3.

FDI AND ECONOMIC GROWTH. EVIDENCE FROM SIMULTANEOUS EQUATION MODELS

Gheorghe RUXANDA*
Andreea MURARU**

Abstract

This paper analyses whether foreign direct investments have an impact on the Romanian economic growth. By means of simultaneous equation methods we obtained evidence of the bi-directional connection between the two, meaning that incoming FDI stimulates economic growth and, in its turn, a higher GDP attracts FDI. Two methods were used in performing the analysis, one considering the relation between the share of FDI in GDP and economic growth in a five-equation system and the second considering the levels of FDI and GDP, respectively, in a two-equation system.

Keywords: foreign direct investment, economic growth, simultaneous equation models

JEL Classification: F21, F43

1. Introduction

When estimating econometric models, one of the problems that frequently arise is the simultaneity of the economic variables that need to be explained. On account of simultaneity, exogenous becomes endogenous correlated with the error term, therefore estimation poses a higher degree of difficulty than in the case of variables independent from the error term. In the attempt to analyse the relationship between foreign direct investments and economic growth the circularity of variables is obvious: FDI is attracted in a certain location also by the economic growth perspective due to the implication it has on capital gains; moreover, FDI, in its turn, generate domestic investment and economic growth as a result of spill-over effects. Mody and Murshid (2004) consider that the relationship between FDI and domestic investment is mostly characteristic of developing economies that offer higher marginal capital gains than

* *The* Academy of Economic Studies, Bucharest, email: ghrux@ase.ro.
***The* Academy of Economic Studies, Bucharest, email: andreeabotezatu@gmail.com.

the global interest rate which is attractive for FDI which consequently favours domestic investment.

The ways in which FDI is known to affect and generate economic growth is through capital stock accumulation, inducing technological progress and by influencing the labour market by reducing unemployment (Delali, 2003). Still, even if it is known and generally admitted that FDI contributes to the technological transfer from developed to developing countries, as Roy and Berg show, most of the FDI flows occur between developed economies, the US being the largest recipient (Roy and Berg, 2006). This is also confirmed by Udo and Obiora who state that FDI has mostly gone to countries where the capital/labour ratio is higher (Udo and Obiora, 2006). A possible explanation can be found in the factors generating the capital inflows: differences in the endowment with production factors (such as lower wages), the desire to gain access to new markets or the access to natural resources (Pauly and Hejazi).

In a study investigating 140 countries, Ghatak and Halicioglu found that FDI has a positive impact on real per-capita GDP (Ghatak and Halicioglu, 2006), furthermore, Roy and Berg also found evidence of positive and significant impact of the share of FDI in GDP on economic growth for the US by using SEM (Roy& Berg, 2006); on the other hand, Udo *et al*. found no evidence of the relation FDI-economic growth when analysing the West African Monetary Zone (Udo and Obiora, 2006), proving the unilateral relation according to which FDI is attracted to countries with higher GDP per capita. Another one-way relation – only that opposed to the previous – was shown by Mehanna who demonstrated that investment precedes growth on a panel of 80 developing countries (Mehanna, 2003).

In this study, we investigate the importance of FDI for economic growth in Romania, throughout the period 2000Q1 – 2009Q1 by means of simultaneous equation systems. There are two approaches; one consists in analysing a larger simultaneous equation system (5 equations) in which we analyse FDI as a share of GDP and the second one consists of a two-equation system in which both FDI and GDP are included in their levels.

The paper has four parts, the first is the introduction, the second shortly describes the simultaneous equation systems, the third presents the models used and the results obtained in the estimation and the fourth part concludes.

2. Simultaneous equation systems – Short description

One of the essential conditions for estimating the parameters in a regression by OLS is the independence of explicative variables from the model residuals. When modelling economic variables, it frequently happens that the variables intended to be explicative and, therefore, exogenous variables in the regression model have a simultaneous behaviour with the endogenous variables, and, consequently, lose their exogeneity characteristics. The endogeneity of explicative variables makes the estimation of efficient and convergent parameter estimators through OLS impossible.

The general form of a system with m simultaneous equations is:

$$BY_t + \Gamma X_t = u_t \quad (1)$$

where: *Y* is a $(m \times 1)$ vector of endogenous variables, *X* is a $(q \times 1)$ vector of predetermined, exogenous, variables and *u* is the $(m \times 1)$ residuals' vector. B is the $(m \times m)$ matrix of coefficients for the endogenous variables and Γ is the $(m \times q)$ matrix of coefficients for the predetermined variables. The errors of the model have the following characteristics: $E(u_t)=0$, $Var(u_t)=\sum$, and are not autocorrelated $cov(u_t,u_s)=0$.

The simultaneity in the variables can be handled by transforming the system from the structural form in (1) to the reduced form:

$$Y_t = -B^{-1}\Gamma X_t + B^{-1}u_t \quad (2)$$

Considering $-B^{-1}\Gamma$ as Π_t and $B^{-1}u_t$ as v, we get:

$$Y_t = \Pi_t X_t + v_t \quad (3)$$

The reduced form makes the connection between the endogenous variables and the exogenous from the X_t, vector, therefore the simultaneity being eliminated.

In order to be estimated, the system needs to be identified, i.e. all its equations to be identified. The fulfilment of the order and rank conditions ensures the identification of the system.

Considering the previously described system (M equations, m endogenous variables in the analysed equation, Q predetermined variables in the system and q in the equation, respectively), the order condition can be put as follows: an equation is identified if it excludes at least m-1 endogenous variables – i.e. the number of endogenous variables absent from the equation to be lower or equal to the number of equations in the system minus 1 (if the number of excluded variables is m-1, then the equation is exactly identified; if it excludes more than m-1 endogenous variables the equation is overidentified and when the number of excluded variables is lower than m-1, the equation is unidentified).[1] Still, the order condition is not sufficient for evaluating the system. Although very easy to check, this condition is not sufficient.

A necessary and sufficient condition is the rank condition. According to the rank condition, an equation is identified if the matrix formed from the columns of the matrices B and Γ corresponding to the variables absent from the analysed equation but present in the other equations is m-1. When the system is unidentified, the matter can be corrected by including supplementary variables in the identified or overidentified equation, or, on the contrary, by eliminating variables from the unidentified equation – if it is in accordance with the economic theory (Pecican, 2005).

As in our analysis we use two methods for estimating simultaneous equation systems (2SLS and 3SLS), only these two will be briefly presented.

When estimating an equation such as

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[1] *The order condition can also be stated as: the number of predetermined variables excluded from the equation shouldn't be lower than the number of endogenous variables included in the equation minus 1 (Q-q≥m-1). (Gujarati, 1995).*

$$y_j = X_j \beta_j + u_j \tag{4}$$

with the help of TSLS, the predetermined and the lagged endogenous variables in the system are used as instruments. Let Z be the vector of these instruments $Z = \begin{pmatrix} z_1 & z_2 & \ldots & z_t \end{pmatrix}'$ and E(Z'u)=0.

Therefore, in the first stage of TSLS, X_j is written as a linear combination of Z:

$$\hat{X}_j = Z(Z'Z)^{-1} Z' X_j \tag{5}$$

In the second stage, y_j is estimated by replacing X_j with the previously estimated values and the estimator $\hat{\beta}$ is obtained:

$$\hat{\beta} = (\hat{X}_j' X_j)^{-1} \hat{X}_j' y_j \tag{6}$$

or,

$$\hat{\beta} = (X_j' Z(Z'Z)^{-1} Z' X_j)^{-1} X_j' Z(Z'Z)^{-1} Z' y_j \tag{10}$$

The 3SLS is a version on 2SLS with the difference that the system parameters are estimated for the whole system and not for each equation.

Writing the model with equations like $y_j = X_j \beta_j + u_j$, in matrix form, we have:

$$\begin{pmatrix} y_1 \\ \vdots \\ y_m \end{pmatrix} = \begin{pmatrix} x_1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & x_m \end{pmatrix} \begin{pmatrix} \beta_1 \\ \vdots \\ \beta_m \end{pmatrix} + \begin{pmatrix} u_1 \\ \vdots \\ u_m \end{pmatrix} \tag{11}$$

or

$$\tilde{y} = \tilde{X}\beta + \tilde{u} \quad (12)$$

$$var(\tilde{u}) = \begin{pmatrix} \sigma_{11} I_T & \cdots & \sigma_{1m} I_T \\ \vdots & \ddots & \vdots \\ \sigma_{m1} I_T & \cdots & \sigma_{mm} I_T \end{pmatrix} = \Sigma \otimes I_T \tag{13}$$

The values of X, estimated exactly as in 2SLS can be put in matrix form as follows:

$$\begin{pmatrix} \hat{x}_1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & \hat{x}_m \end{pmatrix} = \begin{pmatrix} Z(Z'Z)^{-1} Z' x_1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & Z(Z'Z)^{-1} Z' x_m \end{pmatrix} \tag{14}$$

If $C_z = Z(Z'Z)^{-1} Z$, we have:

$$\begin{pmatrix} \hat{x}_1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & \hat{x}_m \end{pmatrix} = \begin{pmatrix} C_z x_1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & C_z x_m \end{pmatrix} = (I_m \otimes C_z)\tilde{X} \tag{15}$$

So, by using (14) and (15) the system's parameters estimated by 3SLS are:

$$\hat{\beta} = (\widetilde{X}'(I_m \otimes C_z)'(\Sigma \otimes I_T)^{-1}(I_m \otimes C_z)\widetilde{X})^{-1}\widetilde{X}'(I_m \otimes C_z)'(\Sigma \otimes I_T)^{-1}\widetilde{y} = \\ = (\widetilde{X}'(\Sigma^{-1} \otimes C_z)\widetilde{X})^{-1}\widetilde{X}'(\Sigma^{-1} \otimes C_z)\widetilde{y} \quad (16)$$

Σ is estimated by $\hat{\Sigma}$, an estimator obtained from the residuals determined as difference between y_j and $X_j\hat{\beta}$:

$$\sigma_{ij} = \frac{e_i' e_j}{T} \quad (17)$$

$$e_j = y_j - X_j\hat{\beta} \quad (18)$$

3. Estimating the relationship between economic growth and FDI through simultaneous equation systems

Using first a five simultaneous equation system and then a more focused two-equation system, we try to point out the degree of inter-correlation between the inflow of FDI and GDP for Romania. The analysis covers the period 2000Q1 – 2009Q1, and is based on quarterly data (source: NBR). The variables affected by seasonality were previously seasonally adjusted by means of the Tramo-Seats procedure implemented in Demetra software. All variables are expressed in real terms and enter the equations in logarithms.

The simultaneous equation estimation is the case of the proposed analysis essential due to the simultaneity bias. An alternative to the system equation estimation would be the VAR, the advantage of the former is a stronger economic premise.

3.1. The 3SLS approach

As non-stationary series lead to spurious results we differenced the affected variables and included a trend component (for the variables entering in levels – TS) in the system so that the results be pertinent.

The equations of the system describe:

1. The GDP determinants

We used for explaining GDP the following factors: FDI as a percentage of GDP, gross fixed capital formation also as percentage of GDP and exports to account for the export driven behaviour of GDP described in the economic literature, and the increase in labour force. This specification of GDP is common when analysing it in relation to FDI (Roy, Berg, 2006; Delai, 2003; Ghatak, Halicioglu, 2006).

gr_gdp=a(1)+a(2)(lgfcf_gdp)+a(3)*(lfdi_gdp)+a(4)*lexport_gdp+a(5)*gr_l* (19)

2. FDI determinants: economic growth, domestic investment, labour cost:

*lfdi_gdp=b(1)+b(2)*gr_gdp+b(3)*lgfcf_gdp+b(4)*d(lwage)+b(5)*lfdi_gdp(-1)* (20)

There still are factors that influence the inflows of FDI which are hard to quantify, such as government policies, economic and political stability, technological infrastructure, the business climate, etc. (Sethi, 2003).

3. Gross fixed capital formation determinants: besides economic activity (GDP) and foreign direct investment that can stimulate GFCF through spill-over effects, we also consider as a determinant of GFCF the deviation of the monetary aggregate from its trend as a measure for the liquidity available for financing investment (Mileva, 2008). The estimated equation is:

$$lgfcf\_gdp=c(1)+c(2)*lfdi\_gdp+c(3)*gr\_gdp+c(4)*deviatie\_m3\_pib+c(5)*lgfcf\_gdp(-1) \quad (21)$$

4. Export and import determinants: GDP which acts as a supply factor for exports and demand factor for import, the exchange rate, FDI (the establishment of new branches sometimes leads to an increase in imports of equipment and, at the same time, the goal of such investment is not only production for the domestic market but especially serving the regional market). The equations for export and import are:

$$export\_gdp=c(1)+c(2)*gr\_gdp+c(3)*lreer+c(4)*lgfcf\_gdp+c(5)*lexport\_gdp(-1) \quad (22)$$

$$limport\_gdp=d(1)+d(2)*gr\_gdp+d(3)*lreer+d(4)*lgfcf\_gdp+d(5)*limport\_gdp(-1) \quad (23)$$

Estimation results show than GDP growth, as it was considered in this first model, is influenced positively by foreign direct investments, the coefficient being statistically significant and positive. Other factors that have a positive impact on economic growth are exports, validating the export-driven hypothesis and also the growth rate of labour[2] . FDI, on the other hand, seems to be positively influenced by the growth rate, even though the statistical significance is doubtful. Furthermore, gross fixed capital formation is positively influenced by economic growth and the liquidity conditions, FDI seems to be acting as a substitute. The main determinants of both exports and imports seem to be economic growth, the real effective exchange rate and gross fixed capital formation. If the economic growth influences both export and import, the exchange rate seems to be influential only for imports, the same being valid for GFCF which acts as a demand factor. The results are shown in Appendix 1.

3.2. 2SLS estimation

The five-equation system estimated previously reveals a slight relation between FDI and GDP. Further on, we will develop a two-equation system in levels not to lose any of the information contained in the variables. We use a different procedure and to some extent different variables to have another picture of the relationship and, therefore, to be able to draw proper conclusions when summing up the results of the two approaches. The system is:

$$\begin{aligned} lfdi&=c(1)+c(2)*lgdp+c(3)*ldo+c(5)*lwage \\ lgdp&=c(6)+c(7)*lfdi+c(8)*lgfcf+c(9)*ltb \end{aligned} \quad (24)$$

As instruments all the exogenous variables will be used: the degree of openness (determined as the share of exports plus imports on GDP), wage, gross fixed capital formation and the trade balance.

When variables are expressed in levels and are not stationary, there is a possibility of spurious results. As in the first stage of the 2SLS, then endogenous variables are regressed on the exogenous ones through the OLS method, we firstly tested for a

[2] *Even though the coefficients are not statistically significant we mention their positive influence as it is really difficult to obtain statistically relevant result when having a small sample and a high number of equations and coefficients.*

cointegration relationship between the variables. If they prove to be cointegrated, we consider that estimating the 2SLS doesn't lead to spurious results.

The analysis of cointegration showed that the variables are cointegrated but in the presence of a trend (see Appendix 2). Therefore, to the previously mentioned instruments the variable accounting for the trend will be added.

The results of the 2SLS estimation of the two-equation system model show that there is a bidirectional or circular relation between FDI and GDP, that is FDI flows to countries with increasing GDP and it leads to an increase in the economic activity in the recipient country. Still, the proportions are different, FDI having a small impact on GDP. The difference from the previous results where the coefficient was higher comes from the manner in which variables enter the equation. Previously the share of FDI in GDP was considered in relation to the economic growth whereas in this case, both variables (GDP and FDI) are in levels.

Table 1

The FDI equation

Estimation Method: Two-Stage Least Squares
Sample: 2000Q1 2008Q4
Included observations: 36
Total system (balanced) observations 72

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-99.656	40.726	-2.447	0.017
C(2)	13.480	5.880	2.293	0.025
C(3)	-1.783	4.842	-0.368	0.714
C(5)	-4.861	2.626	-1.851	0.069

Equation: LFDI=C(1)+C(2)*LGDP+C(3)*LDO+C(5)*LWAGE
Instruments: LDO LWAGE LTB LGFCF @TREND C
Observations: 36

R-squared	0.725	Mean dependent var	6.956
Adjusted R-squared	0.700	S.D. dependent var	0.789
S.E. of regression	0.432	Sum squared resid	5.982
Durbin-Watson stat	1.798		

The results presented in the above table reveal the impact of wages on FDI inflows, showing that lower wage levels may attract inflows, being in fact more attractive due to small production costs.

Table 2

The GDP equation

Estimation Method: Two-Stage Least Squares
Sample: 2000Q1 2008Q4
Included observations: 36
Total system (balanced) observations 72

	Coefficient	Std. Error	t-Statistic	Prob.
C(6)	6.713	0.4875	13.782	0.000
C(7)	0.085	0.028	3.051	0.003
C(8)	0.356	0.0856	4.165	0.001
C(9)	-0.031	0.050	-0.630	0.531

Equation: LGDP=C(6)+C(7)*LFDI+C(8)*LGFCF+C(9)*LTB
Instruments: LDO LWAGE LTB LGFCF @TREND C
Observations: 36

R-squared	0.963	Mean dependent var	10.143
Adjusted R-squared	0.960	S.D. dependent var	0.156
S.E. of regression	0.031	Sum squared resid	0.032
Durbin-Watson stat	2.043		

4. Conclusions

Estimating the relations between variables through system equations takes into account the simultaneity of the variables and the estimation problems, offering the advantage of simultaneously estimating the coefficients from the system using its whole information. Another advantage of using SEM is the important economic background they have.

By using this type of methods, we tried to reach the purpose of this analysis which was to investigate whether, in the case of Romania, FDI has a positive impact on economic growth. The analysis was based on two different approaches. The first consisted of a five-equation system which analysed the connection between economic growth and the share of FDI in GDP by using the 3SLS method for its estimation so as to take account of all the information existent in the system. This attempt revealed a bidirectional connection between the variables and also highlighted the importance of economic growth for all the other endogenous variables.

In the second approach we introduced in a smaller equation system the variables in levels so that all the information existent in their evolution is kept.

The results of both methods converge towards the idea of a circular relation between the two variables. Still, the incoming FDI are attracted not only by GDP but, when looking at the fist estimation procedure, it is clear that other factors not included in the analysis, besides labour costs which proved significant in the second estimation method, have a considerable influence. Therefore, future analysis will include government expenditure, infrastructure, a measure of taxation to point out the determinants of FDI.

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Appendix 1

Estimation Method: Three-Stage Least Squares
Sample: 2000Q2 2009Q1
Included observations: 36
Total system (unbalanced) observations 178
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	22.51	8.528	2.64	0.009
C(2)	3.461	3.142	1.102	0.273
C(3)	3.126	0.732	4.272	0
C(4)	2.59	3.078	0.841	0.402
C(5)	0.201	0.144	1.401	0.163
C(6)	-0.23	0.094	-2.437	0.016
C(7)	-7.23	2.184	-3.311	0.001
C(8)	0.195	0.13	1.499	0.136
C(9)	-1.485	1.167	-1.273	0.205
C(10)	4.72	12.697	0.372	0.711
C(11)	-0.079	0.099	-0.799	0.426
C(12)	0.074	0.025	2.911	0.004
C(13)	-0.672	0.186	-3.614	0
C(14)	0.022	0.01	2.325	0.021
C(15)	-0.084	0.023	-3.641	0
C(16)	0.818	0.071	11.493	0
C(17)	0.277	0.1	2.775	0.006
C(18)	0.007	0.002	3.576	0.001
C(19)	-0.423	0.545	-0.775	0.439
C(20)	0.011	0.009	1.266	0.208
C(21)	-0.011	0.133	-0.081	0.936
C(22)	0.018	0.078	0.235	0.814
C(23)	0.529	0.195	2.717	0.007
C(24)	0.004	0.004	1.126	0.262
C(25)	-1.249	0.798	-1.564	0.12
C(26)	0.076	0.018	4.099	0
C(27)	0.268	0.146	1.838	0.068
C(28)	0.871	0.235	3.712	0
C(29)	-0.418	0.291	-1.437	0.153
C(30)	0.019	0.006	3.34	0.001

Determinant residual covariance	5.17E-12		

Equation: GR_GDP=C(1)+C(2)*(LGFCF_GDP)+C(3)*(LFDI_GDP)
+C(4)*LEXPORT_GDP+C(5)*GR_L+C(6)*@TREND
Instruments: TB LFDI_GDP(-1) LGFCF(-1) DEVIATION_M3_GDP GR_L
LIMPORT_GDP(-1) LEXPORT_GDP(-1) @TREND C
Observations: 36

R-squared	-1.195	Mean dependent var	1.262
Adjusted R-squared	-1.561	S.D. dependent var	0.944
S.E. of regression	1.511	Sum squared resid	68.487
Durbin-Watson stat	2.086		

Equation: LFDI_GDP=C(7)+C(8)*GR_GDP+C(9)*LGFCF_GDP+C(10)
*D(LWAGE)+C(11)*LFDI_GDP(-1)+C(12)*@TREND
Instruments: TB LFDI_GDP(-1) LGFCF(-1) DEVIATION_M3_GDP GR_L
LIMPORT_GDP(-1) LEXPORT_GDP(-1) @TREND C
Observations: 36

R-squared	0.594	Mean dependent var	-3.139
Adjusted R-squared	0.526	S.D. dependent var	0.63
S.E. of regression	0.434	Sum squared resid	5.644
Durbin-Watson stat	2.04		

Equation: LGFCF_GDP=C(13)+C(14)*GR_GDP(-1)+C(15)*LFDI_GDP
+C(16)*LGFCF_GDP(-1)+C(17)*DEVIATION_M3_GDP+C(18)
*@TREND
Instruments: TB LFDI_GDP(-1) LGFCF(-1) DEVIATION_M3_GDP GR_L
LIMPORT_GDP(-1) LEXPORT_GDP(-1) @TREND C
Observations: 36

R-squared	0.975	Mean dependent var	-1.425
Adjusted R-squared	0.97	S.D. dependent var	0.216
S.E. of regression	0.037	Sum squared resid	0.041
Durbin-Watson stat	1.462		

Equation: LEXPORT_GDP=C(19)+C(20)*GR_GDP+C(21)*LREER
+C(22)*LGFCF_GDP+C(23)*LEXPORT_GDP(-1)+C(24)*@TREND

Instruments: TB LFDI_GDP(-1) LGFCF(-1) DEVIATION_M3_GDP GR_L
LIMPORT_GDP(-1) LEXPORT_GDP(-1) @TREND C

Observations: 35

R-squared	0.95	Mean dependent var	-0.879
Adjusted R-squared	0.941	S.D. dependent var	0.121
S.E. of regression	0.029	Sum squared resid	0.025
Durbin-Watson stat	1.553		

Equation: LIMPORT_GDP=C(25)+C(26)*GR_GDP+C(27)*LREER
+C(28)*LGFCF_GDP+C(29)*LIMPORT_GDP(-1)+C(30)*@TREND
Instruments: TB LFDI_GDP(-1) LGFCF(-1) DEVIATION_M3_GDP GR_L
LIMPORT_GDP(-1) LEXPORT_GDP(-1) @TREND C
Observations: 35

R-squared	0.956	Mean dependent var	-0.517
Adjusted R-squared	0.949	S.D. dependent var	0.296
S.E. of regression	0.067	Sum squared resid	0.129
Durbin-Watson stat	1.963		

Appendix 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.708771	95.13410	79.34145	0.0020
At most 1	0.564290	53.19014	55.24578	0.0750
At most 2	0.340423	24.94366	35.01090	0.3870
At most 3	0.224225	10.79436	18.39771	0.4071
At most 4	0.061609	2.162019	3.841466	0.1415

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.708771	41.94396	37.16359	0.0131
At most 1	0.564290	28.24648	30.81507	0.0998
At most 2	0.340423	14.14931	24.25202	0.5738
At most 3	0.224225	8.632338	17.14769	0.5343
At most 4	0.061609	2.162019	3.841466	0.1415

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.952329	234.0270	79.34145	0.0000
At most 1 *	0.931916	136.6371	55.24578	0.0000
At most 2 *	0.733968	50.65255	35.01090	0.0005
At most 3	0.225248	8.280126	18.39771	0.6542
At most 4	0.003535	0.113315	3.841466	0.7364

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.952329	97.38994	37.16359	0.0000
At most 1 *	0.931916	85.98452	30.81507	0.0000
At most 2 *	0.733968	42.37242	24.25202	0.0001
At most 3	0.225248	8.166811	17.14769	0.5846
At most 4	0.003535	0.113315	3.841466	0.7364

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Cointegrating Eq:	CointEq1	Cointegrating Eq:	CointEq1
LFDI(-1)	1.000000	LGDP(-1)	1.000000
LGFCF(-1)	2.526485	LDO(-1)	0.829644
	(1.30117)		(0.14576)
	[1.94170]		[5.69204]
LTB(-1)	-3.035489	LWAGE(-1)	-1.189796
	(0.42912)		(0.16487)
	[-7.07383]		[-7.21652]
LWAGE(-1)	2.286322	LTB(-1)	0.092784
	(2.47736)		(0.02420)
	[0.92288]		[3.83417]
LDO(-1)	15.23344	LGFCF(-1)	0.159539
	(4.88757)		(0.02383)
	[3.11677]		[6.69454]
@TREND(00Q1)	-0.090494	@TREND(00Q1)	-0.007086
C	-45.13365	C	-7.335664