LUSO-SPANISH-FRANCO-ENGLISH RELATIONS VIEWED FROM THE ENTRANCE OF FOREIGN INVESTMENT FUNDS (1970-2001)

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SUMMARY

The main objective of the present paper is to study the relationships and the interrelationships among the financial flows (as Foreign Direct Investment – FDI) that entered the Portuguese, Spanish, French and English economies from 1970 till 2001.

With this objective in mind this paper or communication begins by describing the methodology used, an econometric one, methodology that begins by the utilisation of various tests to appreciate the quality of the data series, namely their stationarity, integration and cointegration, that continues by the appreciation of the multilateral and bilateral causality among the four referred economies and ends with the Auto-Regressive Vector (VAR) modelling. After this it presents the data bank and the origins of the different Foreign Direct Investment series (the FDI entrances). The presentation of an empirical work applied to the four western European economies referred earlier and the interpretation of the results are the last parts of the paper.

Keywords*: integration, cointegration, VAR modelling, causality, foreign direct investment, territorial dynamics, new regional techniques*

1. INTRODUCTION AND MAIN OBJECTIVES

Before we enter 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. "Foreign direct investment (FDI) is defined as an investment involving a long-term relationship and reflecting a lasting interest and control of a resident entity in one economy (foreign direct investor or parent enterprise) in an enterprise resident in an economy other than that of the foreign direct investor (FDI enterprise or affiliate enterprise or foreign affiliate). FDI implies that the investor exerts a significant degree of influence on the management of the enterprise resident in the other economy. Such investment involves both the initial transaction between the two entities and all subsequent transactions between them and among foreign affiliates, both incorporated and unincorporated. FDI may be undertaken by individuals as well as business entities. Flows of FDI comprise capital provided (either directly or through other related enterprises) by a foreign direct investor to an FDI enterprise, or capital received from an FDI enterprise by a foreign direct investor. There are three components in FDI: equity capital, reinvested earnings and intra-company loans. Equity capital is the foreign direct investor's purchase of shares of an enterprise in a country other than its own. Reinvested earnings comprise the direct investor's share (in proportion to direct equity participation) of earnings not distributed as dividends by affiliates or earnings not remitted to the direct investor. Such retained profits by affiliates are reinvested. Intra-company loans or intra-company debt transactions refer to short- or long-term borrowing and lending of funds between direct investors (parent enterprises) and affiliate enterprises.

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 European Union (EU) – more precisely Portugal (P), Spain (S), France (F) and United Kingdom (UK) – departing from the FDI entered in these economies. In order to reach these aims we use the Autoregressive Vector (VAR) model and the Granger causality theory.

More deeply we can say that the main objectives of this work are: (1) to study the Foreign Direct Investment (FDI) entered in the four economies from 1970 till 2001; (2) to appreciate the inter-relationships that can be detected in this way among the 4 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 its 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 Vector Autoregressive (VAR) Model

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

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

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 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

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

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:

$$E[\varepsilon_t] = 0 \quad \forall t$$
$$E[\varepsilon_t \varepsilon'_t] = \begin{cases} \Omega & s = t \\ 0 & s \neq t \end{cases} \qquad \text{(2-3)}$$

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

$$\Delta y_t = c + B_1 \Delta y_{t-1} + B_2 \Delta y_{t-2} + ... + B_{p-1} \Delta y_{t-p+1} - \pi y_{t-1} + \varepsilon_t \qquad \text{(2-4)}$$

where the B's are functions of the A's, π=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 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[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

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

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

$$\left|\hat{\Omega}\right| = \left|\frac{1}{T-p}\sum \hat{\varepsilon}_t \hat{\varepsilon}'_t\right| \tag{2-5}$$

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

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

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

$$AIC = -2l/T + 2nT \tag{2-7}$$

for the first one (AIC) and

$$SC = -2l/T + n\log(T)/T \tag{2-8}$$

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

$$LR = (T-m)\left\{\log\left|\Omega_{l-1}\right| - \log\left|\Omega_l\right|\right\} \sim \chi^2_{k^2} \tag{2-9}$$

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*

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

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

$$l_0 = c + \frac{n}{2}\ln\left|\hat{\Omega}_0{}^{-1}\right|, \qquad l_1 = c + \frac{n}{2}\ln\left|\hat{\Omega}_1{}^{-1}\right| \qquad (2\text{-}11)$$

On these circumstances the LR test statistics can be written as

$$LR = -2(l_0 - l_1) = n\left[\ln\left|\hat{\Omega}_0^{-1}\right| - \ln\left|\hat{\Omega}^{-1}\right|\right] \dot{\sim}\ \chi_q^2 \qquad (2\text{-}12)$$

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:

$$\begin{aligned} y_t &= \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \ldots + \beta_l x_{t-l} + \varepsilon_t \\ x_t &= \alpha_0 + \alpha_1 x_{t-1} + \ldots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \ldots + \beta_l y_{t-l} + u_t \end{aligned} \qquad (2\text{-}13)$$

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 (α_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

$$F = \frac{(SQEr - SQEnr)/m}{SQEnr/(n-k)} \qquad (2\text{-}14)$$

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*.).

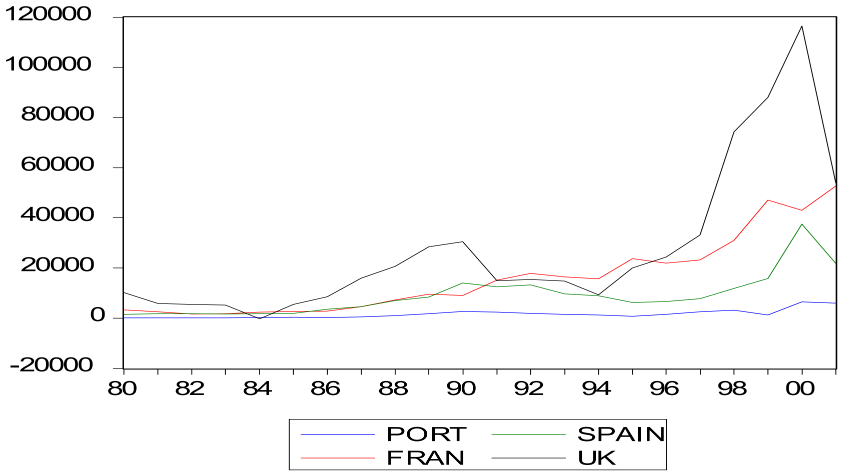
If in such a test we reject both null hypotheses then we say that between the two variables x and y there is a bilateral relationship, if only one of them is rejected we say that there is a unilateral relationship and if we don't reject none of them we say that there is an independent relationship. In 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 variable y and of the variable x are not statistically different from zero in the two regressions.

3. FOREIGN DIRECT INVESTMENT – EMPIRICAL APPLICATION TO 4 EU COUNTRIES

3.1 Data bank

As we said before the data that we are going to use is referred to the foreign direct investment (FDI, inflows) of 4 countries of the European Union – Portugal, Spain, France, and United Kingdom – from the year 1980 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 in current values. The following figure shows the evolution of the FDI inflows over the 21 years of the period.

Figure n. 3.1 – Evolution of the FDI (in 10^6 USA dollars)

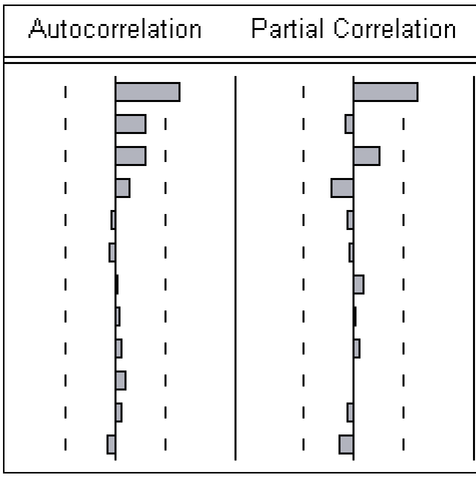


Note: PORT-Portugal, SPAIN-Spain, FRAN-France, UKD-United Kingdom. The Portuguese data for the years 2000 and 2001 are estimates of the UNCTAD.

3.2 The Quality of the Data Series

Either the correlograms of the total and partial autocorrelation functions, ACF and PACF, respectively, 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.

Figure 3.2 – Correlograms and the Box-Pierce Q Test – PORT series



	AC	PAC	Q-Stat	Prob
1	0.559	0.559	7.8464	0.005
2	0.258	-0.079	9.5980	0.008
3	0.270	0.233	11.631	0.009
4	0.121	-0.187	12.058	0.017
5	-0.033	-0.045	12.092	0.034
6	-0.045	-0.031	12.158	0.059
7	0.012	0.095	12.162	0.095
8	0.026	0.024	12.189	0.143
9	0.049	0.057	12.285	0.198
10	0.083	0.007	12.587	0.248
11	0.043	-0.056	12.678	0.315
12	-0.059	-0.120	12.863	0.379

In the same sense point the Augmented Dickey-Fuller (ADF) test – when testing the null hypotheses of the integration or non-stationarity of the respective series, in levels, we could not reject them.

The following table show the results obtained for the Portuguese data series.

Table 3.1 – Results of the ADF Test applied to the PORT series (in levels)

Parameter	Model 1	Model 2	Model 3
β_1	---	219.8140	---
$\beta_2 t$	---	---	151.8999
δ	0.272535	0.160768	-0.580024
α_1	-0.605741	-0.523291	-0.056206
α_2			
R^2	0.147292	0.157700	0.296094
d(DW)	2.038348	2.023993	1.970314
1%	-2.6889	-3.8067	-4.5000
5%	-1.9592	-3.0199	-3.6591
10%	-1.6246	-2.6502	-3.2677
T	1.431107	0.515138	-1.135486

Note: The models referred in the table are the three models indicated by the ADF: the first one without intercept and trend, the second with intercept but without trend and the third with intercept and trend.

Once certified that a data series (for instance the PORT one) is not stationary we apply the same test to the first differences of the same series to see if it is already stationary, fact that is equivalent to say that the original series, the (for instance the PORT one), in levels, is I(1). This is the case at the 10% level of significance for the PORT series, once the absolute value of the τ is greater than the absolute values of the Mackinnon critical values, as is shown in the table 3.3.

Table 3.2 – Results of the ADF Test applied to the PORT series (1st Differences)

ADF Test Statistic	-1.835653	1% Critical Value*	-2.6968
		5% Critical Value	-1.9602
		10% Critical Value	-1.6251

*MacKinnon critical values for rejection of hypothesis of a unit root.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PORT,2)
Method: Least Squares
Sample(adjusted): 1983 2001
Included observations: 19 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PORT(-1))	-1.338862	0.729366	-1.835653	0.0840
D(PORT(-1),2)	0.023310	0.555898	0.041933	0.9670

R-squared	0.653540	Mean dependent var	-21.91158
Adjusted R-squared	0.633160	S.D. dependent var	2280.098
S.E. of regression	1380.994	Akaike info criterion	17.39830
Sum squared resid	32421450	Schwarz criterion	17.49771
Log likelihood	-163.2838	Durbin-Watson stat	1.954651

The utilisation of the Phillips-Perron (PP) test points once more in the same sense: the PORT series, in levels, is integrated as the absolute value of observed PP statistics is inferior to the Mackinnon critical values, though rejecting the null hypothesis (table 3.4).

Table 3.3 – Results of the PP test applied to the PORT series (in levels)

PP Test Statistic	0.696576	1% Critical Value*	-2.6819
		5% Critical Value	-1.9583
		10% Critical Value	-1.6242

*MacKinnon critical values for rejection of hypothesis of a unit root.

Lag truncation for Bartlett kernel: 2	(Newey-West suggests: 2)	
Residual variance with no correction		1707067.
Residual variance with correction		1080508.

Phillips-Perron Test Equation
Dependent Variable: D(PORT)
Method: Least Squares
Date: 09/24/03 Time: 23:03
Sample(adjusted): 1981 2001
Included observations: 21 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PORT(-1)	0.001902	0.143835	0.013220	0.9896

R-squared	-0.047784	Mean dependent var	279.0443
Adjusted R-squared	-0.047784	S.D. dependent var	1307.929
S.E. of regression	1338.813	Akaike info criterion	17.28340
Sum squared resid	35848409	Schwarz criterion	17.33314
Log likelihood	-180.4757	Durbin-Watson stat	2.615691

The same test when applied to the first differences of the PORT series shows that it is already stationary as the absolute of the PP value is superior to the absolute values of the MacKinnon critical values thus rejecting the null hypothesis. This confirms that the Portuguese FDI series is I(1).

Table 3.4 – Results of the PP test applied to the PORT series (1st differences)

PP Test Statistic	-6.737048	1% Critical Value*		-4.5000
		5% Critical Value		-3.6591
		10% Critical Value		-3.2677
*MacKinnon critical values for rejection of hypothesis of a unit root.				
Lag truncation for Bartlett kernel: 2		(Newey-West suggests: 2)		
Residual variance with no correction: 1298460.				
Residual variance with correction: 1212228.				
Phillips-Perron Test Equation				
Dependent Variable: D(PORT,2)				
Method: Least Squares				
Sample(adjusted): 1982 2001				
Included observations: 20 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PORT(-1))	-1.468575	0.221011	-6.644819	0.0000
C	-392.5468	622.0880	-0.631015	0.5364
@TREND(1980)	72.38476	49.72350	1.455745	0.1637
R-squared	0.722492	Mean dependent var		-23.21600
Adjusted R-squared	0.689844	S.D. dependent var		2219.292
S.E. of regression	1235.961	Akaike info criterion		17.21457
Sum squared resid	25969193	Schwarz criterion		17.36393
Log likelihood	-169.1457	F-statistic		22.12971
Durbin-Watson stat	2.023618	Prob(F-statistic)		0.000019

An identical analysis to the one that we came to expose but now applied to the other three FDI series reveals: that the Spanish series (SPAIN) it is integrated of order 2, or I(2), that the French series (FRAN) is integrated of order 1, or I(1), that the English series (UK) is I(1), too. The consequence of this fact – that all the series are integrated – is that we have to be careful when using this data series, because some economical results can be meaningful. For instance if we use these data series to perform a regression analysis we can obtain a spurious regression.

3.3 Cointegration of the Series

To appreciate the cointegration of the 4 series we use the Augmented Engle-Granger (AEG) test to study the cointegration of the series taking two each time, and the Johansen test (1990) to study all of them at the same time.

Let's begin by the first one, the AEG test, and by the analysis of the cointegration relation between the Portuguese and the Spanish FDI entrances. The results of the estimation of the Cointegrating Regression can be seen in the following table:

Table 3.5 – Cointegrating Regression (PORT and SPAIN series)

Dependent Variable: D(PORT)

Method: Least Squares
Sample(adjusted): 1981 2001
Included observations: 21 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	132.1505	200.5791	0.658845	0.5179
D(SPAIN)	0.152050	0.032066	4.741847	0.0001

R-squared	0.542004	Mean dependent var	279.0443
Adjusted R-squared	0.517899	S.D. dependent var	1307.929
S.E. of regression	908.1402	Akaike info criterion	16.55107
Sum squared resid	15669653	Schwarz criterion	16.65055
Log likelihood	-171.7862	F-statistic	22.48511
Durbin-Watson stat	1.910692	Prob(F-statistic)	0.000142

What we need passes by the appreciation of the integration or non stationarity of the cointegrating regression's errors; with this in mind we apply the ADF test again. The results are shown in the table n. 3.7.

Table 3.6 – The ADF test applied to the CR errors

ADF Test Statistic	-5.656147	1% Critical Value*	-4.5348
		5% Critical Value	-3.6746
		10% Critical Value	-3.2762

*MacKinnon critical values for rejection of hypothesis of a unit root.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ERRO)
Method: Least Squares
Sample(adjusted): 1983 2001
Included observations: 19 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERRO(-1)	-2.487433	0.439775	-5.656147	0.0000
D(ERRO(-1))	1.025336	0.284230	3.607422	0.0026
C	-376.0823	403.3265	-0.932451	0.3659
@TREND(1980)	13.16718	31.13266	0.422938	0.6783

R-squared	0.733562	Mean dependent var	104.6807
Adjusted R-squared	0.680274	S.D. dependent var	1285.192
S.E. of regression	726.7033	Akaike info criterion	16.19958
Sum squared resid	7921466.	Schwarz criterion	16.39841
Log likelihood	-149.8960	F-statistic	13.76606
Durbin-Watson stat	2.416152	Prob(F-statistic)	0.000139

As the absolute value of the observed ADF statistic (-5.656147) is greater than the absolute values of the MacKinnon critical values then we reject the null hypothesis of the integration of the cointegration regression what is equivalent to say that the errors of the CR are stationary. But this means, according to the approach in use, that the two series of the Spanish and of the Portuguese FDI are cointegrated. This fact means that between the two Iberian economies (Portugal and Spain) – at least at the FDI level – there is a long term equilibrium relationship. This equilibrium relationship is confirmed by other approaches as we can see in the following using the Johansen test.

The application of the Johansen test to appreciate the multilateral co-integration, or the co-integration of the 4 series, gave the following results:

Table n. 3.7 – Results of the Johansen test to appreciate the cointegration

Sample: 1980 2001
Included observations: 20
Test assumption: Linear deterministic trend in the data
Series: PORT SPAIN FRAN UK
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.907432	92.30108	47.21	54.46	None **
0.716295	44.70488	29.68	35.65	At most 1 **
0.543886	19.50844	15.41	20.04	At most 2 *
0.173380	3.808201	3.76	6.65	At most 3 *

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 4 cointegrating equation(s) at 5% significance level
Unnormalized Cointegrating Coefficients:

PORT	SPAIN	FRAN	UK
0.000352	-6.76E-05	-3.93E-05	3.15E-05
-0.000554	6.80E-05	-2.23E-05	3.59E-05
-0.000222	0.000118	-4.44E-05	5.28E-06
-0.000175	-3.87E-06	4.54E-07	-1.20E-05

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

	PORT	SPAIN	FRAN	UK	C
	1.000000	-0.191867	-0.111687	0.089316	-513.4872
		(0.01873)	(0.02242)	(0.01804)	
Log likelihood		-714.0635			

Normalized Cointegrating Coefficients: 2 Cointegrating Equation(s)

	PORT	SPAIN	FRAN	UK	C
	1.000000	0.000000	0.310406	-0.338677	2971.019
			(0.19280)	(0.16564)	
	0.000000	1.000000	2.199928	-2.230674	18161.07
			(1.14485)	(0.98356)	
Log likelihood		-701.4653			

Normalized Cointegrating Coefficients: 3 Cointegrating Equation(s)

	PORT	SPAIN	FRAN	UK	C
	1.000000	0.000000	0.000000	-0.083463	762.5315
				(0.01211)	
	0.000000	1.000000	0.000000	-0.421905	2508.938
				(0.06262)	
	0.000000	0.000000	1.000000	-0.822195	7114.838
				(0.05165)	
Log likelihood		-693.6152			

As can be seen the LR test denotes the existence of 4 cointegrating equations at the 5% level of significance, thus confirming what we said for the Portuguese and Spanish economies using the AEG methodology, that among these four economies there exist 4 long term equilibrium relationships, at least at the FDI level.

4. FOREIGN DIRECT INVESTMENT – AN EMPIRICAL APPLICATION

4.1 Estimates of the VAR Model

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 4 endogenous variables – one for each exporting country: Portugal, Spain, France and United Kingdom. Unhappily not all the series covered the period 1970-2001 reason why in the estimation process we only use the period 1980-2001 for the estimation process. The optimisation process to estimate the lag length, using either the Akaike Information Criterion (AIC), or the Schwarz Criterion (SC), or the Log Likelihood ratio, indicated the value of 2. The VAR considered the natural logarithms of the original values (so the log(FDI)) in order to make the IRF convergent in the long term.

As can be seen by the table n. 4.1 the estimated VAR model has 36 parameters resulting from the fact of having 4 endogenous variables by the same number of pre-determined ones more 4 constant terms c in the pre-defined VAR model. The values found for these parameters translate thus the relationships and the interrelationship's network among the 4 EU western economies.

Table n. 4.1 Estimation of the VAR(2) model with 4 endogenous Variables

Sample(adjusted): 1982 2001
Included observations: 17
Excluded observations: 3 after adjusting endpoints
Standard errors & t-statistics in parentheses

	LOG(PORT)	LOG(SPAIN)	LOG(FRAN)	LOG(UK)
LOG(PORT(-1))	0.168305	-0.059081	0.176815	0.126486
	(0.37883)	(0.15866)	(0.17553)	(0.23489)
	(0.44428)	(-0.37238)	(1.00733)	(0.53849)
LOG(PORT(-2))	-0.277030	0.231592	0.145548	0.204847
	(0.38067)	(0.15943)	(0.17638)	(0.23604)
	(-0.72774)	(1.45259)	(0.82518)	(0.86786)
LOG(SPAIN(-1))	0.049771	0.325097	0.687368	0.448235
	(0.87458)	(0.36629)	(0.40523)	(0.54228)
	(0.05691)	(0.88754)	(1.69624)	(0.82657)
LOG(SPAIN(-2))	0.606273	-0.012223	-0.770894	-1.606309
	(0.99794)	(0.41796)	(0.46239)	(0.61878)
	(0.60752)	(-0.02925)	(-1.66718)	(-2.59594)
LOG(FRAN(-1))	0.735297	0.535389	1.151993	1.748697
	(0.82777)	(0.34669)	(0.38355)	(0.51326)
	(0.88828)	(1.54430)	(3.00354)	(3.40703)
LOG(FRAN(-2))	-0.661530	-0.667750	-0.155224	-0.839572
	(0.58183)	(0.24368)	(0.26959)	(0.36077)
	(-1.13698)	(-2.74025)	(-0.57578)	(-2.32719)
LOG(UK(-1))	0.522655	0.374333	-0.054725	0.274043
	(0.55574)	(0.23275)	(0.25750)	(0.34459)
	(0.94047)	(1.60828)	(-0.21252)	(0.79528)
LOG(UK(-2))	0.068404	0.174987	-0.331356	-0.061496
	(0.45276)	(0.18963)	(0.20979)	(0.28074)
	(0.15108)	(0.92280)	(-1.57949)	(-0.21905)
C	-4.495090	0.802339	2.328651	7.087005
	(3.43514)	(1.43870)	(1.59166)	(2.12996)
	(-1.30856)	(0.55768)	(1.46303)	(3.32729)
R-squared	0.868891	0.957457	0.969583	0.926473
Adj. R-squared	0.737781	0.914914	0.939165	0.852946
Sum sq. resids	2.418980	0.424312	0.519331	0.930010
S.E. equation	0.549884	0.230302	0.254787	0.340956
F-statistic	6.627219	22.50562	31.87607	12.60046
Log likelihood	-7.548082	7.247290	5.529676	0.577116
Akaike AIC	1.946833	0.206201	0.408273	0.990928
Schwarz SC	2.387946	0.647314	0.849386	1.432041
Mean dependent	7.198236	9.057149	9.526671	10.05302
S.D. dependent	1.073839	0.789530	1.033004	0.889120

Determinant Residual Covariance	1.35E-06
Log Likelihood	18.41472
Akaike Information Criteria	2.068856
Schwarz Criteria	3.833308

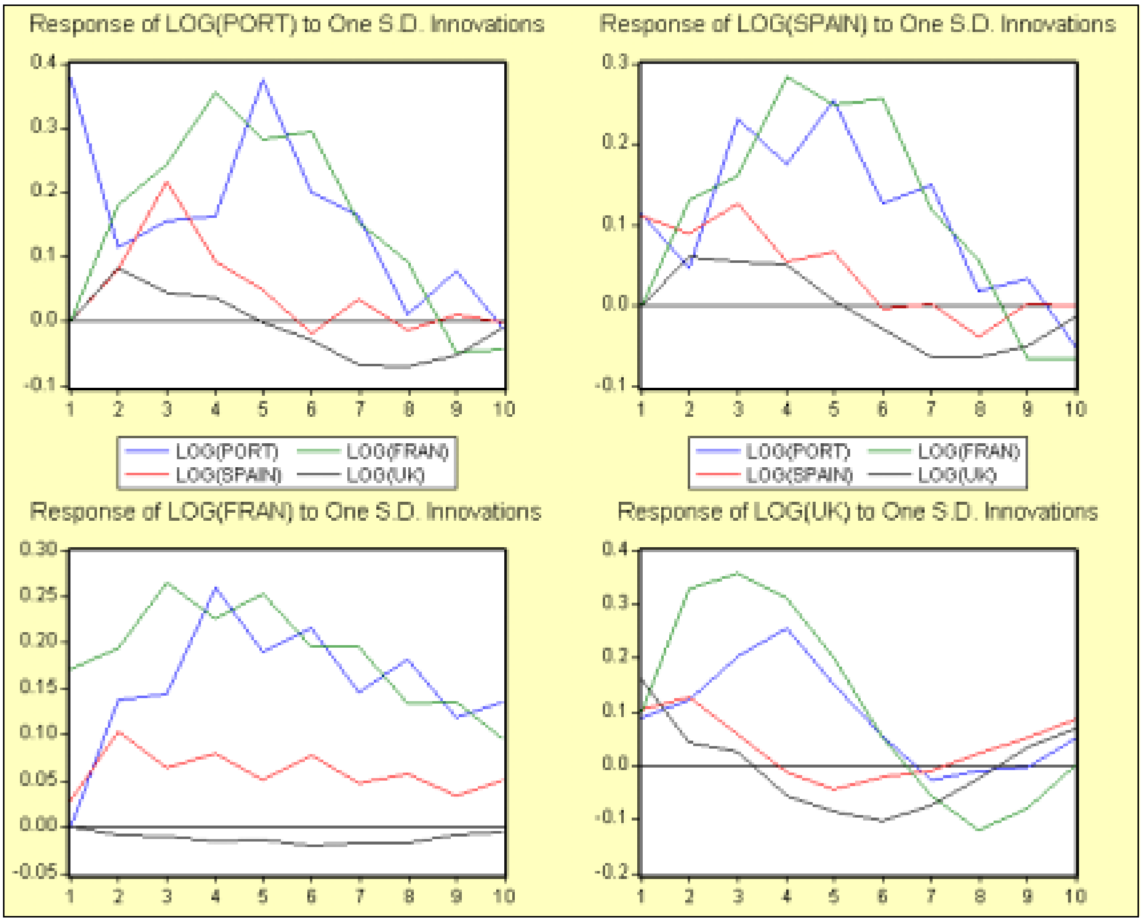
4.2 Interpretation of the Results

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 functions (IRF) and/or the error variance decomposition analysis.

4.2.1 Impulse Response Functions

In order to prevent that the paper becomes too large we decided to include only part of the Impulse Response Functions (IRF) – the response of the economies to impulses of 1 s.d. (figure n. 4.1) – omitting the response of the 4 economies to impulses of 1 s.d. +/- 2 s.e. and passing the Variance Decomposition in the Cholesky way to the append of this paper.

Figure n. 4.1 : Impulse Response Functions



4.3 Multilateral and Bilateral Relations Using the Granger Causality Theory

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 an VAR model without independent terms with the 4 variables – Portugal, Spain, France, United Kingdom – in the logarithms of the 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 in this case was the number 2. With these elements we estimated the VAR model whose elements we don't present here, and we computed the values of the F statistics to test the Granger causality as was referred in the section n. 2 when we exposed the respective methodology.

4.3.2 Multilateral and Bilateral Causality

In the appreciation of the multilateral and bilateral relationships among the Portuguese, Spanish, French and English FDI we are going to follow the approach proposed by Granger (the Granger Causality Theory).

The essential results to carry this analysis is contained in the following table where we adopted a lag length of 2 in accordance with the Akaike Information criteria (AIC), the Schwarz (SC) criteria and the Log Likelihood ratio.

Table 4.2. – Results to Appreciate the Granger Causality

Pairwise Granger Causality Tests
Sample: 1980 2001
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
SPAIN does not Granger Cause PORT	20	4.75064	0.02522
PORT does not Granger Cause SPAIN			11.6387
FRAN does not Granger Cause PORT	20	7.49782	0.00553
PORT does not Granger Cause FRAN			3.05722
UK does not Granger Cause PORT	20	20.3253	5.4E-05
PORT does not Granger Cause UK			7.41013
FRAN does not Granger Cause SPAIN	20	18.9405	7.9E-05
SPAIN does not Granger Cause FRAN			0.48310
UK does not Granger Cause SPAIN	20	34.9693	2.3E-06
SPAIN does not Granger Cause UK			16.3694
UK does not Granger Cause FRAN	20	2.87376	0.08779
FRAN does not Granger Cause UK			7.95805

At the 5% level of significance these results show that there are relationships of the bilateral type between the following economies: the Spanish and the Portuguese, the English and the Portuguese, and the Spanish and the English.

The same table shows that the relationship between the Spanish and the French economies is of the unilateral type and that the sense of this relationship is from France -> to Spain, this meaning that the French FDI is Granger cause of the Spanish one, or, in some sense, that France is precursor of Spain. France and Portugal is also a unilateral relationship the sense is from France till Portugal, what means that France does Granger cause of Portugal. The relation between UK and France is also unilateral from France to UK, what means that the first is precursor or Granger cause the second.

Between these four countries there are no relationships of the independent type.

5. CONCLUSIONS

The analysis we came to present shows (i) that the logarithms of the time series of the foreign direct investment (FDI) of 4 countries of the EU – Portugal, Spain, France, United kingdom – are non stationary and are integrated of order 1, or I(1), (Spain is I(2)) as can be seen using the ADF and PP tests, and (ii) that, besides this, all of them are cointegrated, as was shown by the Johansen test and by the AEG test, too, fact that means that among them there are long term equilibrium relationships.

The estimated VAR model shows the type of relations and of interrelationships that exist among the 4 European FDI. The graphics of the IRF show a long term absorption period of several years, period that the economies take to absorb the innovations or impulses represented by the introduction of a Foreign Direct Investment in the economy or in the dynamic structure of the VAR model and the pattern of this reaction.

At the 5% level of significance and at least at the FDI level the analysis shows: (i) that there are relationships of the bilateral type between the following economies of the western EU: the Spanish and the Portuguese, the English and the Portuguese, and the Spanish and the English; (ii) that the relationship between the Spanish and the French economies, between the French and the

Portuguese, between the French and the Spanish and between the UK and the French are of the unilateral type; (iii) that France is precursor of Spain, France is precursor of Portugal, and UK is precursor of France; that there are no independent relationships.

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APPEND

Table n. A4.1 – Cholesky Variance Decomposition

Period	S.E.	LOG(PORT)	LOG(SPAIN)	LOG(FRAN)	LOG(UK)
1	0.377217	100.0000	0.000000	0.000000	0.000000
2	0.448892	77.24361	3.211169	16.05860	3.486620
3	0.578468	53.88412	15.99694	27.42540	2.693536
4	0.705526	41.61663	12.48876	43.79554	2.099069
5	0.848568	48.29776	8.959916	41.29093	1.451390
6	0.920716	45.74855	7.651599	45.27757	1.322274
7	0.950366	45.85641	7.307759	45.09145	1.744384
8	0.957661	45.17293	7.220099	45.36099	2.245981
9	0.963578	45.27653	7.144470	45.05665	2.522345
10	0.964646	45.19233	7.129307	45.15090	2.527456

Variance Decomposition of LOG(SPAIN):

Period	S.E.	LOG(PORT)	LOG(SPAIN)	LOG(FRAN)	LOG(UK)
1	0.157986	50.40931	49.59069	0.000000	0.000000
2	0.236473	26.53086	36.64103	30.38330	6.444812
3	0.391915	44.16290	23.61817	27.94731	4.271630
4	0.519157	36.40686	14.57840	45.60540	3.409340
5	0.632647	40.65025	10.92740	46.11565	2.306698
6	0.694478	37.00960	9.070970	51.83865	2.080780
7	0.722896	38.38962	8.373351	50.55010	2.686926
8	0.729241	37.78396	8.522054	50.27316	3.420831
9	0.734729	37.41715	8.396138	50.33408	3.852638
10	0.739635	37.41786	8.285130	50.46178	3.835231

Variance Decomposition of LOG(FRAN):

Period	S.E.	LOG(PORT)	LOG(SPAIN)	LOG(FRAN)	LOG(UK)
1	0.174782	0.001021	2.689031	97.30995	0.000000
2	0.312723	19.54257	11.86885	68.50982	0.078761
3	0.439674	20.68020	8.150707	71.08187	0.087228
4	0.564447	33.72771	6.925009	59.22949	0.117786
5	0.649028	34.04257	5.872090	59.95204	0.133307
6	0.716259	37.03704	6.031178	56.74005	0.191723
7	0.758504	36.75889	5.777134	57.23849	0.225483
8	0.793858	38.80110	5.813375	55.13656	0.248961
9	0.814895	38.94835	5.697695	55.10866	0.245293
10	0.833297	39.90125	5.837114	54.02357	0.238074

Variance Decomposition of LOG(UK):

Period	S.E.	LOG(PORT)	LOG(SPAIN)	LOG(FRAN)	LOG(UK)
1	0.233894	14.72405	19.38893	18.87390	47.01313
2	0.443098	11.63510	13.77502	60.50650	14.08338
3	0.608045	17.32643	8.230796	66.80360	7.639168
4	0.730891	24.17846	5.718855	64.25666	5.846021
5	0.778301	25.11329	5.345820	63.21989	6.320998
6	0.789042	24.91299	5.268706	61.95443	7.863879
7	0.795016	24.64465	5.204867	61.52154	8.628944
8	0.804741	24.06541	5.167288	62.25027	8.517028
9	0.811103	23.69028	5.491935	62.25811	8.559673
10	0.820560	23.56562	6.494563	60.83226	9.107556

Ordering: LOG(PORT) LOG(SPAIN) LOG(FRAN) LOG(UK)