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External shocks, consumption-smoothing and capital mobility in India: evidence from an intertemporal optimization approach

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Abstract

We examine the solvency of India's current account (CA) in the post-liberalization period using intertemporal optimization approach to the CA. Using quarterly data ranging from 1996Q1 to 2014Q2, we estimate a benchmark consumption-smoothing model and an extended model that incorporates external shocks. Overall, we find that the predicted optimal CA in both the models can track the actual CA movements and the extended model performs better over the benchmark model. Further, we also find that the optimal CA is more volatile than the actual CA which implies that the capital flows have been less than optimal and thus makes an interesting case for further liberalization of the capital account. Our findings suggest that policies aimed at further liberalization of capital flows will allow larger CA deficits to achieve higher economic growth since it will help agents to further smoothen their consumption without worrying about risks associated with insolvency.

Keywords: Present value model, Current account, Solvency, Consumption-smoothing, Intertemporal approach, India.

JEL Classification: E21, F30, F32, F42

1. Introduction

The recent global financial crisis has led to a burgeoning debate on its link with current account (CA) imbalances (Obstfeld and Rogoff 2009). The failure of financial markets exposed the inability of major developing countries to finance their CA deficits (Ca'Zorzi et al. 2012; Catão and Milesi-Ferretti 2014; Taylor 2012). Small-open economies with large and persistent CA deficits experiencing large capital inflows are vulnerable to 'sudden stop' and hence have an incentive to minimize their external imbalance (Ghosh et al. 2016; Obstfeld and Taylor 2017).

However, CA deficits are not ostensibly detrimental, and emerging market policymakers argue that CA deficits can help achieve higher economic growth through the expansionary effects from capital inflows, only if managed properly (Blanchard and Milesi-Ferretti 2009; Blanchard et al. 2016). Hence, as Blanchard and Milesi-Ferretti (2009) point out, CA deficits can be both "desirable" and "undesirable", depending on the circumstances and its causal factors. CA deficits are usually desirable if they are a result of attractive investment opportunities, sound, and deep financial markets, or if a country's population is aging slower than its trading partners (Blanchard and Milesi-Ferretti 2009).

Similarly, in the context of emerging market economies (EMEs), a CA deficit may seem desirable, if it indicates more attractive investment opportunities that they can afford to undertake with their low levels of domestic saving (Blanchard and Milesi-Ferretti 2012; Caballero et al. 2015). However, less developed domestic financial systems in these EMEs may be unable to allocate foreign capital efficiently. Calvo (1998) argued that economies experiencing large and persistent CA deficits may experience an unexpected stop, known as 'sudden stops', in the financing of their CA gap. Also, deficits in EMEs like India are largely financed by volatile flows, such as portfolio flows that are more prone to a capital flight, leaving the domestic economy vulnerable in times of financial panic (Garg and Prabheesh 2015; Sen Gupta and Sengupta 2016). EMEs (like Russia, Mexico, Thailand, Argentina, Indonesia, etc.) experienced periods of insolvency and sharp reversals of their CA deficit after private financing withdrew in the midst of financial crises. The inability to secure necessary financing further underlines the problems of EMEs in running large and persistent CA deficits given the raised level of integration of these countries with the world market (Taylor 2012; Catão and Milesi-Ferretti 2014).

Our study is motivated by India's growing CA deficits in the post-global financial crisis period and the apparent close link between the size of the CA deficit and risks associated with its financing. We chose India because it is a typical small open economy and has been among the top ten economies with largest CA deficit between 2008 and 2015. Interestingly, after the onset of the East Asian crisis of 1997-98, most of the emerging economies in Asia started running huge CA surpluses by implementing exchange rate devaluation policies, making them relatively immune to external sector vulnerability (Ahearne, 2007). India, however, was the only major EME in Asia that ran huge CA deficits along with few episodes of sudden capital stops (Sen Gupta and Sengupta, 2016).

Large and unmanaged CA deficits are considered a major source of macroeconomic vulnerability and can be a hindrance for a growing EME like India (Blanchard & Milesi-Ferretti 2009, 2012; Milesi-Ferretti & Razin 1996). Many factors affect India's CA balance, some associated with domestic macroeconomic conditions, others with external forces. Garg and Prabheesh (2017) found that domestic factors such as fiscal balance, private investment, and external factors such as exchange rates, foreign income, and oil prices, as main drivers of CA deficits. Although many EMEs show vulnerability to external shocks such as oil price movements, India also suffers from countercyclical CA deficits (Rangarajan and Mishra 2013; Goyal 2015). Given India's persistent CA deficits and its vulnerability to external shocks, we analyze whether India's CA balance is solvent or not. In other words, we test whether capital flows to the economy are sufficient enough to manage the CA balance to maintain the external stability of the country.

Our approach towards testing the above questions is as follows. 1) We construct an optimal CA path using present value models. 2) We identify the deviation of actual CA from its optimal path with the help of an array of formal and informal tests. 3) As a step further, we account the impact of external shocks into the model, to check whether external factors help to smooth the consumption or not. 4) Finally, we also test whether intertemporal or intratemporal substitution improves consumption-smoothing or not.

Our empirical findings conclude as follows. 1) India's CA balance is solvent as the optimal CA path derived from present value models tracks actual CA path. 2) The agent under-borrows for their consumption (less than optimal consumption-smoothing) in the presence of domestic shocks alone. 3) Accommodation of external shocks in the model helps the agent to smoothen their consumption further. 4) The dominance of intratemporal effects over intratemporal effects. 5) The world interest rate plays an important role in the intertemporal substitution of goods between time periods.

We contribute to the present literature in the following ways. First, our empirical findings are in line with the existing studies which found the applicability of present value model in CA in the EMEs context (Ghosh and Ostry 1995; Ostry 1997; Ismail and Baharumshah 2008). However, our findings suggest that consumption-smoothing is less than optimal (under-borrowing) which is in contrast to the previous works that found the evidence of over-consumption (over-borrowing) and CA insolvency in the context of EMEs (Ostry 1997; Ismail et al. 2013). Hence, our study has a significant policy implication, especially for EMEs. Moreover, our findings indicate the scope for further capital account liberalization to smooth the consumption whereas many authors argue for capital controls as a measure to mitigate risk associated with capital flows surges and maintain financial stability (Ostry et al. 2010, 2011).

Second, our study is one of the first attempts to compute and utilize a time-varying share of tradables in consumption, to estimate the optimal CA[1]. Whereas, the previous studies are limited by their reliance upon single point estimate share of tradables in consumption. Thus, we improve upon the above limitation, since the results of the present value model can be sensitive to above estimates. Therefore, the optimal CA path derived in our study is more robust in contrast to previous studies as we employ time-varying share of tradables in the model[2].

Finally, we focus on India, one of the growing EMEs, as the availability of literature is fairly modest. It is argued that predicting the CA behaviour of EMEs is more challenging as compared to developed economies as the former has lesser access to the international capital market and high volatility in income (Bergin and Sheffrin 2000; Deaton 1989; Grimmard 1997). Moreover, external shocks play an important role in determining India's CA, hence our study is the first attempt to test India's CA solvency by taking into account external shocks[3].

[1] The methodology on computation of share of tradables is given in online supplementary material.

[2] The motivation behind estimating a time-varying share of traded goods in consumption is attributed to India's boom in trade in the last two decades wherein the share of tradable has significantly increased from around 15 percent to 50 percent during the study period. Further, our method could be used for analysis of other EMEs who have undergone significant changes in consumption pattern with regards to tradables and non-tradables.

[3] The available studies in the Indian context are by Ghosh and Ostry (1995), Callen and Cashin (1999) and Khundrakpam and Ranjan (2009). Ghosh and Ostry (1995) use annual data from 1960-90 and found present value to be valid. On the contrary, Callen and Cashin (1999) use annual data from 1953-1999 wherein the sample mainly covers the period before liberalization in 1991. Although they accounted for asymmetric capital flows, however, the implicit assumption of capital mobility is only satisfied for the data post-1991. Similarly, Khundrakpam and Ranjan

The remainder of the paper is organized as follows. Section 2 presents the theoretical and empirical review. Section 3 discusses the theoretical models and econometric methodology. Section 4 deals with the data and construction of variables. Section 5 presents the empirical results. Section 6 provides the conclusion.

2. Review of Literature

The intertemporal approach to the CA originated with Sachs (1981, 1982) and was later extended by Obstfeld and Rogoff (1995)[4]. The approach is based on the permanent income hypothesis of Friedman (1957) and expectation theory of Hall (1978). The premise is that a country's CA balance is the outcome of rational expectations of forward-looking representative agents. The consumption depends on the expected permanent income and consumption-smoothing takes place through international lending and borrowing wherein agents have access to international capital markets.

In its initial application, Campbell (1987) and Campbell and Shiller (1987) developed testable present value models to examine the 'saving for a rainy day' hypothesis. This hypothesis implies that an individual will save if she expects her income to decline in future, and vice-versa. Similarly, Sheffrin and Woo (1990), Milbourne and Otto (1992) and Otto (1992) tested a present value model of the CA where the dynamic saving and consumption decisions of households are reflected in the CA balance which acts as a buffer to random domestic shocks to output, investment, and government expenditure.

(2009) use annual data from 1951-2008 and again uses the benchmark model. Hence, both studies investigate consumption-smoothing behaviour with respect to only domestic shocks and do not consider external shocks

[4] The intertemporal approach is a theoretical workhorse in analyzing CA behaviour. It has been extended along several dimensions. Singh (2007) provides an excellent survey of intertemporal models of optimization.

Ghosh (1995) derived a consumption-smoothing model which allows for a joint test of the intertemporal solvency and the assumption of perfect capital mobility. He argues that if the variance of predicted optimal CA is equal to the actual CA series, then the capital borrowing is optimal. It also implies that if the variance of optimal and actual CA series is not equal, then there could be the presence of either over borrowing or under borrowing. Hence, non-equality of variances comprises significant implications for capital flows liberalization along with solvency of a country's CA. Hereafter, Ghosh (1995) model is referred to as the 'Benchmark model'.

The benchmark model derives the optimal CA based on the domestic shocks arising from variables such as saving (both public and private), investment and government expenditure. Whereas, the model by Bergin and Sheffrin (2000) also allows for external shocks that are transmitted through exchange rate and world interest rate and considers both traded and nontraded goods. Similarly, the benchmark model assumes uncovered interest rate parity, whereas the Bergin and Sheffrin (2000) enhance this limitation by simultaneously allowing a time-varying real interest rate and change in the real exchange rate. They found that the fit of the model improves significantly as the agents' information set is extended to include external shocks via movement in the world interest rate and the exchange rate. Hereafter, the Bergin and Sheffrin (2000) model is referred to as the 'Extended model'.

Table 1 provides the overview of the empirical studies in this context and the interesting observations from the table are as follows. 1) The studies are largely focused on developed countries, and after the onset of the recent global financial crisis, their focus is shifted to EMEs as well. 2) Empirical models perform relatively better in periods of capital account liberalization for developed and emerging countries (Bergin and Sheffrin 2000; Cashin and McDermott 1998, 2002; Otto 2003). 3) Callen and Cashin (1999) and Khundrakpam and Ranjan (2009) found that

India’s CA is not solvent for the period before liberalization while the condition is satisfied for the sample including the post-liberalization period.

[Insert Table 1 here]

3. Theoretical Models

We first discuss the benchmark model developed in Ghosh (1995) and then the extended model developed in Bergin and Sheffrin (2000). The two models differ primarily in the assumptions they make about the nature of the utility function of the representative agent, the world rate of interest and in differentiating goods consumed by the economy into tradable and nontradable. In the benchmark model, the agents’ information set only include shocks to domestic macroeconomic variables while in the extended model information set of agents is extended to include external shocks via movement in the real interest rate and the real exchange rate.

3.1 Benchmark Model

Consider an economy is a small open economy that can lend and borrow at an exogenous world interest rate; its horizon infinite and is assumed to be populated by a single, infinitely-lived representative agent whose preferences are given by:

$$U_t = \sum_{t=0}^{\infty} \beta^t \mathrm{E}_t[u(C_t)] \qquad 0 < \beta < 1 \tag{1}$$

where β is the subjective discount factor, $u(.)$ the instantaneous utility function and C_t denotes the consumption of a single good. The utility is of the quadratic form:

$$U(C) = C - \frac{C_t}{2} \qquad C_t < 1$$

The dynamic budget constraint for the economy is given by:

$$CA_t = B_{t+1} - B_t = Y_t + rB_t - C_t - I_t - G_t$$

$$B_{t+1} = (1+r)B_t + Y_t - C_t - I_t - G_t \tag{2}$$

where *Y*, *C*, *I* and *G* denotes the GDP, private final consumption, total investment and government final consumption for the economy, respectively. The utility function in equation (1) can be maximized subject to the budget constraint given in equation (2). Imposing the transversality condition, the optimal level of consumption is derived as:

$$C_t^* = (r/\theta)\left[B_t + \frac{1}{(1+r)}E_t\left\{\sum_{t=0}^{\infty}(1+r)^{-i}(Y_{t+i} - I_{t+i} - G_{t+i}\right\}\right] \tag{3}$$

where $\theta = (\beta(1+r)r)/((\beta(1+r)^2 - 1))$ is the constant of proportionality and measures the consumption-tilting parameter. It reflects the tilting dynamics that may arise because of difference between the world interest rate and domestic rate of time preference (impatience in the economy). The equation (3) is the rational expectations consumption function of an open-economy.

If $\beta < 1/(1+r)$ then $\theta < 1$, implying that the world capital market gives the country a rate of return that failed to compensate for postponing consumption so that a country will *tilt* its consumption towards the present and run CA deficits. If $\theta > 1$, then consumption is tilted towards the future and a country run CA surpluses, and $\theta = 1$ implies the absence of any tilting component. Given (3), we can define the optimal consumption-smoothing CA as:

$$ca_t^* \equiv no_t - \theta c_t^* \tag{4}$$

where no_t and $c^*{}_t$ is the log of NO_t and C_t^*, respectively, and $NO_t = Y_t + rB_t - I_t - G_t$ is the net output. Substituting equation (3) into (4) gives:

$$ca_t^* = -E_t \sum_{t=0}^{\infty} (1+r)^{-i} \Delta no_{t+i} \quad (5)$$

Simplifying equation (5) gives the optimal CA equation:

$$ca_t^* - \sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^i E_t \Delta no_{t+i} \quad (6)$$

The above equation (6) is used for testing the hypothesis of the present value model of the CA where the optimal CA will be equal to minus the expected present discounted sum of future changes in net output.

First, we calculate the tilting component in the actual consumption series and then purge the consumption-tilting component to calculate the actual consumption smoothing CA series. We follow the techniques of Campbell and Shiller (1987) and Ghosh (1995) where the tilting component is obtained by regressing net output on consumption. Thus, the actual consumption smoothing component of the CA is as follows:

$$ca_t^{sm} = no_t - \theta c_t \quad (7)$$

where ca_t^{sm} is the actual consumption-smoothing component of the CA. The two variables, *no* and *c* are expected to be cointegrated, and a regression model based on equation (7) will provide a basis for testing the solvency condition. Next, we employ an unrestricted VAR in first differences of net output and actual consumption-smoothing CA. The VAR can be written as[5]:

$$\begin{bmatrix} \Delta no_t \\ ca_t^{sm} \end{bmatrix} = \begin{bmatrix} \psi_{11} & \psi_{12} \\ \psi_{21} & \psi_{22} \end{bmatrix} \begin{bmatrix} \Delta no_{t-1} \\ ca_{t-1}^{sm} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \quad (8)$$

[5] It is easy to generalize this expression for higher order VAR by writing a *p*-th order VAR in first order form.

Or, more compactly as:

$$X_t = \mathbf{\Psi} X_{t-1} + e_t \tag{9}$$

where $X_t \equiv \left[\Delta no_t \quad ca_t^{sm}\right]$ and ψ is the transition matrix of the VAR. From equation (9), the *k*-step ahead expectation is:

$$E(X_{t+k}) = \Psi^k X_t \tag{10}$$

so that $E_t \Delta NO_{t+k} = \left[1 \quad 0\right] \Psi^k X_t$

If we use the vector $\left[1 \quad 0\right]$ to pick off the forecast of *Δno* then the infinite sum in the present value model in equation (6) can be written as:

$$ca_t^* = -\sum_{k=1}^{\infty} \beta^k \left[1 \quad 0\right] \Psi^k X_t \tag{11}$$

or

$$ca_t^* = -\beta \left[1 \quad 0\right] \Psi (I - \beta \Psi)^{-1} X_t \tag{12}$$

where *I* is an 2×2 identity matrix (for details, see online supplementary material).

The variable ca_t^* is typically called the optimal CA and is an estimate of the CA that is consistent with both the VAR(1) model and the restrictions of the intertemporal model. Therefore, equation (6) is expressed in terms of the VAR in equation (8), which is specifically expressed as:

$$
\begin{aligned}
ca_t^* &= \begin{bmatrix}1 & 0\end{bmatrix}\left[\Psi * \frac{1}{1+r}\right]\left[I - \frac{\Psi}{(1+r)}\right]^{-1}\begin{bmatrix}\Delta no_t \\ ca_t^{sm}\end{bmatrix} \\
&= \begin{bmatrix}\Gamma_{\Delta no} & \Gamma_{ca^{sm}}\end{bmatrix}\begin{bmatrix}\Delta no_t \\ ca_t^{sm}\end{bmatrix}
\end{aligned} \tag{13}
$$

The three testable implications of our intertemporal model are as follows:

- The Granger-causality test,
- The orthogonality test, and
- The goodness-of-fit test.

The first test examines whether the CA Granger-causes subsequent changes in net output. The hypothesis implies that if the present value model is valid, then today's CA will reflect the agents' expectations about future changes in net output. This can be tested formally by running an unrestricted VAR in Δno_t and ca_t^{sm} or using the following model:

$$
\Delta no_t = c + \alpha_1 \Delta no_{t-1} + \alpha_2 ca_{t-1}^{sm} + u_t \tag{14}
$$

Accordingly, if today's CA Granger causes future changes in net output, then the sign of α_2 should be negative and statistically significant.

The test of orthogonality implies that the present value model is valid if and only if $E_{t-1}[ca_t^{sm} - \Delta no_t - (1+r)ca_{t-1}^{sm}] = 0$. Therefore, equality between the actual and the optimal consumption-smoothing CA implies that $R_t = ca_t^{sm} - \Delta no_t - (1+r)ca_{t-1}^{sm}$ should be uncorrelated with the lagged values of Δno_t and ca_t^{sm}. This restriction can be tested formally by constructing R_t and running the following regression:

$$R_t = c + \theta_1 ca_{t-1}^{sm} + \theta_2 \Delta no_{t-1} + e_t \tag{15}$$

and testing the null hypothesis, $H_0 : \theta_1 = \theta_2 = 0$. The non-rejection of the null hypothesis implies evidence in favour of the present value model.

The third test, goodness-of-fit test, implies that a movement in the actual consumption-smoothed CA should fully reflect a movement in the optimal consumption-smoothed CA. We use an array of informal and formal tests to accomplish this. The informal test includes a visual inspection of the actual and the optimal CA series, correlation coefficient and testing the equality of their variances. The formal test is the most stringent test of the model. It involves testing whether the vector *K* equals [0 1]. It is similar to testing whether the actual and the optimal CA paths are equal. This test is performed by using the delta method to calculate a *Wald* statistic for the null hypothesis that $K = [0 \quad 1]$ where:

$$W = (K - L).[J\ V\ J']^{-1}(K - L)'$$

W is the *Wald* statistic, $L = [0 \quad 1]$ is the hypothesized value, *J* is the Jacobian of *K*, i.e., $(\delta K / \delta A)$ and *V* is the variance-covariance matrix of the underlying parameters of the VAR. The *Wald* statistic has an asymptotic χ^2 distribution with two degrees of freedom (Bergin and Sheffrin, 2000).

3.2 Extended model – Accounting for External shocks

The intertemporal models are most appropriate for small open-economies where external shocks transmit to the economy through variations in the world real interest rate and the real exchange rate. Consequently, individuals may adjust their consumption and saving behaviour, and these changes may be reflected in country's CA as well (Bergin and Sheffrin, 2000; Nason and Rogers, 2006; Kim et al. 2006).

The extended model proposed by Bergin and Sheffrin (2000)[6] assumes a country produces both traded and nontraded goods, borrows and lends with the rest of the world at a time-varying real interest rate. Here, the time-varying real exchange rate is the relative price of nontraded goods in terms of traded goods. Thus, the possibility of intratemporal substitution between the traded and nontraded goods is also accounted for along with the usual intertemporal substitution between periods.

The representative agent maximizes the following discounted lifetime utility:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left(C_{Tt}, C_{Nt}\right) \tag{16}$$

s.t.

$$Y_t - \left(C_{Tt} + P_t C_{Nt}\right) - I_t - G_t - r_t B_{t-1} = B_t - B_{t-1} \tag{17}$$

where $U(C_{Tt}, C_{Nt}) = \dfrac{1}{1-\sigma}\left(C_{Tt}^{\alpha}, C_{Nt}^{1-\alpha}\right)^{1-\alpha}$; $\sigma > 0, \sigma \neq 1,\ 0 < \alpha < 1$

The consumption of the traded and nontraded good is denoted by C_{Tt} and C_{Nt}, respectively. P_t denotes the relative price of home nontraded goods in terms of traded goods and α is the share of traded goods in total consumption. The left-hand side of the budget constraint in equation (17) can be interpreted as the CA. Using the first-order conditions, the optimal consumption is derived as:

[6] For a detailed derivation of the model, see Bergin and Sheffrin (2000)

$$1 = E_t\left[\beta^{\gamma}(1+r_{t+1})^{\gamma}\left(\frac{C_t}{C_{t+1}}\right)\left(\frac{P_t}{P_{t+1}}\right)^{(\gamma-1)(1-\alpha)}\right] \tag{18}$$

where γ is the intertemporal elasticity of substitution. Assuming joint log-normality and constant variance and covariance, the log-linear version of the Euler equation implies:

$$E_t\Delta c_{t+1} = \gamma E_t r^*_{t+1} \tag{19}$$

where r^* is a consumption-based real interest rate defined by:

$$r^*_t = r_t + \left[\frac{1-\gamma}{\gamma}(1-\alpha)\right]\Delta p_t + \text{constant} \tag{20}$$

$\Delta p_t = \log P_t - \log P_{t-1}$ and the constant term in equation (20) drops out when the consumption-based interest rate is demeaned. This condition characterizes how the optimal consumption profile is affected by the variable world real interest rate, r, and the change in the relative price of nontraded goods, p. Taking expectations of the log-linear approximation of the intertemporal budget constraint and combining it with the Euler equation, we may write:

$$-E_t\sum_{i=1}^{\infty}\beta^i\left[\Delta no_{t+i} - \frac{\gamma}{\Omega}r^*_{t+i} - \left(1-\frac{1}{\Omega}\right)r_t\right] = no_t - \frac{c_t}{\Omega} + \left(1-\frac{1}{\Omega}\right)b_t \tag{21}$$

Bergin and Sheffrin (2000) choose the steady state in which net foreign assets are zero, implying that $\Omega = 1$ and thus the equation (21) may be written as:

$$CA^*_t = -E_t\sum_{i=1}^{\infty}\beta^i\left(\Delta no_{t+i} - \gamma r^*_{t+i}\right) \tag{22}$$

where,

$$CA^*_t \equiv no_t - c_t \tag{23}$$

As in the benchmark model, the restrictions in equation (22) can be tested by estimating an unrestricted VAR model that represents agents' forecasts. The restrictions on the CA in equation (22) can be expressed more specifically as:

$$\mathrm{hz}_t = -\sum_{i=1}^{\infty} \beta^i \left(\mathrm{g}_1 - \gamma\, \mathrm{g}_2\right) \mathrm{A}^i \mathrm{z}_t \tag{24}$$

where $\mathbf{g_1} = [1 \quad 0 \quad 0]$, $\mathbf{g_2} = [0 \quad 0 \quad 1]$ and $\mathbf{h} = [0 \quad 1 \quad 0]$. For a given $\mathbf{z_t}$, the right-hand side of Equation (24) may be expressed as:

$$\widehat{CA}_t^* = \mathbf{kz_t} \tag{25}$$

where,

$$\mathbf{k} = -(\mathbf{g_1} - \gamma\, \mathbf{g_2})\beta\mathbf{A}(\mathbf{I} - \beta\mathbf{A})^{-1} \tag{26}$$

Equation (25) gives a model prediction of the CA variable consistent with the VAR model as well as the restrictions of the theory. Also, it is important to note that $\mathbf{kz_t}$ is *not* a forecast of the CA in the usual sense, but rather it captures the restrictions imposed by the model. Similar to the benchmark model, the model restrictions can be tested formally by calculating a χ^2 statistic whether the calculated **k** vector is equal to the hypothesized vector $[0 \quad 1 \quad 0]$.

Bergin and Sheffrin (2000) also mention that the intertemporal elasticity of substitution should be chosen to minimize the variance. However, for sensitivity analysis, we test the model using different intertemporal elasticities of substitution. Further, we also check whether the intertemporal or the intratemporal factors improve the performance of the model or not. We accomplish this by excluding the real exchange rate from the consumption-based interest rate.

4. Data and Construction of variables

Our study uses quarterly data over the period 1996Q1 to 2014Q2[7]. The data on GNP (Y+rB), Investment (I), Consumption (C) and Government expenditure (G) is drawn from various publications of the RBI's *Handbook of Statistics on the Indian Economy*. All variables are seasonally adjusted and expressed in real terms, with the common base year shifted to 200405=100. The net output (NO) is constructed as subtracting I and G from GNP. Since the present value model is based on a representative agent, all series is converted to per-capita basis using annual population figures from Reserve Bank of India (RBI). These variables are expressed in logarithmic form for both the models[8].

To compute the consumption-based real interest rate (r^*) requires *ex-ante* world real interest rate and *ex-ante* expected change in the real exchange rate. To calculate *ex-ante* world real interest rate, we first calculate expected inflation using an ARMA (1,1) specification and then subtract expected inflation from the nominal interest rate. The nominal interest rate is proxied by the US 90 days T-bill rate, and inflation is calculated from the US consumer price index (CPI). The data on T-bill rate is drawn from Federal Reserve Bulletin while data on CPI is taken from IMF's *International Financial Statistics*. Similarly, to calculate the *ex-ante* expected change in the real exchange rate, we follow the methodology of Rogoff (1992) and Bergin and Sheffrin (2000). The *ex-ante* expected change in the real exchange rate is calculated by using an ARIMA

[7] We use quarterly data from 1996-2014 for two reasons. First, the empirical literature shows that the present value model when tested using annual data under-reject the restrictions of the model (Bergin and Sheffrin 2000). Second, our study period is more appropriate for analysis as India's capital account is considerably liberalized from the mid-1990s, and hence can be jointly tested for optimal capital flows.

8 Originally, variables are in real per-capita terms in the benchmark model however we use the log form in both the models for the purpose of consistency in the comparison. The results, however, do not differ even we do not use log form in the benchmark model.

(4,1,1) model, where the real exchange rate is proxied by the 36-currencies trade-weighted Real Effective Exchange Rate (REER), drawn from the RBI.

With regards to the other parameters such as γ (intertemporal elasticity), we resort to previous studies. For assigning a value to β (impatience), we take the sample mean value of the US real interest rate and hence define $\beta = 1/(1+\bar{r})$ as equal to 0.982, where $\bar{r}$ is the sample mean. For the intertemporal elasticity, γ, we followed Hall's (1988) recommendation that the intertemporal elasticity is unlikely to be greater than 0.1 in case of developing economies. This is based on the observation that consumption tends to respond very weakly to the real interest rate.

For calculating the share of tradables in consumption, α, we use a time-varying estimate instead of a point estimate used in the previous literature. We followed the method used by Gregorio et al. (1994) and utilized Input-Output Transaction Tables published by the *Ministry of Statistics and Program Implementation* of the Government of India. They classified a category of a good or service as tradable if its exports exceeded 10 percent of its total production. This method is more accurate as compared to other conventional approaches of treating some sectors such as manufacturing as tradable and services as nontradables. The detailed methodology on the calculation of share of traded and nontraded goods is given in online supplementary material.

Finally, the variables such as Δno, ca^* and r^* are demeaned as we are interested only in the dynamic implications of the intertemporal model.

5. Empirical Results and Discussion

5.1 Benchmark model

We first present the results of the benchmark model wherein the agents' information set only include shocks to domestic macroeconomic variables. As a preliminary step, we check for the unit root in c_t and no_t, and then calculate the consumption-tilting parameter from cointegration equation. Once we purge the tilting parameter, we arrive at the actual consumption-smoothing CA which is then compared formally and informally with the predicted optimal CA. The subsequent sub-sections discuss these results in detail.

5.1.1 Unit root tests and Cointegration tests

First, we test whether consumption (c_t) and net output (no_t) are integrated of order one, I(1), or not. We employ ADF and PP unit root tests to check the stationarity. Table 2 reports unit root tests results and confirms that both c_t and no_t are nonstationary at the level and stationary first difference, indicating I(1) process. Therefore, the results of the unit root tests are consistent with the present value models.

[Insert Table 2 here]

Next, we apply Johansen's (1988) and Johansen and Juselius (1990) cointegration technique to check for the long-run relationship between no_t and c_t. Table 3 reports the cointegration results. The panel (a) presents the trace and maximum eigenvalue test statistic while panel (b) presents the estimated consumption-tilting parameter, θ, of the cointegrating relationship.

[Insert Table 3 here]

The cointegration test results suggest the existence of one cointegrating relationship between no_t and c_t at the 1% significance level. The findings are in line with the present value model where no_t and c_t move in the same direction in the long-run which forms a necessary and sufficient condition for satisfying the intertemporal budget constraint of the economy. The estimated coefficient of θ is found to be 0.684 and highly statistically significant[9]. The estimated coefficient shows that India's consumption is tilted towards the present as $\theta < 1$ which is consistent with the CA deficits in India for most of the sample period.

The actual consumption-smoothing component of the CA (ca_t^{sm}) in equation (7) is estimated by subtracting the consumption-tilting parameter from the actual CA:

$$ca_t^{sm} = no_t - 0.684c_t$$

Since no_t and c_t are cointegrated, purging the tilting parameter leaves the actual consumption-smoothing component as a stationary process[10].

5.1.2 VAR and Granger-causality Test

After deriving ca_t^{sm}, we test whether the CA reflects the expectations of agents regarding future changes in the net output. According to the present value model, the CA should Granger-cause subsequent changes in the net output (see, equation (14)). Therefore, we estimated an unrestricted VAR in Δno_t and ca_t^{sm} given in equation (8). The results are summarized in Table 4. We select the lag length prior to estimating VAR. A one-lag VAR model is chosen based on the AIC and SIC criterion[11].

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[9] For robustness, we also use Dynamic OLS to estimate the parameter and the value is estimated at 0.6785 which is consistent with the Johannsen's cointegration estimate. We also tested if the parameter is statistically different from unity and found that the *Wald* test of coefficient restrictions is able to reject the null, $H_0 : \theta = 1$.

[10] In order to verify, we test the actual CA_t^{sm} series for unit root and find that the series is stationary at 1% level of significance.

[11] Diagnostic checking on the estimated VAR model suggests that the model is stable and is free from residual autocorrelation

The results in panel (b) of Table 4 indicate that ca_t^{sm} Granger-causes Δno_t at 1% significance levels. This finding supports the proposition that today's CA reflects agents' expectations about future movements in the net output.

[Insert Table 4 here]

5.1.3 Orthogonality Test

Next, we test whether $R_t = ca_t^{sm} - \Delta no_t - (1+r)ca_{t-1}^{sm}$ is uncorrelated with the lagged values of Δno_t and ca_t^{sm}. This is called the orthogonality test in equation (15). Although the Granger-causality test suggests that the CA is able to forecast changes in the net output, it is important to check if the dependent variable is uncorrelated with the lagged values of Δno_t and ca_t^{sm} (Table 5).

[Insert Table 5 here]

Panel (a) of Table 5 presents the regression results. The insignificance of the θ_1 and θ_2 implies that R_t is uncorrelated with lagged values of Δno_t and ca_t^{sm}. The panel (b) of Table 5 reports the orthogonality test results and shows that the combined coefficients of the lagged variables are jointly equal to zero. Therefore, the model passes the orthogonality condition.

5.1.4 Informal and formal test of the consumption-smoothing model

We have established through the Granger-causality test and orthogonality test that the present value model is valid. However, these tests do not provide any evidence of how well the model prediction fits the actual Indian CA data. Therefore, we conduct an array of informal and formal test to check if the actual CA series is equal to the optimal series.

The informal test includes goodness of fit, a test of equality of variances and correlation coefficient test. For this, we first need to calculate the optimal CA series by taking a linear combination of Δno_t and ca_t^{sm} (as in equation 13) where the estimated weights on Δno_t and ca_t^{sm} are nonlinear functions of the VAR(1) coefficients. The calculated point estimates of the weights $\Gamma_{\Delta NO}$ and $\Gamma_{CA^{sm}}$ are -0.063 and 1.284, respectively.

[Insert Figure 1 here]

Figure 1 shows the path of the actual and optimal consumption-smoothed CA over the sample period. It can be observed from the visual inspection that the optimal CA path track the major turning points for most of the period, including the East Asian crisis of 1997 and the recent Global Financial crisis of 2008.

Table 6 (a) present the formal tests results. The validity of present value model is examined by testing if the actual value of the *k* vector is statistically equal to the hypothesized value of the *k* vector, i.e. [0 1]. The statistical test can be conducted through delta method where we calculate a *Wald* statistic that follows an asymptotic χ^2 distribution. The calculated value for *Wald* statistic is found to be 1.516, which is well below the 5% critical value of 7.38. Thus, the null hypothesis that the actual vector *k* is equal to [0 1] cannot be rejected, and this implies that the optimal consumption-smoothing CA is equal to actual consumption-smoothing CA and hence the present value model is valid.

Similarly, the correlation coefficient between the actual and the optimal consumption-smoothed CA is found to be 0.993 (Table 6, part b). However, it is interesting to note that the variance of the optimal CA is higher (1.582) than that of the actual CA, and is statistically different from unity. This implies that actual consumption-smoothing is less than optimal and scope for further borrowing to reach an optimal level.

[Insert Table 6 here]

The main findings summarized as follows:

1. The present value model is valid, and the CA balance is solvent.
2. When agents consider only the domestic shocks in their information set, their borrowing is less than optimal.
3. Statistical inequality of variance ratio implies that more capital can be absorbed by agents to further smoothen their consumption to an optimal level.

5.2 Extended model (Accounting for External Shocks)

As seen in the previous section, the agents do not smooth their consumption to an optimal level in the presence of domestic shocks. In this subsection, we examine whether the external shocks help to smooth consumption to a desired optimal level or not. The agents' information set is extended to include the external factors such as real interest rate and real exchange rate. To address this issue, we undertake the following steps. First, we test for unit roots in Δno_t, ca_t^* and r_t^*[12]. Second, we compare actual and optimal CA through various informal and formal tests. Third, we test for sensitivity by allowing for an alternate value of intertemporal elasticity, γ, and checking if the intertemporal or intratemporal factors improve the performance of the model.

5.2.1 Unit root tests and VAR analysis

[12] The extended model does not allow for purging of consumption-tilting parameter and uses actual CA to be compared with the predicted optimal CA.

Table 7 reports the results from ADF and PP tests, and it shows that all the three variables, viz., Δno_t, ca_t^* and r_t^*, are stationary at levels. Then we estimated an unrestricted VAR and obtained the weights of the underlying parameters. We then construct an optimal CA series as given in equation (25) using these weights (Figure 2).

[Insert Table 7 here]

Then, we conducted various informal and formal tests to check the sensitivity of our results. We construct the optimal CA series as a linear combination of the weights calculated by using the underlying parameters of the unrestricted VAR in Δno_t, ca_t^* and r_t^*. We then constructed an optimal CA series as given in equation (25) using these weights (Figure 2).

5.2.2 Informal and formal test of the extended model. The visual inspection of Figure 2 itself reveals that the extended model performs better than the traditional benchmark model; implying that the predicted optimal CA series is able to track the actual CA path more accurately.

[Insert Figure 2 here]

The results from delta method (Table 8, column 3) also indicate that the respective weights on Δno_t, ca_t^* and r_t^* have now moved more closely to the actual hypothesized value of [0 1 0]. The χ^2 value is substantially low (0.254) as compared to the benchmark model (1.582). The lower value of χ^2 and its statistical insignificance indicates that the optimal and actual consumption-smoothing CA series are equal and the present value model is valid. Similarly, the higher correlation coefficient, i.e., 0.998 (part b, table 8) also shows better co-movements of the actual and the optimal consumption-smoothing CA in the case of extended model. It is interesting to observe that the variance ratio is 1.097, which is much lower than that of benchmark model (1.582) and statistically insignificant as well. This implies that the variance of both actual and the optimal consumption are the same. This is the clear indication that the under-borrowing reported in the benchmark model is substantially eliminated in the extended model.

[Insert Table 8 here]

5.3.3 Sensitivity analysis

We perform a sensitivity analysis by testing two alternative cases. In Case 1, we change the value of intertemporal elasticity (γ) from 0.1 to 0.01 to verify if the intertemporal substitution in consumption improves the model fit or not. In Case 2, we exclude the real exchange rate in the model and keep only the world real interest rate to check whether the intertemporal or intratemporal effect improves the performance of the model. The results reported in Table 8 (column 4) shows that reducing the value of γ (case 1) improves the performance of the model as *Wald* statistic declined from 0.254 to 0.234. Interestingly, in Case 2, the result reveals that *Wald* statistic declined, i.e., to 0.019, this implies the presence of intertemporal effect improves the fit of the model substantially. This dominance of intertemporal over intratemporal effect suggests that the world real interest plays a major role in the intertemporal substitution of goods between time periods. Finally, Table 9 also shows that extended model performs better than benchmark model in terms of the deviation of actual CA from optimal CA and further confirms the dominance of intertemporal effects over intratemporal effects.

[Insert Table 9 here]

In other words, our findings suggest that when agents consider the external variables in their information set, then they can reach to an optimal point of borrowing, which makes an interesting case for further liberalization of capital flows.

The main findings summarized as follows:

1. When agents consider the external shocks in their information set, their borrowing becomes optimal.
2. The extended model performs better than the traditional benchmark model.
3. The dominance of intertemporal effect over intratemporal effect improves the fit of the model.
4. The world real interest plays a major role in the intertemporal substitution of goods between time periods.

6. Conclusion and further discussion

After the recent global financial crisis, the issues related to financing the CA deficit has been widely debated among policymakers. Financing these deficits through capital flows, especially when the latter is volatile, may cause the country to face difficulty in managing its CA balance and may lead to the issue of insolvency. In this paper, we examined the solvency of India's CA in the post-liberalization period using quarterly data from 1996 to 2014. Resorting to intertemporal approach to the CA, the study estimated two models, first, a benchmark model that accounts the domestic shocks alone in the agents' information set and second, an extended model that incorporates the information set of external shocks as well. Our overall empirical findings reveal that India's CA is solvent and the CA is acting as a buffer for the consumers in the face of any random domestic or external shocks. Our findings are also consistent with the economic intuition behind the present value models of the CA, which states that consumption decreases when there is an expectation about a future decline in net output, and vice-versa, and the CA here is the resulting balance.

Interestingly, our extended model performs well and tracks the actual CA, as compared to the benchmark model. Empirical findings show that the agents under-borrow for their consumption in the presence of domestic shocks, and while optimally borrows to further smoothen their consumption in the presence of external shocks. Our empirical findings entail relevant policy implications since India's capital account is not fully liberalized.

Our empirical findings suggest that India has potential to accommodate more CA deficit by allowing for more borrowing to further smoothen its consumption. Thus, the policies aimed at further opening up of the capital account will allow agents to draw information from external sector to form their consumption decisions. It would help to attain an optimal level of borrowing, without worrying about risks associated with insolvency[13]. Therefore, policies focused on further liberalization and mobility of capital flows, although pragmatic, will allow larger CA deficits to achieve higher economic growth. Further, the dominance of intertemporal effects implies that interest rate can serve as a correcting mechanism to keep the CA solvent since the interest rate differential drives the capital flows required for the financing of the deficit.

Our study opens up the scope for further research, especially in the context of EMEs that have not fully liberalized their capital account. From the theoretical perspective, the inclusion of risk premium along with interest rate differential could be a reasonable extension of the model. While the models worked well in the Indian case, it could be seen in the literature that, for some EMEs, the extended model is violated. Hence, incorporating risk-premium would determine the actual movement of capital across countries, especially in economies where the financial structure and institutions are under-developed.

[13] There is another strand of literature that deals with type of capital flows that are more stable and expansionary in nature.

References

Adedeji O., 2001. "Consumption-Based Interest Rate and the Present-Value Model of the Current Account-Evidence from Nigeria." IMF Working Papers. 2001/93. 1-29. http://dx.doi.org/10.5089/9781451851656.001

Adedeji, O.S., and J. Handa. 2008. "The size and sustainability of the Nigerian current account deficits." *The Journal of Developing Areas* 41(2): 1-25. https://doi.org/10.1353/jda.2008.0000

Ahearne, A., 2007. "Global Imbalances: The Risks for the World Economy." *Field Day Review* 3: 108-123. http://www.jstor.org/stable/30078844

Bergin, P.R., and S.M. Sheffrin. 2000. "Interest rates, exchange rates and present value models of the current account." *The Economic Journal* 110(463): 535-558. DOI:10.1111/1468 0297.00536

Blanchard, O., and G.M. Milesi-Ferretti. 2009. Global imbalances: in midstream. IMF Staff Position Note SPN/09/29. http://dx.doi.org/10.5089/9781462333387.004

Blanchard, O., and G.M. Milesi-Ferretti. 2012. "(Why) should current account balances be reduced?" *IMF Economic Review* 60(1): 139-150. DOI:10.1057/imfer.2012.2

Blanchard, O., J. D. Ostry, A. R. Ghosh, and M. Chamon. 2016. "Capital Flows: Expansionary or Contractionary?" *American Economic Review* 106(5): 565-69. DOI: 10.1257/aer.p20161012

Caballero, R. J., E. Farhi, and P. Gourinchas. 2015. "Global Imbalances and Currency Wars at the ZLB." NBER Working Papers 21670.

Callen, T., and P. Cashin. 1999. "Assessing External Sustainability in India." IMF Working Paper, WP/99/181, December.

Calvo, G.A. 1998. “Capital flows and capital-market crises: the simple economics of sudden stops.” *Journal of Applied Economics* 1(1): 35-54. Retrieved from https://www.ucema.edu.ar/publicaciones/download/volume1/calvo.pdf

Cashin, P. and C. McDermott. 1998. “Are Australia's current account deficits excessive?” *Economic Record* 74(227): 346-361. DOI:10.1111/j.1475-4932.1998.tb01930.x

Cashin, P., and C.J. McDermott. 2002. “Intertemporal consumption smoothing and capital mobility: evidence from Australia.” *Australian Economic Papers* 41(1): 82-98. DOI:10.1111/1467-8454.00151

Campa, J.M. and A. Gavilan. 2011. “Current accounts in the euro area: An intertemporal approach.” *Journal of International Money and Finance* 30(1): 205-228. https://doi.org/10.1016/j.jimonfin.2010.08.003

Campbell, J. Y. 1987. “Does saving anticipate declining labor income? An alternative test of the Permanent Income Hypothesis.” *Econometrica* 55(6): 1249-1273. DOI:10.2307/1913556

Campbell, J. Y., and R. J. Shiller. 1987. “Cointegration and tests of present value models.” *Journal of Political Economy* 95(5): 1062-1088. DOI:10.1086/261502

Catão, L.A., and G.M. Milesi-Ferretti. 2014. “External liabilities and crises.” *Journal of International Economics* 94(1): 18-32. DOI:10.1016/j.jinteco.2014.05.003

Ca’Zorzi, M., A. Chudik, and A. Dieppe. 2012. “Thousands of models, one story: Current account imbalances in the global economy.” *Journal of International Money and Finance* 31(6): 1319-1338. https://doi.org/10.1016/j.jimonfin.2012.02.003

Darku, A. B. 2010. “Consumption Smoothing, Capital Controls, and the Current Account: Evidence from Ghana.” *Applied Economics* 78(7): 1466-83. http://dx.doi.org/10.1080/00036840801964542

Deaton, A. 1989. "Saving in developing countries: Theory and review." *The World Bank Economic Review* 3(suppl_1): 61-96. https://doi.org/10.1093/wber/3.suppl_1.61

Gregorio, J., A. Giovannini, and T.H. Krueger. 1994. "The behavior of nontradable-goods prices in Europe: Evidence and interpretation." *Review of International Economics* 2(3): 284-305. DOI: 10.1111/j.1467-9396.1994.tb00045.x

Friedman, M. A. 1957. *A Theory of the Consumption Function*. Princeton University Press.

Garg, B. and K.P. Prabheesh. 2015. "Causal relationships between the capital account and the current account: an empirical investigation from India." Applied Economics Letters 22(6): 446-450. http://dx.doi.org/10.1080/13504851.2014.948669

Garg, B. and K.P. Prabheesh. 2017. "Drivers of India's current account deficits, with implications for ameliorating them." *Journal of Asian Economics* 51: 23-32. https://doi.org/10.1016/j.asieco.2017.06.002

Ghosh, A.R. 1995. "International capital mobility amongst the major industrialized countries: too little or too much?" *The Economic Journal* 105(428): 107-128. DOI:10.2307/2235322

Ghosh, A.R. and J.D. Ostry. 1995. "The current account in developing countries: A perspective from the consumption-smoothing approach." *The World Bank Economic Review* 9(2): 305-333. https://doi.org/10.1093/wber/9.2.305

Ghosh, A. R., J. D. Ostry, and M.S. Qureshi. 2016. "When do capital inflow surges end in tears?" *The American Economic Review* 106(5): 581–585. http://dx.doi.org/10.1257/aer.p20161015

Goh, S.K. 2007. "Intertemporal consumption smoothing and capital mobility: evidence from Malaysia." *Journal of Business and Public Affairs* 1(1): 21-36. http://www.scientificjournals.org/journals2007/articles/1076.pdf

Goyal, A. 2015. External shocks. Chapter 3. in Mahendra Dev S (edition) India development report 2015, IGIDR and Oxford University Press, New Delhi, 36–51.

Grimard, F. 1997. “Household consumption smoothing through ethnic ties: evidence from Cote d'Ivoire.” Journal of Development Economics 53(2): 391-422. https://doi.org/10.1016/S0304-3878(97)00016-3

Hall, R.E. 1978. “Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence.” Journal of Political Economy 86(6): 971-87. DOI:10.2307/1840393

Hall, R.E. 1988. “Intertemporal substitution in consumption.” Journal of political economy 96(2): 339-357. DOI:10.1086/261539

Ismail, H.B., and A.Z. Baharumshah. 2008. ‘Malaysia’s current account deficits: an intertemporal optimization perspective.” Empirical Economics 35(3): 569-590. DOI:10.1007/s00181-007-01795

Ismail, H., A.Z. Baharumshah, and R. MacDonald. 2013. “Intertemporal approach to the current account.” Jurnal Pengurusan 37:3-13. http://ejournals.ukm.my/pengurusan/article/view/3622/2108

Johansen, S. 1988. “Statistical analysis of cointegration vectors.” Journal of economic dynamics and control 12(2-3): 231-254. https://doi.org/10.1016/0165-1889(88)90041-3

Johansen, S., and K. Juselius. 1990. “Maximum likelihood estimation and inference on cointegration—with applications to the demand for money.” Oxford Bulletin of Economics and Statistics 52(2): 169-210. DOI:10.1111/j.1468-0084.1990.mp52002003.x

Kano, T. 2008. “A structural VAR approach to the intertemporal model of the current account.” Journal of International Money and Finance 27(5): 757-779. http://doi.org/10.1016/j.jimonfin.2008.04.003

Khundrakpam, J.K., and R. Ranjan. 2009. “Consumption Smoothing and Current Account Balance in India: Further Evidence.” Indian Economic Review 44(2): 185-201. http://www.jstor.org/stable/29793940

Kim, K., V.B. Hall, and R.A. Buckle. 2006. “Consumption-smoothing in a small, cyclically volatile open economy: Evidence from New Zealand.” Journal of International Money and Finance 25(8): 1277-1295. http://doi.org/10.1016/j.jimonfin.2006.09.002

Landeau, S. A. S. 2002. “The intertemporal approach to the current account: Evidence for Chile.” Revista de Análisis Económico 17(2): 95-122. http://www.rae-ear.org/index.php/rae/article/view/20

Makrydakis, S. 1999. “Consumption-smoothing and the excessiveness of Greece's current account deficits.” Empirical Economics 24(2): 183-209. DOI:10.1007/s001810050051

Milbourne, R., and G. Otto. 1992. “Consumption smoothing and the current account.” Australian Economic Papers 31(59): 369-384. DOI:10.1111/j.1467-8454.1992.tb00716.x

Moccero, D.N. 2008. “The intertemporal approach to the current account: Evidence for Argentina.” Journal of Applied Economics 11(2): 327-353 http://www4.cema.edu.ar/pjae/m/171moccero200811

Mukhtar, T., and A.H. Khan. 2011. “The current account dynamics in Pakistan: an intertemporal optimization perspective.” The Pakistan Development Review 50(4): 401-420. http://www.jstor.org/stable/23617707

Nason, J.M., and J.H. Rogers. 2006. “The present-value model of the current account has been rejected: Round up the usual suspects.” Journal of International Economics 68(1): 159-187. http://doi.org/10.1016/j.jinteco.2005.01.004

Obstfeld, M., and K. Rogoff. 1995. “The intertemporal approach to the current account.” In Handbook of International Economics, Grossman, G.H., Rogoff, K. (Eds.), Vol. 3. Elsevier, North-Holland, Amsterdam, 1731–1799.

Obstfeld, M., and K. Rogoff. 2009. “Global Imbalances and the Financial Crisis: Products of Common Causes.” CEPR Discussion Papers No. 7606.

Obstfeld, M., and A.M. Taylor. 2017. “International Monetary Relations: Taking Finance Seriously.” Journal of Economic Perspectives 31(3): 3-28. https://doi.org/10.1257/jep.31.3.3

Ostry, J. 1997. "Current Account Imbalances in ASEAN Countries: Are They a Problem?" IMF Working Paper: WP/97/51.

Ostry, J.D., A.R. Ghosh, K. Habermeier, M. Chamon, M.S. Qureshi, and D.B.S. Reinhardt. 2010. “Capital inflows: the role of controls.” IMF Staff Position Note SPN/10/04.

Ostry, J.D., A.R. Ghosh, K. Habermeier, M. Chamon, M.S. Qureshi, and A. Kokenyne. 2011. “Managing Capital Inflows: What Tools to Use?” IMF Staff Discussion Note 11/06.

Otto, G. 1992. “Testing a present-value model of the current account: evidence from US and Canadian time series.” Journal of International Money and Finance 11(5): 414–430. https://doi.org/10.1016/0261-5606(92)90009-M

Otto, G. 2003. “Can an intertemporal model explain Australia's current account deficit?” Australian Economic Review 36(3): 350-359. DOI:10.1111/1467-8462.00294

Rangarajan, C., and P. Mishra. 2013. “India’s external sector: Do we need to worry?” Economic & Political Weekly 48 (7): 52–59.

Rogoff, K. 1992. “Traded goods consumption smoothing and the random walk behavior of the real exchange rate.” NBER Working Paper. 1992/4119. DOI:10.3386/w4119

Sachs, J. D. 1981. “The current account and macroeconomic adjustment in the 1970s.” Brookings Papers on Economic Activity 1: 201–268.

Sachs, J. 1982. “The current account in the macroeconomic adjustment process.” The Scandinavian Journal of Economics 84(2): 147–159. DOI:10.2307/3439631

Sen Gupta, A., and R. Sengupta. 2016. “Capital account management in India.” Economic & Political Weekly 51(12): 103-111.

Sheffrin, S. M., and W. T. Woo. 1990. “Present value tests of an intertemporal model of the current account.” Journal of International Economics 29(3): 237-253. https://doi.org/10.1016/0022-1996(90)90032-H

Taylor, A.M. 2012. “External imbalances and financial crises.” NBER Working Paper No. 18606. 2 DOI:10.3386/w18606

Table 1. Review of Empirical Literature

Studies	Countries and Sample Covered	Model	Solvency
Ghosh (1995)	**Canada, Japan, the UK, the US, 1960-1988 Germany, 1962-88 (Quarterly)**	**Benchmark**	**the US**
Ghosh and Ostry (1995)	45 developing countries, 1948-91 Different samples for different countries	Benchmark	29 countries
Cashin and McDermott (1998)	Australia, 1954-94	Benchmark	Hold
Makrydakis (1999)	Greece, 1950-95	Benchmark	Violated
Callen and Cashin (1999)	India, 1953-1999	Benchmark	Violated till 1991
Bergin and Sheffrin (2000)	**Canada, the UK, 1960Q1-1996Q2, Australia, 1961Q2-1996Q2**	**Extended**	**Canada, Australia**
Adedeji (2001)	Nigeria, 1960-97	Both	Holds only for extended model
Cashin and McDermott (2002)	Australia, 1984Q1-1999Q1	Benchmark	Hold
Landeau (2002)	Chile, 1960Q1-1999Q4	Both	Holds only for extended model
Otto (2003)	Australia, 1960-2000	Benchmark	Hold
Kim et al. (2006)	New Zealand, 1982Q2-1999Q3	Both	Hold
Nason and Rogers (2006)	Canada, 1961Q1-1998Q1	Benchmark	Violated
Goh (2007)	Malaysia, 1960-2000	Benchmark	Violated
Adedeji and Handa (2008)	Nigeria, 1960-2003	Benchmark	Hold
Moccero (2008)	Argentina, 1885-2002	Extended	Violated
Ismail and Baharumshah (2008)	Malaysia, 1960-2004	Both	Hold
Khundrakpam and Ranjan (2009)	India, 1951-2008	Benchmark	Hold
Darku (2010)	Ghana, 1960-2002	Extended	Hold
Mukhtar and Khan (2011)	Pakistan, 1960-2009	Both	Holds only for extended model
Campa and Gavilan (2011)	Ten Euro Area Countries, 1977-2005 (Different Samples; Quarterly)	Extended	Valid for six countries out of ten
Ismail et al. (2013)	Indonesia, Malaysia, 1960-2004	Benchmark	Holds only for Malaysia

Note: Studies highlighted in bold, i.e., Ghosh (1995) and Bergin and Sheffrin (2000) represents benchmark model and extended model, respectively.

Table 2. Test for unit root for the benchmark model

Variable	**Test**	
	Level	**First Difference**
Augmented Dickey-Fuller		
c	-0.623	-7.703*
no	-1.023	-11.056*
Phillips-Perron		
C	-0.758	-7.730*
no	-1.250	-11.045*

Notes: This table reports ADF and PP unit root test results. We do not include a constant in the regressions since both the series have been demeaned. * represents significance at 1% level.

Table 3. Test for cointegration of *no* and *c*.

(a) Johansen Cointegration test

Hypothesis no of CE(s)	Eigenvalue	Test statistic	5% critical value	Prob.
		Trace		
None*	0.237	20.208	15.494	0.009
At most 1	0.009	0.698	3.841	0.403
		Max-Eigen		
None*	0.237	19.509	14.264	0.006
At most 1	0.009	0.698	3.841	0.403

(b) Cointegration regression of *no* on *c*

Coefficient	Estimated Value	Standard error
θ	-0.684	0.035

Notes: This table reports two sets of results organized into Panels a and b. In panel a, we test for a cointegrating relationship between *no* and *c* using Johansen's cointegration test. In panel b, we measure the value of θ, the consumption-tilting component, which is then removed from the actual CA to get the actual consumption-smoothing CA component. * represents significance at 1% level. The probability values are the MacKinnon-Haug-Michelis *p*-values.

Table 4. Unrestricted VAR model and Granger-causality test

(a) Unrestricted VAR model of Δno_t and ca_t^{sm}

Variable	Δno_t	ca_t^{sm}
Δno_t	-0.091	-0.124
	(0.114)	(0.075)
ca_t^{sm}	-0.683	0.452
	(0.167)	(0.110)

(b) Granger-causality test

Null Hypothesis	*F*-statistic	Prob.

ca_t^{sm} does not cause Δno_t	16.476	0.000
Δno_t does not cause ca_t^{sm}	2.674	0.106

Notes: This table reports two sets of results organized into Panels a and b. In panel a, the VAR analysis is performed. The standard errors are in parenthesis. In panel b, Granger-causality test, the first testable implication of the benchmark model, is conducted to check if the CA Granger causes subsequent changes in the net output.

Table 5. Orthogonality test

(a) The estimation of $R_t = c + \theta_1 ca_{t-1}^{sm} + \theta_2 \Delta no_{t-1} + e_t$

Coefficient	Estimated Value	Standard Error	t-statistic	Prob.
c	-0.001	0.003	-0.319	0.750
θ_1	0.117	0.094	1.253	0.214
θ_2	-0.035	0.064	-0.543	0.588

(b) Orthogonality Test

	Test statistic	Value	*df*	Prob.
$H_0 = \theta_1 = \theta_2 = 0$	*F* statistic	0.785	(2, 69)	0.460
	χ^2 statistic	1.570	2	0.455

Notes: This table reports orthogonality test results, the second testable implication of the benchmark model, organized into Panels a and b. In panel a, we test if R_t is uncorrelated with the lagged values of Δno_t and. ca_t^{sm} . In panel b, we test the null hypothesis if θ_1 and θ_2 are jointly equal to zero.

Table 6. Tests for the benchmark consumption-smoothing model

(a) Informal Test of the model

Variance Ratios and Correlations	
$\mathrm{Var}(ca^*)/\mathrm{Var}(ca^{sm})$	1.582
	(0.053)
$Corr(ca^*, ca^{sm})$	0.993

(b) Formal test of the model

Wald tests	*k*-vector	Hypothesized k-vector
$\Phi_{\Delta no}$	-0.063	0
Φ_{ca^*}	1.284	1
Wald, χ^2 statistic	1.516	
	(0.468)	

Notes: This table reports two sets of results organized into Panels a and b. In panel a, informal test results of the benchmark model are reported. The correlation coefficient is Spearman's rank correlation coefficient. Probability values are in parenthesis. The probability values are associated with the *F*-test for a test for equality of variances. In panel b, formal test results of the benchmark model are reported. *Wald* statistic follows a χ^2 distribution and it tells us whether the tests of the restriction implied by the model are satisfied or not.

Table 7. Unit root test results for the extended model

Variable	Test: Level	First Difference
Augmented Dickey-Fuller		
Δno	-11.137*	-11.498*
*ca**	-1.970**	-8.484*
*r**	-7.478*	-7.603*
Phillips-Perron		
Δno	-11.125*	-40.197*
*ca**	-2.424**	-14.437*
*r**	-7.466*	-49.668*

Notes: This table reports ADF and PP unit root test results. We do not include a constant or a time trend in the regressions since all the three series have been demeaned. * and ** represent significance at 1% and 5% level, respectively.

Table 8. Results of the extended model and sensitivity analysis

(a) Informal Tests of the model

Variance Ratios and Correlations	Extended Model	Sensitivity analysis	
		Case 1	Case 2
	$\gamma = 0.1$	$\gamma = 0.01$	just interest rate
$\mathrm{Var}(ca^*)/\mathrm{Var}(ca^{sm})$	1.097	1.154	1.010
	(0.694)	(0.544)	(0.965)
$Corr(ca^*, ca^{sm})$	0.998	0.998	0.998

(b) Formal Test of the model

Cases	Hypothesis k-vector	Extended Model	Sensitivity analysis	
			Case 1	Case 2
		$\gamma = 0.1$	$\gamma = 0.01$	just interest rate
$\Phi_{\Delta no}$	0	-0.004	0.022	-0.004
Φ_{ca^*}	1	1.054	0.930	1.045
Φ_{r^*}	0	-0.032	-0.002	-0.241
Wald, χ^2 statistic		0.254	0.234	0.019
		(0.968)	(0.974)	(0.993)

Notes: *Notes*: This table reports two sets of results organized into Panels a and b. Further, the results from sensitivity analysis are reported in column 3 and 4. Case 1 (column 3) uses a smaller value of intertemporal elasticity, γ, and case 2 (column 4) tests whether intertemporal or intratemporal effects are dominant. In panel a, informal test results of the extended model are reported. The correlation coefficient is Spearman's rank correlation coefficient. Probability values are in parenthesis. The probability values are associated with the *F*-test for a test for equality of variances. In panel b, formal test results of the extended model are reported. *Wald* statistic follows a χ^2 distribution and it tells us whether the tests of the restriction implied by the model are satisfied or not.

Table 9. Measures of fit for the benchmark and the extended model

	Benchmark Model	Extended Model	Sensitivity analysis	
			$\gamma = 0.01$	just interest rate
Fit of the model[a]	0.007	0.001	0.002	0.001

[a] Fit is measures as the sum of squares of the difference between the actual and the optimal CA series.

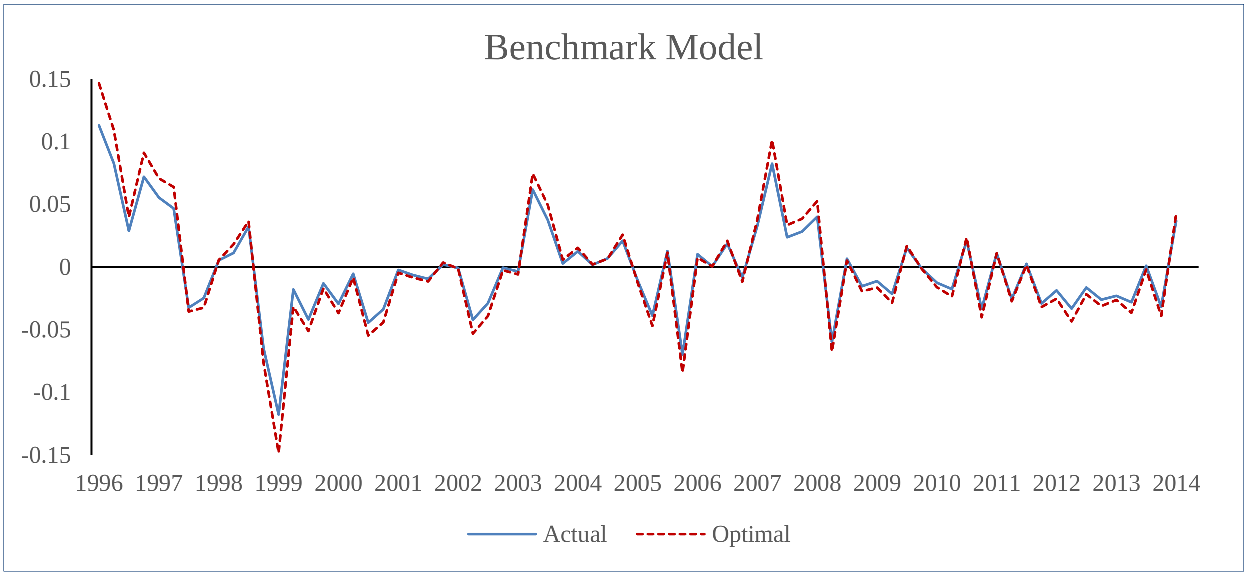

Figure 1: The actual and optimal consumption-smoothing CA

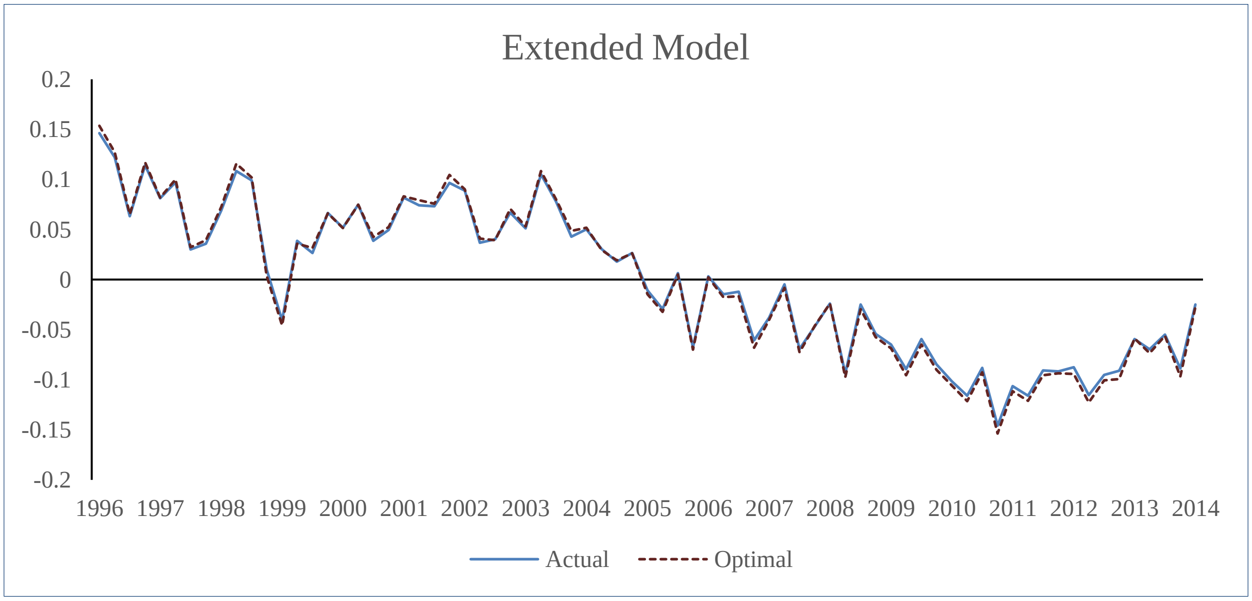

Figure 2: The actual and optimal CA (extended model)