The Determinants of the Greek Current Account Deficit: The EMU Experience

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Abstract In this paper we investigate empirically, the factors that have affected the current account balance in the Greek Economy, primarily after the EMU accession. Using the Johansen Cointegration analysis and Error Correction Model (ECM) on quarterly data over the period 1995Q1 – 2006Q4 period, we test for the empirical importance of the factors that contributed to the recent widening of the Greek current account deficit. In particular, it is shown that, from a point of a long-run perspective, the deterioration of competitiveness, the ongoing process of real convergence, which has been primarily facilitated by strong credit growth reflecting the impact of financial liberalization and lower interest rates, the cyclical position of the Greek economy and to lesser extent the fiscal expansion, have all contributed to higher current account deficits. Also, significant role on the short-run dynamics of the current account has been played by two exogenous factors involving developments in oil and freight prices.

Keywords: Current account deficit, the Greek economy, cointegration analysis, competitiveness, fiscal deficit

JEL Classification: F41

1. Introduction

Historically, the Greek economy has been characterized by large current account deficits. However, during the last decade and particularly after 1999, the year during which the euro was introduced and Greece decided on the rate of exchange that drachma would be replaced by the euro, there has been a widening trend in the current account deficit which reached as high as 12.1 of GDP in 2006. This record high deficit and the growing foreign debt accumulation have raised concerns regarding the extent to which it poses serious risks for the economy. That is, although Greece’s participation in the EMU takes care of the financing needs, the extent to which the large current account deficits may be a symptom of macroeconomic imbalance could have a negative impact on future growth.

This widening of the deficit has been attributed to several factors, some of which, either directly or indirectly, are related to Greece’s EMU accession. A major such factor refers to the gradual erosion of price competitiveness that the Greek economy has experienced over the last decade. This development reflects the fact that consumer price inflation has remained persistently above the euro area average, while, at the same time, there has been a steady rise in relative unit labor costs relative to other euro area countries. Note that the participation of the country in the euro zone prevented any alleviation of the negative effects stemming from the losses in price
competitiveness that could have occurred, even in the short-run, through possible changes in the exchange rate.

In addition, the increased domestic demand, particularly after the country’s accession in the EMU, has contributed as well to wider current account deficits. In particular the increase in consumer spending reflected the impact, on the one hand, of financial liberalization that took place by the mid-1990’s, and on the other, the considerable drop in interest rates following Greece’s participation in the EMU. Also, the fact that the economy is undergoing real income convergence would imply high financing needs which, together with improved borrowing condition, also contributed to higher domestic demand. Indeed, after 2000 and in light of the undertaking of the Olympic Games in 2004, there has been a considerable increase in fixed investment which increased the import content of domestic demand. Furthermore, the cyclical position of the Greek economy primarily relative to other EU members has also contributed to rising current account deficits. In particular, the output gap has been positive for most of the period after 1999, while the same cannot be said for the EU output gap. Finally, the current account reflects not only the behavior concerning private saving and investment decisions but also developments with respect to net public saving. The deterioration in the fiscal position of the country during the period 2000-05 has also contributed to expanding current account deficits. Fiscal policy of the previous decade and of the current decade in many respects mirrors the fiscal policy in the 1980s. This is particularly true in that growing budget deficits are reflected in growing current account deficits. The stylized Mundell-Fleming models propose that increases in the fiscal deficit lead to current account imbalance by driving up domestic interest rates, the exchange rate, and the rate of capital inflows. More elaborate explanations in support of the twin deficits hypothesis draw upon the quantitative perspectives provided in the context of the Mundell-Fleming models of exchange rate regimes (Mundell, 1960 and Fleming, 1962).1

Summarizing the main factors that have contributed to the recent widening of the current account deficit, we can speak of five different blocks. The first refers to increased domestic demand. This primarily takes place through high investment and consumer spending as the economy converges towards the EU patterns.2 These catching up dynamics, although temporary, are likely to last longer particularly since the exchange rate adjustment mechanism though changes in the nominal exchange rate cannot be used. The second concerns the cyclical position of Greece vis-à-vis the other European states. The third reflects the result of the deteriorating fiscal position. The forth block includes the adverse competitiveness developments. All measures of real exchange rate appreciated significantly over the last ten year period. Finally, the fifth block is related to factors that are exogenous to developments in the Greek economy. A major such factor refers to developments in oil and freight prices. Large swings in oil prices considerably affect the Greek economy in general and the external sector in particular. This was more profound during the period 2005-06 when large increases in oil prices contributed significantly to the deterioration of the country’s external position. Freight prices have also played a significant role in current account developments. Given the importance of the Greek commercial fleet to receipts from transportation services, increases in freight prices, which primarily occurred during the 2004-05 period, affect favorably the external sector.

This paper aims at pinpointing the empirical importance of these factors and to the extent they have contributed to the recent current account developments in Greece. In particular, we rely on VAR analysis (long-run cointegration equations and dynamic error correction model) and use
quarterly data for the period 1995Q1-2006Q4 in order to empirically evaluate the recent developments in the Greek external sector.

The paper has the following structure. Section 2 presents a theoretical overview which depicts the main current account determinants. In the third section, we will present the empirical results as well as some stability and specification tests of our model. Particularly, we attempt to present tests for structural breaks (Chow, 1960 and Kim and Siegmud 1989), for unit root tests of Kwiatkowski et al. (KPSS test, 1992) and Elliot et al. (DFGLS test, 1996). Also, in this section we will apply the maximum likelihood cointegration technique proposed by Johansen (1996) and Johansen and Juselius (1990, 1992) to test for the possibility of cointegration between current account deficit and the explanatory variables as well as the dynamic error correction model (ECM) in order to assess the extent of adjustment to long-run equilibrium. Finally, the conclusions of the analysis will be presented in Section 4.

2. A Theoretical Overview

The national account identity constitutes the theoretical basis that connects the current account with the rest of the macro economy. More specifically, from the national income accounts, the current account deficit, reflects the excess of the level of domestic absorption over the domestically produced output

\[ CAD \equiv (M - X) = A - Y, \]  

where \( CAD \) refers to Current Account Deficit, \( M \) stands for imports of goods and services, exports of goods and services, \( X \) the exports of goods and services, \( Y \) is the level domestic output and \( A \) stands for domestic absorption. Alternatively the above equation at a sectoral level can be expressed as

\[ CAD = BD + (I - S) = (G - T) + (I - S), \]  

where \( BD \) is the budget deficit (\( G \) is the government purchases of goods and services, \( T \) is the income of individuals that paid in taxes), \( S \) is private saving and \( I \) is private investment. Equation 2, relates the current account deficit to fiscal deficit and to private saving and investment decisions. The equation which we will be estimated, taking under consideration the determinants of net private saving, is the following equation (3):3

\[ CAD = \alpha_0 + a_1 BD + a_2 REER + a_3 Y_{gap} + a_4 R + a_5 RER + a_6 TT + a_7 Y_{Egap} + a_8 OP_d + a_9 FP_d, \]

where \( Y_{gap} \) is the output gap, \( REER \) is the real effective exchange rate, \( R \) is the real interest rate, \( TT \) refers to the terms of trade, \( Y_{Egap} \) is the output gap for the European Union (fifteen member states) and lastly \( OP_d \) and \( FP_d \) represent deviations of the oil and freight prices from their long-run trends, respectively.

In equation (3), the first term captures the effect of the budget deficits on the current account deficits and the second the impact of price competitiveness. The domestic output gap, the real
interest rate, and the terms of trade capture the impact of domestic demand. Also, the domestic output gap together with the European output gap refers to the effect of cyclical factors. Finally, the last two terms capture the impact of the two exogenous variables representing the deviations of oil and freight prices from their trends.

Following the discussion in the previous section, we expect the budget deficit to have a positive impact on the current account deficit. Note that in this analysis we endorse the traditional view (also referred to as the Keynesian absorption theory) instead of the Ricardian Equivalence Hypothesis, primarily due to the relative short time horizon of our sample. According to the traditional view, when an economy is operating to or near full employment capacity, an increase in the budget deficit drives the balance of payments into deficit by inflating the aggregate demand for goods and services including demand for imports. In the Keynesian view, deficits can be used to offset gaps between saving and investment, thereby stabilizing output around its potential (full-employment) level. Unlined the traditional view (Keynesian Hypothesis), which sees public and private saving as essentially unrelated, the Ricardian view (Ricardian Equivalence) sees them as perfect substitutes. According to this view, changes in public saving are matched by an equal but opposite change in private saving. Because the Ricardian view holds that changes in deficit have no net effect on the excess demand for the credit or aggregate demand, deficits should be uncorrelated with interest rates, the trade deficit, the price level, output or total saving. The real exchange rate reflects the impact of relative prices on current account developments. In particular, an appreciation (increase) in the real exchange rate means a fall in competitiveness and thus leads to wider CAD. According to the absorption approach, devaluation, through its impact on the terms of trade and domestic production, leads to a switch in spending from foreign to domestic goods, and hence, an improvement in the trade balance. Turning to the factors that affect domestic demand, domestic output gap is expected to have a positive impact on CAD. As pointed out, in the case of Greece, the domestic output gap has been positive over most of the period reflecting the high level of domestic demand. The opposite, however, has been true with respect to European output gap. That is, the negative European output gap has not helped towards the recovery of the Greek external sector. The real interest rate is expected to have a negative impact on CAD. Particularly, the fall in interest rates due to Greece’s accession in the EMU must have also contributed to high domestic demand. The terms of trade constitute the third factor through which domestic spending affects the CAD. Increases in the terms of trade could affect the CAD either positively or negatively (Kent and Cashin, 2003). More specifically, a deterioration in the terms of trade results in a decline in real income leading to lower CAD. However, to the extent that the deterioration in the terms of trade affect the optimal stock of capital causing higher investment spending could lead to wider CAD. Finally, deviations oil prices from their trend are expected to have a positive effect on CAD, while the corresponding deviations of freight prices are expected to affect the CAD negatively.

As mentioned earlier, our analysis will rely on quarterly data for the period 1995Q1-2006Q4 since our aim is to capture the recent developments in the Greek current account. Most of the variables used in the models are expressed in percentage change, except for the oil and freight prices which is expressed as deviation from its trend. The sources of the data uses include, Bank of Greece, Eurostat and IMF (IFS).

In this section we will investigate the time series properties of the data using recent developments in the econometrics of non-stationarity, and also we will present the results referring to the main determinants of current account deficit from the estimation of equation (3) for Greece over the period 1995Q1-2006Q4 using quarterly observations. The present study implements a multivariate vector autoregressive model (MVAR model) that helps us explain the effects of the separate factors that influence current account developments in Greece. Equation (3) is essentially a long-run equilibrium relationship derived from economic theory. If this equilibrium model exists, the set of variables included in the model must be cointegrated even if the individual variables are non-stationary (Engle and Granger, 1987).

In this paper we will apply the maximum likelihood cointegration technique proposed by Johansen (1996) and Johansen and Juselius (1990). The Johansen-Juselius technique performs better than the single equation methods and alternative multivariate methods (e.g. Stock and Watson, 1988, Gonzalo, 1994). This technique has the advantage that it completely captures the underlying time series properties of the data, provides estimates of all the cointegrating vectors that exist within a vector of variables and offers a test statistic for the number of cointegrating vectors without imposing a priori normalization on the dependent variable (Paleologos, 1996, p. 300). However, before proceeding to test for cointegration and estimation of ECMs, it is necessary to test for structural breaks. The only structural break which is captured by the Chow test occurred in 1999Q1 and is related to the move to the single currency in January of 1999, (Appendix I, part b). Thus we have two sub-periods, one prior to the single currency, i.e. period 1995Q1-1999Q1 and the other for the euro period, 1999Q1-2006Q4. The deterioration of the current account deficit is primarily connected with the second sub-period and the introduction of the euro. According to the Figure 1, a second structural break seems to have occurred in 2005Q1, due to increases in oil prices and freight rates, which, however, is not verified by the chow test, (Appendix I, part A and B).

We now turn to establish the time series properties of the individual series used modern unit root tests, see for instance Kwiatkowski et al. (1992) and Elliot et al. (1996). In particular, Table 1 (see Appendix II) presents DFGLS and KPSS unit root tests on each variable included in equation (3). The results for the order of integration are reported in Table 1 which indicate that the non-stationary hypothesis is rejected for the first differences of the series concerned, thus indicating that \( CAD, BD, REER, Y_{gap}, R, Y_{Egap}, TT, OP_d \) and \( FP_d \) are all I(1). In Table 1 (see Appendix II), it comes out that the DF-GLS tests accepted the alternative hypothesis, which means that the time series under consideration are stationary; so DF-GLS (\( \hat{\tau}_\mu \)) and DF-GLS(\( \hat{\tau}_\tau \)) are smaller than the critical values, in almost all the levels of importance. The critical values of DF-GLS (\( \hat{\tau}_\mu \)) and DF-GLS(\( \hat{\tau}_\tau \)) are presented by Elliot et al. (1996, Table 1). Moreover, observing Table 1, it comes out that the results are also verified by the KPSS test, the critical values \( \hat{\eta}_\mu \) and \( \hat{\eta}_\tau \) of which have been calculated by Kwiatkowski et al. (1992, Table 1). Consequently, all these series can be inserted in the cointegration equations and then we can apply the Johansen–Juselius cointegration technique (Cuthbertson et al., 1992).
In Johansen and Juselius technique (Johansen (1996); Johansen and Juselius (1990, 1992)) there are two statistics from the Johansen vector autoregressive tests that determine the rank of the cointegration space. One is the value of the likelihood ratio (LR) test based on the maximum eigenvalue ($\lambda_{\text{max}}$) of the stochastic matrix. The other is the value of the LR test based on the trace of the stochastic matrix ($\lambda_{\text{Trace}}$). In addition, in order to apply the Johansen methodology, a lag length must be selected for the VAR model. A model with a three lag structure was selected using the information criterion of Akaike (AIC), Likelihood Ratio Sims statistics (Sims, 1980), the information criterion of Hannan-Quinn (HQ) and the information criterion of Schwartz (SBC) (see Table 2, Appendix III). Table 2 shows the tests of the lag structure for the VAR models.

The results from the trace and maximum eigenvalue tests are shown in Table 3 and Table 4 (see Appendix IV). The maximum eigenvalue likelihood ratio test statistic ($\lambda_{\text{max}}$) shows the existence of one significant cointegrating relationship, and the trace likelihood ratio test statistic ($T_r$) shows the appearance of one or more cointegrating relationships against the alternative hypothesis of $r = 0$ (zero cointegrating relationship). We accepted the existence of three cointegrating vectors. Following Johansen and Juselius, 1990, our decision to accept three cointegrating relationships was based on the evidence of the stronger $\lambda_{\text{max}}$ test statistic at 5% level of significance, while at 1% level of significance we only accept one cointegrating relationship, (see Table 4, Appendix IV). Now, according to the information criteria Akaike and Swhartz, we selected cointegration vector 1 to be used for the dynamic Error Correction Model (ECM). The results of Table 3 and Table 4 do not provide strong evidence that there is long run relationship among the variables $\text{CAD, BD, REER, Y_{gap}, R_s, Y_{E_{gap}}}$ and $\text{TT}$ due to the existence of a structural break (Appendix I). Note, that the two variables representing the deviations of oil and freight prices from their trends are exogenous and are not included in the long-run equation.

In Table 5 (see Appendix V) we attempt to show the test statistic for zero restrictions in coefficients on the current account deficit, budget deficit, domestic output gap, long run real interest rate, real effective exchange rate, terms of trade and the European output gap in the cointegration relationship. We conclude that the hypothesis for zero restrictions for all variables is rejected, which, in turn, verifies the importance and consistency of all the variables used in the long-run relationship.

Table 6 (see Appendix VI) shows the estimates of the normalized cointegrating relationships that resulted by using the full information likelihood (FIML) technique of Johansen. The eigenvectors were normalized on the CAD. If we judge from the signs and the asymptotic t-statistics of the estimated coefficients we observe that they are highly significant and have the correct sign. However, it is necessary to mention that the maximum likelihood cointegration procedure of Johansen, while it establishes a long – run relationship among the variables of the VAR model, it is unable to produce coefficient estimates with structural interpretation (Dickey, Jansen and Thornton, 1994; Alogoskoufis and Smith, 1991).

Finally, Table 7 (see Appendix VII) shows the dynamic error correction estimates. The diagnostic and specification tests indicate that ECM representation is correctly specified. The RESET (Regression Specification Test) statistics reveal no serious omission of variables, indicating the correct specification of the model. LM is the Lagrange multiplier (LM) test that reveals no significant serial correlation in the disturbances of the error term. The Lutkepohl
(2005) and Urzua (1997) multivariate tests show the normality of residuals. The White F –
statistic shows the absence of simultaneity bias in the estimates.

The error-correction term (EC_{-1}) reflects short-run dynamics and appears in the set of
regressors. The coefficients of the lagged values of CAD, BD, REER, Y_{gap}, R_t, Y_{Egap}, TT, OP_d
and FP_d are short-run parameters measuring the immediate impact of independent variable on
CAD. The EC term is negative and highly significant. The coefficient value of -0.250188 means
that approximately 25.02% of the discrepancy between the actual and the long-run domestic
CAD is corrected after three lags.

Our analysis indicates that all variables included in the long-run relationship are statistically
significant. However the presence of a structural break significantly reduces the strength of the
aggregate long-run relationship. With respect to the dynamic adjustment not all variables appear
to be statistically significant. The coefficients for the budget deficit, real interest rate, domestic
and European output gap and for the terms of trade have the correct signs and are statistically
significant, although not in all lags. The coefficient for the real effective exchange rate is
significant at the 10 percent level. The coefficients of the two exogenous variables, deviations of
oil and freight prices form their trends, have the correct signs and are statistically significant at
the 5% level.

Our results suggest that all the factors included in our analysis have, to a lesser or greater extent,
influenced developments in the current account deficit. Changes in the real effective exchange
rate and the real interest rate have had the greatest impact on current account developments
during the last decade. Thus the competitiveness issue and the impact of lower interest rates must
have played a very significant role in the worsening of the current account. Furthermore, changes
in the European output gap and the terms of trade have had a considerable impact although are
marginally significant at the 5% level. That is, the cyclical positioning of the European economy
during the last decade did not help in diminishing the widening of the current account. Also, the
increases in the terms of trade have had a greater impact on consumer spending rather than on
investment affecting the current account deficit negatively. The budget deficit does not seem to
have had a strong impact on the current account deficit. This is in line with recent studies, see for
instance Bartolini and Labiri (2006), which find a weak relationship concerning the twin deficits
hypothesis.

4. Concluding Remarks

Our analysis has tested for the empirical importance of the factors that affected current account
developments in Greece over the last ten years. In particular, from a point of a long-run
perspective, the deterioration of competitiveness, the ongoing process of real convergence, which
has been primarily facilitated by strong credit growth reflecting the impact of financial
liberalization and lower interest rates, the cyclical positioning of the country vis-à-vis the other
European states and to lesser extent the fiscal expansion have all contributed to higher current
account deficits. Furthermore, significant role on the short-run dynamics of the current account
has been played by the two exogenous factors involving developments in oil and freight prices.

The current account situation could improve over the medium term. This would occur either
automatically through a considerable output contraction or through policy action. First,
automatic improvement primarily refers to the adjustment of domestic demand as financial liberalization matures and household indebtedness reaches the EU average signaling the deceleration of consumption growth or as the cyclical effect fades out. Second, policy action initiatives include, on the one hand, the easing of inflationary pressures and, on the other, the speeding up structural reforms. Fiscal consolidation, which to a significant degree was achieved in 2006, and efforts to reduce in nominal wage growth below the EMU average represent policy actions that would reduce inflationary pressures and improve competitiveness. Structural reforms could raise productivity growth, reduce unit labor costs and thus push for higher potential output growth.

It must be pointed out that the aim of the paper is to concentrate of the recent developments in the Greek current account deficit and, as a result, relied on quarterly data primarily targeting the period after the EMU accession. Thus, variables that one would expect to have a temporary effect on current account and be insignificant in the long-run appear to be statistically significant. This, for instance, refers to variables that represent cyclical effects, capturing their impact on domestic demand, and which are normally expected not to have permanent effects in the case of samples of much longer size. However, the analysis is quite useful since it provides significant evidence for the factors that played a rather dominant role in explaining the widening of the Greek current account deficit after the introduction of the single currency.

Endnotes

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2. The same argument holds for other EU member countries such as Portugal, see, for instance, Blanchard and Giavazzi (2002) and Blanchard (2007).


4. The effect of monetary policy on current account and budget deficits is examined by Chen (2007).

5. Excluding, as we shall see, oil and freight prices that are exogenous to the model.
6. See also, Gagales (2007).

References


Appendixes

Appendix I

Testing for Structural Breaks

a) Recursive Residuals

i) 1995q1 – 2006q4

Figure 1

![Recursive Residuals ± 2 S.E.](image)

ii) CUSUM Test of Recursive Residuals (1995Q1 – 2006Q4)

Figure 2

![CUSUM 5% Significance](image)

b) Breakpoint Chow tests

1999:Q1  F - statistic = 5.9595 (0.0405) *

2005:Q1  F - statistic = 4.4257 (0.0631)

(*) In 1999:q1, there is a structural break, and in 2005:Q1 the structural break is not statistically important, p-value in parentheses.
Appendix II
Testing for Unit Roots (DFGLS Test and KPSS Test)

Table 1. Testing for Unit Roots: 1995Q1 – 2006Q4

<table>
<thead>
<tr>
<th>Variables</th>
<th>DF-GLS test</th>
<th>KPSS test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(\hat{\tau}_\mu)</td>
<td>(\hat{\tau}_\tau)</td>
</tr>
<tr>
<td>(\Delta CAD)</td>
<td>-4.946609</td>
<td>-6.504662</td>
</tr>
<tr>
<td>(\Delta BD)</td>
<td>-6.564796</td>
<td>-7.060268</td>
</tr>
<tr>
<td>(\Delta REER)</td>
<td>-13.00942</td>
<td>-14.53215</td>
</tr>
<tr>
<td>(\Delta Y_{gap})</td>
<td>-5.798850</td>
<td>-7.306096</td>
</tr>
<tr>
<td>(\Delta R)</td>
<td>-4.324738</td>
<td>-6.856811</td>
</tr>
<tr>
<td>(\Delta Y_{gap})</td>
<td>-7.749113</td>
<td>-8.122552</td>
</tr>
<tr>
<td>(\Delta TT)</td>
<td>-5.303619</td>
<td>-5.604496</td>
</tr>
<tr>
<td>(\Delta OP_d)</td>
<td>-3.734672</td>
<td>-5.143961</td>
</tr>
<tr>
<td>(\Delta FP_d)</td>
<td>-6.980479</td>
<td>-6.993397</td>
</tr>
</tbody>
</table>

The critical value for the KPSS are given in Kwiatkowski et al. (1992, Table 1, p. 166). The numbers in the columns are DFGLS statistic (Elliot et al., 1996) and KPSS statistic (Kwiatkowski et al., 1992). \(\hat{\tau}_\mu\) and \(\hat{\tau}_\tau\) for DF-GLS test and \(\hat{\eta}_\mu\) and \(\hat{\eta}_\tau\) for KPSS test are the test statistics allowing for constant mean, and for a time trend in mean respectively. Elliot et al. (1996, Table 1, p. 825) provided critical values for this DF – GLS test.

Appendix III
Test of the lag structure on the VAR Model (Equation 3)

Table 2

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SBC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-238.2952</td>
<td>NA</td>
<td>0.000164</td>
<td>11.14978</td>
<td>11.43363</td>
<td>11.25505</td>
</tr>
<tr>
<td>1</td>
<td>-87.62225</td>
<td>246.5557</td>
<td>1.66e-06</td>
<td>6.528284</td>
<td>9.508669</td>
<td>7.370401</td>
</tr>
<tr>
<td>2</td>
<td>-44.32710</td>
<td>57.07088</td>
<td>2.55e-06</td>
<td>6.787595</td>
<td>11.04532</td>
<td>8.366565</td>
</tr>
<tr>
<td>3</td>
<td>154.9045</td>
<td>101.7740*</td>
<td>5.38e-08*</td>
<td>1.277067*</td>
<td>8.799071*</td>
<td>4.329742*</td>
</tr>
</tbody>
</table>

*Indicates lag order selected by the information criterion
LR: likelihood ratio Sims test for the choice of the lag structure of a VAR model (Sims, 1980, 1992) (each test at 5% significant level), FPE: Final Prediction Error, AIC: Akaike Information Critetion, SBC: Schwarz Information Criterion, HQ: Hannan-Quinn information criterion
Appendix IV
Johansen – Juselius Cointegration Test

<table>
<thead>
<tr>
<th>Trace Statistic</th>
<th>H₀</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>95% Critical Value</th>
<th>99% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0 **</td>
<td>0.734982</td>
<td>173.6146</td>
<td>136.61</td>
<td>146.99</td>
<td></td>
</tr>
<tr>
<td>r ≤ 1 **</td>
<td>0.551830</td>
<td>115.1844</td>
<td>104.94</td>
<td>114.36</td>
<td></td>
</tr>
<tr>
<td>r ≤ 2 *</td>
<td>0.504403</td>
<td>79.87078</td>
<td>77.74</td>
<td>85.78</td>
<td></td>
</tr>
<tr>
<td>r ≤ 3</td>
<td>0.365892</td>
<td>48.98308</td>
<td>54.64</td>
<td>61.24</td>
<td></td>
</tr>
<tr>
<td>r ≤ 4</td>
<td>0.341984</td>
<td>28.93946</td>
<td>34.55</td>
<td>40.49</td>
<td></td>
</tr>
<tr>
<td>r ≤ 5</td>
<td>0.146175</td>
<td>10.52429</td>
<td>18.17</td>
<td>23.46</td>
<td></td>
</tr>
<tr>
<td>r ≤ 6</td>
<td>0.077953</td>
<td>3.571011</td>
<td>3.74</td>
<td>6.40</td>
<td></td>
</tr>
</tbody>
</table>

Trace test indicates 3 cointegrating equations at 5% and 2 cointegrating equations at 1% levels
*(**) denotes rejection of the hypothesis at the 5%(1%) level

<table>
<thead>
<tr>
<th>λ_max Statistic</th>
<th>H₀</th>
<th>Eigenvalue</th>
<th>Statistic</th>
<th>95% Critical Value</th>
<th>99% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0 **</td>
<td>0.734982</td>
<td>58.43017</td>
<td>48.45</td>
<td>54.48</td>
<td></td>
</tr>
<tr>
<td>r ≤ 1 *</td>
<td>0.551830</td>
<td>43.31364</td>
<td>42.48</td>
<td>48.17</td>
<td></td>
</tr>
<tr>
<td>r ≤ 2 *</td>
<td>0.504403</td>
<td>40.88770</td>
<td>36.41</td>
<td>41.58</td>
<td></td>
</tr>
<tr>
<td>r ≤ 3</td>
<td>0.365892</td>
<td>28.04361</td>
<td>30.33</td>
<td>35.68</td>
<td></td>
</tr>
<tr>
<td>r ≤ 4</td>
<td>0.341984</td>
<td>18.41517</td>
<td>23.78</td>
<td>28.83</td>
<td></td>
</tr>
<tr>
<td>r ≤ 5</td>
<td>0.146175</td>
<td>6.953282</td>
<td>16.87</td>
<td>21.47</td>
<td></td>
</tr>
<tr>
<td>r ≤ 6</td>
<td>0.077953</td>
<td>3.571011</td>
<td>3.74</td>
<td>6.40</td>
<td></td>
</tr>
</tbody>
</table>

Max-eigenvalue test indicates 3 cointegrating equations at 5% and 1 cointegrating equation at 1% levels
*(**) denotes rejection of the hypothesis at the 5%(1%) level

r indicate the number of eigenvectors. λ_trace and λ_max show the trace and maximum eigenvectors statistics respectively for the unrestricted model. Critical values at 95% are taken from Osterwald – Lenum (1992), (tables 1* and 1).
Appendix V

Test of zero Restrictions in coefficients on the cointegrating relationship

Table 5
Test of Exclusion Restrictions

<table>
<thead>
<tr>
<th>Variables</th>
<th>( r )</th>
<th>( X^2(2** )</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD</td>
<td>9.09831</td>
<td>0.015739</td>
<td></td>
</tr>
<tr>
<td>BD</td>
<td>26.43460</td>
<td>0.000244</td>
<td></td>
</tr>
<tr>
<td>REER</td>
<td>14.29278</td>
<td>0.006788</td>
<td></td>
</tr>
<tr>
<td>( Y_{gap} )</td>
<td>34.20216</td>
<td>0.000194</td>
<td></td>
</tr>
<tr>
<td>RT</td>
<td>20.91864</td>
<td>0.000439</td>
<td></td>
</tr>
<tr>
<td>( Y_{Egap} )</td>
<td>5.975848</td>
<td>0.049039</td>
<td></td>
</tr>
<tr>
<td>TT</td>
<td>8.053493</td>
<td>0.024542</td>
<td></td>
</tr>
</tbody>
</table>

*The hypothesis of zero restrictions is rejected in significant level 5%, \( r \) denotes the number of accepted significant cointegrating vectors (\( r=3 \)).

** 2 are the degree of freedom in Chi-square distribution.

Appendix VI

Maximum Likelihood Estimates of Cointegrating Vectors

Table 6

<table>
<thead>
<tr>
<th>Variables</th>
<th>MLE of Cointegrating Vector 1</th>
<th>MLE of Cointegrating Vector 2</th>
<th>MLE of Cointegrating Vector 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD</td>
<td>1.00000</td>
<td>1.00000</td>
<td>1.00000</td>
</tr>
<tr>
<td></td>
<td>0.24329</td>
<td>0.15732</td>
<td>0.14458</td>
</tr>
<tr>
<td>BD</td>
<td>(1.96776)</td>
<td>(2.01849)</td>
<td>(1.89320)</td>
</tr>
<tr>
<td>REER</td>
<td>1.41002</td>
<td>1.60870</td>
<td>0.92404</td>
</tr>
<tr>
<td></td>
<td>(6.43412)</td>
<td>(4.12271)</td>
<td>(3.39005)</td>
</tr>
<tr>
<td>( Y_{gap} )</td>
<td>0.54478</td>
<td>0.88345</td>
<td>0.98973</td>
</tr>
<tr>
<td></td>
<td>(5.39925)</td>
<td>(4.50988)</td>
<td>(2.05318)</td>
</tr>
<tr>
<td>R</td>
<td>-1.69814</td>
<td>-1.28990</td>
<td>-1.20119</td>
</tr>
<tr>
<td></td>
<td>(-3.47323)</td>
<td>(-1.14373)</td>
<td>(-1.97178)</td>
</tr>
<tr>
<td>( Y_{Egap} )</td>
<td>-1.15224</td>
<td>-0.841752</td>
<td>-0.39160</td>
</tr>
<tr>
<td></td>
<td>(-1.97446)</td>
<td>(-2.07348)</td>
<td>(-8.03072)</td>
</tr>
<tr>
<td>TT</td>
<td>-1.23721</td>
<td>-1.09804</td>
<td>-1.02910</td>
</tr>
<tr>
<td></td>
<td>(-1.98535)</td>
<td>(-4.18730)</td>
<td>(-4.02433)</td>
</tr>
<tr>
<td>Constant</td>
<td>7.050785</td>
<td>4.17463</td>
<td>3.19921</td>
</tr>
</tbody>
</table>

Asymptotic t-statistics in parentheses
### Appendix VII

#### Dynamic Error Correction Model

Table 7

<table>
<thead>
<tr>
<th>Estimations of Error Correction Equation</th>
<th>Error Correction Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD, BD, REER, Ygap, Rt, YEgap, and TT,</td>
<td>and the Exogenous Variables OPd and FPd</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\Delta \text{CAD} &= 0.413567 \Delta \text{CAD}(-1) + 0.322978 \Delta \text{CAD}(-2) + 0.643619 \Delta \text{CAD}(-3) \\
& \quad + 0.415876 \Delta \text{BD}(-1) + 0.885368 \Delta \text{BD}(-2) + 3.197594 \Delta \text{BD}(-3) \\
& \quad + 1.978840 \Delta \text{REER}(-1) + 1.254890 \Delta \text{REER}(-2) + 1.960664 \Delta \text{REER}(-3) \\
& \quad + 0.066473 \Delta \text{Ygap}(-1) + 0.236706 \Delta \text{Ygap}(-2) + 0.028291 \Delta \text{Ygap}(-3) \\
& \quad - 0.136583 \Delta \text{Rt}(-1) - 0.051294 \Delta \text{Rt}(-2) - 0.201799 \Delta \text{Rt}(-3) \\
& \quad + 0.700015 \Delta \text{YEgap}(-1) + 0.060073 \Delta \text{YEgap}(-2) + 0.003985 \Delta \text{YEgap}(-3) \\
& \quad - 2.803769 \Delta \text{TT}(-1) - 1.835010 \Delta \text{TT}(-2) - 0.809597 \Delta \text{TT}(-3) \\
& \quad - 0.250188 \Delta \text{EC}(-1) \\
\end{align*}
\]

\[
\begin{align*}
\text{R}^2 &= 0.685794, \quad \hat{R}^2 = 0.405244, \quad \text{D.W.} = 2.633956, \quad \text{S.E. Equation} = 1.536178, \\
\text{F – statistic} &= 4.427102, \quad \text{AIC} = 3.972768, \quad \text{SBC} = 5.067612
\end{align*}
\]

Test of Residuals

#### Multivariate Tests for Normality:

- Cholesky of covariance (Lutkepohl): 12.15054 ((p-value: 0.0023)
- Square root of covariance (Urzua): 15.06823 ((p-value: 0.0005)

#### Autocorrelation LM Test:

- \( \text{LM (4)} = 48.43678 \)

#### Stability tests:

- Ramsey Reset Test:
  - \( F \text{ – statistic} = 6.07834 \) (p-value: 0.0180)
  - \( \text{Log Likelihood Ratio} = 6.79025 \) (p-value: 0.0071)

#### Coefficient Tests:

- \( F \text{ – statistic} = 36.1353 \) (p-value: 0.00045)

#### White Heteroskedasticity Test:

- \( F \text{ – statistic} = 3.45092 \) (p-value: 0.019)
* These variables are exogenous

Asymptotic t-statistics in parentheses, $R^2$ is the adjusted $R^2$, D.W is the Durbin-Watson statistic, S.E. is the Standard Error of regression, Lutkepohl and Urzua are the multivariate tests for the normality of residuals, RESET is the Ramsey F – statistic for omitted variables, White is the White F – statistic for the Heteroskedasticity Test, AIC and SBC are the information criteria. LM is the Lagrange multiplier (LM) test third order serial correlation of the residuals. The LM statistic is asymptotically distributed as $\chi^2$ (d.f. = 4).