Public Investment and Growth in Jamaica

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Abstract

This paper seeks to uncover the relationship between public investment and growth in Jamaica. Here, public investment relates to capital expenditure by Central Government. The relationship is established through the use of a VECM. It was found that although public investment had a positive impact on GDP, it was not significant. Public investment also crowed-out net private investment as it resulted in higher domestic private investment but lower foreign domestic investment, with the latter effect being much more substantial.

[1] The views expressed are those of the authors and not necessarily those of the Bank of Jamaica.

Table of Contents

1. INTRODUCTION

There are mixed views on the impact of fiscal policy with respect to stimulating economic growth. On one hand, Keynesian economists believe that left alone an economy would rarely operate at full employment and as such both fiscal and monetary policy is needed to stimulate aggregate demand. On the other hand, Monetarist and Classical economists believe that fiscal policy should be kept to a minimum due to its potential to create inefficiency in the use of resources. However, most economists would agree that there are situations when increasing government spending would be beneficial and situations where less government spending would spur growth. This is exemplified by the Rahn curve, which shows that when government spending is zero there is little or no growth, however after a certain point, increasing government spending results in lower growth.

It is argued that government spending can bolster economic growth by putting money in the hands of the public. This is as public investment may lead to an increase in employment which should multiply throughout the economy. Public investment in infrastructure development may provide an incentive for further investment by the private sector. However, public investment could also lead to a crowding-out of private investment which would have negative implications for growth. It is in this context that the paper seeks to uncover the relationship between public investment and growth in the case of Jamaica. Here, public investment relates to capital expenditure by Central Government. This was done with the use of a vector error correction model (VECM) as not all the variables used in the model were stationary. The rest of the paper is organised as follows, section 2 gives a brief review of the literature. A discussion of the empirical methodology is carried out in section 3. Section 4 deals with the data description. An analysis of the results is undertaken in section 5 while, section 6 delves into the scenario analysis and section 7 concludes.

2. LITERATURE REVIEW

There have been a number of studies done on countries with varying structures with conflicting results. Roache (2007) utilised a panel vector autoregression (PVAR) approach to assess the impact of public investment on growth in the Eastern Caribbean Currency Union (ECCU). The study was done using real GDP, real public investment and the bilateral real exchange rate as endogenous variables. The OECD growth rate, aid flows, as well as dummy variables for natural disasters and elections were included as exogenous variables. The model estimates was as follows

$$\Delta x_t = a_0 + \sum_{l=1}^{m} a_l \Delta x_{t-l} + \sum_{l=1}^{m} g_l \Delta w_{t-l} + \Theta f_t + v_t$$

Where

x is the vector of endogenous variables

w is the OECD growth rate, and

f is the vector of dummy variables

The results showed that public investment had only a temporary and limited effect on growth in the region and is probably negative. It was found that where the government's investment was financed through borrowing there was a greater impact on the debt stock than growth.

A similar study on the Southern African Customs Union (SACU) region[2] looked at the relationship between public investment and economic growth in South Africa, Botswana, and Namibia using the VECM methodology. This study was conducted using the variables real GDP, real public consumption, real public investment, and real private investment[3] in the following model.

[2] Done by Ashipala and Haimbodi (2003)

[3] Gross fixed capital formation by government and private enterprise was used as a proxy for public investment and private investment, respectively.

$$\Delta X_t = a + \prod X_{t-1} + D_1 \Delta X_{t-1} + ... + D_{p-1} \Delta X_{t-p+1} + U_t \qquad \text{t=1,...,n}$$

Where

X is the vector of endogenous variables

D is a matrix of estimated parameters

U is a vector of impulses

It was found that in all three cases the effect of public investment on growth was not statistically significant however, it did have the correct sign. On the other hand, private investment was shown to have a long run growth impact in South Africa and Namibia.

Pineda and Rodriguez (2006) showed that public investment in infrastructure in Venezuela resulted in higher levels of productivity. Similarly, a study by David Alan Aschauer (1989) indicated that public investment in physical infrastructure plays an important role in stimulating private investment. He argues that the main cause of the US economy's relatively poor economic performance between the 1970s and 1990s is the slow down in public investment during the period. These public facilities are necessary to the production process of a firm's own capital equipment. He also shows that the payoff in GNP growth from public infrastructure investment is estimated to exceed that of private investment.

3. EMPIRICAL METHODOLOGY

3.1 VAR-VECM Model

The VECM model used in the paper is the typical error correction methodology as can be seen below. Consider the vector autoregressive process given in equation 1:

$$(1) \qquad y_t = \sum_{i=1}^{p} s_i y_{t-i} + AD_t + e_t$$

Where :

s_i is a matrix of coefficients

y_t is a vector of endogenous $I(1)$ variables, and

AD_t is a deterministic term which can contain a constant, a trend, dummy variables, or nonstochastic regressors.

e_t is a vector of white noise serially uncorrelated error terms.

Following the Granger Representation Theorem, the vector error correction model VECM(p) can be applied as followed

$$\Delta y_t = \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + AD_t + e_t \quad (2)$$

where,

$\Gamma_i = -\sum_{j=i+1}^{p} s_j$ and

$\prod = ab'$

such that equation (2) can be rewritten as

$$\Delta y_t = ab' y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + AD_t + e_t \quad (3)$$

where

$ab' = -I_k + \sum_{i=1}^{p} s_i$

Where:

Δy_t is a vector of endogenous variables in first difference form,

a represents the adjustment coefficient, and

b is a the cointegrating vector or long-run parameters.

4. DATA

The paper uses quarterly data running from the fourth quarter of fiscal year 1994/95 to the last quarter of fiscal year 2006/07 (that is, 1994/05:04 – 2006/07:04). This gives a total of forty-nine data points. Although, reliable fiscal data is available from the first quarter of fiscal year 1993/94, the period chosen for the study was limited by the availability of data on foreign direct investment (FDI).

The paper seeks to ascertain whether it would be growth inducing for the Government to run higher deficits with the extra funds being channelled toward capital expenditure. Consequently, for the purposes of the paper, public investment relates specifically to capital expenditure by the Jamaican Central Government and not to capital expenditure by other public bodies. The variables used in the study were chosen on the basis of economic theory as well as those generally used in related literature. The variables are real gross domestic product (GDP), capital expenditure, private sector credit, FDI, and the real effective exchange rate (REER), which can be seen in Figure 1.

Capital expenditure is used as the measure of public investment by the Central Government. Here, private sector credit relates to loans from financial institutions to non public sector entities in the different areas of the economy. Although there as several ways by which firms may finance their capital investment such as from retained earnings, the issuing of shares, or by floating bonds, credit from financial institutions remains the most widely used source of funding. As such, it is seen as a suitable proxy for private investment. FDI was converted to its Jamaica Dollar equivalent using the exchange rate corresponding to the quarter in which the investment took place[4]. As indicated by Roache 2007, the inclusion of the REER was based on the links between investment and competitiveness. All the variables used in the paper were expressed in their natural logarithmic form.

[4] Capital expenditure, private sector credit, and FDI, are all expressed in real terms as they were deflated by the CPI.

4.1 Stationarity

The Augmented Dickey Fuller (ADF) test and the Phillips-Perron test were used to determine the stationarity of the variables used in the model. The null hypothesis is that the variable has a unit root, that is, the variable is non-stationary, relative to the alternative hypothesis that the variable is stationary. The two tests show conflicting results in levels with regards to GDP, capital expenditure and FDI. With regards to GDP, the ADF test suggests that the variable is stationary at the 5 percent level of significance, whereas the Phillips-Perron test suggests that the null hypothesis of a unit root cannot be rejected and the variable is integrated of order I(1). With respect to capital expenditure, the ADF test shows that the variable has a unit root in levels and is only stationary after differencing, while the Phillips-Perron test indicates that the variable is stationary at the 5 percent level without differencing. In relation to FDI, the ADF test indicates that there is no need to difference the variable as the null hypothesis of a unit root can be rejected at the 5 percent level. This result is rejected by the Phillips-Perron test which shows that the variable is integrated of order one I(1). With regards to the other variables, the two tests are generally in agreement with each other. The Phillips-Perron test indicates that after one round of differencing, the hypothesis of a unit root can be rejected at the 1 percent level of significance for all the variables. This is basically in line with the findings from the ADF test as can be seen in Table 1. Given that both tests indicate that the variables are stationary in first difference form, cointegration analysis can be carried out to see if there exits a stable long run relationship between the variables.

Figure 1

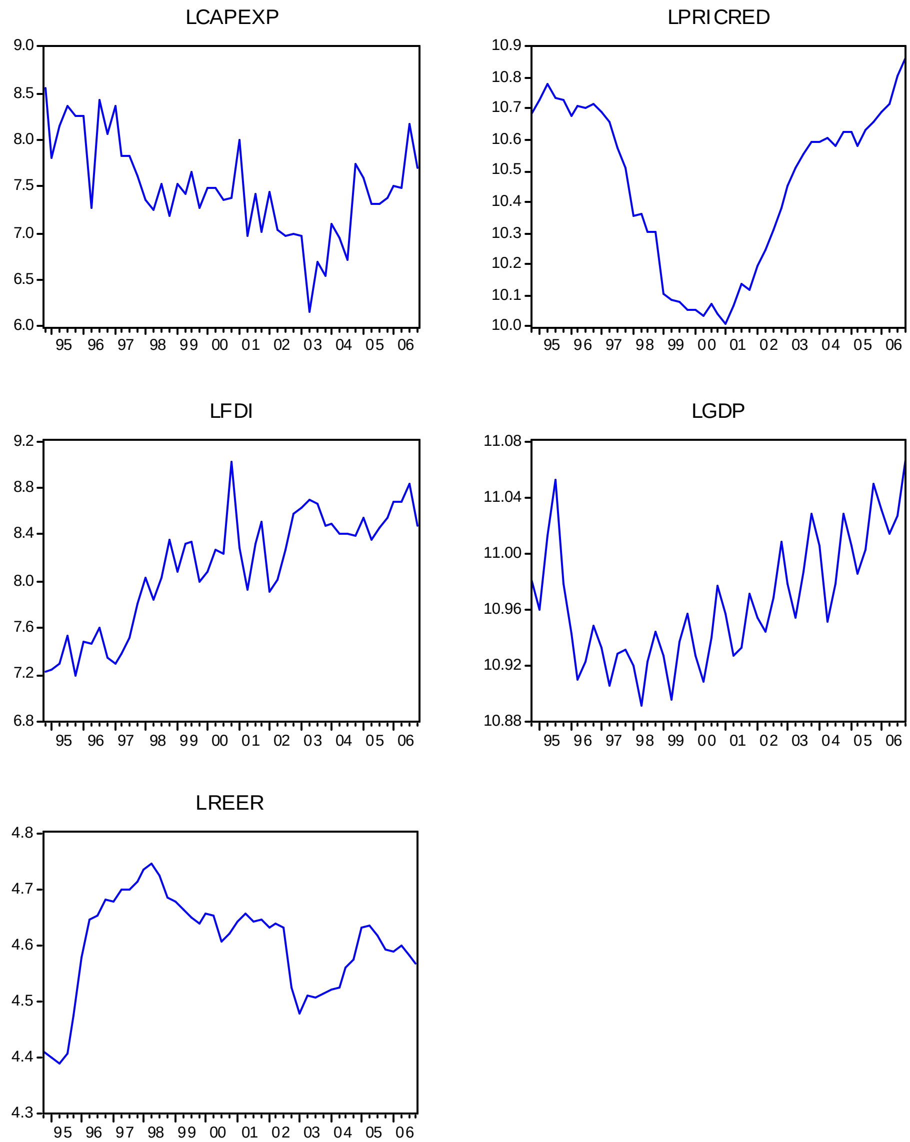


Table 1 **Unit Root Tests**

Variables	ADF		Phillips-Perron	
	Level	1st Difference	Level	1st Difference
Real GDP	-4.146283*	-3.951298*	-2.237882	-7.259958**
Capital Expenditure	-1.896323	-13.19160**	-4.133173*	-15.02999**
REER	-3.259419	-4.116491**	-2.285583	-4.105589**
FDI	-3.910445*	-7.533819**	-2.068807	-10.27044**
Private Credit	-1.269386	-2.454696*	-0.501231	-5.683982**

Note: * denotes rejection of the null hypothesis of a unit root at the 5% level

** denotes rejection of the null hypothesis of a unit root at the 1% level

5. ESTIMATION RESULTS AND ANALYSIS

5.1 Correlation and Causation

The relationship between the variables used in the study is first assessed using correlation analysis. This is done through the use of a pairwise correlation matrix. This matrix shows the linear relationship between two variables as can be seen in Table 2. The results from the matrix indicate that there is only a weak association between GDP and capital expenditure however, the correlation has the expected positive sign. This means that although capital expenditure and GDP move in the same direction the association between the two variables is not very strong. It can be seen from the table that there is a fairly substantial positive linear relationship between GDP and private credit. The linear relationship between GDP and FDI is also positive albeit, not as strong as the relationship between GDP and domestic private investment. The results indicate a strong inverse affiliation between GDP and the REER. This is expected given that as the Jamaican Dollar appreciates, the exports of the country become more expensive, which should result in a fall in demand for local goods. Its can also be seen that capital expenditure and domestic private investment move in the same direction. However, there is a strong inverse relationship between capital expenditure and FDI. This suggests that the linear association between capital expenditure and foreign investment and capital expenditure and domestic investment is opposing. There is also a relatively weak inverse relationship between capital expenditure and the REER. Interestingly, domestic private investment and FDI move in opposite directions. This is also the case for domestic private investment and the REER. As expected the affiliation between FDI and the REER is positive.

Table 2. Pairwise Correlation

	Real GDP	Capital Expenditure	Private Credit	FDI	REER
Real GDP	1.000000	0.026503	0.509620	0.376551	-0.603331
Capital Expenditure	0.026503	1.000000	0.334800	-0.616328	-0.068763
Private Credit	0.509620	0.334800	1.000000	-0.266121	-0.448364
FDI	0.376551	-0.616328	-0.266121	1.000000	0.055972
REER	-0.603331	-0.068763	-0.448364	0.055972	1.000000

While correlation is important, it does not imply causation. As such, the next logical step is to do an assessment of causation, which will be done through the use of the pairwise Granger causality test. The results of the Granger causality test can be seen in Table 3. The results of the Granger causality test is made even more important due to the inconsistency of the results of the unit root tests on some of the variables as the Granger test will also help to validate the inclusion of some of the variables in the VECM model.

The null hypothesis that capital expenditure does not Granger cause real GDP cannot be rejected, which is consistent with the weak correlation between the two variables. However, the null hypothesis that GDP does not Granger cause capital expenditure can be rejected at the 10 percent level of significance. The causality test between private credit and GDP shows that the null hypothesis that private sector credit does not Granger cause GDP can be decisively rejected in favour of the alternative hypothesis. On the other hand, there may exist some element of reverse causality since the null hypothesis that GDP does not Granger cause private sector credit can also be decisively rejected. This indicates that domestic private investment and GDP are not exogenous of each other. The results also show that at the 10 percent level of significance, the null hypothesis that FDI does not Granger cause GDP can be rejected. However, GDP does not Granger cause FDI. Therefore, it can be seen that both domestic private investment and FDI lead GDP. The hypothesis that the REER does not Granger cause GDP can be rejected at the 5 percent level however, reverse causality may again be present as the hypothesis that GDP does not Granger cause the REER may also be rejected at the 10 percent level of significance. The Granger results indicate that public investment and domestic private investment are exogenous of each other as neither variable seems to cause the other. This is also the case for public investment and FDI. However, the null hypothesis that public investment does not Granger cause the REER can be rejected. FDI seems to cause domestic private investment but private investment does not Granger cause FDI. The REER and FDI also seem to be exogenous of each other as one does not cause the other.

Table 3

Pairwise Granger Causality Tests
Date: 11/22/07 Time: 12:51
Sample: 1994Q4 2006Q4
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Probability
LCAPEXP does not Granger Cause LGDP	46	1.83017	0.15764
LGDP does not Granger Cause LCAPEXP		2.39220	0.08320
LPRICRED does not Granger Cause LGDP	46	5.74046	0.00236
LGDP does not Granger Cause LPRICRED		6.67401	0.00096
LFDI does not Granger Cause LGDP	46	2.65387	0.06194
LGDP does not Granger Cause LFDI		0.35290	0.78727
LREER does not Granger Cause LGDP	46	3.12207	0.03675
LGDP does not Granger Cause LREER		2.66174	0.06140
LPRICRED does not Granger Cause LCAPEXP	46	0.88347	0.45809
LCAPEXP does not Granger Cause LPRICRED		0.26442	0.85061
LFDI does not Granger Cause LCAPEXP	46	0.14296	0.93357
LCAPEXP does not Granger Cause LFDI		2.22401	0.10067
LREER does not Granger Cause LCAPEXP	46	0.51470	0.67457
LCAPEXP does not Granger Cause LREER		3.61997	0.02130
LFDI does not Granger Cause LPRICRED	46	2.99609	0.04226
LPRICRED does not Granger Cause LFDI		0.54977	0.65130
LREER does not Granger Cause LPRICRED	46	1.05985	0.37719
LPRICRED does not Granger Cause LREER		2.36326	0.08597
LREER does not Granger Cause LFDI	46	1.90910	0.14407
LFDI does not Granger Cause LREER		1.83119	0.15745

5.2 Lag Length

The selection of the appropriate lag order to be used in the cointegration test and VECM is critical as the lag length chosen may have a bearing on the results. As such, the lag order for use in the paper was determined with the use of the VAR lag length criteria test. Given the limited number of data points, a maximum lag length of four is considered as the inclusion of more lags will results in a loss of data points and reduce the degrees of freedom[5]. As can be seen in Table 4, nearly all of the criteria suggested a lag order of three, with only the Schwarz information criterion (SC) differing and suggestion a lag order of one. As such, three lags were selected as the appropriate number of lags to be used in the model[6].

Table 4 **Lag Length Test**

VAR Lag Order Selection Criteria
Endogenous variables: LCAPEXP LPRICRED LFDI LGDP LREER
Exogenous variables: C
Date: 11/24/07 Time: 19:55
Sample: 1994:4 2006:4
Included observations: 45

Lag	LogL	LR	FPE	AIC	SC	HQ
0	123.5489	NA	3.54E-09	-5.268842	-5.068102	-5.194008
1	277.8295	267.4197	1.14E-11	-11.01465	-9.810204*	-10.56564
2	309.8009	48.31223	8.74E-12	-11.32448	-9.11634	-10.50131
3	348.4248	49.78200*	5.33E-12*	-11.92999*	-8.718148	-10.73265*
4	366.8792	19.68467	8.97E-12	-11.63908	-7.42353	-10.06756

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

5.3 Cointegration

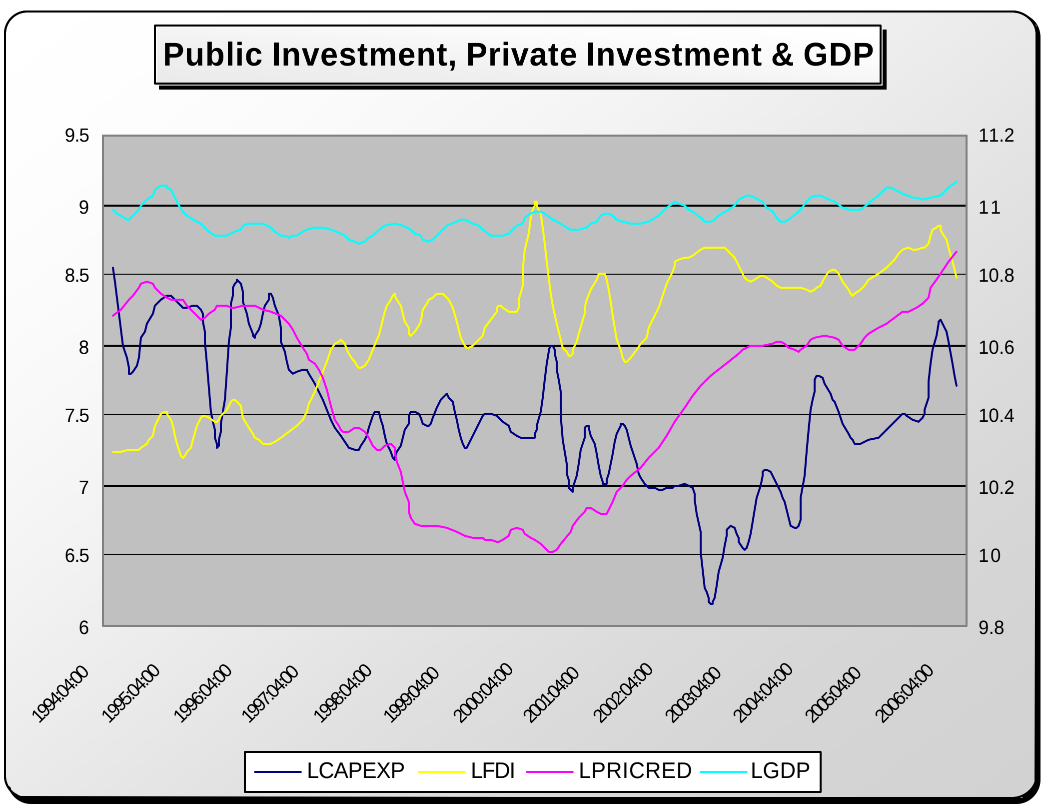
If a set of variables are cointegrated, then is means that there exists a stable long-run relationship between the variables. Therefore, while the variables may diverge from each other in the short-run, in the long-run the variables should eventually move back along

[5] As pointed out by Ganegodage etal. (2003) as long as the residuals are not serially correlated, a lower lag length can be chosen.
[6] "Although a shorter lag length is preferred, there is no practical basis for considering order one for an error correction model, because to do so would directly imply that there is no short-run dynamic part in the model after fixing the long run behaviour" Ganegodage etal. (2003).

the same path. A look at Figure 2 shows that although the variables exhibit bouts of divergence from each other, they generally tend to move in the same direction.

A formal test of the long long-run relationship is assessed using the Johansen's Maximum Likelihood approach. The summary results of the cointegration test can be seen in Table 5. The trace test suggests that the null hypothesis of no cointegrating equation can be rejected at the 5 percent level of significance. The test goes on to further reject the hypothesis of one (1) cointegrating equation at the 5 percent level of significance. Therefore, the trace test indicates two (2) cointegrating equations at the 5 percent level. The max-eigenvalue test suggests that the null hypothesis of no cointegrating equation can be rejected at the 5 percent level of significance, in line with the results from the trace test. However, the hypothesis of one (1) cointegrating equation cannot be rejected. Thus, the max-eigenvalue test indicates that there is one long-run cointegrating equation.

Figure 2[7]



[7] Capital expenditure and FDI are on the Y-axis and private sector credit and GDP are on the Z-axis.

Table 5 **Cointegration**

Date: 11/23/07 Time: 17:57
Sample (adjusted): 1995Q4 2006Q4
Included observations: 45 after adjustments
Trend assumption: Linear deterministic trend
Series: LGDP LCAPEXP LPRICRED LFDI LREER
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.551083	87.73542	69.81889	0.0010
At most 1 *	0.437395	51.69411	47.85613	0.0209
At most 2	0.325433	25.81109	29.79707	0.1345
At most 3	0.150096	8.095286	15.49471	0.4553
At most 4	0.017115	0.776855	3.841466	0.3781

Trace test indicates 2 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 *	0.551083	36.04131	33.87687	0.0272
At most 1	0.437395	25.88302	27.58434	0.0812
At most 2	0.325433	17.71580	21.13162	0.1408
At most 3	0.150096	7.318431	14.26460	0.4522
At most 4	0.017115	0.776855	3.841466	0.3781

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 Cointegrating Coefficients (normalized by b'*S11*b=I):

LGDP	LCAPEXP	LPRICRED	LFDI	LREER
-45.04521	0.572971	3.793497	3.407786	7.531606
109.2438	-4.189247	-7.978606	-7.341903	32.57241
-8.129137	2.393470	-0.90753	4.916810	-10.98134
-19.05253	3.305955	-2.284946	1.688033	-3.09659
-4.722519	-3.088966	-3.548596	-2.538196	-5.38573

Unrestricted Adjustment Coefficients (alpha):

D(LGDP)	0.007963	0.000484	0.002061	-0.001447	-0.001213
D(LCAPEXP)	0.039169	0.010065	0.095885	-0.094504	0.008900
D(LPRICRED)	-0.004899	0.018693	0.012202	0.003158	0.000675
D(LFDI)	-0.054569	0.054856	-0.065969	-0.035886	-0.01066
D(LREER)	-0.013498	-0.010121	4.06E-05	0.000497	-0.000701

5.4 VECM Estimates

The VECM shows that domestic private investment, FDI, and the REER all have a significantly direct effect on the level of GDP in the long-run (see appendix). Domestic private investment and FDI have the expected positive relationship with GDP meaning that as private investment increases whether from domestic or foreign sources, it will result in an increase in GDP. However, the long-run relationship between the REER and GDP is unexpectedly positive suggesting that as the REER appreciates GDP will increase. This may be the case in Jamaica where an appreciation of the currency makes it cheaper for companies to import capital goods without have a significant negative impact on exports. This is in a context where many exports are quota driven or priced in US Dollar and as such are not affected by the an appreciation of the REER. The VECM results show that a 1 percent increase in domestic private investments increases GDP by 0.084 percent in the long-run. A 1 percent increase in FDI should also result in a 0.077 increase in GDP in the long-run. This indicates that an equivalent percentage increase in domestic private investment and FDI will both have relatively the same long-run impact on GDP. The coefficient on the REER is 0.167, which means that a 1 percent increase in the REER will cause GDP to increase by 0.167 percent over the long-run. The coefficient on capital expenditure has the expected positive sign meaning that as the level of public investment increases then this result in an increase in GDP in the long run. However, the coefficient on capital expenditure is not significant.

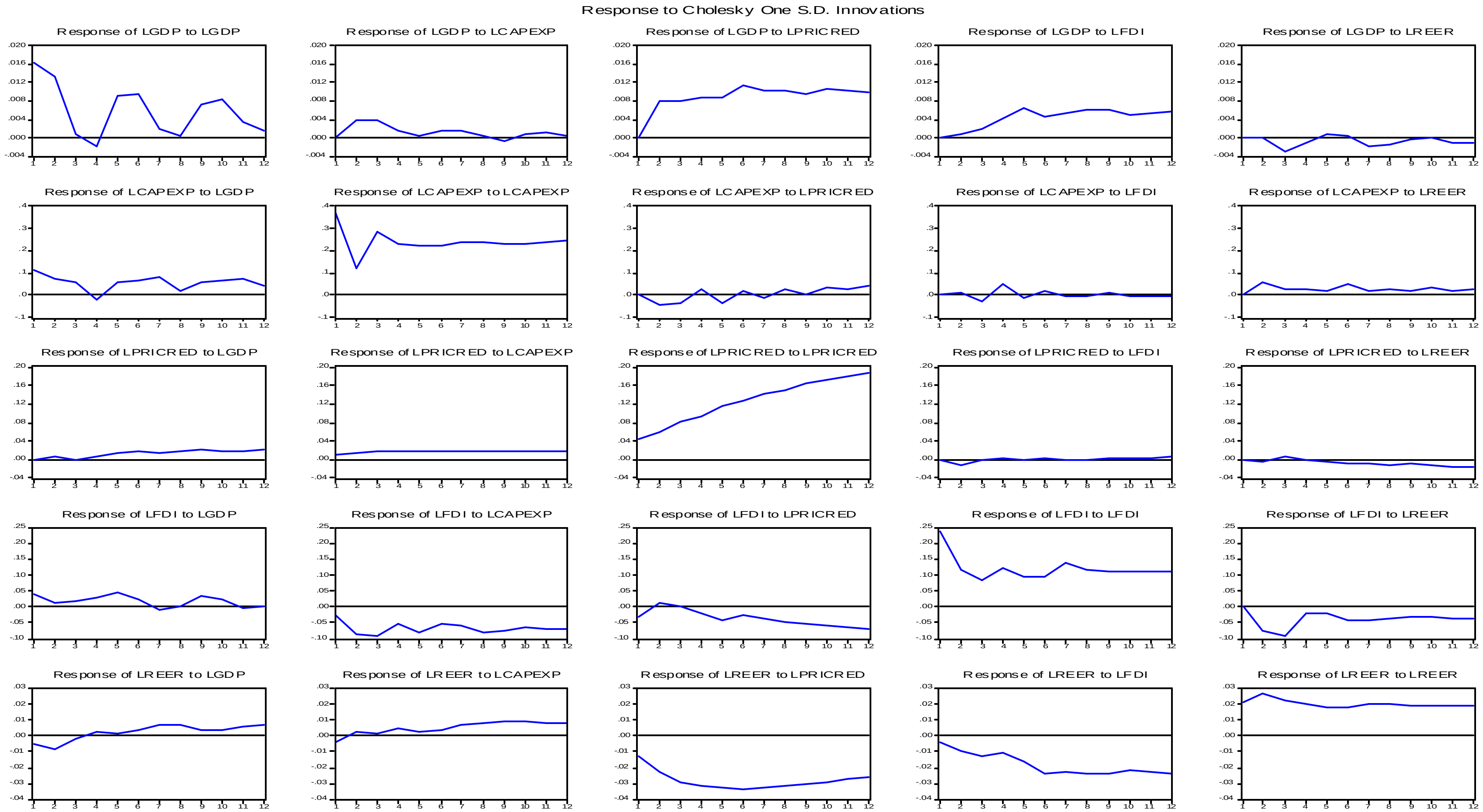
5.4 Impulse Response Functions

The short-run impact of the variables on each other can be determined from the error correction model. However, given that these are difficult to analyse, the short-run dynamic will be assessed with the use of the impulse response functions (IRF). The IRF shows the impact that a shock to the innovation of one variable has on the other variables in the model. Generally, the focus will be on the first row and the second column of Figure 3 (row 4 & column 2), that is, how the different variables impact GDP and how shocks to capital expenditure impact on the other variables of the model.

The IRFs show that as expected, GDP initially moves higher in response to a shock to GDP. A shock to capital expenditure essentially has no impact on GDP in the first period and a weak positive reaction over the subsequent periods. In the first period, GDP shows no reaction to an increase in domestic private investment and a sustained positive response over the remaining twelve quarters. This positive association is between domestic private investment and GDP is what is expected based on economic theory as these investments put the economy's resources to productive use. There is a similar result for FDI, where there is no impact on GDP in the first period after the shock thereafter, GDP is permanently higher. In response to a shock to the REER, GDP stays flat for the first two quarters and then oscillates. Here, apriori expectations were that an appreciation in the REER would result in lower GDP levels as the rise in the value of the local currency results in a loss in international competitiveness.

It can be seen from the IRFs that capital expenditure increases and remains permanently higher in response to a shock to itself. Similarly, domestic private investment increases in response to a shock to the innovations of public investment and remains higher over the ensuing 12 quarters. Conversely, FDI falls in response to an increase in public investment and remains permanently lower. Therefore, it can be seen that public investment crowds-in domestic private investment but crowds-out FDI. As such, the net impact of public investment on private investment will depend on which effect is greater, which will be assessed in the scenario analysis section to follow. The initial impact of a shock to public investment on the REER is that it depreciates however, the effect quickly changes to an appreciation.

Figure 3 **Impulse Response Functions**



5.5 Variance Decomposition

The variance decomposition which can be seen in the appendix, gives information on the percentage importance of each variable on the variance in forecast of another variable. Looking at the variance decomposition of GDP, it can be seen that as expected the majority of the variance in the forecast is initially explained by a shock to the variable itself (see appendix). However as time passes, a shock to domestic private investment explains a significant proportion of the variance in forecast of GDP, moving from 12 percent in the second quarter to 48 percent by the twelfth quarter. A similar trend is exhibited by FDI albeit not with the same magnitude, as a shock to the variable explains 0.2 percent of forecast variance of GDP in the second quarter, which increases to 13 percent by the twelfth quarter. A shock to public investment explains less than 5 percent of the forecast variance of GDP.

The variance in the forecast of domestic private capital investment is largely explained by a shock to private domestic investment. Although, a shock to public investment is the next most significant variable in explaining the forecast of private domestic investment, it generally explains less than 5 percent. Conversely, a shock to public investment explains as much as 18 percent of the variance in the forecast of FDI.

6. SCENARIO ANALYSIS

In the upcoming section, the implication for GDP of running higher deficits by increasing capital expenditure is assessed through the use of a scenario modelling. The modelling will also show whether or not public investment crowds out private investment. The model uses the representation of the equation derived from the VECM. The representation gives a system of equations with each variable being the regressand in one equation and dependent on lags of the other variables and itself. Each equation in the representation is a combination of the long run relationship as deduced from the cointegration equation and the individual error correction relationships. The representation can be seen in the appendix.

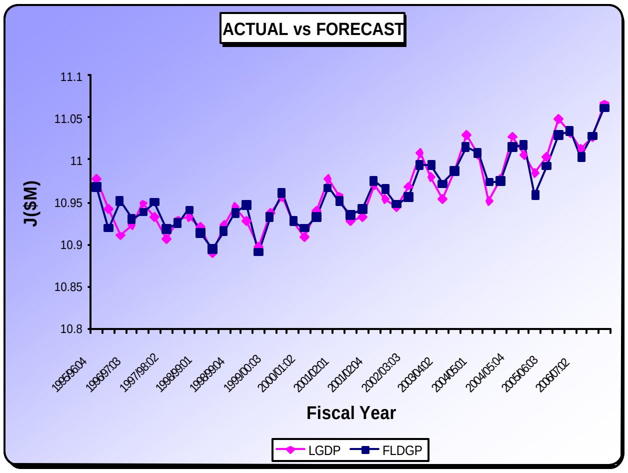
6.1 Forecast Results

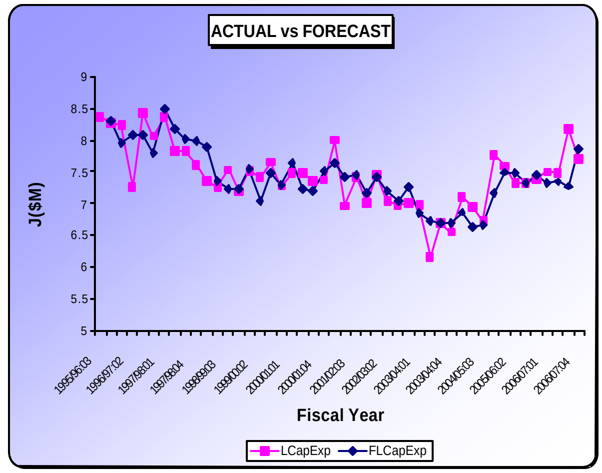
Before engaging in the scenario analysis, the accuracy of the equations derived from the VECM is assessed. This accuracy is determined though the conduct of an in-sample forecast. The precision of the forecast is evaluated using the Theil-U inequality coefficient. The closer the coefficient is to zero, the better is the fit of the model while, a value closer to one indicates significant divergence from the actual data. The resulting Theil-U values from the forecast are juxtaposed to the Theil-U statistics from a simple random walk plus drift. The results can be seen in Table 6. The results show that the model is not only accurate but also more precise than just modelling the variables on past values of themselves. This is in a context where the forecasted values of the variables derived from the VECM model were all better than those obtained from the random walk with drift. As shown in Figure 4, the VECM does an excellent job at forecasting GDP, REER, and Private Credit as the values for the Theil inequalities are all very close to zero. While, the forecast of FDI and capital expenditure were not as good, they are still adequate as they are closer to zero than one. This is evident as the forecasts perform a reasonably satisfactory job of predicting the actual turning points of the variables.

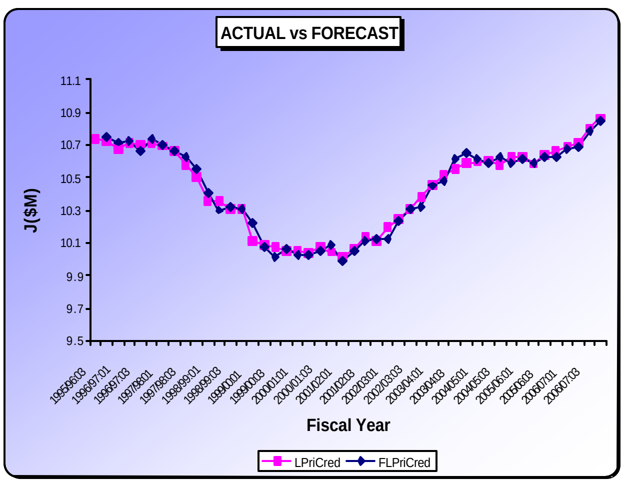
Table 6

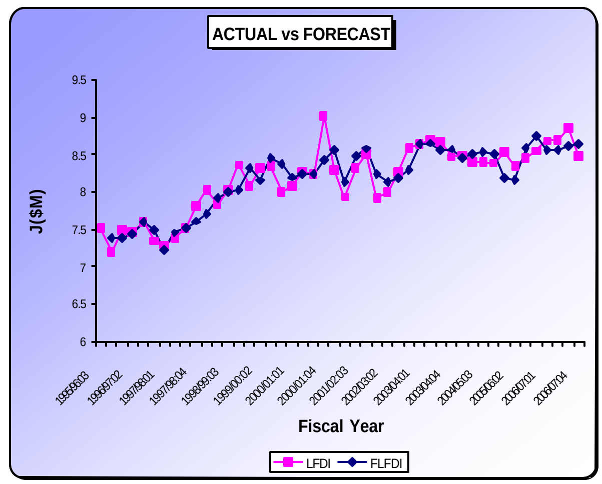
Theil-U Statistic		
	Forecast	Random Walk
GDP	0.00059	0.00210
Capital Expenditure	0.02060	0.03110
Private Sector Credit	0.00177	0.02190
FDI	0.01188	0.02029
REER	0.00220	0.01026

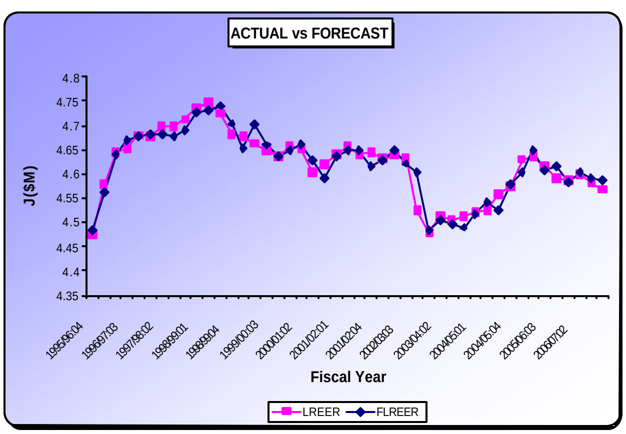
Figure 4


ACTUAL vs FORECAST
J($M)
11.1
11.05
11
10.95
10.9
10.85
10.8
Fiscal Year
LGDP
FLDGP


ACTUAL vs FORECAST
J($M)
9
8.5
8
7.5
7
6.5
6
5.5
5
Fiscal Year
LCapExp
FLCapExp


ACTUAL vs FORECAST
J($M)
11.1
10.9
10.7
10.5
10.3
10.1
9.9
9.7
9.5
Fiscal Year
LPriCred
FLPriCred


ACTUAL vs FORECAST
J($M)
9.5
9
8.5
8
7.5
7
6.5
6
Fiscal Year
LFDI
FLFDI


ACTUAL vs FORECAST
J($M)
4.8
4.75
4.7
4.65
4.6
4.55
4.5
4.45
4.4
4.35
Fiscal Year
LREER
FLREER

6.2 Scenario Results

A one standard deviation (approximately 6.8 percent) increase in capital expenditure causes a small 0.028 percent increase in GDP (see table 7). It also results in a 0.271 percent appreciation of the REER. The increase in capital expenditure crowds-in domestic private capital investment and crowds-out foreign domestic investment. However, the impact of the increase in domestic private investment is much smaller than the decline in FDI thus, the net effect of an increase in public investment on private investment is negative. Therefore, public investment crowds-out net private investment.

Table 7

Simulation Results	
Variables	% Change
GDP	0.028
Private Sector Credit	0.018
FDI	-1.475
REER	0.271

1 std. deviation increase in capital expenditure

7. SUMMARY AND CONCLUSION

The paper used a VECM to assess the impact of public investment on GDP using data from fiscal year 1994/95 to 2006/07. The correlation results indicate only a weak relationship between GDP and public investment whereas, the Granger causality result suggests that public investment does not cause GPD however, reverse causality could not be convincingly rejected. Nonetheless, it was found that there exists a stable long-run relationship between the variables used in the model as the cointegration analysis indicated at least one cointegrating equation. The VECM showed that in the long-run domestic private sector investment, FDI, and the REER all have a positive statistically significant direct impact on the level of GDP. Public investment was not found to have any significant impact on GDP. In fact it was found to have the effect of crowding-out net private investment.

Given the results of the VECM and the scenario results, it can be concluded that running higher deficits with the extra funds being channelled towards capital expenditure would not be feasible as the impact on GDP is very small. This is in a context where the increase GDP would not offset the possible negative impact of the financing the higher deficit. However, it is important that funds are directed to productive capital projects that will spur domestic private investment. An area for further work would be to disaggregate capital expenditure to highlight which elements of public investment have the greatest impact on growth, which have a positive impact on domestic private investment and, which elements crowd-out FDI. This would further help to inform policy as the government could then invest in those specific areas which would result in a net positive benefit for the economy. A caveat to running higher deficits is that there is a fall in FDI and the Government could be viewed negatively by the international capital market, particularly, as Jamaica is already running deficits above best practices. It may also be informative to broaden the definition of public investment to include project spending by public sector enterprises given that in Jamaica significant project funding (including that for infrastructural projects) is channelled through theses entities.

8. APPENDIX

8.1 Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 11/23/07 Time: 17:58
Sample (adjusted): 1995Q4 2006Q4
Included observations: 45 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LGDP(-1)	1.000000
LCAPEXP(-1)	-0.012720 (0.01816) [-0.70057]
LPRICRED(-1)	-0.084215 (0.02100) [-4.00997]
LFDI(-1)	-0.075653 (0.01983) [-3.81589]
LREER(-1)	-0.167201 (0.08281) [-2.01899]
C	-8.599944

Error Correction:	D(LGDP)	D(LCAPEXP)	D(LPRICRED)	D(LFDI)	D(LREER)
CointEq1	-0.358681 (0.10940) [-3.27855]	-1.764360 (2.60806) [-0.67650]	0.220679 (0.31497) [0.70064]	2.458091 (1.65721) [1.48327]	0.608005 (0.17300) [3.51450]
D(LGDP(-1))	0.147077 (0.20594) [0.71417]	4.611783 (4.90944) [0.93937]	0.371099 (0.59290) [0.62591]	-2.248555 (3.11955) [-0.72080]	-0.826787 (0.32566) [-2.53884]
D(LGDP(-2))	-0.638760 (0.12936) [-4.93797]	0.746470 (3.08375) [0.24207]	-0.740340 (0.37242) [-1.98794]	-1.669215 (1.95947) [-0.85187]	-0.205763 (0.20455) [-1.00592]

D(LGDP(-3))	-0.041223	-3.787574	0.710306	0.011064	-0.670138
	(0.19811)	(4.72266)	(0.57034)	(3.00086)	(0.31327)
	[-0.20809]	[-0.80200]	[1.24540]	[0.00369]	[-2.13920]
D(LCAPEXP(-1))	0.001348	-0.668226	0.006519	-0.200704	0.031986
	(0.00824)	(0.19639)	(0.02372)	(0.12479)	(0.01303)
	[0.16363]	[-3.40261]	[0.27486]	[-1.60837]	[2.45537]
D(LCAPEXP(-2))	0.000271	-0.067839	-0.005770	-0.186232	0.013600
	(0.01094)	(0.26082)	(0.03150)	(0.16573)	(0.01730)
	[0.02478]	[-0.26010]	[-0.18317]	[-1.12373]	[0.78610]
D(LCAPEXP(-3))	0.001812	0.062794	-0.019310	0.027839	0.010478
	(0.00834)	(0.19874)	(0.02400)	(0.12628)	(0.01318)
	[0.21733]	[0.31596]	[-0.80454]	[0.22045]	[0.79479]
D(LPRICRED(-1))	0.146807	-0.135545	0.257879	-0.201039	-0.096996
	(0.06493)	(1.54783)	(0.18693)	(0.98352)	(0.10267)
	[2.26108]	[-0.08757]	[1.37957]	[-0.20441]	[-0.94472]
D(LPRICRED(-2))	-0.074417	-0.694217	0.423483	-1.105908	-0.033881
	(0.06483)	(1.54546)	(0.18664)	(0.98201)	(0.10251)
	[-1.14790]	[-0.44920]	[2.26897]	[-1.12616]	[-0.33050]
D(LPRICRED(-3))	0.091006	2.039883	0.043505	-0.210443	-0.029332
	(0.06240)	(1.48757)	(0.17965)	(0.94523)	(0.09867)
	[1.45842]	[1.37129]	[0.24217]	[-0.22264]	[-0.29726]
D(LFDI(-1))	-0.022971	-0.036751	-0.031110	-0.379732	0.026934
	(0.01274)	(0.30377)	(0.03669)	(0.19302)	(0.02015)
	[-1.80271]	[-0.12098]	[-0.84802]	[-1.96729]	[1.33665]
D(LFDI(-2))	-0.014550	-0.173360	0.037546	-0.354071	0.015052
	(0.01321)	(0.31482)	(0.03802)	(0.20004)	(0.02088)
	[-1.10176]	[-0.55066]	[0.98754]	[-1.76998]	[0.72078]
D(LFDI(-3))	-0.015268	0.068177	0.050571	-0.156601	0.033578
	(0.01148)	(0.27373)	(0.03306)	(0.17393)	(0.01816)
	[-1.32969]	[0.24906]	[1.52978]	[-0.90035]	[1.84929]
D(LREER(-1))	-0.058513	2.557981	-0.127978	-3.123737	0.374629
	(0.11587)	(2.76236)	(0.33360)	(1.75525)	(0.18323)
	[-0.50496]	[0.92601]	[-0.38362]	[-1.77965]	[2.04454]
D(LREER(-2))	-0.173266	-0.566331	0.389264	-0.792232	-0.317669
	(0.12721)	(3.03260)	(0.36624)	(1.92697)	(0.20116)

	[-1.36204]	[-0.18675]	[1.06287]	[-0.41113]	[-1.57919]
D(LREER(-3))	-0.009732	-0.335336	-0.259059	1.372484	0.071875
	(0.10929)	(2.60546)	(0.31465)	(1.65556)	(0.17283)
	[-0.08905]	[-0.12870]	[-0.82331]	[0.82902]	[0.41588]
C	0.003790	-0.014185	0.000396	0.064055	0.002251
	(0.00284)	(0.06776)	(0.00818)	(0.04305)	(0.00449)
	[1.33331]	[-0.20935]	[0.04838]	[1.48778]	[0.50075]
R-squared	0.822370	0.529318	0.581323	0.468288	0.620599
Adj. R-squared	0.720867	0.260357	0.342079	0.164453	0.403798
Sum sq. resids	0.007432	4.223848	0.061603	1.705400	0.018585
S.E. equation	0.016292	0.388396	0.046905	0.246794	0.025763
F-statistic	8.101923	1.968011	2.429835	1.541258	2.862531
Log likelihood	132.0907	-10.61912	84.50605	9.787178	111.4693
Akaike AIC	-5.115141	1.227517	-3.000269	0.320570	-4.198635
Schwarz SC	-4.432624	1.910034	-2.317752	1.003087	-3.516118
Mean dependent	0.000299	-0.014337	0.002891	0.021159	0.003567
S.D. dependent	0.030837	0.451611	0.057828	0.269991	0.033366

Determinant resid covariance (dof adj.)	1.93E-12
Determinant resid covariance	1.80E-13
Log likelihood	341.0322
Akaike information criterion	-11.15698
Schwarz criterion	-7.543660

8.2 Variance Decomposition

Variance Decomposition of LGDP:

Period	S.E.	LGDP	LCAPEXP	LPRICRED	LFDI	LREER
1	0.016292	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.022930	84.93205	2.837913	12.04124	0.188627	0.000176
3	0.024786	72.76757	4.788028	20.35889	0.724001	1.361510
4	0.026789	62.71551	4.451614	28.56681	2.957381	1.308679
5	0.030269	58.09983	3.512357	30.43016	6.815861	1.141788
6	0.034049	53.79288	2.985142	34.90623	7.386212	0.929535
7	0.036148	48.02596	2.867555	39.34692	8.670144	1.089421
8	0.038054	43.34503	2.605215	42.50927	10.42538	1.115105
9	0.040398	41.72348	2.323857	43.41347	11.54924	0.989947
10	0.042982	40.75715	2.103044	44.69660	11.56827	0.874929
11	0.044719	38.20278	2.042785	46.75888	12.12595	0.869597

12	0.046250	35.84955	1.927284	48.37666	12.97137	0.875135

Variance Decomposition of LCAPEXP:

Period	S.E.	LGDP	LCAPEXP	LPRICRED	LFDI	LREER
1	0.388396	8.563277	91.43672	0.000000	0.000000	0.000000
2	0.419063	10.58334	86.41178	0.900553	0.091802	2.012526
3	0.513476	8.434317	88.55109	1.059918	0.385611	1.569061
4	0.565151	7.105168	89.31046	1.069304	1.006502	1.508570
5	0.612166	6.979957	89.47112	1.273223	0.883975	1.391722
6	0.658378	6.981572	89.16398	1.214435	0.837419	1.802599
7	0.705188	7.303427	89.21345	1.085360	0.736859	1.660903
8	0.744932	6.629233	89.96466	1.125898	0.670188	1.610017
9	0.783358	6.555429	90.27795	1.018293	0.618778	1.529550
10	0.821871	6.658655	90.09546	1.117213	0.566862	1.561812
11	0.859443	6.836756	90.05403	1.099287	0.519274	1.490652
12	0.895541	6.504559	90.30754	1.258806	0.479029	1.450064

Variance Decomposition of LPRICRED:

Period	S.E.	LGDP	LCAPEXP	LPRICRED	LFDI	LREER
1	0.046905	0.065062	4.567182	95.36776	0.000000	0.000000
2	0.079287	0.944083	5.489291	91.49404	1.884826	0.187764
3	0.115276	0.461385	5.333469	92.92077	0.932998	0.351376
4	0.148231	0.496495	4.543648	94.16617	0.581158	0.212524
5	0.189044	0.743445	3.559960	95.10826	0.369579	0.218752
6	0.228895	1.021773	3.044923	95.36548	0.261157	0.306666
7	0.270029	0.957564	2.609238	95.92147	0.188132	0.323597
8	0.310265	1.076756	2.281894	96.13619	0.142541	0.362618
9	0.352042	1.181585	2.094303	96.24569	0.115217	0.363202
10	0.392578	1.202620	1.912551	96.38359	0.106809	0.394436
11	0.432946	1.153071	1.755495	96.56146	0.099850	0.430126
12	0.472221	1.162102	1.615649	96.65762	0.108287	0.456342

Variance Decomposition of LFDI:

Period	S.E.	LGDP	LCAPEXP	LPRICRED	LFDI	LREER
1	0.246794	2.436218	0.960413	1.663643	94.93973	0.000000
2	0.296508	1.878328	9.103141	1.365410	81.48233	6.170796
3	0.334590	1.742684	15.01021	1.072295	70.16557	12.00924
4	0.361590	2.193738	14.88391	1.198935	71.17172	10.55170

5	0.387199	3.247122	17.10759	2.100809	68.12129	9.423187
6	0.405469	3.274087	17.16414	2.322937	67.69894	9.539892
7	0.436433	2.879816	16.54840	2.716881	68.76530	9.089597
8	0.463002	2.561556	17.78171	3.556019	67.32656	8.774157
9	0.486724	2.824212	18.49812	4.303575	65.97737	8.396720
10	0.508188	2.854874	18.47048	5.156683	65.49092	8.027051
11	0.529474	2.631451	18.70247	6.206042	64.63811	7.821926
12	0.551349	2.430740	18.86250	7.292054	63.80066	7.614053

Variance Decomposition of LREER:

Period	S.E.	LGDP	LCAPEXP	LPRICRED	LFDI	LREER
1	0.025763	4.206325	2.576644	25.73354	2.065166	65.41833
2	0.045248	4.561493	1.196213	33.77473	4.891475	55.57609
3	0.059576	2.706947	0.775754	42.61420	7.341618	46.56148
4	0.071350	2.033675	0.934435	49.11211	7.378705	40.54108
5	0.082157	1.559945	0.792541	52.81252	9.586339	35.24866
6	0.093563	1.357328	0.770553	53.48067	13.73382	30.65763
7	0.104257	1.549229	1.103421	52.90394	15.85994	28.58347
8	0.113947	1.647915	1.459235	52.14058	17.55020	27.20207
9	0.121952	1.527161	1.789539	51.48169	19.05201	26.14960
10	0.128853	1.448873	2.047822	51.07211	19.93310	25.49810
11	0.135334	1.517810	2.181722	50.38764	20.81622	25.09661
12	0.141485	1.654488	2.333019	49.50682	21.76199	24.74369

Cholesky Ordering: LGDP LCAPEXP LPRICRED LFDI LREER

8.3 VECM Representations

VAR Model - Substituted Coefficients:
===============================
D(LGDP) = - 0.3586812005*(LGDP(-1) - 0.01271991423*LCAPEXP(-1) - 0.08421532824*LPRICRED(-1) - 0.0756525739*LFDI(-1) - 0.1672010348*LREER(-1) - 8.599943588) + 0.1470770969*D(LGDP(-1)) - 0.6387599788*D(LGDP(-2)) - 0.04122332205*D(LGDP(-3)) + 0.001347987947*D(LCAPEXP(-1)) + 0.0002711051488*D(LCAPEXP(-2)) + 0.001811815167*D(LCAPEXP(-3)) + 0.1468070588*D(LPRICRED(-1)) - 0.07441718928*D(LPRICRED(-2)) + 0.09100579967*D(LPRICRED(-3)) - 0.02297134548*D(LFDI(-1)) - 0.01454985761*D(LFDI(-2)) - 0.01526813464*D(LFDI(-3)) - 0.05851267135*D(LREER(-1)) - 0.173266239*D(LREER(-2)) - 0.009732044321*D(LREER(-3)) + 0.003789602836

D(LCAPEXP) = - 1.764359862*(LGDP(-1) - 0.01271991423*LCAPEXP(-1) - 0.08421532824*LPRICRED(-1) - 0.0756525739*LFDI(-1) - 0.1672010348*LREER(-1) - 8.599943588) + 4.611782568*D(LGDP(-1)) + 0.7464703556*D(LGDP(-2)) -

3.787573633*D(LGDP(-3)) - 0.6682258068*D(LCAPEXP(-1)) - 0.06783899261*D(LCAPEXP(-2)) + 0.06279374304*D(LCAPEXP(-3)) - 0.1355449154*D(LPRICRED(-1)) - 0.6942172374*D(LPRICRED(-2)) + 2.039882958*D(LPRICRED(-3)) - 0.03675098773*D(LFDI(-1)) - 0.1733599011*D(LFDI(-2)) + 0.06817697477*D(LFDI(-3)) + 2.557981251*D(LREER(-1)) - 0.5663310838*D(LREER(-2)) - 0.3353357088*D(LREER(-3)) - 0.01418495817

D(LPRICRED) = 0.2206786341*(LGDP(-1) - 0.01271991423*LCAPEXP(-1) - 0.08421532824*LPRICRED(-1) - 0.0756525739*LFDI(-1) - 0.1672010348*LREER(-1) - 8.599943588) + 0.3710992422*D(LGDP(-1)) - 0.7403397971*D(LGDP(-2)) + 0.7103056766*D(LGDP(-3)) + 0.006518947035*D(LCAPEXP(-1)) - 0.005769500701*D(LCAPEXP(-2)) - 0.01931001144*D(LCAPEXP(-3)) + 0.2578787042*D(LPRICRED(-1)) + 0.4234834084*D(LPRICRED(-2)) + 0.0435049831*D(LPRICRED(-3)) - 0.03111018429*D(LFDI(-1)) + 0.03754610743*D(LFDI(-2)) + 0.05057109176*D(LFDI(-3)) - 0.1279777838*D(LREER(-1)) + 0.3892642223*D(LREER(-2)) - 0.2590586214*D(LREER(-3)) + 0.000395908087

D(LFDI) = 2.458091104*(LGDP(-1) - 0.01271991423*LCAPEXP(-1) - 0.08421532824*LPRICRED(-1) - 0.0756525739*LFDI(-1) - 0.1672010348*LREER(-1) - 8.599943588) - 2.248554823*D(LGDP(-1)) - 1.669215279*D(LGDP(-2)) + 0.01106406332*D(LGDP(-3)) - 0.2007043914*D(LCAPEXP(-1)) - 0.1862321135*D(LCAPEXP(-2)) + 0.0278387445*D(LCAPEXP(-3)) - 0.2010390249*D(LPRICRED(-1)) - 1.105907661*D(LPRICRED(-2)) - 0.2104431818*D(LPRICRED(-3)) - 0.3797323202*D(LFDI(-1)) - 0.3540709585*D(LFDI(-2)) - 0.156600686*D(LFDI(-3)) - 3.123736736*D(LREER(-1)) - 0.7922317269*D(LREER(-2)) + 1.372483713*D(LREER(-3)) + 0.06405468295

D(LREER) = 0.6080046973*(LGDP(-1) - 0.01271991423*LCAPEXP(-1) - 0.08421532824*LPRICRED(-1) - 0.0756525739*LFDI(-1) - 0.1672010348*LREER(-1) - 8.599943588) - 0.8267870492*D(LGDP(-1)) - 0.2057633156*D(LGDP(-2)) - 0.6701380348*D(LGDP(-3)) + 0.03198556959*D(LCAPEXP(-1)) + 0.01359994585*D(LCAPEXP(-2)) + 0.0104776553*D(LCAPEXP(-3)) - 0.09699581616*D(LPRICRED(-1)) - 0.0338812883*D(LPRICRED(-2)) - 0.02933182982*D(LPRICRED(-3)) + 0.02693352359*D(LFDI(-1)) + 0.01505194756*D(LFDI(-2)) + 0.03357810023*D(LFDI(-3)) + 0.3746286358*D(LREER(-1)) - 0.3176691159*D(LREER(-2)) + 0.07187506968*D(LREER(-3)) + 0.002250591917

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