Terms of Trade and Present Value Tests of Intertemporal Current Account Models: Evidence from the United Kingdom and Canada

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Abstract

This paper extends the present value current account model of Bergin and Sheffrin (2000) to an economy consisting of three goods: nontradables, exportables, and importables. In this framework, the terms of trade are introduced as a new variable that can help explain the dynamics of a small open economy's current account. To see if the addition of the terms of trade improves the fit of the present value current account model over previous studies, quarterly data from the United Kingdom and Canada are subject to present value tests. The paper finds that the three-good model performs decisively better than the simpler one-good and two-good models for both countries.

1. Introduction

The prevailing framework used today to address theoretical issues related to current account dynamics is the intertemporal approach. This approach focuses on the consumption-smoothing behavior of a representative household in a world of perfect capital mobility. While the theoretical literature has made significant progress in developing richer and more realistic models[1], empirical work on intertemporal current account models has not kept pace with these innovations.

The most commonly used methodology to test intertemporal models of the current account is the present value approach. In the context of a simple one-good intertemporal model, the current account can be expressed as the present value of expected changes in a country's net output.[2] The difficulty in estimating such an expression is how one proxies for private agent's expectations of future values of net output. The insight of the present value approach is that the current account itself should reflect all information about the future course of net output and thus, the current account should be included in the conditioning information set.[3] A vector autogression (VAR) including net output and the current account can then be estimated to compute a forecast of this present value. If the intertemporal current account model is true, this VAR forecast should be equal to the actual path of the current account. This implication of the model can be evaluated formally by way of a Wald test and informally by visually comparing the actual and VAR forecasted path of the current account.

Many studies including Sheffrin and Woo (1990), Otto (1992), Ghosh (1995), and Agenor et al. (1999) have tested the one-good intertemporal model using the present value approach. In general, the results from these studies indicate that the single-good model does a rather poor job in capturing short-term fluctuations in external balances. For most developed countries, the formal statistical test rejects the present value model. On the other hand, the informal or graphical evidence is usually not as bleak. The forecasted current account for some countries actually parallels the data fairly well except for the fact that the actual current account is often much more volatile. As discussed in Nason and Rogers (2001), there are many features of the

[1] For a good survey of this literature see Obstfeld and Rogoff (1995).
[2] Net output is defined as output less investment less government expenditures.
[3] The present value approach was originally developed by Campbell (1987) and Campbell and Shiller (1987) to test consumption and asset pricing theory.

basic intertemporal model that can potentially explain its poor empirical performance. Thus, many in the literature have noted the need to develop and test more complex present value current account models.

Recently, Bergin and Sheffrin (2000) took a step in this direction by developing a two-good intertemporal current account model that can be tested using the present value approach.[4] They argue that small open economies are likely to be affected by shocks originating in the rest of the world primarily through the altering of international relative prices, which are absent in the one-good framework. The intertemporal approach illustrates that changes in these relative prices can affect the time profile of saving and hence the current account. In their framework comprising of tradables and nontradables, Bergin and Sheffrin show that current account imbalances are not only determined by innovations to net output, but also by innovations to the world interest rate and the real exchange rate. They test the implications of their two-good model using quarterly data from three countries that have proved very problematic in past studies: Australia, Canada, and the United Kingdom. In general, Bergin and Sheffrin find that the inclusion of time-varying interest rates and real exchange rates improves the intertemporal model's ability to explain movements in the current account compared to the one-good model. The statistical test fails to reject the model for Australia and Canada, but the model is still rejected for the United Kingdom. Bergin and Sheffrin also conclude that intratemporal effects arising from the presence of variable real exchange rates appears to be responsible for most of the model's improved fit.

What is missing from the Bergin and Sheffrin analysis, however, is another key international relative price, the terms of trade. The terms of trade are also believed to be a major transmission mechanism of shocks that originate in the rest of the world. Moreover, the intertemporal approach also indicates that changes in the terms of trade can impact the current account through its effect on the time profile of saving. The main question posed in this paper is whether the addition of the terms of trade in the Bergin-Sheffrin framework will improve the intertemporal approach's ability to explain movements in the current account beyond that already demonstrated by Bergin and Sheffrin. To examine this question, the model of Bergin and Sheffrin (2000) is extended to a three-good framework. In this framework, current account balances are determined by innovations to net output, the world interest rate, the real exchange, and the terms

[4] For other interesting extensions of the present value current account model see Ghosh and Ostroy (1997) who incorporate precautionary saving and Gruber (2001) who incorporates habit persistence.

of trade. The model developed below is subject to present value tests using quarterly data from the United Kingdom and Canada.

Unfortunately, theory does not provide a clear *a priori* reason as to whether the answer to the above question should be positive or negative. This is true because there are different channels through which terms of trade shocks impact a country's external balance. In a three-good intertemporal current account model (Greenwood, 1984; Ostry, 1988; Gavin, 1990), the response of the current account to terms of trade shocks is due to three channels. First, there is a direct channel due to intertemporal substitution effects. A temporary negative shock raises the cost of current total consumption in terms of future consumption as the consumption-based rate of interest increases. This implies an increase in saving and contributes to an improvement of the current account. There are also two indirect channels due to intratemporal substitution effects and income effects. In the intratemporal substitution case, a change in the terms of trade indirectly affects the current account by altering the real exchange rate. A temporary terms of trade deterioration causes individuals to substitute away from import goods in favor of domestic goods, which bids up the price of the domestic good. This real appreciation increases the cost of current consumption in terms of future consumption, thereby raising saving and improving the current account. The income effect is when a temporary negative shock implies a temporary fall in income, and by consumption smoothing, consumption falls less, which worsens the current account. The inclusion of the terms of trade variable in the Bergin-Sheffrin framework is then simply allowing for the additional influence of the above intertemporal channel on the current account. The strength of this channel is determined by the size of the intertemporal elasticity of substitution. If this parameter is small, innovations in net output and the real exchange rate would capture most of the effects stemming from terms of trade shocks and adding the terms of trade variable itself would not significantly improve the fit of the present value model.[5]

The rest of the paper is organized as follows. The next section outlines the derivation of the theoretical model. Section three describes the empirical methodology. Section four discusses the data and the empirical results. Section five concludes.

[5] Using the different empirical methodology of Glick and Rogoff (1995) to test intertemporal current account models, Iscan (2000) finds that the response of the current account to the terms of trade is insignificant.

2. Theoretical Framework

In this section, the model of Bergin and Sheffrin (2000) is extended to include the terms of trade.[6] A small open economy is considered in which there are three types of goods: importables, nontradables, and exportables. It is assumed that the importable is consumed but not produced, and the exportable is produced but not consumed.

The economy consists of an infinitely-lived representative agent who maximizes an expected lifetime utility function of the form

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{*1-\sigma}}{1-\sigma}, \qquad \sigma > 0, \tag{2.1}$$

where β denotes the subjective discount factor and C* is an index of total consumption. It is assumed that the functional form for C* is Cobb-Douglas:

$$C^* = C_n^a C_m^{1-a}, \qquad 0 < a < 1, \tag{2.2}$$

where C_n is consumption of nontradables and C_m is consumption of imports.

The agent can borrow or lend freely in international capital markets. An international bond is the only available financial asset, and its real return is the world real interest rate r. The world interest rate can vary exogenously and is denominated in terms of exportables. Net holdings of these bonds are denoted B_t, and they evolve according to

$$B_{t+1} - B_t = r_t B_t + Y_{x,t} + Q_t Y_{n,t} - P_t C_{m,t} - Q_t C_{n,t} - I_t - G_t, \tag{2.3}$$

where Y_x is output of exportables, Y_n is output of nontradables, I is investment, G is government spending, Q is the relative price of nontradables in terms of exportables, and P is the relative

[6] This extension has also been independenttly derived by Adedeji (2001), who tests the model using data from Nigeria.

price of importables in terms of exportables.[7] The numeraire in the model is chosen to be the exportable good. Thus, when measured in units of exportables, total expenditures, C_t, is equal to $P_t C_{m,t} + Q_t C_{n,t}$ and total output, Y_t, is equal to $Y_{x,t} + Q_t Y_{n,t}$.

The agent's problem is solved following the method delineated by Obstfeld and Rogoff (1996, Chp. 4). First, a consumption-based price index P* is defined as the minimum amount of consumption expenditure that buys a unit of C*, given Q and P. To derive P*, the agent's intratemporal problem is solved, which is to maximize $C_{n,t}^{a} C_{m,t}^{1-a}$ subject to $C_t = P_t C_{m,t} + Q_t C_{n,t}$. In Appendix A, the derivation of P* is shown to produce

$$P_t^* = \frac{Q_t^a P_t^{1-a}}{a^a (1-a)^{1-a}}. \qquad (2.4)$$

The next step is to reformulate the agent's optimization problem in terms of the single composite good C*. The period budget constraint (2.3) is rewritten using the definitions of total output and total expenditures and the fact that $P_t^* C_t^* = C_t$. The outcome is

$$B_{t+1} = (1+r_t) B_t + Y_t - P_t^* C_t^* - I_t - G_t. \qquad (2.5)$$

The intertemporal problem for the agent then becomes to maximize (2.1) subject to (2.5) and the resulting first-order condition is

$$E_t \left[\beta (1+r_{t+1}) \left(\frac{C_t^*}{C_{t+1}^*} \right)^{\sigma} \left(\frac{P_t^*}{P_{t+1}^*} \right) \right] = 1. \qquad (2.6)$$

Substituting in for C* and P* using (2.2) and (2.4) obtains

[7] The variable P is also defined as the terms of trade while the variable Q will be interpreted as the real exchange rate throughout the remainder of the paper.

$$E_t\left[\beta(1+r_{t+1})\left(\frac{C_t}{C_{t+1}}\right)^{\sigma}\left(\frac{Q_t^a P_t^{1-a}}{Q_{t+1}^a P_{t+1}^{1-a}}\right)^{1-\sigma}\right]=1. \qquad (2.7)$$

An explicit solution for consumption based on Euler equation (2.7) is not possible. An approximation of this expression is needed. A standard approximation technique is to assume joint log normality for all variables in the above expression. Thus, equation (2.7) can be written in log-linearized form as[8]

$$E_t\left[\ln\beta + r_{t+1} - \sigma\Delta c_{t+1} + (1-\sigma)\ln Q_t^a P_t^{1-a} - (1-\sigma)\ln Q_{t+1}^a P_{t+1}^{1-a}\right] + \frac{1}{2}Var\left(\ln X\right) = 0, \qquad (2.8)$$

where $X \equiv \beta(1+r_t)\left(C_t / C_{t+1}\right)^{\sigma}\left((Q_t^a P_t^{1-a})/(Q_{t+1}^a P_{t+1}^{1-a})\right)^{1-\sigma}$, $\Delta c_{t+1} = \ln C_{t+1} - \ln C_t$, and the approximation $\ln(1+r_{t+1}) \approx r_{t+1}$ is used. It is further assumed that variances and covariances between all variables are constant and (2.8) after a little algebra becomes

$$E_t\Delta c_{t+1} = E_t\left[\gamma r_{t+1} - a\left(\gamma-1\right)\Delta q_{t+1} - (1-a)\left(\gamma-1\right)\Delta p_{t+1}\right] + \text{ constant}, \qquad (2.9)$$

where $\Delta p_{t+1} = \ln P_{t+1} - \ln P_t$, $\Delta q_{t+1} = \ln Q_{t+1} - \ln Q_t$, and $\sigma = 1/\gamma$. Equation (2.9) can be rewritten in terms of a consumption-based interest rate:

$$E_t\Delta c_{t+1} = \gamma E_t r_{t+1}^{**}, \qquad (2.10)$$

where r** is a consumption-based interest rate defined as[9]

$$r_t^{**} = r_t - \left[a(\frac{\gamma-1}{\gamma})\right]\Delta q_t - \left[(1-a)(\frac{\gamma-1}{\gamma})\right]\Delta p_t. \qquad (2.11)$$

[8] If x is lognormally distributed, it has the property that $\log E_t(x) = E_t(\log x) + 1/2Var_t(\log x)$.

The above expression shows how the time profile of optimal consumption is influenced by the world interest rate, the real exchange rate, and the terms of trade. In the one-good intertemporal current account model, the expected change in consumption is zero as households always try to smooth consumption. In a three-good model, the relevant rate of interest for intertemporal consumption decisions is the world interest rate adjusted for expected changes in the relative price of nontradables and importables. Expression (2.11) reveals that the profile of optimal consumption may temporarily tilt up or down in response to a change in one of these three variables. For example, a temporary increase in the world real interest rate makes current total consumption more expensive relative to future total consumption as the consumption-based interest rises. This induces substitution toward future consumption and the profile of consumption tilts up. A change in the relative price of importables or the relative price of nontradables influences consumption through intertemporal substitution and intratemporal substitution effects. As it is evident from (2.11), however, the combined effect of both substitution channels depends on the size of the intertemporal elasticity of substitution. For example, if the relative price of importables temporarily rises, the consumption-based interest rate rises and the cost of current total consumption is higher in terms of future total consumption. The intertemporal channel tends to decreases current total consumption. The temporary rise in the relative price of importables also causes nontraded goods to become more attractive relative to importables. This intratemporal substitution effect tends to raise current total consumption. In the case of $\gamma < 1$, the intratemporal channel dominates the intertemporal channel and the path of consumption tilts down. In the case of $\gamma > 1$, the intertemporal effect wins out and consumption tilts up.

The next step in the model's derivation is to log-linearize the agent's intertemporal budget constraint. Forward iteration of (2.3) yields

$$E_0 \sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t C_t = B_0 + E_0 \sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t NO_t \,, \tag{2.12}$$

[9] The constant term in (2.11) was dropped as the series for the consumption-based interest rate will be demeaned in the empirical implementation of the model

where net output is defined as $NO = Y - I - G$ and the transversality condition $\lim_{t\to\infty} E_0 \left(1/(1+r)\right)^t B_t = 0$ is imposed. Log-linearization of (2.12) is based on the technique of Campbell and Mankiw (1989) and Huang and Lin (1993). In Appendix B, the result is shown to be

$$-\left[\sum_{s=1}^{\infty} \beta^s \left(\Delta no_{t+s} - \frac{\Delta c_{t+1}}{\Omega} - \left(1 - \frac{1}{\Omega}\right) r_t\right)\right] = no_0 - \frac{c_0}{\Omega} + \left(1 - \frac{1}{\Omega}\right) b_0 , \qquad (2.13)$$

where Ω is a constant slightly less than one, $\Omega = 1 - \bar{B} / \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t C_t$, and $\bar{B}$ is the steady state value of net foreign assets. All lower-case letters represent the logs of upper-case counterparts. Taking expectations of (2.13) and combining it with (2.9) yields

$$-E_t\left[\sum_{s=1}^{\infty} \beta^s \left(\Delta no_{t+s} - \gamma r_{t+1} + a(\gamma - 1)\Delta q_{t+1} + (1-a)(\gamma - 1)\Delta p_{t+1} - \left(1 - \frac{1}{\Omega}\right) r_t\right)\right] = no_0 - \frac{c_0}{\Omega} + \left(1 - \frac{1}{\Omega}\right) b_0 \qquad (2.14)$$

Following Bergin and Sheffrin (2000), the steady state around which I linearize is chosen to be the one in which net foreign assets are zero. This implies $\Omega = 1$ and (2.14) becomes

$$ca_t = -E_t\left[\sum_{s=1}^{\infty} \beta^s \left(\Delta no_{t+s} - \gamma r_{t+s} + a(\gamma - 1)\Delta q_{t+s} + (1-a)(\gamma - 1)\Delta p_{t+s}\right)\right], \qquad (2.15)$$

where $ca_t \equiv no_t - c_t$. The difference between the present value expression for the current account in Bergin and Sheffrin and in this paper is the inclusion of the terms of trade variable (Δp) in (2.15).

Equation (2.15) summarizes the basic predictions of the intertemporal current account model. For example, if net output is expected to temporarily rise, the current account deteriorates as individuals borrow funds from abroad in order to smooth consumption over current and future periods. This is the classic consumption-smoothing motive. The presence of international relative prices also adds a consumption-tilting motive to current account dynamics as discussed earlier. Rewriting (2.15) in terms of the consumption-based real interest rate yields

$$ca_t = -E_t\left[\sum_{s=1}^{\infty}\beta^s\left(\Delta no_{t+s} - \gamma r_{t+s}^{**}\right)\right]. \qquad (2.16)$$

A rise in the consumption-based interest rate causes the current account to improve as households substitute towards future consumption and a fall in the consumption-based interest rate has the exact opposite effect. Equation (2.16) will constitute the main estimating equation of the paper.

3. Empirical Methodology

In this section, the present value approach is described in terms of the preceding intertemporal current account model. The difficulty in testing the implications of equation (2.16) is that proxies for the expected future values of all right-hand side variables must be constructed. Present value tests as developed by Campbell (1987) and Campbell and Shiller (1987) offer a suitable approach for handling this estimation. The present value test makes full use of the model's structure to derive a testable hypothesis. If the model is correct as expressed by (2.16), the current account itself should reflect all information available to private agents in forecasting the linear combination of the future values of net output and the consumption-based interest rate. This insight leads to the assumption that private agents form expectations of these future variables by estimating a vector autoregressive (VAR) model of the form

$$\begin{bmatrix}\Delta no \\ ca \\ r^{**}\end{bmatrix}_t = \begin{bmatrix}A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33}\end{bmatrix}\begin{bmatrix}\Delta no \\ ca \\ r^{**}\end{bmatrix}_{t-1} + \begin{bmatrix}u_{1t} \\ u_{2t} \\ u_{3t}\end{bmatrix}. \qquad (3.1)$$

This reduced-form VAR can be written more compactly as $\mathbf{z}_t = \mathbf{A}\mathbf{z}_{t-1} + \mathbf{u}_t$, where $E(\mathbf{z}_{t+s}) = \mathbf{A}^s\mathbf{z}_t$.[10] Using (3.1), the restrictions on the current account in (2.16) can be written as

$$\mathbf{h}\mathbf{z}_t = -\sum_{s=1}^{\infty}\beta^s\left(\mathbf{g}_1 - \gamma\mathbf{g}_2\right)\mathbf{A}^s\mathbf{z}_t\ , \qquad (3.2)$$

where $\mathbf{h}' = [0\ 1\ 0]$, $\mathbf{g}_1' = [1\ 0\ 0]$, and $\mathbf{g}_2' = [0\ 0\ 1]$. For a given $\mathbf{z}_t$, the right-hand side of equation (3.2) can be expressed as

$$\overline{ca_t} = \mathbf{k}\mathbf{z}_t\ , \qquad (3.3)$$

where $\mathbf{k} \equiv -\left(\mathbf{g}_1 - \gamma\mathbf{g}_2\right)\beta\mathbf{A}(\mathbf{I} - \beta\mathbf{A})^{-1}$. Equation (3.3) gives a prediction of the current account variable consistent with the VAR and the restrictions of the intertemporal model.

The three-good, present value current account model can be evaluated informally by comparing graphically the actual path of the current account with the model's predicted path generated by (3.3). A formal test of the model's restrictions can also be conducted. If the restrictions are consistent with the data, $\overline{ca_t} = ca_t$ should be true. In other words, the predicted current account should equal the actual data, which implies that the vector **k** should be equal to $[0\ 1\ 0]$. It is standard in the literature to test this hypothesis by using a Wald test statistic. Let **R** be the difference between the actual **k** and the hypothesized value. Then $\mathbf{R}\left((\partial\mathbf{k}/\partial\mathbf{A})\mathbf{V}(\partial\mathbf{k}/\partial\mathbf{A})'\right)^{-1}\mathbf{R}$ will be distributed chi-square with degrees of freedom equal to the number of restrictions, where $\mathbf{V}$ is the variance-covariance matrix of the underlying parameters in the VAR, and $\partial\mathbf{k}/\partial\mathbf{A}$ is the matrix of derivatives of the **k** vector with respect to these underlying parameters.

To examine the robustness of my results, equation (2.15) will also be estimated. In this case, the estimated VAR consists of 5 variables and the restrictions of the model are written as

[10] These expressions can be easily generalized for higher order VARs.

$$\mathbf{hz}_t = -\sum_{s=1}^{\infty} \beta^s \left(\mathbf{g}_1 - \gamma \mathbf{g}_2 - (1-a)(1-\gamma)\mathbf{g}_3 - a(1-\gamma)\mathbf{g}_4\right) \mathbf{A}^s \mathbf{z}_t \;, \tag{3.4}$$

where $\mathbf{h} = [0\ 1\ 0\ 0\ 0]$, $\mathbf{g}_1 = [1\ 0\ 0\ 0\ 0]$, $\mathbf{g}_2 = [0\ 0\ 1\ 0\ 0]$, $\mathbf{g}_3 = [0\ 0\ 0\ 1\ 0]$, and $\mathbf{g}_4 = [0\ 0\ 0\ 0\ 1]$. Hence, the parameter vector $\mathbf{k}$ is $\mathbf{k} \equiv -\left(\mathbf{g}_1 - \gamma \mathbf{g}_2 - (1-a)(1-\gamma)\mathbf{g}_3 - a(1-\gamma)\mathbf{g}_4\right) \beta \mathbf{A}(\mathbf{I} - \beta \mathbf{A})^{-1}$.

4. Data and Empirical Results

4.1 Data and Parameters

Quarterly data from the United Kingdom and Canada are examined. All data are from the International Financial Statistics (IFS) and cover the period from 1968:1 to 1998:4. The series for net output was constructed by subtracting investment and government expenditures from GDP and deflating by the appropriate GDP deflator (1995=100) and by population. The net output series was then logged and differenced. The series for the current account was constructed by subtracting the log of real per capita consumption from the log of real per capita net output.

As in Bergin and Sheffrin, a measure of a world real interest rate was constructed following the methodology of Barro and Sala-i-Martin (1990). This variable is based on quarterly data from the G-7 countries. T-Bill rates or money market rates are used as proxies for nominal interest rates in each of the G-7 countries. A series for inflation is constructed for each country using consumer price indexes (CPI). Expected inflation is then forecasted using an ARMA(1,1) with deterministic seasonals for each quarter. Each regression uses inflation data from 1963:1 up to the quarter prior to the date being forecasted. An ex ante real interest rate for each country is computed by subtracting the expected inflation rate from the nominal interest rate proxy. An ex ante world real interest rate is then computed by averaging the sum of all the individual country's real rates using time-varying weights. The time-varying weights are calculated for each country based on its share of real GDP in the G-7 total. A graph of this series is presented in Figure 1. It should be noted that the series for the world interest rate in Bergin and Sheffrin (2000) was found after publication to contain an error in its formulation. Essentially, their world interest rate series was specified in nominal terms and not in real in terms. Therefore, the series used in this paper is quite different.

A measure of the real exchange rate is used as a proxy for the relative price of nontradables. This measure is also used by Bergin and Sheffrin. The real exchange rate is computed by first taking the ratio of an individual country's CPI to a CPI calculated for industrialized countries as a group. This figure is then multiplied by the nominal effective exchange rate (1995=100) based on unit labor costs for the country in question. This series is then logged and differenced. The terms of trade are constructed by taking the ratio of import to export unit value indexes (1995=100). This series is then logged and differenced. Each of these series in levels is presented in Figures 2 and 3.

There are three parameter values in the model that need to be set. The first is the subjective discount rate β and the implied steady-state conditions of the model are used to assign it a value. The model suggests that $\beta = 1/(1+\bar{r})$ where $\bar{r}$ is the sample mean of the world real interest rate. The subjective discount rate used in this paper is then set at 0.98. For the share of nontradables in private consumption, I set $a = 0.4$ for the United Kingdom and $a = 0.46$ for Canada. These values correspond to the estimates reported in Stockman and Tesar (1995). They calculate these parameter values over the period from 1980 to 1988 by using services as a proxy for nontradables. The intertemporal elasticity of substitution is estimated within the context of the present value model rather than relying on outside studies. As in Bergin and Sheffrin, the procedure of Campbell and Shiller (1989) is followed, which uses the restrictions of the model in order to identify a particular value for this parameter. This is done by mechanically finding the value of the intertemporal elasticity of substitution that minimizes the Wald test statistic of the present value test.[11] Campbell and Shiller interpret this procedure as a method-of-moments estimation. Finally, each series used in the VARs is expressed in deviations from their means. I thus test only the dynamic restrictions implied by the model.

[11] Note that when the minimized chi-square statistic is used to evaluate the restrictions of the model, a penalty must be imposed by reducing by one the degrees of freedom for the distribution.

4.2 Unit Root Tests and Choice of Lag Length

The present value test requires that the current account and the world real interest rate are stationary in levels while net output, the terms of trade, and the real exchange rate are stationary in differences. Table 1 presents the results of unit root tests for each of the country series using the Augmented Dickey-Fuller (ADF) approach. The tests were carried out considering one, three, and five lag lengths in the test regressions, which did not include a constant or time trend. The results in Table 1 confirm that the null hypothesis of a unit root is rejected for all country series at virtually all lags.

To determine the number of lags used in each country's VAR, the Akaike's Information Criterion (AIC) and the Schwarz Criterion (SC) were administered. In the case of the United Kingdom, the AIC and SC both selected one lag. For Canada, the AIC and SC also selected one lag. These values correspond closely to Ghosh (1995) who uses two lags for the UK and one lag for Canada and Bergin and Sheffrin who use one lag for the UK and two lags for Canada.

4.3 Present Value Tests

The results from present value tests for the United Kingdom and Canada are presented in Tables 2 and 3, respectively. The first column reports results from model 1, which ignores changes in the world interest rate, the terms of trade, and the real exchange rate. This model corresponds to the simple one-good model mentioned in the introduction. If the intertemporal current account model is correct, the hypothesized k-vector should be [0 1]. The actual k-vector for the UK is [0.22 0.08], which is significantly different from the hypothesized value. Accordingly, the chi-square statistic indicates that the model's restrictions are strongly rejected with a p-value of zero. The poor performance of this model is also evident by looking at the time series plots of the predicted path of the current account and the actual path of the current account (Figure 4). The graph confirms that model 1 hardly captures any of the actual fluctuations in the current account over time. These results for the UK are very typically of what has been found in past studies.

For Canada, the actual k-vector for model 1 is [0.07 0.48]. The chi-square statistic implies that the null hypothesis of the k-vector being [0 1] is not rejected with a p-value of 0.21. This is true even though the coefficient on the current account is far from the value of unity. Figure 5 shows that the predicted path does seem to resemble the actual path fairly well. The volatility of the predicted path, however, is very small compared to the actual volatility of the current account.

Since the one-good model for Canada has never been shown to *not* fail the formal test in the literature, the results here deserve some attention. Otto (1992) estimates a 4 lag VAR for Canada over the period from 1950:1 to 1987:4, and the statistical test rejects his one-good present value model. Ghosh (1995) estimates a 1 lag VAR for Canada over the period from 1960:1 to 1988:4, and the statistical test rejects the model. Hence, the results reported in this paper could either be sensitive to the lag length selected or the sample length used. The evidence seems to support that the latter is true. In Bergin and Sheffrin, the model for Canada was rejected using a 2 lag VAR estimated over the period 1960:3 to 1996:4. I also estimated a 2 lag VAR for Canada and found that the model was rejected if Bergin and Sheffrin's subjective discount factor of 0.94 was used. This discount factor was based on an erroneous time series for the world real interest rate as mentioned earlier. The correct series for the world real interest rate implies that the subjective discount factor should be 0.98. Using this larger value, the above result is reversed and the model is not rejected for Canada using a 2 lag VAR. Therefore, it seems that the additional time series from the 1990s is the reason why the one-good model is able to explain the data better than previous thought. Only at a lag length of 4, is the one-good model still rejected for Canada.

The second column of Tables 2 and 3 reports results from model 2, which includes the world real interest rate and the real exchange rate in the consumption-based interest rate (changes in the terms of trade are ignored). In this case, the intertemporal approach suggests that the hypothesized k-vector should be [0 1 0]. For the UK, the actual k-vector coefficient on the current account in model 2 is 1.82 and the coefficient on the consumption-based interest rate is 1.57. These very large values are due to the rather large intertemporal elasticity of substitution that was found to minimize the Wald test statistic. The chi-squared statistic indicates that the model's restrictions are rejected with a p-value of 0.01. The plot of the predicted current account shows that the model is much more volatile than the dynamics of the actual current account (Figure 4).

For Canada, it was found that a value of zero for the intertemporal elasticity of substitution minimized the Wald test statistic in model 2. This implies that world interest rate should not affect the current account and the real exchange rate will only affect the current account via intratemporal substitution. Since the real exchange rate in the consumption-based interest rate is undefined in this case, a VAR including the current account, net output, and the real exchange rate was estimated instead. The k-vector coefficient for the current account is close to unity at 0.81 while the two other coefficients are not very far from their hypothesized values of zero. The outcome of the Wald test reflects this performance by failing to reject the model with a p-value of 0.36. The good fit of the model is also apparent by looking at Figure 5. The predicted path of the current account closely tracks the actual path and is nearly two-thirds as volatile as the data.

The last column of Tables 2 and 3 reports results from model 3, which includes all three international relative prices in the consumption-based interest rate. For the UK, this model performs the best out of the three. First, the k-vector coefficient on the current account is 0.99 and the coefficients on net output and the consumption-based interest rate are 0.12 and 0.32, respectively. Second, the Wald test of the model's restrictions is not rejected with the highest p-value among all models of 0.99. Third, Figure 4 demonstrates that model 3 visually fits the data the best. Lastly, the ratio of the variance of the predictive path to the variance of the actual path is 1.32, which is a marked improvement over the previous models. For Canada, the results are similarly positive. The k-vector coefficient on the current account is 0.99, which is an increase over model 2. The other two coefficients are relatively near their hypothesized values of zero. The chi-square statistic indicates that the null hypothesis is soundly not rejected with a p-value of 0.99. The reported volatility of the predicted current account is 1.11 percent of that of the actual current account.

These results for model 3 indicate that incorporating the terms of trade into the Bergin-Sheffrin framework does unambiguously improve the intertemporal model's ability to explain the data for both the UK and Canada. Therefore, intertemporal effects arising from the presence of the terms of trade appears to be mainly responsible for the improvement.

This section also undertakes a test of robustness of the results reported above. It has been assumed to this point that households forecast future values of the consumption-based interest rate rather than forecasting its individual components separately. In order to gauge how sensitive the results are to this assumption, Tables 4 and 5 show the outcome of present value tests with the consumption-based interest rate decomposed into its individual components. For the UK, the results are similar in that model 2 is rejected and model 3 is not rejected. The sensitivity by decomposing the consumption-based interest rate seems to lie with the estimated intertemporal elasticities of substitution. In this case, the values, which minimize the Wald test statistic, are smaller than before. This in turn causes the k-vector coefficients and the variances of the predicted current accounts to be smaller as well. For Canada, the decomposing of the consumption-based interest rate causes the intertemporal elasticities of substitution to be of the wrong sign. The present value test are very sensitive in this case as to whether the consumption-based interest rate is estimated or its individual components separately.

4.5 Variance Decompositions

This section presents variance decompositions of the current account for each country. The objective for this exercise is simply to get a quantitative sense of the relative contribution of the innovations stemming from substitution effects versus income effects in explaining the variance of the current account. While it is understood that these innovations could be emanating from several different "structural" sources in the economy, the identification of these primary sources is not necessary here. Hence, orthogonalization based on the standard Choleski decomposition is sufficient.

The recursive ordering necessary for the Choleski decomposition is the following. First, the assumption of a small open economy implies that the world real interest rate and the terms of trade are exogenous. This implies that these two variables should be ordered ahead of the other three variables. Second, the theoretical model of section 2 suggests that the world interest rate, the terms of trade, the real exchange rate, and net output are predetermined with respect to the current account. This implies that the current account should be ordered last. This leaves only the relative ordering between net output and the real exchange rate in question. Since there is not a strong prior for whether one variable can be consider predetermined with respect to the other, both orderings are considered.

The variance decomposition results are reported in Tables 6 and 7. It was found that whether the real exchange rate was ordered before or after net output, the results were virtually the same for each country. Thus, the decomposition with the real exchange rate ordered before net output is reported in Tables 8 and 9. In the short run, shocks to net output and "own" shocks account for the majority of the variance of current account movements. At the one-quarter horizon, income effects explain about 81 percent of the variation in the UK's external balance and about 91 percent of the variation in Canada's external balance. At longer horizons, the relative contribution of substitution effects increases. After 20 quarters, nearly 25 percent of the current account variance is due to substitution effects in the case of Canada and 33 percent in the case of the UK. These decompositions seem to confirm some general findings from the present value tests. First, substitution effects do matter when it comes to explaining current account dynamics. Second, substitution effects play a bigger role in the dynamics of the United Kingdom's current account than it does for Canada.

5. Conclusion

This paper has extended the present value current account model to an economy consisting of three goods. The three-good model shows that current account fluctuations are due to innovations in net output, the world interest rate, the real exchange rate, and to a new variable, the terms of trade. The presence of the terms of trade adds another possible substitution channel in which external shocks can impact a small open economy's current account.

This additional channel was found to be relevant in explaining current account fluctuations in the United Kingdom and Canada. Therefore, the question posed at the outset of this paper was answered in the affirmative: the three-good model was able to improve the fit of the present value current account model over the one-good and two-good versions. Moreover, it appears that intertemporal substitution effects play a bigger role in enhancing the performance of the present value model than previously thought.

Appendix A

Derivation of Equation (2.4)

The agent's intratemporal problem is to maximize $C_{n,t}^{a}C_{m,t}^{1-a}$ subject to $C_t = P_tC_{m,t} + Q_tC_{n,t}$. The resulting first-order conditions are

$$aC_{n,t}^{a-1}C_{m,t}^{1-a} - \lambda Q_t = 0, \qquad \text{(a.1)}$$

$$(1-a)C_{m,t}^{-a}C_{n,t}^{a} - \lambda P_t = 0. \qquad \text{(a.2)}$$

Combining (a.1) and (a.2), I obtain

$$P_t = \frac{Q_t(1-a)C_{n,t}}{aC_{m,t}}, \qquad \text{(a.3)}$$

The demand for nontradables and importables is obtained by substituting (a.3) into $C_t = P_tC_{m,t} + Q_tC_{n,t}$. The resulting demand functions are

$$C_{m,t} = \frac{(1-a)C_t}{P_t} \qquad \text{(a.4)}$$

$$C_{n,t} = \frac{aC_t}{Q_t}. \qquad \text{(a.5)}$$

Substituting (a.4) and (a.5) into $C^{*} = C_{n,t}^{a}C_{m,t}^{1-a}$ and using the definition of P*, I obtain

$$P_t^{*} = \frac{Q_t^{a}P_t^{1-a}}{a^{a}(1-a)^{1-a}}. \qquad \text{(a.6)}$$

Appendix B

Derivation of Equation (2.13)

The intertemporal budget constraint can be rewritten as

$$\Phi_0 = B_0 + \Psi_0, \qquad \text{(a.7)}$$

where $\Phi_0 = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^{t} C_t$ and $\Psi_0 = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^{t} NO_t$. The first step is to log-linearize the expression for Φ_0. If this expression is forwarded by one period I obtain

$$\Phi_1 = \sum_{t=1}^{\infty}\left(\frac{1}{1+r}\right)^{t-1} C_t \,. \tag{a.8}$$

Rewriting (a.8) I have

$$\Phi_1 = (1+r_0)\sum_{t=1}^{\infty}\left(\frac{1}{1+r}\right)^{t} C_t \,. \tag{a.9}$$

Further manipulation of (a.9) yields

$$\Phi_1 = (1+r_0)\left[\sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^{t} C_t - C_0\right]. \tag{a.10}$$

Finally, (a.10) simplifies to

$$\Phi_1 = (1+r_0)\left(\Phi_0 - C_0\right). \tag{a.11}$$

Dividing (a.11) by Φ_0 and taking logs on both sides yields

$$\phi_1 - \phi_0 = r_0 + \ln\left[1-\exp(c_0-\phi_0)\right], \tag{a.12}$$

where $\phi_t = \ln\Phi_t$ and the approximation $\ln(1+r)\approx r$ has been used. Following Campbell and Mankiw (1989) the last term in (a.12) is approximated by a first-order Taylor expansion around its steady state value:

$$\ln\left[1-\exp(c_0-\phi_0\right] \approx \ln\left(1-\exp(\overline{c-\phi})\right) - \frac{\exp(\overline{c-\phi})}{1-\exp(\overline{c-\phi})}\left[\left(c_0-\phi_0\right)-(\overline{c-\phi})\right]. \tag{a.13}$$

Hence, (a.13) simplifies to

$$\ln\left[1-\exp(c_0-\phi_0\right] \approx k_1 + \left(1-1/\rho\right)\left(c_0-\phi_0\right), \tag{a.14}$$

where the constant $k_1 \equiv \ln\rho - \left(1-1/\rho\right)\ln(1-\rho)$ and the parameter $\rho \equiv 1-\overline{C}/\Phi_0$ is a number slightly less than one. Now substitute (a.14) into (a.12) which produces

$$\phi_1 - \phi_0 = r_0 + k_1 + \left(1-1/\rho\right)(c_0-\phi_0). \tag{a.15}$$

The left-hand side of (a.15) can be expressed as

$$\phi_1 - \phi_0 = \Delta c_1 + (c_0-\phi_0) - (c_1-\phi_1). \tag{a.16}$$

Combining (a.15) and (a.16) obtains

$$c_0 - \phi_o = \rho\left[(c_1 - \phi_1) - \Delta c_1 + r_0 + k_1\right]. \tag{a.17}$$

Solving (a.17) forward produces

$$c_0 - \phi_o = \sum_{t=1}^{\infty} \rho^t \left(r_t - \Delta c_t\right) + \gamma. \tag{a.18}$$

where γ is a constant.

The second step is to log-linearize the expression for Ψ_0. Following the exact procedure as steps (a.7) through (a.18) above, the following expression is derived:

$$no_0 - \psi_0 = \sum_{t=1}^{\infty} \rho^t \left(r_t - \Delta no_t\right) + \upsilon, \tag{a.19}$$

where $\psi = \ln \Psi$, $no = \ln NO$, υ is a constant, and following Bergin and Sheffrin (2000) the simplifying assumption that $1 - (\overline{NO} / \Psi_0)$ is equal to ρ has been made.

The penultimate step is log-linearize (a.7). Dividing (a.7) by Ψ_0 and taking logs I have

$$\phi_0 - \psi_0 = \ln\left[1 + \exp\left(b_0 - \psi_0\right)\right], \tag{a.20}$$

where $b = \ln B$. Taking a first-order Taylor approximation of the last term in (a.20) yields

$$\phi_0 - \psi_0 = k_2 + (1 - 1/\Omega)\left(b_0 - \psi_0\right), \tag{a.21}$$

where $k_2 \equiv \ln \Omega - \left(1 - 1/\Omega\right)\ln(1 - \Omega)$ and $\Omega = 1 - \overline{B} / \Psi_0$ is a constant slightly less than one. Finally, substituting equations (a.18) and (a.19) into (a.21), I obtain equation (2.13) in the text. Note that the constant terms in (2.13) have been dropped since the model will be fitted with demeaned time series data.

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Figure 1: Ex Ante Real World Interest Rate

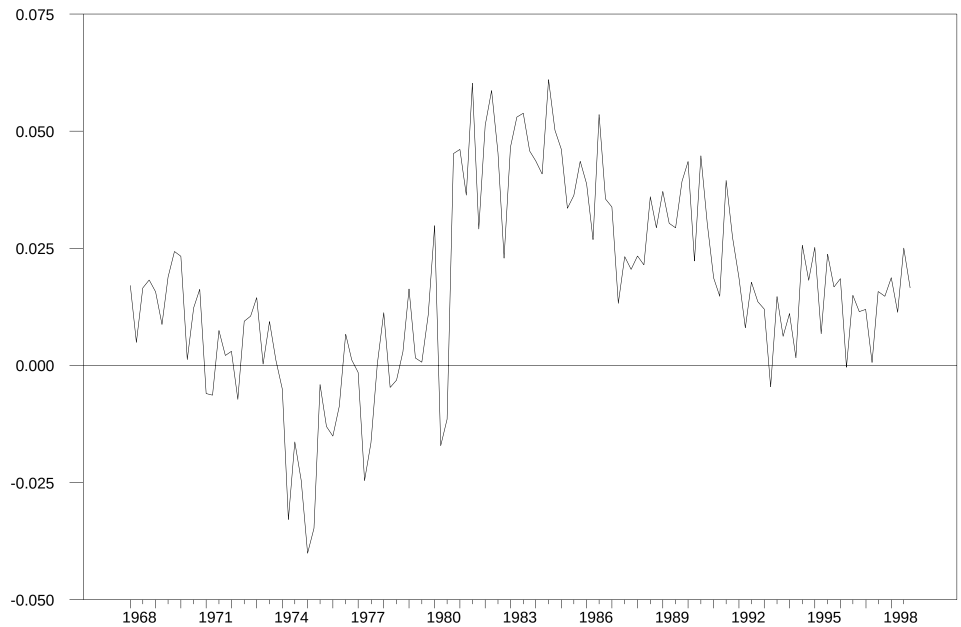

Figure 2: Terms of Trade and the Real Effective Exchange Rate for the United Kingdom

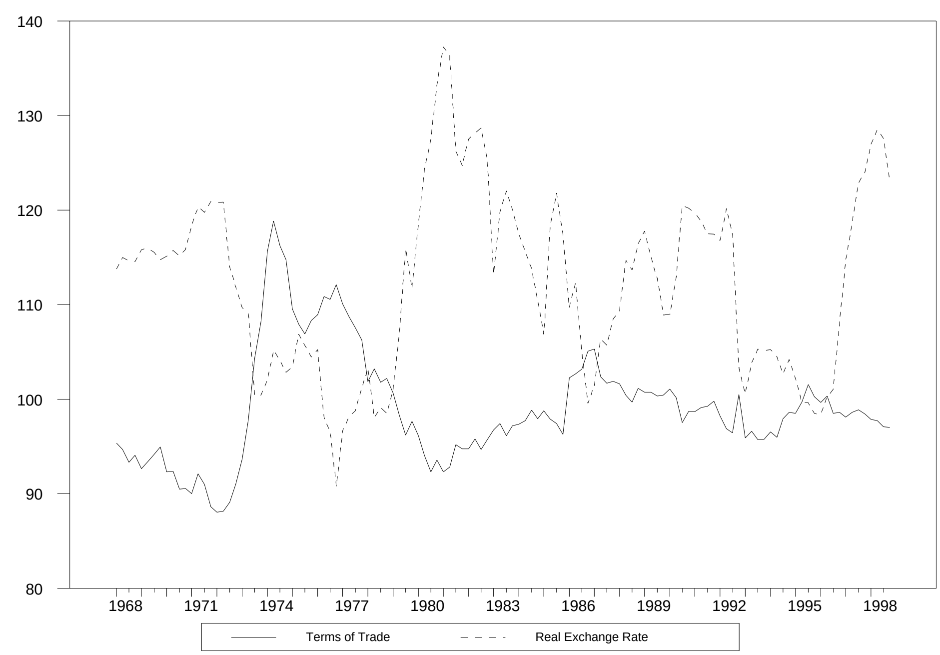

Figure 3: Terms of Trade and the Real Effective Exchange Rate for Canada

Table 1: Tests for Unit Roots

Lags	1	3	5
	United Kindgom		
△no	-9.62***	-5.69***	-5.42***
ca	-2.53**	-2.83***	-2.59**
r	-3.17***	-1.56	-1.76*
△p	-5.91***	-4.79***	-4.98***
△q	-7.55***	-4.95***	-4.27***
	Canada		
△no	-7.61***	-4.52***	-3.63***
ca	-2.39**	-2.57**	-2.20**
△p	-6.06***	-4.12***	-3.46***
△q	-6.95***	-5.36***	-3.22***

Notes: Tests for unit roots are based on the Augmented Dickey-Fuller (ADF) test statistic. The sample period is 1965:1 to 1998:4 for all variables except △q for which the sample period is 1968:1 to 1998:4. The null hypothesis of a unit root is tested versus the trend-stationary alternative. Regressions do not include a constant or time trend. A ***, **, and * indicates rejection of the null of a unit root at 1%, 5%, 10%, respectively.

Table 2: Present Value Tests for the United Kingdom

Model:	Model 1 (excluding r_t, Δp_t, Δq_t)	Model 2 (excluding Δp_t)	Model 3
γ	--	.74	.41
k-vector:			
Δno_t	.22	-.04	.12
	(.05)	(.18)	(.09)
ca_t	.08	1.82	.99
	(.28)	(.94)	(.50)
r_t*, r_t**		1.57	.32
		(.54)	(.13)
χ^2-statistic	19.00	8.97	.002
P-value	.000	.01	0.99
σ_{ca*}/σ_{ca}	.02	5.97	1.31

Notes: The sample period is 1965:1 to 1998:4 for model 1 and 1968:1 to 1998:4 for models 2 and 3. Standard errors for estimates of the **k** vector are in parentheses and are computed numerically by $\sqrt{(\partial \mathbf{k} / \partial \mathbf{A})\mathbf{V}(\partial \mathbf{k} / \partial \mathbf{A})'}$. The last row entry σ_{ca*}/σ_{ca} is defined as the ratio of the variance of the predicted path of the current account to the variance of the actual path of the current account.

Table 3: Present Value Tests for Canada

Model:	Model 1 (excluding r_t, Δp_t, Δq_t)	Model 2 (excluding Δp_t)	Model 3
γ	--	0	0.22
k-vector:			
Δno_t	.08	-0.04	0.03
	(.06)	(.11)	(.13)
ca_t	.48	0.81	0.99
	(.30)	(.50)	(.60)
Δq_t		0.17	
		(.14)	
r_t**			0.13
			(.07)
χ^2-statistic	3.16	2.06	0.000
P-value	.21	0.36	0.99
σ_{ca*}/σ_{ca}	.24	0.67	1.11

Notes: The sample period is 1965:1 to 1998:4 for model 1 and 1968:1 to 1998:4 for models 2 and 3. Standard errors for estimates of the **k** vector are in parentheses and are computed numerically by $\sqrt{(\partial \mathbf{k} / \partial \mathbf{A})\mathbf{V}(\partial \mathbf{k} / \partial \mathbf{A})'}$. The last row entry σ_{ca*}/σ_{ca} is defined as the ratio of the variance of the predicted path of the current account to the variance of the actual path of the current account.

Figure 4: Actual De-meaned Current Account & Predicted De-meaned Current Account for the United Kingdom

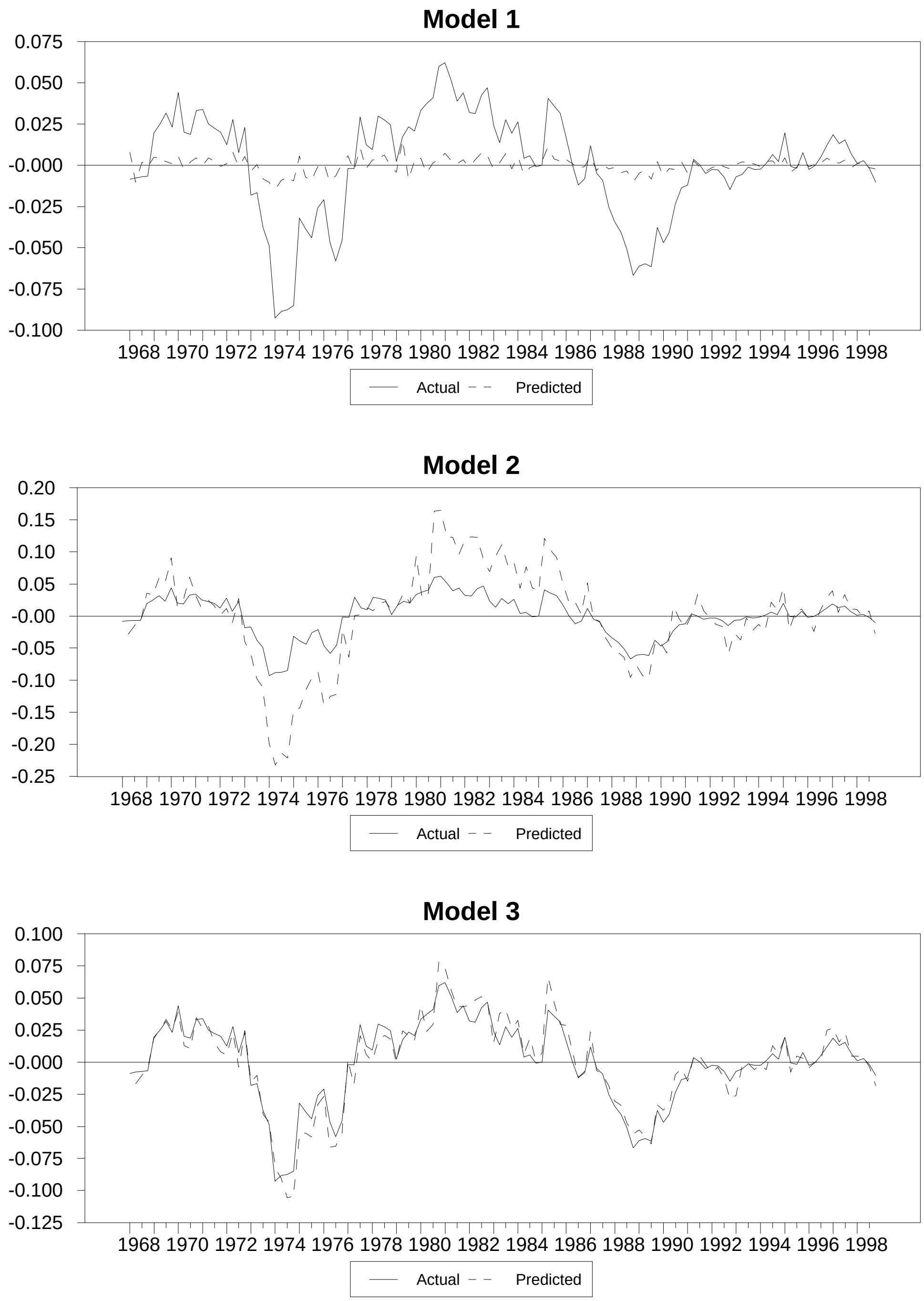

Figure 5: Actual De-meaned Current Account & Predicted De-meaned Current Account for Canada

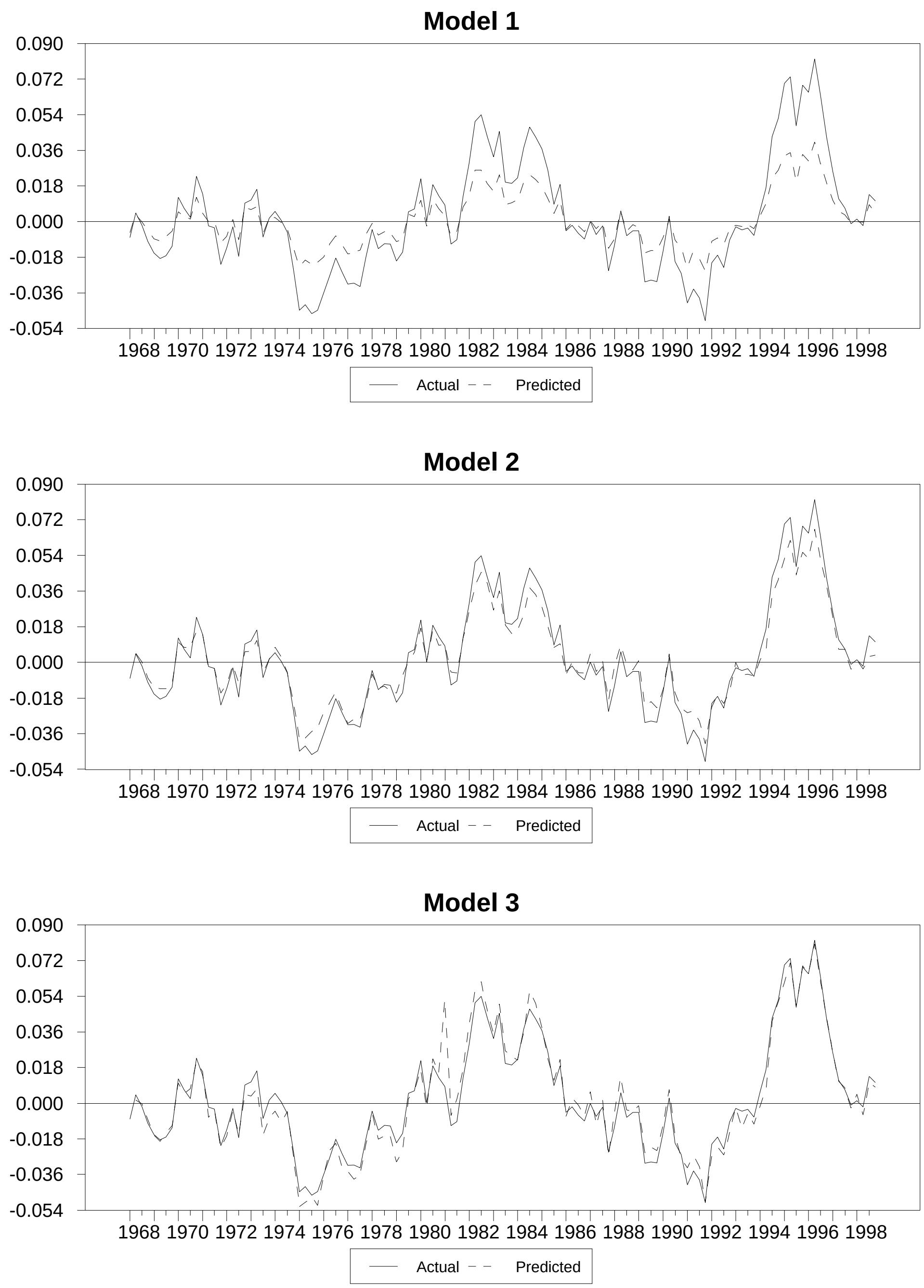

Table 4: Robustness of Present Value Tests for the United Kingdom (with the consumption-based interest rate decomposed into its individual components)

Model:	Model 2 (excluding Δp_t)	Model 3
γ	.48	.24
k-vector:		
Δno_t	.07	.14
	(.12)	(.09)
ca_t	1.23	.76
	(.63)	(.42)
r_t	.97	.49
	(.37)	(.27)
Δp_t		.07
		(.06)
Δq_t	.07	.16
	(.07)	(.13)
χ^2-statistic	8.47	.03
P-value	.04	0.99
σ_{ca*}/σ_{ca}	2.63	.93

Note: The sample period is 1968:1 to 1998:4 for Models 2 and 3. Standard errors for estimates of the **k** vector are computed numerically by $\sqrt{(\partial \mathbf{k} / \partial \mathbf{A})\mathbf{V}(\partial \mathbf{k} / \partial \mathbf{A})'}$. The last row entry σ_{ca*}/σ_{ca} is defined as the ratio of the variance of the predicted path of the current account to the variance of the actual path of the current account.

Table 5: Robustness of Present Value Tests for Canada (with the consumption-based interest rate decomposed into its individual components)

Model:	Model 2 (excluding Δp_t)	Model 3
γ	-.20	-.03
k-vector:		
Δno_t	-.06	.08
	(.11)	(.13)
ca_t	.46	.37
	(.51)	(.53)
r_t	.01	.54
	(.31)	(.32)
Δp_t		.17
		(.18)
Δq_t	.14	.12
	(.16)	(.13)
χ^2-statistic	3.30	.13
P-value	.35	0.99
σ_{ca*}/σ_{ca}	.22	.45

Note: The sample period is 1968:1 to 1998:4 for Models 2 and 3. Standard errors for estimates of the **k** vector are computed numerically by $\sqrt{(\partial \mathbf{k} / \partial \mathbf{A})\mathbf{V}(\partial \mathbf{k} / \partial \mathbf{A})'}$. The last row entry σ_{ca*}/σ_{ca} is defined as the ratio of the variance of the predicted path of the current account to the variance of the actual path of the current account.

Table 6: Variance Decomposition of the Current Account for the United Kingdom

	Percentage of variance due to						
	world interest rate	terms of trade	real exchange rate	net output	current account	substitution effects	income effects
1 quarter	.79	16.35	2.26	32.69	47.92	19.39	80.61
4 quarters	.44	28.93	1.29	24.82	44.52	30.66	69.34
8 quarters	.38	31.22	1.19	23.75	43.46	33.19	66.81
20 quarters	.03	32.06	1.15	23.36	43.06	33.04	66.96

Notes: The variance decomposition results are based on the ordering of $\{r, \Delta p, \Delta q, \Delta no, ca\}$. Substitution effects are the combined effects of world interest rate, the terms of trade and the real exchange rate innovations. Income effects are the combined effects of net output and 'own' innovations.

Table 7: Variance Decomposition of the Current Account for Canada

	Percentage of variance due to						
	world interest rate	terms of trade	real exchange rate	net output	current account	substitution effects	income effects
1 quarter	5.32	.61	3.20	34.45	56.42	9.13	90.87
4 quarters	7.11	5.18	4.82	25.08	57.83	16.37	83.63
8 quarters	10.94	5.73	4.25	23.90	55.17	20.93	79.07
20 quarters	15.92	5.07	3.66	22.89	52.47	24.64	75.36

Notes: The variance decomposition results are based on the ordering of $\{r, \Delta p, \Delta q, \Delta no, ca\}$. Substitution effects are the combined effects of world interest rate, the terms of trade and the real exchange rate innovations. Income effects are the combined effects of net output and 'own' innovations.