0.565446 | 9.392136 | 11.40082 | 76.99722 | 0.934136 |
| 4 | 0.573709 | 0.681854 | 0.506884 | 8.468317 | 10.47034 | 78.42056 | 1.452041 |
| 5 | 0.595516 | 0.634101 | 0.479155 | 8.149847 | 9.774011 | 79.50891 | 1.453977 |
| 6 | 0.610010 | 0.606102 | 0.456699 | 7.926672 | 9.339065 | 80.25600 | 1.415464 |
| 7 | 0.619889 | 0.589396 | 0.442311 | 7.757992 | 9.072465 | 80.72956 | 1.408273 |
| 8 | 0.626653 | 0.577946 | 0.433309 | 7.647668 | 8.899028 | 81.03214 | 1.409908 |
| 9 | 0.631280 | 0.570069 | 0.427391 | 7.576206 | 8.781834 | 81.23568 | 1.408819 |
| 10 | 0.634457 | 0.564757 | 0.423348 | 7.527618 | 8.702609 | 81.37420 | 1.407466 |

Decomposition of the VARiance of DLG:

| Period | S.E. | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|---|
| 1 | 0.318103 | 6.531004 | 4.978014 | 0.011653 | 6.345545 | 0.102289 | 82.03150 |
| 2 | 0.337905 | 6.478621 | 4.512985 | 9.531851 | 6.482864 | 0.149967 | 72.84371 |
| 3 | 0.347453 | 6.161545 | 4.616654 | 10.57952 | 6.990482 | 0.334635 | 71.31716 |
| 4 | 0.348920 | 6.266402 | 4.900900 | 10.50630 | 6.933894 | 0.562076 | 70.83043 |
| 5 | 0.349512 | 6.288336 | 4.891234 | 10.47569 | 6.973521 | 0.724770 | 70.64645 |
| 6 | 0.349783 | 6.280813 | 4.883670 | 10.48621 | 6.964925 | 0.844626 | 70.53975 |
| 7 | 0.349968 | 6.274904 | 4.879544 | 10.48676 | 6.957561 | 0.935402 | 70.46583 |
| 8 | 0.350093 | 6.271129 | 4.876555 | 10.48223 | 6.953256 | 1.001116 | 70.41571 |
| 9 | 0.350180 | 6.268222 | 4.874130 | 10.47867 | 6.950545 | 1.047164 | 70.38127 |
| 10 | 0.350241 | 6.266106 | 4.872444 | 10.47633 | 6.948470 | 1.079318 | 70.35733 |

Ordering: DLP DLE DLF DLUK DLI DLG

## Table n. A.4.2 – Granger Causality – VAR(2) Model with 6 Variablesand without Independent terms

Sample(adjusted): 1975 2001
Included observations: 18
Excluded observations: 9 after adjusting endpoints
Standard errors & t-statistics in parentheses

| | DLP | DLE | DLF | DLUK | DLI | DLG |
|---|---|---|---|---|---|---|
| DLP(-1) | 0.233860 | 0.077225 | -0.153844 | -0.223887 | 0.175875 | 0.063247 |
| | (0.18988) | (0.15166) | (0.12609) | (0.25287) | (0.22752) | (0.14651) |
| | (1.23160) | (0.50921) | (-1.22011) | (-0.88539) | (0.77301) | (0.43170) |
| DLP(-2) | -0.526618 | 0.233038 | 0.210861 | 0.018533 | -0.117194 | -0.152121 |
| | (0.17530) | (0.14001) | (0.11641) | (0.23345) | (0.21005) | (0.13526) |
| | (-3.00407) | (1.66442) | (1.81141) | (0.07939) | (-0.55794) | (-1.12468) |
| DLE(-1) | 0.484890 | 0.296583 | 0.248667 | 0.237009 | 0.256815 | 0.300570 |
| | (0.41138) | (0.32857) | (0.27317) | (0.54784) | (0.49292) | (0.31741) |
| | (1.17869) | (0.90266) | (0.91029) | (0.43262) | (0.52101) | (0.94695) |
| DLE(-2) | -1.166788 | 0.065857 | 0.364663 | 0.077347 | -0.030971 | 0.054459 |
| | (0.35408) | (0.28280) | (0.23512) | (0.47153) | (0.42426) | (0.27319) |
| | (-3.29530) | (0.23288) | (1.55096) | (0.16404) | (-0.07300) | (0.19934) |
| DLF(-1) | 0.000346 | -0.070335 | -0.665761 | -0.279383 | -0.129192 | -0.343823 |
| | (0.49963) | (0.39905) | (0.33178) | (0.66537) | (0.59867) | (0.38550) |
| | (0.00069) | (-0.17625) | (-2.00666) | (-0.41989) | (-0.21580) | (-0.89188) |
| DLF(-2) | 0.057342 | -0.526632 | -0.380623 | -0.527494 | 0.288669 | -0.276258 |
| | (0.47524) | (0.37957) | (0.31558) | (0.63289) | (0.56944) | (0.36669) |
| | (0.12066) | (-1.38743) | (-1.20610) | (-0.83347) | (0.50693) | (-0.75339) |
| DLUK(-1) | 0.228780 | 0.282213 | 0.380555 | 0.214903 | -0.150233 | 0.218343 |
| | (0.33257) | (0.26562) | (0.22084) | (0.44288) | (0.39849) | (0.25660) |
| | (0.68792) | (1.06248) | (1.72323) | (0.48524) | (-0.37701) | (0.85091) |

| | | | | | | |
|---|---|---|---|---|---|---|
| DLUK(-2) | 0.407453 | 0.081004 | 0.013253 | -0.355023 | -0.024465 | 0.197276 |
| | (0.33546) | (0.26793) | (0.22276) | (0.44673) | (0.40195) | (0.25883) |
| | (1.21462) | (0.30234) | (0.05950) | (-0.79471) | (-0.06087) | (0.76218) |
| DLI(-1) | 0.971815 | -0.229455 | 0.054074 | 0.055342 | -0.979763 | 0.334731 |
| | (0.37991) | (0.30343) | (0.25228) | (0.50593) | (0.45521) | (0.29313) |
| | (2.55801) | (-0.75620) | (0.21434) | (0.10939) | (-2.15232) | (1.14193) |
| DLI(-2) | 0.769659 | -0.451400 | -0.178494 | 0.257396 | -0.479688 | 0.259970 |
| | (0.42471) | (0.33921) | (0.28203) | (0.56559) | (0.50889) | (0.32770) |
| | (1.81219) | (-1.33073) | (-0.63290) | (0.45509) | (-0.94261) | (0.79333) |
| DLG(-1) | 0.115285 | 0.383942 | 0.498153 | 0.471487 | 0.030743 | -0.141912 |
| | (0.40562) | (0.32397) | (0.26935) | (0.54017) | (0.48602) | (0.31297) |
| | (0.28422) | (1.18513) | (1.84947) | (0.87285) | (0.06325) | (-0.45344) |
| DLG(-2) | 1.191615 | 0.073053 | 0.465821 | 0.369021 | 0.309103 | -0.361002 |
| | (0.66333) | (0.52979) | (0.44048) | (0.88336) | (0.79481) | (0.51181) |
| | (1.79642) | (0.13789) | (1.05754) | (0.41775) | (0.38890) | (-0.70535) |
| R-squared | 0.870388 | 0.746025 | 0.824929 | 0.484868 | 0.642469 | 0.555754 |
| Adj. R-squared | 0.632767 | 0.280404 | 0.503966 | -0.459540 | -0.013005 | -0.258698 |
| Sum sq. Resids | 1.617870 | 1.032048 | 0.713399 | 2.869214 | 2.322794 | 0.963154 |
| S.E. equation | 0.519273 | 0.414738 | 0.344819 | 0.691522 | 0.622200 | 0.400657 |
| F-statistic | 3.662921 | 1.602215 | 2.570166 | 0.513410 | 0.980159 | 0.682365 |
| Log likelihood | -3.857540 | 0.188549 | 3.511883 | -9.013891 | -7.112483 | 0.810328 |
| Akaike AIC | 1.761949 | 1.312383 | 0.943124 | 2.334877 | 2.123609 | 1.243297 |
| Schwarz SC | 2.355530 | 1.905965 | 1.536705 | 2.928458 | 2.717190 | 1.836878 |
| Mean dependent | 0.167346 | 0.085101 | 0.117184 | 0.129155 | 0.078281 | 0.097590 |
| S.D. dependent | 0.856890 | 0.488911 | 0.489593 | 0.572398 | 0.618193 | 0.357118 |

| | |
|---|---|
| Determinant Residual CoVARiance | 1.39E-09 |
| Log Likelihood | 30.28123 |
| Akaike Information Criteria | 4.635419 |
| Schwarz Criteria | 8.196906 |