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Sergejs Saksonovs

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Darwin College
Cambridge University
United Kingdom CB3 9EU
www.dar.cam.ac.uk/dcrr

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The Intertemporal Approach to the Current Account and Currency Crises

Sergejs Saksonovs

Faculty of Economics
University of Cambridge
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Abstract

This paper investigates the relationship between optimal current account deficits and currency crises. The framework for determining the optimal size of the current account is the intertemporal approach. The intertemporal model of the current account is empirically estimated for a sample of 17 countries, ten of which did experience a currency crisis (broadly defined).

Given the large number of countries analyzed under a single set of restrictive assumptions, the intertemporal model of the current account performed well, often capturing important dynamics in the data. In five cases current account levels deviated substantially from the optimal level before the occurrence of the currency crisis, showing that the intertemporal approach has some predictive power for the currency crises. Finally, there was no evidence for countries being unable to run optimal current accounts because of lack of access to the world financial markets in the aftermath of the crisis.

1 Introduction

Current account deficits have been observed in a variety of countries over time. In the last several decades two tendencies - gradual removal of trade barriers and increased freedom of international capital flows have made it easier for countries to engage in international trade and borrowing or lending across the borders. During the same time, however, there has been "*pervasive currency turmoil*" in the aftermath of the collapse of the Bretton Woods system and later a series of currency crises in the nineties (Kaminsky and Reinhart, 1999). According to Edwards (2001), "*currency crises of the 1990s shocked investors, academics, international civil servants and policy makers*". Efforts to explain these developments motivate increased attention to the modeling of the dynamics of current accounts for different countries.

The link between the current account and the potential of the currency crisis lies in the fundamental insight that no country is able to accumulate foreign debt (run a current account deficit) indefinitely. If the current account deficit at some point becomes unsustainable, then a currency crisis - an adjustment to a surplus through a rapid depreciation of the domestic currency is possible. The key characteristic of the current account deficits is therefore their sustainability not their size. Countries that run large current account deficits do not necessarily end up having currency crises. In order to assess sustainability of the current account deficits, a theoretical framework of analysis is required.

One possible approach to analyzing current account deficits is to view them as a difference between saving and investment flows. A prime example of a country with large current account deficit, which so far has been sustainable, is the United States. Bernanke (2005) explains the US current account deficit by the hypothesis of the 'saving glut', which states that the current deficit is responding to the inflow of surplus world saving, which caused favorable shocks to the stock prices and the interest rate. Similarly, for Cooper (2001) the growing US current account deficit is a vote of confidence by the rest of the world in claims on Americans. Mann (2002), on the other hand, concludes that an adjustment to smaller levels of the current account deficit is inevitable and is likely to occur either through dollar depreciation or structural changes within the United States, including an increase in the domestic saving by the US residents.

The prevalent theoretical framework for studying the dynamics of the current account is the intertemporal approach, which views current account as a change in the net foreign asset position of a country. The intertemporal approach is founded on utility maximizing decisions by economic agents. Therefore it provides a better way to judge sustainability of the deficits than an approach based on aggregate relationships between saving and investment flows. Large deficits according to the intertemporal approach can be optimal and sustainable and therefore not a cause of concern for policymakers.

The contribution of this paper is to use the empirical method of Bergin and Sheffrin (2000) to test the intertemporal current account model for 17 of countries, some of which did experience currency crises and some of which did not. Empirical tests of the intertemporal models of current account behaviour have been fewer than the amount of theoretical literature on the topic (Kasa, 2003). Calderon et al. (2000) also mentions that studies empirically analyzing the effect of macroeconomic variables on current account deficits are few compared to the importance frequently attached to the current account by policymakers.

This paper also considers two hypotheses regarding the relationship between current account deficits and currency crises. Firstly, if one observes a significant deviation of the current account levels from the ones predicted by the intertemporal model, which describes the optimal evolution of the current account, it could serve as a signal of unsustainable deficits. This is true, if one assumes that the optimal path for the current account is also sustainable. Therefore intertemporal models of current account could have predictive power for currency crises.

Secondly, one of the crucial assumptions of the intertemporal approach is the ability of the country to borrow at the prevalent 'world interest rate' - that is a country is assumed to have unlimited access to international financial markets. In the aftermath of a crisis, access to international financial markets may be impeded, due to foreign investor fears. This can be tested by assessing the fit of the intertemporal approach for such countries compared to the countries which have not experienced a crisis.

Section 2.1 explains the fundamental implications of the intertemporal approach to the current account. **Section 2.2** formulates a testable implication of the model that the empirical analysis is based on. **Section 3** describes the data collection and assumptions made for fitting the model. **Section 4** shows the results of the empirical analysis and discusses its limitations and **Section 5** provides conclusions and directions for future research.

2 Theory of the Intertemporal Approach

2.1 The Intertemporal Approach to the Current Account

Originally the current account was thought of as the net export balance of a country. Consequently, relative international prices and their determinants were viewed as central to the dynamics of the current account. The alternative viewpoint emphasized that the current account is also the difference between saving and investment and focused on macroeconomic factors that determine these two variables. The intertemporal approach to the current account recognizes that saving and investment decisions result from forward looking calculations based on the expected values of various macroeconomic factors. It achieves a synthesis between the trade and financial flow perspectives by recognizing how macroeconomic factors influence future relative prices and how relative prices affect saving and investment decisions (Obstfeld and Rogoff, 1995).

Obstfeld and Rogoff (1995) separate the intertemporal current account models into two broad groups - deterministic and stochastic. Deterministic models operate under the assumption of perfect foresight of relevant variables and complete information. The basic model postulates that a representative consumer maximizes a time separable utility function:

$$U = \sum_{t=0}^{\infty} \beta u(C_t) \tag{2.1}$$

The consumer is discounting the value of future utility ($0 < \beta < 1$), and the marginal utility of private consumption at the end of period t - C_t is always positive ($u'(C_t) > 0$), but decreasing ($u''(C_t) < 0$).

The next step involves specifying the resource constraint for the economy. At the end of period t the economy produces domestic output Y_t and receives income on existing net foreign assets A_t[1] with an interest rate r_t between periods $t-1$ and t. The received income is spent on private sector consumption C_t, government consumption G_t, net investment I_t and potentially acquisition of more foreign assets. Recalling that the current account is defined as the change in net foreign assets, one can write:

$$CA_t = A_{t+1} - A_t = r_t A_t + Y_t - C_t - G_t - I_t \tag{2.2}$$

Following Obstfeld and Rogoff (1995), one can define the market discount factor at date t for the consumption at a future date k ($k > t$), which accounts for the variable interest rate as follows:

$$R_{t,k} = \frac{1}{\prod_{i=t+1}^{k}(1+r_i)} \tag{2.3}$$

The intertemporal approach expresses the current account in deviations from 'permanent' levels of variables. A 'permanent' level of variable Z at time t is defined as:

$$\hat{Z}_t = \frac{\sum_{k=t}^{\infty} R_{t,k} Z_k}{\sum_{k=t}^{\infty} R_{t,k}} \tag{2.4}$$

In particular, the 'permanent' relationship between the market and consumer's discount rates can be defined as:

$$\widehat{\left(\frac{\beta}{R}\right)^{\sigma}} = \frac{\sum_{k=t}^{\infty} R_{t,k} \left(\frac{\beta^{k-t}}{R_{t,k}}\right)^{\sigma}}{\sum_{k=t}^{\infty} R_{t,k}} \tag{2.5}$$

Appendix A uses (2.2) to derive the following equation describing the current account behaviour as a deviation of macroeconomic variables from their permanent levels:

$$CA_t = (r_t - \hat{r}_t)A_t + (Y_t - \hat{Y}_t) - (I_t - \hat{I}_t) - (G_t - \hat{G}_t) + \left(1 - \frac{1}{\widehat{\left(\frac{\beta}{R}\right)^{\sigma}}}\right)(\hat{r}_t A_t + \hat{Y}_t - \hat{I}_t - \hat{G}_t) \tag{2.6}$$

Equation (2.6) is the key insight of the intertemporal approach. The first four terms reflect consumption smoothing processes in the economy. For the example, if the world interest rate is higher than the permanent level and the country is net foreign creditor ($A_t > 0$), the current account will increase as agents smooth the effects of temporarily higher interest income on foreign assets. Similarly, agents will smooth the effects of an increased output above its permanent level, while they will use foreign borrowing (decreasing the current account) to smooth the effects of temporarily high investment or government spending.

The final term in (2.6) reflects consumption tilting. Consumption tilting arises due to the difference between world real interest rate and domestic rate of time preference. If the home country is on average more impatient than the rest of the world, then $\widehat{\left(\frac{\beta}{R}\right)^{\sigma}}$ will be less than 1 and there will be a tendency to the decrease in the current account,

[1] There is debate about accounting net foreign asset positions. Hausmann and Sturzenegger (2006) argue that net foreign assets should be valued on the basis of their returns rather than their historical costs. The majority of literature, however, including this paper, uses cost basis.

that is proportional to the 'permanent' values of economy's resources. If the domestic economy is more patient, then the reverse effect occurs (Obstfeld and Rogoff, 1995).

It is possible to extend this basic framework, by introducing production function and capital accumulation, comparative advantage (expressed in different time preferences of consumers in different countries), accounting for non-tradable and durable goods, etc. However, (2.6) is the starting point for formulating testable implications of the intertemporal approach.

One important caveat of (2.6) is that it describes the current account when there is complete certainty. Stochastic models of the current account introduce uncertainty over the changes of relevant macroeconomic variables. As Obstfeld and Rogoff (1995) point out, the key consideration in introducing uncertainty is the extent to which agents can insure themselves against unpredictable contingencies (e.g. output fluctuations that are subject to random shocks).

One extreme way of introducing uncertainty is to introduce the finite number of states of the world with known characteristics and the existence of markets to trade goods contingent on the occurrence of a particular state (Arrow-Debreu securities). In this case, one can analyse the model, as if no uncertainty existed, but rather the number of goods has been increased to include all possible contingencies. An intermediate option is to introduce partially complete markets, where incompleteness stems from asymmetric information at the micro level (Obstfeld and Rogoff, 1995). A polar opposite of the Arrow-Debreu setup, is to postulate the existence of a single traded asset. This is the framework used in this paper. The insights of such a model are qualitatively similar to the deterministic model, except that the relevant variables are now replaced by their expectations.

2.2 The Testable Hypothesis of the Intertemporal Approach

For the empirical analysis of the current account (2.6), which includes non-observable factors, has to be made operational. In the simplest case, one can assume that there are no divergences between the world real interest rate and the subjective rate of time preference, thereby eliminating the consumption tilting term of the (2.6). The main problem is to find the permanent values of output, investment, government consumption and interest rate, or, in the case of a model with uncertainty, their expectations. Information on expectations over a wide variety of countries and time periods is generally not available to the analyst (Ghosh, 1995).

The solution in the literature has been to use the methodology developed for testing present value models by Campbell and Shiller (1987). In context of the current account, the idea is that under the null hypothesis of the intertemporal approach to the current account, the history of the current account includes the information agents have about the values of relevant macroeconomic variables, which might not otherwise be observable to the analyst.

Ghosh (1995), Otto (1992) and others have tested the intertemporal approach to the current account for various countries. The general results of these early tests have not been encouraging. The predicted current account series were typically far less volatile than the actual data and failed to capture important dynamics in the data. To improve the results, the tests were extended to relax some assumptions. One way is to relax the assumption of a constant real interest rate equal to the rate of time preference. Bergin and Sheffrin (2000) allow for a variable interest rate and also extend the baseline model to account for the existence of tradable and non-tradable goods and the variation in the relative prices of non-tradable goods. This is the theoretical justification for the fact that the current account should be responsive to exchange rate shocks. They achieve a marked improvement for countries, where previously the results were problematic. This paper uses the method of Bergin and Sheffrin (2000) to test the intertemporal approach across different countries, firstly, because it has improved results, and, secondly, because it takes into account the variations in the exchange rate, which is important in context of the currency crises.

In order to incorporate the distinction between traded and non-trade goods, Bergin and Sheffrin (2000) modify the instantaneous utility function to be:

$$u(C_T, C_N) = \frac{(C_T^a C_N^{1-a})^{1-\sigma}}{1-\sigma} \tag{2.7}$$

A new parameter a is the share of traded goods in private final consumption (C_T is the consumption of traded goods and C_N is the consumption of non-traded goods). Under certain assumptions on distributions of stochastic variables, Bergin and Sheffrin (2000) derive a version of the Euler equation:

$$E_t \Delta c_{t+1} = \frac{1}{\sigma} E_t \tilde{r}_{t+1} \tag{2.8}$$

where $\Delta c_{t+1} = \log C_{t+1} - \log C_t$, $1/\sigma$ is the intertemporal elasticity of substitution and $\tilde{r}$ is 'consumption-based' interest rate defined as follows:

$$\tilde{r}_t = r_t + \left[\frac{1 - \frac{1}{\sigma}}{\frac{1}{\sigma}} (1-a) \right] \Delta p_t + \eta \tag{2.9}$$

In (2.9), p_t is the log of the relative price of non-traded goods in terms of traded goods. In this way, one can include the effects of variable interest rates and relative prices. The constant term η, consists of variances and covariances of interest rate, consumption and relative prices of traded goods and can be disregarded, when the model is fitted using the demeaned series.

The key testable implication of the intertemporal approach is obtained by linearizing the intertemporal budget constraint around the steady state in which the net foreign assets are equal to zero. **Appendix B** shows that after log-linearizing the intertemporal budget constraint, taking expectations and using (2.8), one can obtain:

$$\widehat{CA}_t = -E_t \sum_{i=1}^{\infty} \beta^i (\Delta no_{t+i} - \frac{1}{\sigma} \tilde{r}_{t+i}) \tag{2.10}$$

where no_t is the log of 'net output' (defined as: $Y_t - I_t - G_t$) and $\widehat{CA}_t$ is the value of the current account predicted by the model.

To generate expected values of relevant macroeconomic variables, following Bergin and Sheffrin (2000), the following vector autoregression model is used.

$$\begin{bmatrix} \Delta no_t \\ CA_t \\ \tilde{r}_t \end{bmatrix} = \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} \Delta no_{t-1} \\ CA_{t-1} \\ \tilde{r}_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \tag{2.11}$$

Equation (2.11) in matrix notation can be written as: $\mathbf{y}_t = \mathbf{A}\mathbf{y}_{t-1} + \mathbf{u}_t$, which means: $E_t\mathbf{y_{t+i}} = \mathbf{A}^i\mathbf{y}_t$. Furthermore, using appropriate vectors one can write (2.10) in matrix notation using (2.11):

$$\widehat{CA}_t = -\sum_{i=1}^{\infty} \beta^i \left(\mathbf{l}_1 - \frac{1}{\sigma}\mathbf{l}_2\right) \mathbf{A}^i \mathbf{y}_t$$

where $\mathbf{l}_1 = \begin{bmatrix}1 & 0 & 0\end{bmatrix}$ and $\mathbf{l}_2 = \begin{bmatrix}0 & 0 & 1\end{bmatrix}$. Assuming that the processes in $\mathbf{y}_t$ are stationary (Campbell and Shiller, 1987), the infinite sum in the equation (2.10) will converge as follows:

$$\mathbf{k}\mathbf{y}_t = -\left(\mathbf{l}_1 - \frac{1}{\sigma}\mathbf{l}_2\right) \beta\mathbf{A}(\mathbf{I} - \beta\mathbf{A})^{-1}\mathbf{y}_t \tag{2.12}$$

The testable implication is that, assuming the intertemporal approach holds, the estimated vector $\mathbf{k}$ should be equal to $\begin{bmatrix}0 & 1 & 0\end{bmatrix}$. The equation (2.12) allows obtaining the value of the current account implied by the restrictions of the intertemporal model. This predicted value can be compared with the actual data both visually and formally.

For every country this paper performs a VAR estimation with one lag to obtain the matrix $\mathbf{A}$ and subsequently the vector $\mathbf{k}$ according to the equation (2.12) together with their standard errors. By delta method the variance covariance matrix of the vector $\mathbf{k}$ elements is given by: $(\partial\mathbf{k}/\partial\mathbf{A})\mathbf{V}(\partial\mathbf{k}/\partial\mathbf{A})'$, where $\mathbf{V}$ is the 9×9 variance covariance matrix of the estimated VAR parameters, and $\partial\mathbf{k}/\partial\mathbf{A}$ is a 3×9 matrix containing the derivatives of the $\mathbf{k}$ vector with respect to the VAR parameters.

Apart from simple statistical tests on the significance of estimated elements of vector $\mathbf{k}$, this paper uses two other informal criteria to assess the overall performance of the model. The first is the variance ratio between the predicted and actual current account series. This is motivated by the repeated finding in the literature (for example, Ghosh (1995) or Bergin and Sheffrin (2000)) that modeled current account series often exhibit lesser volatility than the actual data. The second criteria is the root mean square error between the modeled current account series and the actual data.

However, it is also desirable to have a way to jointly assess the restrictions of the model. Theoretically a simple Wald test of the non-linear restriction on the vector $\mathbf{k}$ implied by (2.12) is appropriate. However, as Mercereau and Jacques (2004) show there are problems with this method due to the possible near singularity of the matrix $(\mathbf{I} - \beta\mathbf{A})$. A test that is not affected by this issue can be derived by multiplying vector $\mathbf{k}$ by the matrix $(\mathbf{I} - \beta\mathbf{A})$ and testing the corresponding linear restriction instead of the non-linear one.

Campbell and Shiller (1987) show that these tests are equivalent, although the Wald test statistics will not be the same. Adapting the method by Campbell and Shiller (1987) and Mercereau and Jacques (2004), one can define $R_t = CA_t - CA_{t-1}/\beta - \Delta no_t + (1/\sigma)\tilde{r}_t$ and regress it on the lagged values of CA_t, Δno_t and $\tilde{r}_t$. The test that is equivalent to the non-linear restriction in (2.12), is then simply the test of the joint nullity of the regression coefficients.

3 Data Collection and Series Analysis

There are 17 countries in the sample used in this paper - Australia, Canada, France, Germany, Italy, Japan, Korea, Mexico, Netherlands, Norway, Philippines, South Africa, Spain, Sweden, Switzerland, United Kingdom and the United States. All countries are currently economies that are fairly open to and involved in international trade. The main criteria for choosing the sample was the availability of comparable, quarterly data for a sufficiently large period. Annual observations were not used for three reasons. First, there is generally larger uncertainty about annual estimates (Bergin and Sheffrin, 2000). Second, there are concerns about the performance of the empirical method on small samples (Mercereau and Jacques, 2004). Finally, annual observations would not allow close analysis of the before and after crisis situations. To ensure a sufficient number of observations, only the series that had started before or on 1981 were chosen.

The first parameter, which is fundamental to the model, is the 'world real interest rate'. This value is to an extent an abstraction, which needs to be substituted by a suitable proxy. Similarly to Bergin and Sheffrin (2000), this paper follows the method of Barro and Sala i Martin (1990). First, quarterly nominal interest rate series of G7 member countries were collected. T-bill rate or money market rate series from IFS was used as a measure of benchmark nominal real interest rate series. To deal with missing observations, for some countries the euro area series was used (from 1999 to 2005).

Second, data on inflation was computed using the quarterly CPI series from IFS[2]. Inflation expectations were then computed with an autoregression for six quarters. To find the real interest rate, inflation expectations were subtracted from the nominal interest rate for each country. Unfortunately, this method can be problematic for the periods of high inflation in all G7 economies, such as the end of the seventies, because the computed real interest rate turns out to be substantially negative for those periods.

Finally, to compute the 'world real interest rate' from the real interest rates of G7 economies, a real GDP weighted average is used. Real GDP in dollars is obtained from the World Bank Development Indicators database[3]. The 'world real interest rate' series is used to construct the consumption based interest rate according to (2.9) and is the same for all of the countries in the sample.

The parameter β is set to be equal to $1/(1 + \bar{r}^w)$, where $\bar{r}^w$ is the mean for the calculated world real interest rate. This does not imply that there is no consumption tilting for an individual country, but rather that there is no consumption tilting over time and across countries on average. The value of β is equal to 0.98.

Regarding a - the share of traded goods in the private final consumption, Bergin and Sheffrin (2000) cite two empirical studies which produce the estimates of $a \approx 1/2$ and $a \approx 2/3$. Their results do not depend significantly on the choice of the coefficient and a less generous estimate of $a = 1/2$ is chosen. This coefficient is likely to be slowly increasing over time as international trade becomes easier and new traded goods (for example, software) emerge. However, counteracting this trend could be the growing importance of services in consumption.

The parameter σ can be interpreted as the coefficient of relative risk aversion for the utility function used in (2.7). More relevant for estimating (2.9) is the value of $1/\sigma$ interpreted as the intertemporal elasticity of substitution. Although these measures show as reciprocals due to the nature of the utility function, they are distinct and Bergin and Sheffrin (2000) cite mutually exclusive estimates of σ and $1/\sigma$. Bergin and Sheffrin (2000) find that the model performs best with low values of intertemporal elasticity of

[2]Adjusted West Germany country series were used to determine Germany CPI from 1975 to 1990.
[3]Since the GDP is the annual series, the weights also change annually.

substitution, in line with the existing empirical estimates of about 0.1. The value of $1/\sigma$ is set to 0.1 for all countries in order to identify whether there are tendencies in the fit of the model that do not depend on differing consumer preferences for intertemporal substitution.

For the price of the non-traded goods in terms of traded goods - P_t in (2.9), this paper uses a measure of the real exchange rate as a proxy. The real exchange rate series is taken from the OECD Main Economic Indicators database. OECD real effective exchange rate measure is based on a principle which takes into account relative market shares held by country's competitors on the common markets, including the home market, and the importance of these markets for the country in question (OECD, 2006)[4]. Six quarter autoregression is used to generate expected values of the exchange rate. With the values of r_t, $1/\sigma$, a and P_t one can construct the $\tilde{r}_t$, consumption based interest rate series according to (2.9) for every individual country.

The OECD Main Economic Indicators database provides the data on deflated GDP components for the majority of the countries in the sample. For the countries, where OECD data was not available for the sufficiently large period (Germany, Japan and the Philippines) the IFS series were used, adjusted by the GDP deflator. Since one of the fundamental implications behind the intertemporal approach is the framework of a working representative agent, the series were converted on a per unit of labor force basis. Data on labor force was obtained from the OECD Main Economic Indicators or, where unavailable, from the World Bank Development Indicators. The OECD definition of labour force includes all persons who fulfil the requirements for inclusion among the employed or the unemployed during a specified reference period.

The net output series was calculated as the difference between GDP and gross fixed capital formation combined with government consumption expenditure per unit of labour force. The logged and differenced series was termed Δno_t. The current account measure CA_t was obtained by subtracting the log of per labour force consumption from the log of the net output. All three series $\tilde{r}_t$, Δno_t and CA_t are used in their demeaned form, which means that the focus is on checking the dynamic implications of the model.

4 Results

4.1 Stationarity Tests

There are three reasons to perform stationarity tests on the series. First, under the assumption of rational expectations, (2.10) implies that the current account should be a linear combination of the stationary series (Trehan and Walsh (1991) also link stationarity and budget constraints). Second, stationarity of all three series is required for the infinite sum to converge as in (2.12). Third, series used in VAR estimated by the OLS need to be stationary.

To check that the series used in the estimation of VAR are stationary, both the Phillips-Perron test statistic and the augmented Dickey-Fuller test statistics are reported

[4]This series was not available for South Africa and the Philippines. For these countries, the nominal exchange rate index from IFS was used and adjusted by the ratio of the home country's CPI and CPI of the industrial countries.

as well as their accompanying p-values for the null hypothesis that the series contains a unit root. Since the series are used in their demeaned form, test regressions do not include a constant and time trends.

Table 1 summarizes the results of the two unit root tests on all three series used in the model. Two of the series, differenced net output Δno_t and consumption based real interest rate $\tilde{r}_t$, do not present any problems with both tests strongly rejecting the null of the unit root in all cases. The situation is different with the current account series CA_t. In most cases tests can only reject the null of the unit root at 10% and in some cases one of the tests fails to reject the null of the unit root at all. The demeaned current accounts do not exhibit any apparent trends, therefore a simple detrending procedure does not remove the non-stationarity.

Earlier empirical estimation of intertemporal models, (e.g. Ghosh (1995)), had problems establishing stationarity and Hall et al. (1999) establish a procedure to identify periodic non-stationarity in current account series, which they link with an increased probability of a crisis event. It is also well documented that classical unit root tests have low power against stationary, but slowly mean reverting alternatives. This becomes particularly relevant for the countries, which have exhibited a strong tendency towards current account surplus or current account deficits closer to the end of the sample, for example, Australia, with its rising current account deficits during the last several years.

The threshold for considering series to be stationary was set low because of these issues. If at least one test was able to reject the null hypothesis at 10% significance level, the series was considered stationary. However, given that such a variety of countries is considered in the study, it has been impossible to find a suitably large period, during which all of the country current account series would be stationary.

4.2 Results for the Non-crisis Countries

The group of countries, which did not suffer a crisis, includes Australia, Canada, Japan, Germany, Netherlands, Switzerland and the United States.

Table 3 shows the results for the panel of non-crisis countries. The first three columns show the estimated elements of **k** vector. The next columns list the number of observations in the sample, the variance ratio of the predicted current account series to the actual data, the root mean square error (RMSE) of the fit and, finally, a test statistic to test the joint restrictions of the model, which is distributed as χ^2 with three degrees of freedom, and it's p-value.

The elements of the **k** vector that the theory predicts to be zero (k_{no} and k_r) are never significantly different from zero. In six cases out of seven the estimated value of k_{CA}, which theory predicts to be one, is significantly different from zero, with the only exception being Australia. In four cases out of those six the estimated coefficients were not significantly different from one. One interesting exception was Japan, whose estimated value of k_{CA} was equal to 3.349 and significantly different from unity.

In three cases, the model predicts a much more volatile current account series than actually exhibited, which is rare across the sample. The three cases are Japan, Switzerland and the United States. A plausible explanation is that the assumed value of the intertemporal elasticity of substitution is very different from the actual preferences of the consumers. Japan, for example, had historically high levels of domestic saving, whereas the United States had the opposite situation. The average ratio of the predicted variance to actual variance in the developed countries is equal to 4.72, although this value is significantly distorted by three cases mentioned above.

The average RMSE of the prediction is equal to 0.029. For comparison, the information about the means and standard deviation of the current account series is given in Table 2. One can see, that the prediction RMSE is roughly equal in the order of magnitude to the standard deviations of the current account series. The best fit of the model is achieved in the case of Germany, whereas the worst, significantly enough, in for the United States.

The test statistics for the overall restrictions of the model generally reject the null hypothesis of the intertemporal approach being true at 10%. The only exception is Australia. However, the estimates for Australia are far from their theoretical values, which suggests that the failure to reject the null is due to the uncertainty of the estimates in general. The null is most strongly rejected in cases of Switzerland and the United States, two countries, which also had more volatility in the predicted series than in the actual value.

The United States, given the importance of its current account deficit, is a particularly important case. Since the predicted deficit is larger than the actual one, it can serve as evidence that concerns about the current account deficit in the US are misplaced and that the viewpoints of Bernanke (2005) or Cooper (2001) reflect reality. However, since the model relies on expectations, it is also possible that it simply reflects the status quo arrangements, where the US had no trouble financing its current account deficit. This situation may change due to forces not included in the model.

4.3 Results for the Crisis Countries

The crisis of the European Monetary System (EMS) has been a predecessor to the currency crises in Latin America and Asia. Eichengreen (2000) identifies the main countries that suffered during the EMS crisis - Italy, United Kingdom and to a lesser extent Spain, Sweden, France and Norway.

Sachs et al. (1996) reviews currency crises involving currency devaluation and the depletion of currency reserves. Several countries from the sample of this paper are mentioned in his study - Mexico (for the notable crisis in December 1994), Korea, which was also later affected by the Asian crisis, Philippines and South Africa. The crisis countries therefore are France, Italy, South Korea, Mexico, Norway, South Africa, Philippines, Spain, Sweden and United Kingdom.

Table 4 summarizes the results of the estimation for the group of the crisis countries. Again, the first three columns report elements of the $\mathbf{k}$ vector. As in the case of healthy countries k_{no} and k_r are never significantly different from zero. The k_{CA} coefficient is not significantly from zero only for the Philippines. The standard error of the estimated coefficient on the current account of the Philippines is too large and the coefficient cannot be distinguished from either zero or one.

Among the nine countries, whose estimated values of k_{CA} are significantly different from zero, in three cases the coefficient is not significantly different from unity giving the best match between theory and data - Mexico, South Africa and the United Kingdom. In the remaining six cases, three countries have the values of k_{CA} that are between zero and unity and significantly different from both of those values. The interesting exceptions are Sweden and France, where the estimated values of k_{CA} are negative and significantly different from zero.

On average among the crisis countries the model generates current accounts that are about half as volatile as the actual data. There are only two instances where the volatility of the predicted series slightly exceeds the actual volatility - South Africa and the United Kingdom, which are also the countries with best fits of the predicted series.

The average root mean square error of the prediction is equal to 0.029, which is the same as for the panel of healthy countries. This means that if the currency crisis exhibits any effects on the fit of the intertemporal model to the current account, they are too small to be felt in the context of the large sample of several decades. France and Sweden exhibit the worst fit of the model (being the only two countries where the sign of k_{CA} is negative), whereas South Africa and the United Kingdom show the best fits.

The test for the overall model restrictions cannot reject at 10% the null of the intertemporal approach being true in the case of France, Italy, South Africa, Spain and the United Kingdom. For France it is again the general uncertainty over values that does not let the null to be rejected. South Africa and the United Kingdom, however, are clearly the most successful instances of the model over both healthy and crisis countries.

4.4 Current Accounts before and after the Crisis Events

To analyse the fit around the time of the currency crisis it is necessary to first define the point of the crisis. According to Eichengreen (2000), who provides an overview of the EMS crisis, Italy and the United Kingdom devalued and left the exchange rate mechanism (ERM) in the third quarter of 1992. In the fourth quarter of 1992, Sweden and Norway also abandoned the ERM. Spain devalued twice with the larger devaluation occurring in the second quarter of 1993. At the same time France also struggled with the impending devaluation.

Sachs et al. (1996) review the crises in the developing countries. One of the most significant events is the crisis in Mexico, in the last quarter of 1994. South Korea and Philippines, which Sachs et al. (1996) find vulnerable, were a part of the East Asian currency crisis with the main devaluations in the last quarter of 1997. Finally, South Africa, which was frequently mentioned in the literature (e.g. Sachs et al. (1996) and Furman et al. (1998)) as vulnerable to a currency crisis had suffered from a speculative attack in the first quarter of 1996 (Aron and Elbadawi, 1999).

These time points will be used to investigate the performance of the intertemporal model of current account before and after the crisis. The fact that the average root mean square errors over the whole of the period in question are generally the same suggests that currency crises will generally have a short-term effect on the fit of the intertemporal model. Therefore, to see the usefulness of the intertemporal approach as a predictor of the currency crisis, the estimated current account series and the actual current account for two years (eight quarters) before the crisis point are compared. In addition, the performance of the model for two years after the crisis is assessed to see whether the currency crisis had affected the ability of the country to access the international financial markets.

Figures 1 through 9 present the performance of the intertemporal current account model for the countries that have experienced a crisis in chronological order. In addition the root mean square error is reported both for the two years before the crisis and the two years after the crisis.

The first two countries are Italy and the United Kingdom. Figure 1 shows that before the Italian devaluation, Italy was running a current account deficit, which was higher than the one predicted by the model. After the crisis, the current account switches to surplus and again it's higher than the one predicted by the model. The RMSE before the crisis point is more than three times than that after the crisis point, suggesting that model's performance improves after the crisis. This confirms the hypothesis that the intertemporal approach can have predictive power, but provides evidence against credit constraints in the aftermath of the crisis.

Figure 2 shows that the United Kingdom does not have a similar pronounced effect, the actual current account deficit is lower than the predicted one before the crisis. This presents evidence against both of the hypotheses.

Figures 3 and 4 show the situation in Sweden and Norway respectively. Figure 3 shows that Sweden has been running a current account deficit before the crisis, when the model was a predicting a surplus. The RMSE of the model is seven times higher before the crisis than afterwards. Norway (Figure 4), however, shows that the model performs better before the crisis point than afterwards. At the point of the crisis Norway is running a higher current account surplus than predicted by the model.

Figure 5 shows that the predicted current account deficit for Spain was higher than the actual one before the crisis. Again, the RMSE before the crisis is higher than afterwards, similar to the case of Sweden and Italy. France (Figure 6) was running a deficit instead of the predicted surplus before the crisis, however, the RMSE is virtually unchanged both before and after the crisis.

Figure 7 shows that the intertemporal model fits Mexico very well even around the period of the crisis, similarly to the United Kingdom. The RMSE does not change significantly before or after the crisis. Figure 8 shows that the model also tracks South African current account quite well around the time of the crisis (slightly overpredicting the deficit).

Figure 9 shows that Korea has been running a deficit much higher than the one predicted by the model and then similarly to Italy a higher surplus. The RMSE of the model decreased after the crisis. Similarly, the Philippines (Figure 10) also ran a higher than predicted current account deficit before the crisis. The RMSE again decreased after the crisis.

One can therefore conclude that while there's diversity of results, the model does appear to have some predictive power for the currency crises, confirming the first hypothesis of this paper. The fact that it does not do so for all countries may suggest several differences in the nature of currency crises that are not accounted for in this paper. First, the crises that are not predicted by the model can arise not due to the current account deficit that is not optimal, but rather due to adjustment to different equilibrium determined by changing fundamentals. Second, this may be an evidence of the 'tequila effect' described by Sachs et al. (1996), who argues that crises tend to spread affecting countries that are vulnerable to them. It is possible, that some instances of the currency crisis, for example, Norway were not due to the dangerous imbalance of the current account, but simply due to the overall panic in the financial markets.

The other possible explanation is that the assumptions underlying the estimation are too restrictive and that there are significant differences between preferences and conditions in individual countries. For example, the intertemporal elasticity of substitution, the share of traded goods can differ.

The RMSE of the model generally falls after the crisis suggesting that in some instances the crisis did bring the current account closer to the optimum and that there is no evidence of countries facing significant borrowing constraints on the international financial markets in the aftermath of the crisis. The reason for that could be the fact that the crisis does represent a process of adjustment, bringing financial markets (including conditions of access) in line with the economic fundamentals. Therefore, after the crisis there is no reason for credit constraints, since the changed fundamentals are now reflected in the exchange rate or other financial variables.

4.5 Forecasts for Non-stationary Current Accounts

Out of 17 countries in the sample, 8 countries have had their sample shortened in order to make the current account series stationary (shown in bold in Table 1). These countries are Australia, France, South Korea, Netherlands, Philippines, South Africa, Sweden and the United Kingdom. Four years was the maximum amount of observations that was removed, typically it was enough to remove one or two years.

It is first useful to find out whether the non-stationarity is associated with the current account surpluses or current account deficits. The countries that have non-stationary current account *deficits* are Australia, France, South Africa and the United Kingdom. Figures 11, 12, 13 and 14 show the mean forecasted values of the current account as well as the confidence intervals (+/- 2 standard deviations). Only in the case of Australia, the current account falls outside the forecast bands. It has been mentioned before that a truly non-stationary current account deficit is an indicator of a potential crisis.

South Korea, Netherlands, Philippines and Sweden (Figures 15, 16, 17 and 18) have run non-stationary current account *surpluses*. In these countries, only South Korean surplus falls outside the band of the two standard deviations from the forecast.

This can be interpreted as an indirect confirmation of the fact that the current account series actually are stationary and that the failure to reject the unit root is probably due to the nature of tests. However, in two instances of Korea and Australia the model also suggests that there's perhaps a temporary force driving the non-stationary dynamics of the current account that cannot be explained by the model. An extension of the approach by Hall et al. (1999), which could identify the periods of local non-stationarity and correlate them with various fundamentals, could potentially explain this situation, but falls outside the scope of this work.

The standard deviations of the forecasts are substantial, reflecting that it is difficult to use a model, which is fundamentally reliant on expectations for forecasting, particularly over longer time periods of several years.

4.6 Sensitivity of the Results

The analysis in this paper depends on a number of assumptions, particularly on the parameters of the model. The real interest rate series, for example, is negative in the end of the seventies due to high levels of inflation experienced in the G7 countries. The real interest rate affects the value of β, the subjective discount parameter in the utility function, and the 'consumption based interest rate' series. The possible singularity of the matrix $(\mathbf{I}-\beta\mathbf{A})$ depends on the value β, which can affect the inference results.

The results are less sensitive to the value of the intertemporal elasticity of substitution. It is possible to estimate it within the model by looking for the value that gives the best fit and appropriately reducing the degrees of freedom. Given the large number of countries in this study, however, an assumption of fixed intertemporal elasticity of substitution is made. Another implicit assumption is that the share of traded goods in all of the economies considered is constant and does not vary across time. Modeling the behavior of traded good share for an individual country can certainly generate new insights.

The most fundamental limitation inherent in the model is the reliance on expectations, which can be variable across different countries and not obvious in hindsight. Expectations could be affected by the actions of institutions such as central banks committed to defending their currencies or the IMF preparing a bailout package for the government. All of these factors would need to be taken into account into analysis that aims to explain a particular incident of the currency crisis.

5 Conclusion

There are three main contributions of this paper. The first is to perform an empirical test of the intertemporal current account model on a large sample of countries. Given the restrictiveness of the assumptions across this sample, the model performs quite well, often capturing important features of the data, even though it is often statistically rejected.

The second contribution is to assess the predictive power of the intertemporal model for the currency crises. There's evidence that intertemporal model could have indicated a potential currency crisis in cases of Italy, Sweden, France, South Korea and Philippines out of the total of 10 countries that have experienced significant devaluations. Considering the diversity of the countries and the strength of assumptions described previously, this can be interpreted as favorable evidence for the hypothesis.

The third hypothesis is about the performance of the model in the aftermath of the currency crisis. The results have shown close to no support for the argument that countries face significant problems accessing the international financial markets in the aftermath of the crisis. Presumably the crisis brings the conditions of access to the markets in line with the fundamentals.

A productive direction for future research is the idea that shocks that affect the country's state of the current account as well as the probability of the currency crisis depend both in their frequency and nature on the type of the country. Countries could be differentiated by their macroeconomic fundamentals, nature of exchange rate regimes or their financial systems. Since the model used is open to extensions, for example, including the terms of trade shocks or the idea of 'saving glut', the analysis can be repeated for different groups of countries to gauge which types of shocks are more important for which types of countries. This could help the design of proper stabilization policies, if the current account deficit becomes unsustainable as well as evaluation of sustainability of current account deficits in the first place.

A Derivation of the Basic Current Account Model

Rearranging equation (2.2), one can write:

$$(1 + r_t)A_t = A_{t+1} + (C_t + G_t + I_t - Y_t)$$

Since the present consumption is not discounted when $k = t$, $R_{t,k} = 0$. After repeated substitution for A_{t+1}, in equation (2.2), one can express it as:

$$(1 + r_t)A_t = \lim_{k\to\infty} R_{t,k}A_k + \sum_{k=t}^{\infty} R_{t,k}(C_k + G_k + I_k - Y_k) \tag{A.1}$$

Consider now the term $\lim_{k\to\infty} R_{t,k}A_k$, which represents the present value of foreign assets into the infinite future. Since, according to the equation (2.1), agents only derive utility from consumption, no country would be willing to accumulate foreign assets indefinitely, which rules out positive values of $\lim_{k\to\infty} R_{t,k}A_k$. This implies the No Ponzi game condition ruling out the negative values of $\lim_{k\to\infty} R_{t,k}A_k$. Therefore $\lim_{k\to\infty} R_{t,k}A_k = 0$. The resource constraint facing the economy is:

$$\sum_{k=t}^{\infty} R_{t,k}(C_k + G_k + I_k) = (1 + r_t)A_t + \sum_{k=t}^{\infty} R_{t,k}Y_k \tag{A.2}$$

The interpretation of the equation (A.2) is that the present value of the government expenditure, investment and consumption must equal the present value of output and the current income on net foreign assets, which can instead be payments to creditors, if net foreign assets are negative. The constraint is satisfied with equality, since the marginal utility of consumption is always positive and therefore no resources are willingly forgone.

At the optimal point consumers, who are maximizing utility as defined in the equation (2.1), subject to (A.2), will be indifferent, between saving and consumption, which lets us informally derive the traditional consumption Euler equation:

$$u'(C_t) = \beta(1 + r_{t+1})u'(C_{t+1}) \tag{A.3}$$

For further insight into current account behaviour, one needs to specify the form of the utility function. A typical choice is the isoelastic utility form given by:

$$u(C_t) = \frac{C_t^{1-\frac{1}{\sigma}} - 1}{1 - \frac{1}{\sigma}} \tag{A.4}$$

Rearranging the equation (A.2), one can write:

$$\sum_{k=t}^{\infty} R_{t,k}C_k = (1 + r_t)A_t + \sum_{k=t}^{\infty} R_{t,k}(Y_k - G_k - I_k)$$

Using the Euler equation (A.3), one can note that the left hand side of the previous equation can be written as:

$$\sum_{k=t}^{\infty} R_{t,k}C_k = C_t + R_{t,t+1}\beta^{\sigma}(1 + r_{t+1})^{\sigma}C_t + R_{t,t+2}\beta^{\sigma}(1 + r_{t+2})^{\sigma}C_{t+1} + ...$$

$$= C_t + R_{t,t+1}\beta^{\sigma}(1 + r_{t+1})^{\sigma}C_t + R_{t,t+2}\beta^{2\sigma}(1 + r_{t+2})^{\sigma}(1 + r_{t+1})^{\sigma}C_t + ...$$

$$= C_t \left(1 + R_{t,t+1}\left(\frac{\beta}{R_{t,t+1}}\right)^{\sigma} + R_{t,t+2}\left(\frac{\beta^2}{R_{t,t+2}}\right)^{\sigma} + ...\right) = C_t \sum_{k=t}^{\infty} R_{t,k}\left(\frac{\beta^{k-t}}{R_{t,k}}\right)^{\sigma}$$

Plugging this expression into the equation (A.2), one can obtain the expression for the consumption in the economy:

$$C_t = \frac{(1+r_t)A_t + \sum_{k=t}^{\infty} R_{t,k}(Y_k - G_k - I_k)}{\sum_{k=t}^{\infty} R_{t,k}\left(\frac{\beta^{k-t}}{R_{t,k}}\right)^{\sigma}} \tag{A.5}$$

With this definition of consumption, one can rewrite the equation (2.2) as:

$$\begin{aligned} CA_t &= r_t A_t + Y_t - \frac{(1+r_t)A_t + \sum_{k=t}^{\infty} R_{t,k}(Y_k - G_k - I_k)}{\sum_{k=t}^{\infty} R_{t,k}\left(\frac{\beta^{k-t}}{R_{t,k}}\right)^{\sigma}} - G_t - I_t = \\ &= \left(r_t - \frac{1+r_t}{\sum_{k=t}^{\infty} R_{t,k}\left(\frac{\beta^{k-t}}{R_{t,k}}\right)^{\sigma}}\right) A_t + \left(Y_t - \frac{\sum_{k=t}^{\infty} R_{t,k} Y_k}{\sum_{k=t}^{\infty} R_{t,k}\left(\frac{\beta^{k-t}}{R_{t,k}}\right)^{\sigma}}\right) \\ &\quad - \left(G_t - \frac{\sum_{k=t}^{\infty} R_{t,k} G_k}{\sum_{k=t}^{\infty} R_{t,k}\left(\frac{\beta^{k-t}}{R_{t,k}}\right)^{\sigma}}\right) - \left(I_t - \frac{\sum_{k=t}^{\infty} R_{t,k} I_k}{\sum_{k=t}^{\infty} R_{t,k}\left(\frac{\beta^{k-t}}{R_{t,k}}\right)^{\sigma}}\right) \end{aligned}$$

Adding and subtracting the permanent levels of variables and multiplying and dividing the fractional terms in the equation by $\sum_{k=t}^{\infty} R_{t,k}$, one can write the current account equation as[5]:

$$CA_t = (r_t - \hat{r}_t)A_t + (Y_t - \hat{Y}_t) - (I_t - \hat{I}_t) - (G_t - \hat{G}_t) + \left(1 - \frac{1}{\left(\frac{\hat{\beta}}{R}\right)^{\sigma}}\right)(\hat{r}_t A_t + \hat{Y}_t - \hat{I}_t - \hat{G}_t)$$

B Log-linearised Budget Constraint

To derive equation 2.10[6], consider first equation A.2, which one can rewrite as (where A_0 is the initial level of net foreign assets):

$$\sum_{k=0}^{\infty} R_{0,k} C_k - \sum_{k=0}^{\infty} R_{0,k}(Y_k - G_k - I_k) = A_0$$

First, define the net output variable $NO_t = Y_t - G_t - I_t$, to rewrite the intertemporal budget constraint as:

$$\sum_{k=0}^{\infty} R_{0,k} C_k - \sum_{k=0}^{\infty} R_{0,k} NO_k = \hat{C}_0 - \hat{NO}_0 = A_0$$

[5]The final step in the derivation is to note that $\sum_{k=t+1}^{\infty} R_{t,k} r_k = 1$. One can see this algebraically expanding the summation: $\frac{r_{t+1}}{(1+r_{t+1})} + \frac{r_{t+2}}{(1+r_{t+2})(1+r_{t+1})} + \frac{r_{t+3}}{(1+r_{t+3})(1+r_{t+2})(1+r_{t+1})} + ... = \frac{r_{t+1}(1+r_{t+2})(1+r_{t+3})*...+r_{t+2}(1+r_{t+3})*...+r_{t+3}*+...}{(1+r_{t+3})(1+r_{t+2})(1+r_{t+1})*...} = \frac{(r_{t+3}+1)((1+r_{t+2})(r_{t+1})+r_{t+2}+...)}{(1+r_{t+3})(1+r_{t+2})(1+r_{t+1})*...}$. The terms of the summation eventually cancel out. Alternatively, one can note that the left hand side of the equation is the discounted stream of payoffs from 1 unit of output, hence it cannot be different from 1, otherwise arbitrage would be possible.

[6]The general method of this derivation follows Huang and Lin (1993).

Dividing the previous equation by $\hat{NO}_0$, taking logs and denoting the log values of the variables by lower case, one can write:

$$\hat{c}_0 - \hat{no}_0 = \log\left(1 + \frac{A_0}{\hat{NO}_0}\right)$$

The first order Taylor expansion of the R.H.S. of the previous equation around the steady state assets $\bar{A}$, one can write:

$$\begin{aligned}\log\left(1 + \frac{A_0}{\hat{NO}_0}\right) &= \log(1 + \exp(a_0 - \hat{no}_0)) \\ &\approx \log(1 + \exp(\bar{a} - \hat{no}_0)) + \frac{\exp(\bar{a} - \hat{no}_0)}{1 + \exp(\bar{a} - \hat{no}_0)}(a_0 - \hat{no}_0 - (\bar{a} - \hat{no}_0))\end{aligned}$$

One can define $\lambda = 1 + \exp(\bar{a} - \hat{no}_0) = 1 + \frac{\bar{A}}{\hat{NO}_0}$, which will be a constant and write:

$$\log\left(1 + \frac{A_0}{\hat{NO}_0}\right) \approx \ln(\lambda) - \left(1 - \frac{1}{\lambda}\right)\ln(\lambda - 1) + \left(1 - \frac{1}{\lambda}\right)(a_0 - \hat{no}_0)$$

Disregarding the linearisation constant (the last two terms) since the data will be fit with demeaned series, one can write:

$$\hat{c}_0 - \hat{no}_0 = \left(1 - \frac{1}{\lambda}\right)(a_0 - \hat{no}_0) \tag{B.1}$$

Consider now linearising the present value of current and future consumption, which at period 0 is equal to:

$$\hat{C}_0 = \sum_{k=0}^{\infty} R_{0,k} C_k = \sum_{k=0}^{\infty} \frac{1}{\prod_{t=0}^{k}(1 + r_t)} C_k$$

From the definition of present value of consumption it follows that one can write the law of motion for the permanent value of consumption as:

$$\hat{C}_{t+1} = (1 + r_{t+1})(\hat{C}_t - C_t)$$

Dividing both sides by $\hat{C}_t$, taking logs and denoting log values by lower case letters to obtain:

$$\hat{c}_{t+1} - \hat{c}_t = \ln(1 + r_{t+1}) + \ln\left(1 - \frac{C_t}{\hat{C}_t}\right)$$

Using the Taylor expansion of the second term on the right hand side around the steady state level of consumption $\bar{C}$ and the initial level of permanent consumption $\hat{C}_0$:

$$\begin{aligned}\ln\left(1 - \frac{C_t}{\hat{C}_t}\right) &= \ln\left(1 - \exp(c_t - \hat{c}_t)\right) \\ &\approx \ln\left(1 - \exp(\bar{c} - \hat{c}_0)\right) + \frac{-\exp(\bar{c} - \hat{c}_0)}{1 - \exp(\bar{c} - \hat{c}_0)}(c_t - \bar{c}) + \frac{\exp(\bar{c} - \hat{c}_0)}{1 - \exp(\bar{c} - \hat{c}_0)}(\hat{c}_t - \hat{c}_0) \\ &= \ln\left(1 - \exp(\bar{c} - \hat{c}_0)\right) + \frac{\exp(\bar{c} - \hat{c}_0)}{1 - \exp(\bar{c} - \hat{c}_0)}(\bar{c} - \hat{c}_0) - \frac{\exp(\bar{c} - \hat{c}_0)}{1 - \exp(\bar{c} - \hat{c}_0)}(c_t - \hat{c}_t)\end{aligned}$$

Denoting $\rho = 1 - \exp(\bar{c} - \hat{c}_0)$ which is a constant, one can write:

$$\ln\left(1 - \frac{C_t}{\hat{C}_t}\right) \approx \ln\rho - \left(\frac{\rho-1}{\rho}\right)\ln(1-\rho) + \left(\frac{\rho-1}{\rho}\right)(c_t - \hat{c}_t)$$

Using the usual approximation of $\ln(1 + r_{t+1}) = r_{t+1}$:

$$\hat{c}_{t+1} - \hat{c}_t \approx r_{t+1} + \ln\rho - \left(\frac{\rho-1}{\rho}\right)\ln(1-\rho) + \left(\frac{\rho-1}{\rho}\right)(c_t - \hat{c}_t)$$

It turns out to be helpful to write the difference between two permanent values of consumption as follows, by adding and subtracting the consecutive consumption values:

$$\hat{c}_{t+1} - \hat{c}_t = c_{t+1} - c_{t+1} + \hat{c}_{t+1} + c_t - c_t - \hat{c}_t = \Delta c_{t+1} - (c_{t+1} - \hat{c}_{t+1}) + (c_t - \hat{c}_t)$$

Therefore one can write:

$$\Delta c_{t+1} - (c_{t+1} - \hat{c}_{t+1}) + (c_t - \hat{c}_t) = r_{t+1} + \ln\rho - \left(\frac{\rho-1}{\rho}\right)\ln(1-\rho) + \left(\frac{\rho-1}{\rho}\right)(c_t - \hat{c}_t)$$

Simplifying and rearranging:

$$c_t - \hat{c}_t = \rho(c_{t+1} - \hat{c}_{t+1}) + \rho(r_{t+1} - \Delta c_{t+1}) + \rho\ln\rho - (\rho - 1)\ln(1-\rho)$$

Disregarding the linearisation constant and imposing the limiting condition $\lim_{t\to\infty}(c_t - \hat{c}_t) = 0$, one can solve this difference equation forward to obtain:

$$c_0 - \hat{c}_0 = \sum_{t=1}^{\infty} \rho^t (r_t - \Delta c_t) \tag{B.2}$$

Using a similar chain of reasoning, one can linearize the permanent value of the net output to obtain:

$$no_0 - \hat{no}_0 = \sum_{t=1}^{\infty} \rho^t (r_t - \Delta no_t) \tag{B.3}$$

Finally, plugging in (B.2) and (B.3) into (B.1), one can write:

$$\begin{aligned} no_0 - \hat{no}_0 &= \sum_{t=1}^{\infty} \rho^t (r_t - \Delta no_t) + \sum_{t=1}^{\infty} \rho^t (r_t - \Delta c_t) - c_0 \\ &= \left(1 - \frac{1}{\lambda}\right)(a_0 - \hat{no}_0) - \left(1 - \frac{1}{\lambda}\right)\left(\sum_{t=1}^{\infty} \rho^t (r_t - \Delta c_t) - c_0\right) \end{aligned} \tag{B.4}$$

Equation (B.4) can be rewritten as:

$$-\sum_{t=1}^{\infty} \beta^t \left(\Delta no_t - \frac{\Delta c_t}{\lambda} - \left(1 - \frac{1}{\lambda}\right) r_t\right) = no_0 - \frac{c_0}{\lambda} + \left(1 - \frac{1}{\lambda}\right) b_0$$

Choosing the steady state such that the net foreign assets are 0 and therefore $\lambda = 1$, one can write:

$$-\sum_{t=1}^{\infty} \beta^t (\Delta no_t - \Delta c_t)) = no_0 - c_0$$

Finally, taking expectations of the above and using (2.8), one obtains the (2.10) as given in text:

$$no_0 - c_0 = -E_t \sum_{i=1}^{\infty} \beta^i (\Delta no_{t+i} - \frac{1}{\sigma}\hat{r}_{t+i})$$

C Tables and Figures

Table 1: Stationarity Test Results

Country	Test	Δno_t	CA_t	$\tilde{r}_t$	Time Period
Australia	ADF	-2.78 *	-2.11 (0.03)	-11.59 *	**1975Q1 - 2004Q4**
	PP	-15.30 *	-1.91 (0.05)	-11.56 *	
Canada	ADF	-4.69 *	-2.53 (0.01)	-4.95 *	1975Q1 - 2005Q4
	PP	-10.24 *	-1.82 (0.07)	-11.41 *	
France	ADF	-6.31 *	-1.79 (0.07)	-6.53 *	**1978Q1 - 2004Q4**
	PP	-9.73 *	-1.58 (0.11)	-12.32 *	
Germany	ADF	-12.08 *	-2.49 (0.01)	-4.94 *	1975Q1 - 2005Q4
	PP	-12.07 *	-2.46 (0.01)	-10.02 *	
Italy	ADF	-8.90 *	-1.82 (0.07)	-11.03 *	1981Q1 - 2005Q4
	PP	-8.88 *	-1.88 (0.06)	-11.47 *	
Japan	ADF	-4.67 *	-3.04 *	-9.80 *	1975Q1 - 2005Q4
	PP	-18.23 *	-2.90 *	-9.94 *	
South Korea	ADF	-12.06 *	-1.74 (0.08)	-12.21 *	**1975Q1 - 2002Q4**
	PP	-12.18 *	-1.88 (0.06)	-12.44 *	
Mexico	ADF	-14.55 *	-1.74 (0.08)	-14.04 *	1980Q1 - 2005Q4
	PP	-14.27 *	-1.78 (0.07)	-14.00 *	
Netherlands	ADF	-14.12 *	-1.65 (0.09)	-9.80 *	**1977Q1 - 2003Q4**
	PP	-14.83 *	-1.75 (0.08)	-9.81 *	
Norway	ADF	-14.78 *	-1.65 (0.09)	-10.12 *	1978Q1 - 2005Q4
	PP	-15.51 *	-1.70 (0.08)	-10.12 *	
Philippines	ADF	-4.14 *	-1.07 (0.26)	-9.80 *	**1981Q1 - 2002Q4**
	PP	-8.35 *	-1.70 (0.08)	-9.80 *	
South Africa	ADF	-5.01 *	-1.38 (0.15)	-11.02 *	**1975Q1 - 2003Q4**
	PP	-13.93 *	-2.08 (0.04)	-11.02 *	
Spain	ADF	-14.87 *	-2.51 (0.01)	-3.43 *	1975Q1 - 2005Q4
	PP	-15.01 *	-2.78 *	-9.20 *	
Sweden	ADF	-4.26 *	-1.79 (0.07)	-4.81 *	**1980Q1 - 2004Q4**
	PP	-30.99 *	-1.40 (0.15)	-9.88 *	
Switzerland	ADF	-5.05 *	-3.51 *	-10.14 *	1981Q1 - 2005Q4
	PP	-10.19 *	-3.66 *	-10.14 *	
United Kingdom	ADF	-3.66 *	-1.71 (0.08)	-10.75 *	**1975Q1 - 2001Q4**
	PP	-12.67 *	-1.90 (0.06)	-10.75 *	
United States	ADF	-11.16 *	-1.29 (0.18)	-4.58 *	1975Q1 - 2005Q4
	PP	-11.19 *	-1.71 (0.08)	-11.65 *	

Note: * the test statistic is significant at 1% significance level. p-values for the respective test statistics are reported in parenthesis, where the test statistic is not significant at 1%. Regressions do not include a constant or a time trend. Modified Akaike Information Criterion was used to select the lag length for regressions. ADF - augmented Dickey-Fuller unit root test. PP - Phillips-Perron unit root test.

Table 2: Actual Current Account Characteristics

Country	Mean	Standard Deviation	Country	Mean	Standard Deviation
Australia	0.015	0.029	Norway	0.178	0.113
Canada	0.020	0.050	Philippines	-0.048	0.066
France	0.002	0.020	South Africa	0.152	0.102
Germany	0.040	0.036	Spain	-0.016	0.033
Italy	0.003	0.030	Sweden	0.074	0.056
Japan	0.032	0.020	Switzerland	0.010	0.016
Korea	0.179	0.068	United Kingdom	0.010	0.031
Mexico	0.016	0.045	United States	-0.024	0.021
Netherlands	0.072	0.045			

Table 3: Estimation Results for the Healthy Countries

Country	k_{no}	k_{CA}	k_r	N	Variance Ratio	RMSE	Model test
Theoretical Values	0	1	0				
Australia	0.146	0.399	-0.007	118	0.189	0.017	4.359
	(0.581)	(0.272)	(0.063)				(0.225)
Canada	-0.280	0.646	0.001	122	0.408	0.018	6.846
	(0.417)	(0.210)	(0.033)				(0.077)
Germany	0.139	0.747	-0.015	122	0.583	0.009	7.632
	(0.310)	(0.269)	(0.043)				(0.054)
Japan	0.236	3.349	0.014	122	11.999	0.048	7.338
	(0.249)	(1.090)	(0.037)				(0.062)
Netherlands	0.230	0.293	0.036	106	0.120	0.031	11.253
	(0.348)	(0.132)	(0.061)				(0.010)
Switzerland	-0.642	2.575	0.004	98	6.440	0.024	14.850
	(0.592)	(0.928)	(0.038)				(0.002)
United States	-0.385	3.641	-0.002	122	13.270	0.054	7.076
	(0.702)	(1.844)	(0.050)				(0.070)
Average					**4.72**	**0.029**	

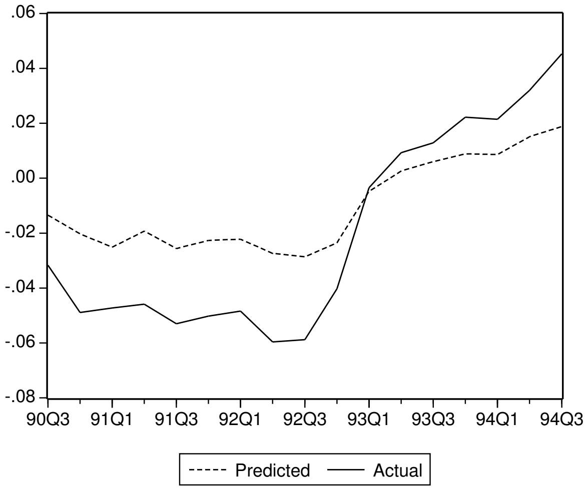
Note: Standard errors are reported in brackets. Estimation is over time period in Table 1. VARs are estimated by OLS.

Table 4: Estimation Results for the Crisis Countries

Country	k_{no}	k_{CA}	k_r	N	Variance Ratio	RMSE	Model test
Theoretical Values	0	1	0				
France	-0.160	-0.327	-0.016	106	0.107	0.027	6.059
	(0.518)	(0.150)	(0.038)				(0.109)
Italy	-0.077	0.454	-0.024	98	0.477	0.016	2.654
	(0.426)	(0.180)	(0.030)				(0.448)
South Korea	0.373	0.311	-0.010	110	0.010	0.047	30.073
	(0.297)	(0.147)	(0.043)				(0.000)
Mexico	0.094	0.816	-0.024	102	0.858	0.014	11.176
	(0.371)	(0.335)	(0.031)				(0.011)
Norway	0.160	0.300	0.028	110	0.094	0.078	17.563
	(0.417)	(0.149)	(0.063)				(0.001)
Philippines	-0.264	0.664	0.019	86	0.432	0.027	13.663
	(0.785)	(0.413)	(0.074)				(0.003)
South Africa	0.021	0.989	-0.005	114	1.030	0.002	1.856
	(0.472)	(0.477)	(0.046)				(0.603)
Spain	0.166	0.519	0.015	122	0.311	0.015	2.455
	(0.324)	(0.201)	(0.044)				(0.483)
Sweden	0.282	-0.234	0.021	98	0.199	0.064	16.015
	(0.284)	(0.092)	(0.048)				(0.001)
United Kingdom	0.008	1.178	-0.009	106	1.391	0.006	0.811
	(0.438)	(0.520)	(0.04)				(0.847)
Average					**0.491**	**0.029**	

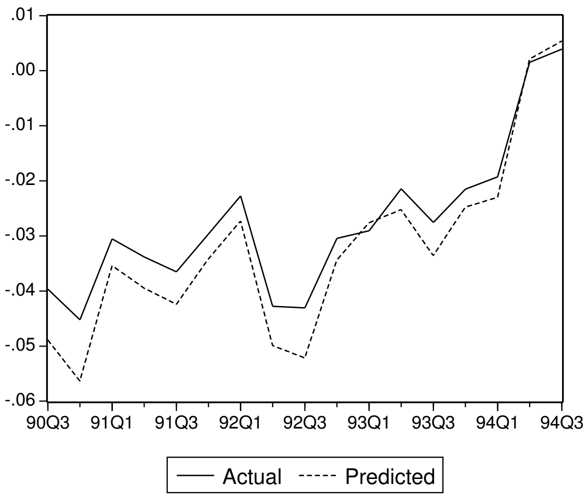
Note: Standard errors are reported in parenthesis. Estimation is over time period in Table 1. VARs are estimated by OLS.

Figure 1: Italy Demeaned Current Account Before and After the Crisis



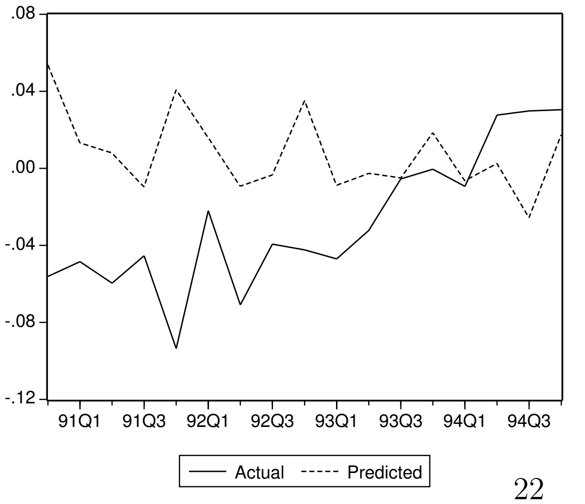
Crisis Point: 1992Q3	RMSE
Before the Crisis:	0.00072
After the Crisis:	0.00021

Figure 2: United Kingdom Demeaned Current Account Before and After the Crisis



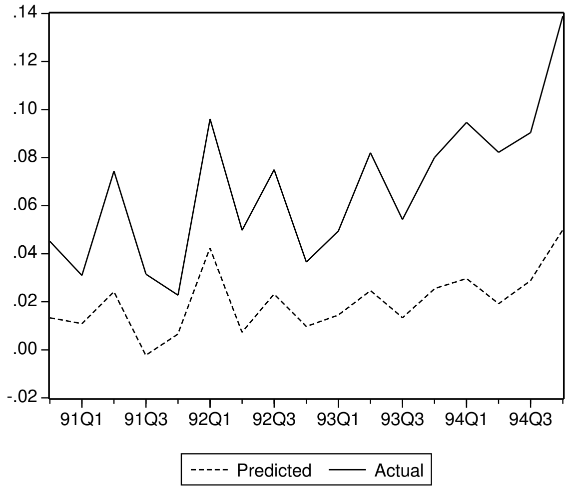
Crisis Point: 1992Q3	RMSE
Before the Crisis:	0.00005
After the Crisis:	0.00001

Figure 3: Sweden Demeaned Current Account Before and After the Crisis



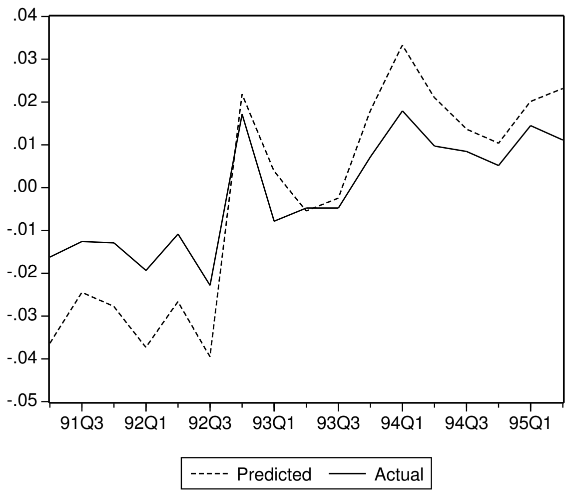
Crisis Point: 1992Q4	RMSE
Before the Crisis:	0.00542
After the Crisis:	0.00083

Figure 4: Norway Demeaned Current Account Before and After the Crisis



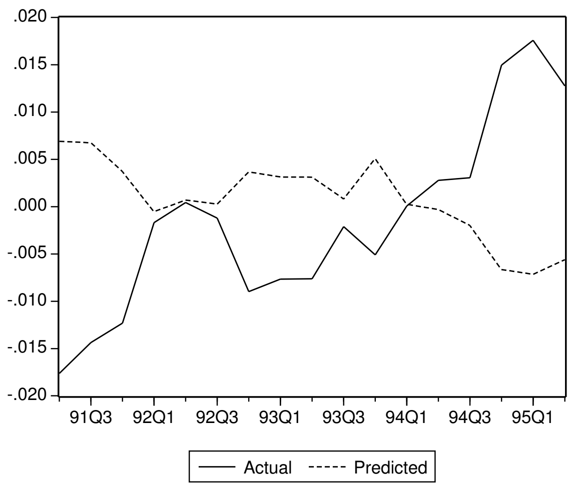
Crisis Point: 1992Q4	RMSE
Before the Crisis:	0.00149
After the Crisis:	0.00364

Figure 5: Spain Demeaned Current Account Before and After the Crisis



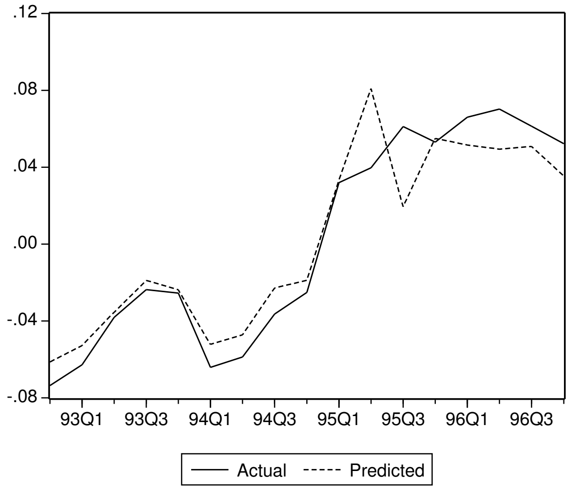
Crisis Point: 1993Q2	RMSE
Before the Crisis:	0.00020
After the Crisis:	0.00009

Figure 6: France Demeaned Current Account Before and After the Crisis



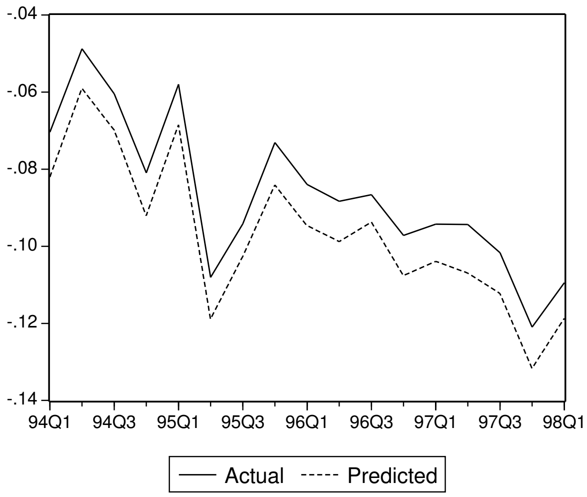
Crisis Point: 1993Q2	RMSE
Before the Crisis:	0.00019
After the Crisis:	0.00016

Figure 7: Mexico Demeaned Current Account Before and After the Crisis



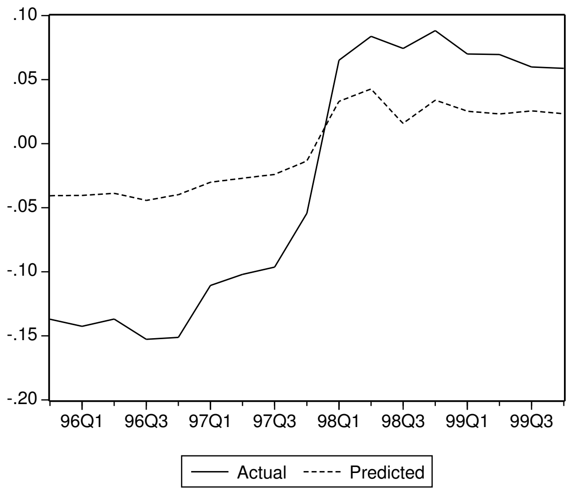
Crisis Point: 1994Q4	RMSE
Before the Crisis:	0.00009
After the Crisis:	0.00056

Figure 8: South Africa Demeaned Current Account Before and After the Crisis



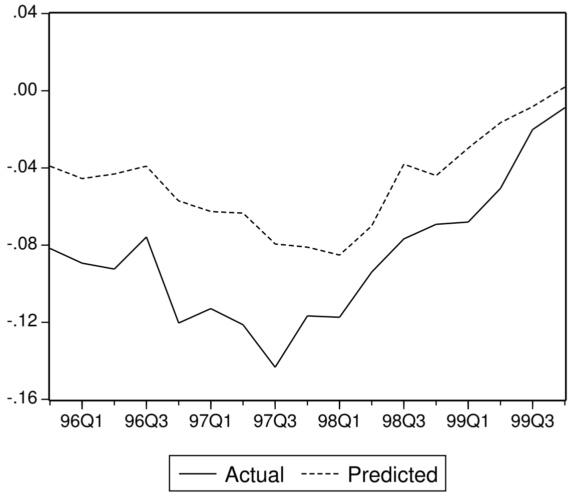
Crisis Point: 1996Q1	RMSE
Before the Crisis:	0.000001
After the Crisis:	0.000004

Figure 9: Korea Demeaned Current Account Before and After the Crisis



Crisis Point: 1997Q4	RMSE
Before the Crisis:	0.00576
After the Crisis:	0.00341

Figure 10: Philippines Demeaned Current Account Before and After the Crisis



Crisis Point: 1997Q4	RMSE
Before the Crisis:	0.00140
After the Crisis:	0.00029

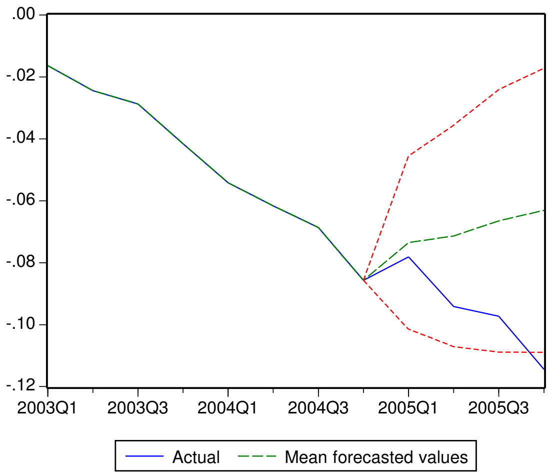


Figure 11: Australia Demeaned Current Account, 2003 - 2005

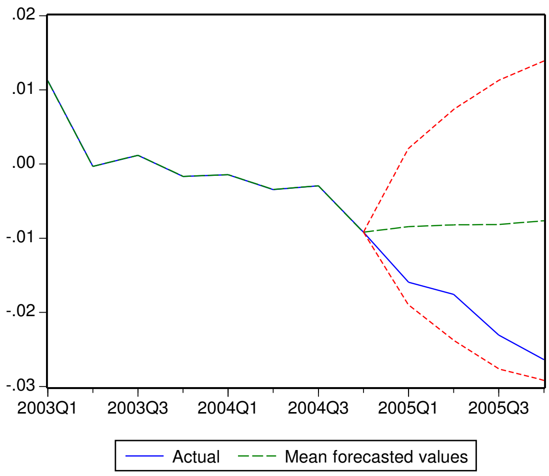


Figure 12: France Demeaned Current Account, 2003 - 2005

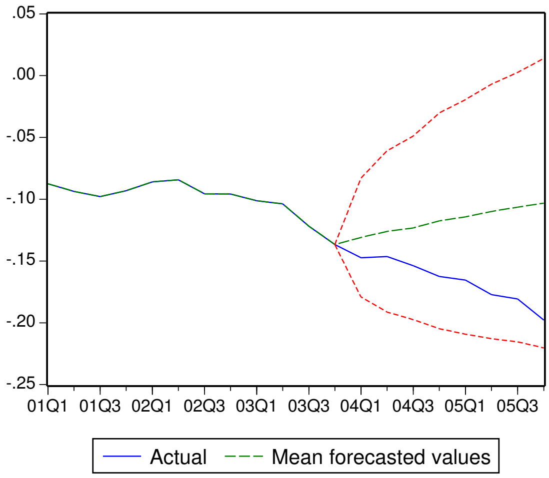


Figure 13: South Africa Demeaned Current Account, 2001 - 2005

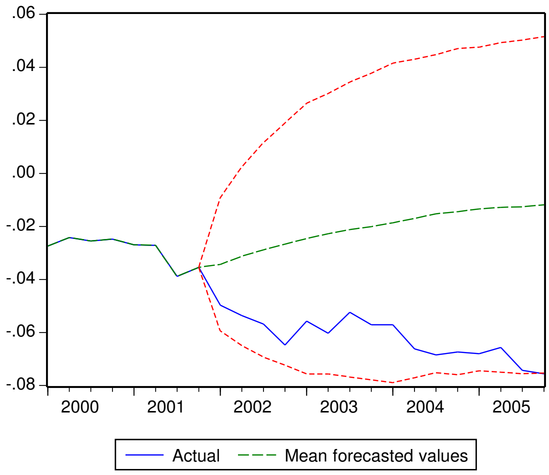


Figure 14: United Kingdom Demeaned Current Account, 2001 - 2005

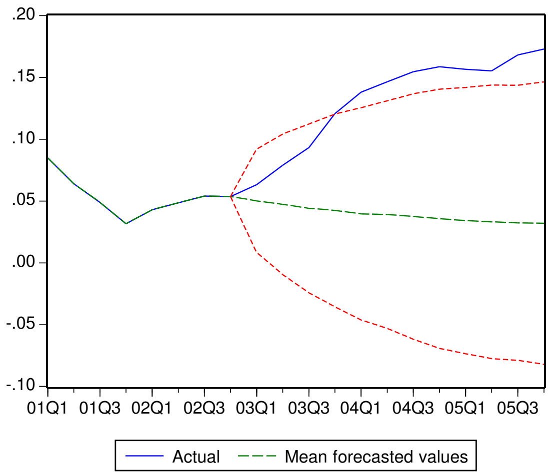


Figure 15: South Korea Demeaned Current Account, 2001 - 2005

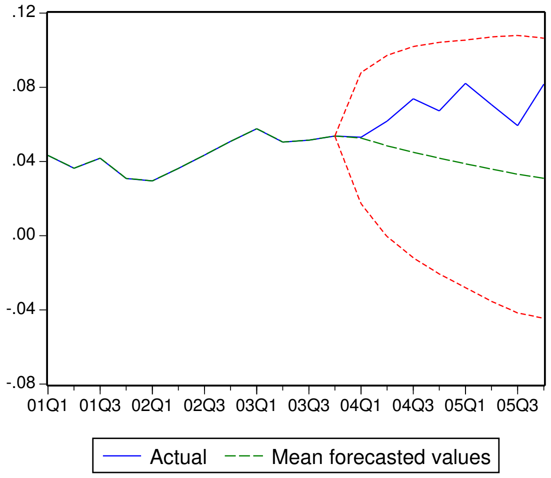


Figure 16: Netherlands Demeaned Current Account, 2001 - 2005

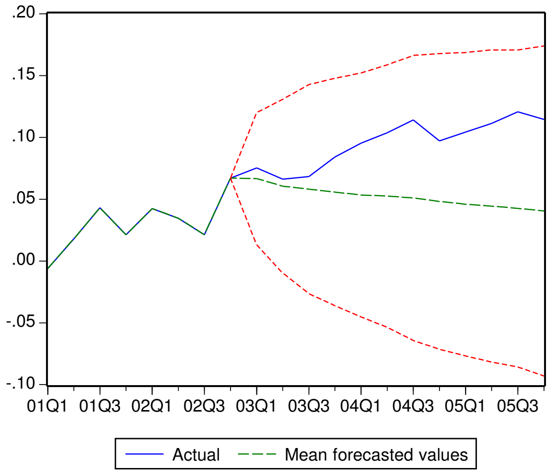


Figure 17: Philippines Demeaned Current Account, 2001 - 2005

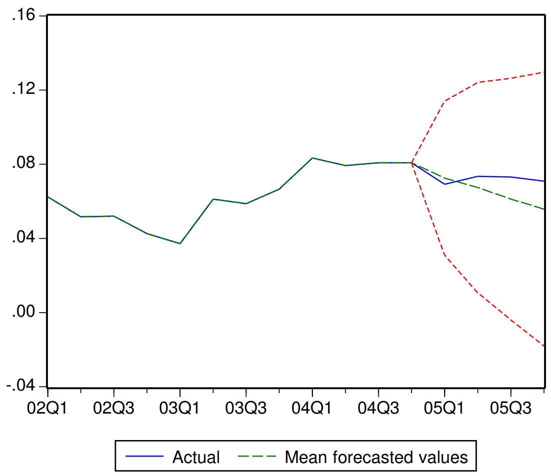


Figure 18: Sweden Demeaned Current Account, 2002 - 2005

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