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The present-value model of the current account has been rejected: Round up the usual suspects

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Abstract

Tests of the present-value model (PVM) of the current account are frequently rejected by data. Standard explanations rely on the "usual suspects" of non-separable preferences, fiscal policy and world real interest rate shocks, external imperfect international capital mobility, and an internalized risk premium. We confirm these rejections on post-war Canadian data, then investigate their source by calibrating and simulating alternative versions of a small open economy, real business cycle model (RBC). Bayesian Monte Carlo experiments reveal that a "canonical" RBC model is close to the data, but far from the PVM predictions. Although each suspect matters in some way, none improve the fit to the data. However, the PVM restrictions are reproduced when the internalized risk premium is introduced into the canonical model. By adding the exogenous world real interest rate shock to this version of the model, it matches the data better and is moved closer to the PVM predictions. This suggests that there is an important common world component to current account fluctuations, which points to additional underlying macroeconomic factors that drive the current account.

Keywords: Current account; Present value model; World real interest rate; International capital mobility; Bayesian Monte Carlo

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1. Introduction

Current account fluctuations resist easy explanations. Large current account deficits have persisted in the U.S. through periods of large government budget deficits and surpluses, large and persistent real appreciations and depreciations of the dollar, and all phases of the business cycle. In Canada, the expansion of the 1980s coincided with large current account deficits, but an expansion in the 1990s witnessed current account surpluses.

Economists increasingly employ the intertemporal approach to study the current account. The intertemporal approach views the current account as a tool domestic residents use to smooth consumption by borrowing from or lending to the rest of the world. For example, if future income is expected to rise, say due to a technology shock, domestic agents try to smooth consumption by borrowing abroad prior to the high-income years, thereby running a current account deficit. As such, the intertemporal approach relies on permanent income fluctuations (driven by technology shocks) to explain current account movements. Compared to traditional Keynesian views, the intertemporal approach reduces emphasis on the economy's intratemporal competitiveness measured by the real exchange rate.

The intertemporal approach to the current account is encompassed by several classes of small open economy models. The most basic is the present-value model (PVM) of the current account. Sheffrin and Woo (1990), Otto (1992), Ghosh (1995), and Bergin and Sheffrin (2000) test the PVM and find it routinely rejected by the data.[1]

Despite rejections of the PVM cross-equation restrictions, it is argued that abandoning the underlying scheme is unwarranted. Adherents point out that the (in-sample) current account forecast of the most unadorned PVM often closely tracks the actual current account (e.g., Obstfeld and Rogoff, 1996, pp. 92–94). Thus, the PVM, which is rejected, is seen in the literature as "useful" overall. Although appropriate, this conclusion is unsatisfactory because it fails to say which parts of the intertemporal model are most responsible for the poor empirical performance of the PVM.

This paper studies a set of "usual suspects"–factors other than technology shocks that theory teaches can matter for the current account–as potential sources of empirical rejections of the PVM. These factors are non-separable preferences, country-specific fiscal and world real interest rate shocks, imperfect international capital mobility, and an internalized risk premium. We place the suspects in a "canonical" small open economy-real business cycle (RBC) model that nests the PVM and serves as our benchmark intertemporal model of the current account.

Our "testing" strategy compares moments of synthetic data produced by the RBC model to those of actual data. Rather than focus on the usual variances and covariances, the "moments" we study are the cross-equation restrictions of the PVM. The actual data we use is from post-war Canada, a proto-type small open economy for which rejections of the

[1] Other authors, such as Ahmed (1986) and more recently Glick and Rogoff (1995), İşcan (2000), and Nason and Rogers (2002), test a variety of implications of the intertemporal approach and present evidence that favors some aspects of it.

PVM are found uniformly in the literature.[2] We evaluate the empirical and theoretical distributions implied by the cross-equation restrictions using Bayesian Monte Carlo methods, which measure the fit of the RBC model to the actual data.

The canonical RBC model includes no suspects. This economy features perfect international capital mobility and a permanent, country-specific technology shock, but lacks transitory fiscal policy or world real interest rate shocks. Thus, the canonical model nests the PVM. Next, we add suspects to the canonical model one at a time to create alternative specifications. With each alternative, we generate artificial data, test the cross-equation restrictions, and compare synthetic to sample moments. These exercises give us evidence about the culpability of each of the suspects.

Our choice of suspects is guided by related work on the intertemporal approach. Non-separable preferences can affect the current account in several ways. Ghosh and Ostry (1997) find that incorporating precautionary saving into the PVM helps to explain current account volatility, but interestingly not for Canada. Bergin and Sheffrin (2000) improve the fit of the PVM by adding non-separable utility between tradable and non-tradable goods and a stochastic world real interest rate. Striking evidence of the importance of fiscal shocks, especially large ones, for intertemporal external borrowing decisions has been presented by Ahmed (1986) and Ahmed and Rogers (1995). Hercowitz (1986) and Blankenau et al. (2001) report that world real interest rate shocks help to explain aggregate fluctuations in small open economies. Cole and Obstfeld (1991) argue that small barriers to international capital mobility negate the benefits of consumption smoothing. Barriers to international capital mobility are modeled by Mendoza (1991, 2002), Valderrama (2002), and Schmitt-Grohé and Uribe (2003). Mendoza (1991) puts exogenous capital controls into a RBC model, Mendoza (2002) and Valderrama place bounds on a household's debt–income ratio that play the role of a risk premium in the aggregate optimality conditions, while Schmitt-Grohé and Uribe study a time-varying risk premium in a RBC model. We identify the time-varying risk premium with the debt–output ratio, to create an internalized risk premium, which becomes a suspect.

In the next section, we describe the testable predictions of the PVM of the current account and confirm rejections of those predictions on Canadian data. Section 3 presents our small open economy-RBC model, derives its optimality conditions, and explains the numerical methods employed to solve the model. We report Monte Carlo experiment results in Section 4. Conclusions appear in Section 5.

2. The present-value model of the current account

Empirical studies of the PVM of the current account have adapted the permanent-income model of consumption to the small open economy to derive the tests of Campbell (1987) and Campbell and Shiller (1987). As Sheffrin and Woo (1990), Otto (1992), Ghosh

[2] An example is Ghosh (1995), who obtains rejections for Canada, but ironically, finds the PVM holds better in U.S. data. He and Obstfeld and Rogoff (1996) report "excess smoothness" of the predicted Canadian current account, as we report below.

(1995), and Bergin and Sheffrin (2000) report, the cross-equation restrictions implied by the PVM are almost always rejected by the data. In this section, we review these restrictions and confirm their rejections on a sample of post-war Canadian data. We then pursue the paper's main objective of uncovering the sources of these rejections.

2.1. Tests of the present-value model of the current account

The PVM of the current account is derived from the permanent-income decision rule of a small open economy, $\bar{C}_t = rB_t + r(1+r)^{-1}\sum_{j=0}^{\infty}(1+r)^{-j}\ \mathbf{E}_t\{Y_{t+j} - I_{t+j} - G_{t+j}\},\ 0<r$, where $\bar{C}_t$ is the permanent income-level of consumption, and r, Y_t, I_t, G_t, and B_t denote the non-stochastic world real interest rate, output, investment, government spending, and net domestic ownership of foreign assets, respectively. It is assumed that there is only one disturbance, a unit root country-specific technology shock that generates a permanent response in Y_t. Replacing C_t with $\bar{C}_t$ in the expenditure identity, $Y_t \equiv C_t + I_t + G_t + \text{NX}_t$, where net exports, NX_t, equals the current account minus income from net domestic ownership of foreign assets, $\text{CA}_t - rB_t$, it follows that

$$\text{CA}_t = -\sum_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j \mathbf{E}_t \Delta\text{NY}_{t+j},\ \ \text{NY}_t \equiv Y_t - I_t - G_t,\ \ \Delta\text{NY}_{t+j} \equiv \text{NY}_{t+j} - \text{NY}_{t+j-1}. \tag{1}$$

The PVM relation (1) implies that when expected future net income is above trend, the current account is in deficit. This occurs because agents smooth consumption by borrowing abroad in response to the positive permanent income shock.

The PVM cross-equation restrictions rely on the assumption that the joint data generating process (DGP) of ΔNY and CA is an unrestricted pth-order bivariate autoregression, AR(p). Create a $2p$-dimensional vector AR(1), $\mathcal{W}_t = \mathcal{D}\mathcal{W}_{t-1} + \mathcal{V}_t$, from this AR($p$), where $\mathcal{D}$ is the companion matrix, $\mathcal{W}_t \equiv [\Delta\text{NY}_t \ldots \Delta\text{NY}_{t-p+1}\ \text{CA}_t \ldots \text{CA}_{t-p+1}]'$, and $\mathcal{V}_t \equiv [\upsilon_{\Delta\text{NY},t} 0 \ldots, 0\ \upsilon_{\text{CA},t}\ 0 \ldots 0]'$ is a vector of mean zero, homoskedastic errors. The vector AR(1) yields an unrestricted forecast of $\mathcal{W}_{t+j}$, $\mathbf{E}_t\mathcal{W}_{t+j} = \mathcal{D}^j\mathcal{W}_t$. This and the row vector $\mathcal{F} \equiv [1\ 0_{p-1}]$ yield $\mathbf{E}_t\Delta\text{NY}_{t+j} = \mathcal{F}\mathcal{D}^j\mathcal{W}_t$. Substitute this into the present-value relation (1) to find $\mathcal{H} = -\mathcal{F}\mathcal{D}[I - \mathcal{D}/(1+r)]^{-1}/(1+r)$, where $\mathcal{H}$ is a $2p$ row vector.

The cross-equation restrictions of the PVM are embodied in $\mathcal{H}$. These restrictions imply the linear rational expectations forecast of the current account, $\text{CA}_{f,t} = \mathcal{H}\mathcal{W}_t$. The PVM predicts that $\text{CA}_{f,t}$ is identical to the actual contemporaneous current account because it is the $p+1$st element of the date t information set, $\mathcal{W}_t$. Thus, the null hypothesis $\text{CA}_{f,t} = \text{CA}_t$ holds when all elements of $\mathcal{H}$ are zero except its $p+1$st element, which equals one.

Another implication of the model is that the difference between the forecast and actual current account is unpredictable, given the history of $\mathcal{W}_t$. Campbell (1987) provides a way to test this prediction. When the PVM is assumed to be exact, only the country-specific technology shock drives the small open economy. In this case, $\mathcal{D}$ is singular because the difference between its $p+1$st row and first row equals its $p+2$nd row multiplied by $(1+r)$.

We define the implied variable as $\mathcal{CA}_t$ (note the script notation).[3] Given that $\mathcal{D}$ is singular, $\mathcal{CA}_t$ is orthogonal to lags of $\mathcal{W}_t$. According to Campbell, these predictions fail in the presence of a serially uncorrelated transitory demand shock. In this case, since $\mathcal{CA}_t$ and $\mathcal{W}_{t-1}$ are correlated, the PVM predicts that $\mathcal{W}_{t-1}$ has no power to forecast $\mathcal{CA}_{t-1}$ rather than $\mathcal{CA}_t$. This is a test of the extent to which current account fluctuations can be explained by shocks other than those that affect permanent income.

In sum, there are two tests of the cross-equation restrictions of the PVM of the current account: (i) all elements of $\mathcal{H}$ are zero except the $p+1$st element which equals one; and (ii) the forecast innovation is orthogonal to $\mathcal{W}_{t-1}$, so the coefficients of the regression of $\mathcal{CA}_t$ or $\mathcal{CA}_{t+1}$ on $\mathcal{W}_{t-1}$ are all zero.

2.2. The data and empirical results

We employ Canadian data on the current account, GDP net of investment, and government spending from Statistics Canada and Basic Economics. The entire sample is $1961Q1$–$1998Q1$ and the estimation sample runs from $1963Q1$ to $1997Q4$, for a total of $T=140$ observations. The data is measured on a per capita basis in 1992 Canadian dollars and is seasonally adjusted at annual rates. We demean ΔNY_t and CA_t, and estimate a vector AR (VAR) conditional on $p=4$. The calibration sets $r=0.0091$ (or 3.70% on an annual basis) to compute $\mathcal{H}$.[4]

The data reject the PVM cross-equation restrictions. The Wald statistic of the cross-equation restrictions (computed as in Sheffrin and Woo, 1990) embodied in $\mathcal{H}$ is 16.12 with an asymptotic p-value of 0.04 given eight degrees-of-freedom. This rejects the PVM. The LM test statistic, $T \times R^2$, of the orthogonality conditions also rejects. When $\mathcal{CA}_{t+1}$ $(\mathcal{CA}_t)$ is the dependent variable, the test statistic of 14.78 (19.55) has an asymptotic p-value of 0.06 (0.01) on eight degrees-of-freedom. This indicates the regression coefficients are not all zero.

Rejections of the PVM cross-equation restrictions are confirmed by estimates of $\mathcal{H}$. These estimates, $[0.11\ -0.03\ -0.06\ 0.06\ 0.08\ 0.06\ -0.04\ -0.10]'$, are small and none is significantly different from zero. The associated asymptotic standard errors are [0.20 0.20 0.14 0.09 0.41 0.12 0.12 0.11]. The key theoretical prediction, $\mathcal{H}_5 = 1.0$, implies the PVM forecast moves one-for-one with the actual current account, is strongly rejected in the data. This suggests permanent income shocks do not dominate current account fluctuations because the PVM forecast is too smooth.

Finally, as derived in the previous section, $\hat{\mathcal{H}}$ yields a forecast of the current account, $\text{CA}_{f,t}$. The left-side window of Fig. 1 plots this forecast (dot-dash line) and compares it to the actual current account (solid line). Clearly, $\text{CA}_{f,t}$ is less persistent and less volatile than the actual current account. This “excess smoothness”, found uniformly for Canada in the literature, still exists when we account for uncertainty in the estimated parameters of the

[3] The $p+1$st row of $\mathcal{D}$ contains the response of CA_t to $\mathcal{W}_{t-1}$, while the first and $p+2$nd rows of $\mathcal{D}$ are the responses of ΔNY_t and CA_{t-1}, respectively. Hence, $\mathcal{CA}_t \equiv \text{CA}_t - \Delta \text{NY}_t - (1+r)\text{CA}_{t-1}$.

[4] Sheffrin and Woo (1990), Otto (1992), and Ghosh (1995) also demean ΔNY_t and CA_t prior to estimation. To select p, we compute the Akaike information criterion (AIC) and general-to-specific likelihood ratio (LR) tests. The AIC and LR tests select $p=4$. The Canadian sample average of r is calculated using Fisher’s equation, the 3-month Euro-dollar deposit rate, the Canadian dollar–U.S. dollar exchange rate, and the GDP deflator of Canada.

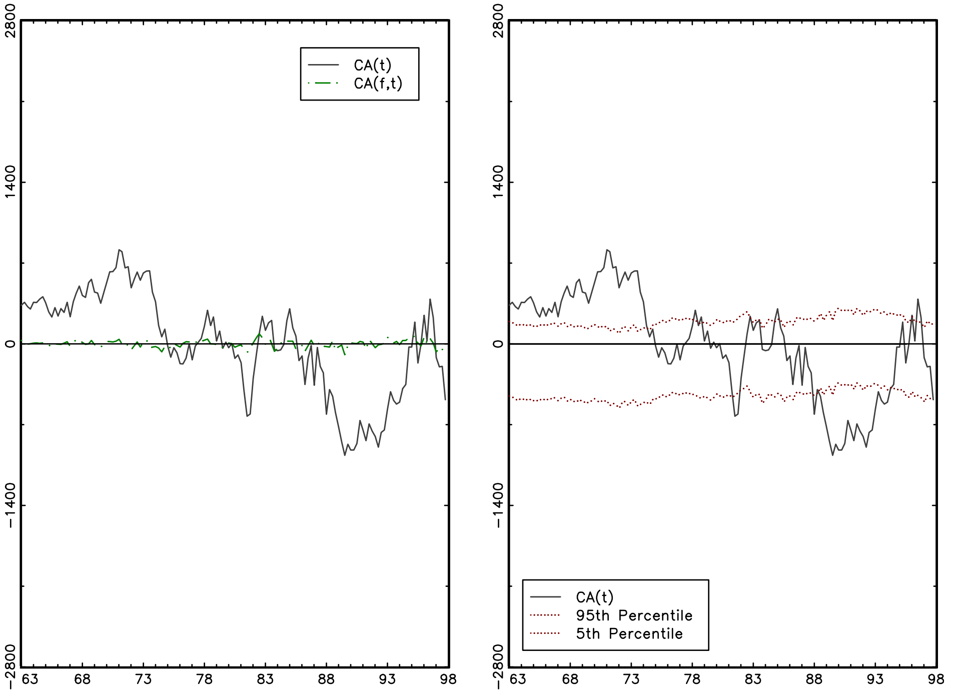

Fig. 1. Canadian CA and PVM forecast.

unrestricted VAR. This is seen in the right-side window of Fig. 1, which contains the actual Canadian current account (solid line) and the fifth and 95th percentiles of the piecewise probability bands of $CA_{f,t}$ (dotted lines), generated using the Bayesian Monte Carlo integration methods of Geweke (1999a).[5] For most of the sample, the actual current account falls outside of the 90% probability bands. This is particularly striking for the second half of the 1980s and the early 1990s, when the actual current account is below the lower probability band of the PVM current account forecast.

3. A small open economy-RBC model

In this section, we construct a one-sector small open economy-RBC model to study several possible sources of the empirical rejections of the PVM. The model acts as a restricted DGP to explore the role of the usual suspects in explaining empirical failures of the PVM. We solve our RBC model numerically around its deterministic steady state and choose prior distributions of the model's parameters. We do this for a benchmark model,

[5] We generate 5000 replications of $CA_{f,t}$ with software Geweke provides at http://www.econ.umn.edu/~bacc. Serial correlation in the 90% confidence bands is handled by computing the two largest principal components of the covariance matrix of the ensemble of synthetic $CA_{f,t}$.

which has only a country-specific permanent technology shock, that we label the "canonical RBC model", and for alternative specifications that feature our suspects.

3.1. Tastes, technology, and the impulse structure

The small open economy-RBC model consists of a representative household, a constant returns to scale (CRS) technology, and an external sector. The household chooses uncertain streams of the single consumption good, C_t, and leisure, L_t, to maximize discounted expected lifetime utility

$$\mathbf{E}_t \sum_{i=0}^{\infty} \beta^i U(C_{t+1}, L_{t+1}), \quad 0<\beta<1. \tag{2}$$

Leisure plus time supplied to the labor market, N_t, sums to the unit of time endowment the household receives each date t, $L_t = 1 - N_t$. Consumption and leisure enter the period utility function either separably

$$U(C_t, L_t) = \phi \ln[C_t] + (1-\phi)\ln[1-N_t], \tag{3}$$

or in non-separable form

$$U(C_t, L_t) = \frac{\left[C_t^{\phi}(1-N_t)^{(1-\phi)}\right]^{(1-\psi)}}{1-\psi}, \quad 0<\phi<1, \psi \neq 1. \tag{4}$$

The restriction is $\psi = 1$ for the separable and log period utility function (3).

When period utility is non-separable in consumption and leisure, changes in time-worked alter the discount the small open economy applies to future expected returns. This links the demand for foreign assets (the current account) to current and expected future domestic labor market activity, and affects consumption smoothing. Thus, under non-separable utility, there is an additional channel for shocks to produce current account fluctuations: through intertemporal movements in time-worked. A second way in which the assumption of non-separable utility can influence the current account is because the (non-log utility) risk aversion it implies yields "consumption-tilting" behavior. The greater the risk aversion, the more responsive is the current account to transitory shocks to consumption.

The household consumes, C_t, accumulates capital, K_{t+1}, through investment, I_t, or alters its stock of the internationally traded bond, B_{t+1}, through net exports, NX_t. The law of motion of capital is

$$K_{t+1} = (1-\delta)K_t + \left(\frac{K_t}{I_t}\right)^{\alpha} I_t, \quad 0<\alpha, \delta<1. \tag{5}$$

This features installation costs in the flow of new capital as in Baxter and Crucini (1993).

An international bond is the only financial asset available to the household, which may purchase (sell) a unit of B_{t+1} from (to) the rest of the world at the end of date t. During date $t+1$, the small open economy receives (sends) one unit of the consumption good plus a stochastic return, r_t, from (to) the rest of the world. The stochastic return is the world real interest rate. Thus, the law of motion of B_{t+1} is

$$B_{t+1} = (1 + r_t)B_t + \mathrm{NX}_t, \tag{6}$$

where NX_t reflects the net flow of the good between the small open economy and the rest of the world.

There are two components to r_t, an exogenous and stochastic return q_t, which is common across the world, and a country-specific risk premium that is assumed to be a linear function of the economy's bond–output ratio. Thus,

$$r_t = q_t - \varphi \frac{B_t}{Y_t}, \quad 0<\varphi. \tag{7}$$

A risk premium, linear in the bond–output ratio of the small open economy, can be motivated by the Bernanke and Gertler (1989) "balance sheet effects" model, according to Céspedes et al. (2000) and Mendoza (2002).

In our model, movements in the world real interest rate are an additional source of consumption smoothing. Interest rate fluctuations can arise from exogenous shocks, q_t, or from endogenous fluctuations in the risk premium, $\varphi(B_t/Y_t)$, in response to other shocks.[6] Exogenous shocks generate income and substitution effects in the small open economy and produce current account fluctuations by driving a wedge between expected returns to the international bond and domestic physical capital (which equals the marginal product of K_{t+1}). Movements in the risk premium have the same effect and imply, for example, that an economy that is a net debtor, $B_{t+1}<0$, pays a premium above q_t.[7]

We assume that the risk premium is independent of any action the small open economy may take. Thus, the small open economy treats the risk premium as exogenous, i.e., its decision rules fail to account for changes in the risk premium, $\varphi(B_t/Y_t)$, which is the approach Schmitt-Grohé and Uribe (2003) take. From this perspective, imperfect capital mobility is equivalent to the risk premium because either produces a wedge between q_t and r_t.

Our model is tied together by the resource constraint

$$Y_t = C_t + I_t + G_t + \mathrm{NX}_t. \tag{8}$$

Output is produced with the CRS technology

$$Y_t = K_t^{\theta}[A_t N_t]^{(1-\theta)}, \quad 0<\theta<1, \tag{9}$$

[6] Placing the risk premium (7) in the law of motion of the unit discount bond (6) negates a unit root in the *linearized* solution of our small open economy-RBC model. Schmitt-Grohé and Uribe (2003) study several devices that achieve a well-posed linearized solution for this class of RBC models, including a risk premium that is strictly increasing in the unit discount bond, and show that they all produce the same responses to one-time technology shocks. One contribution of our paper is to show the extent to which the Schmitt-Grohé and Uribe result holds in a model with multiple shocks.

[7] The risk premium a debtor pays is higher the more negative is its bond–output ratio. However, a debtor whose output grows faster than its foreign liabilities sees its risk premium fall. This allows our small open economy in principle to remain in debt permanently.

where A_t denotes a country-specific technology shock. It evolves as a random walk with drift

$$A_{t+1} = A_t \exp\{\gamma + \varepsilon_{t+1}\}, \quad 0<\gamma, \quad \varepsilon_{t+1} \sim \mathbf{N}\left(0, \sigma_\varepsilon^2\right). \tag{10}$$

Since A_t drives permanent movements in the model's quantity variables (except for N_t), it plays the role of the domestic disturbance to permanent income.

Shocks to the transitory component of government spending, $g_t = G_t / Y_t$, and the exogenous component of the world real interest rate, q_t are assumed to follow AR(1) processes

$$g_{t+1} = g^{*(1-\rho_g)} g_t^{\rho_g} \exp\{\eta_{t+1}\}, \quad |\rho_g|<1, \quad \eta_{t+1} \sim \mathbf{N}\left(0, \sigma_\eta^2\right), \tag{11}$$

and

$$1 + q_{t+1} = (1 + q^*)^{(1-\rho_g)} (1 + q_t)^{\rho_g} \exp\{\xi_{t+1}\}, \quad |\rho_g|<1, \quad \xi_{t+1} \sim \mathbf{N}\left(0, \sigma_\xi^2\right), \tag{12}$$

where g^* is the steady state or unconditional mean of g_t and q^* is the exogenous component of the world real interest rate. We assume that the innovations ε_t, η_t, and ξ_t are uncorrelated at all leads and lags.

3.2. Optimality and equilibrium

Maximizing (2) subject to (5)–(12), and K_{t+1}, C_t, I_t, and N_t non-negative, yields well-known optimality conditions for the labor market, domestic market for physical capital, and the international (unit discount) bond market. Any candidate equilibrium path must satisfy the optimality conditions for the labor, physical capital, and international bond markets, the laws of motion of (5)–(7), and aggregate resource constraint (8) by necessity, given the production function (9) and exogenous shock processes (10)–(12). The transversality conditions $\lim_{j\to\infty}\beta^j \mathbf{E}_t\{\lambda_{K,t+j}K_{t+1+j}\}=0$ and $\lim_{j\to\infty}\beta^j \mathbf{E}_t\{\lambda_{B,t+j} B_{t+1+j}\}=0$, provide sufficient conditions for any candidate equilibrium, where $\lambda_{K,t+j}$ and $\lambda_{B,t+j}$ are shadow prices attached to the laws of motion of (5) and (6), respectively. Brock (1982) shows that the optimality, equilibrium, and transversality conditions are used to establish uniqueness of the equilibrium for a class of economies that covers our small open economy-RBC model.

3.3. The numerical solution and priors

Our numerical solution proceeds by first, stochastically detrending the aggregate quantity variables (with the exception of N_t) using A_t. Second, we take a first-order Taylor expansion around the deterministic steady state of the stochastically detrended optimality and equilibrium conditions. Next, we arrange the results of the linearization into a two-sided linear vector stochastic difference equation for $\mathcal{M}_{t+1} = \left[\tilde{K}_{t+1}\tilde{B}_{t+1}\right]'$, where, for example, $\tilde{K}_{t+1} = K_{t+1}A_t^{-1}/K^* - 1$ and K^* denotes the steady state value of capital. We conjecture the solution

$$\mathcal{M}_{t+1} = \mu_{\mathcal{M}}\mathcal{M}_t + \mu_{\mathcal{Z}}\mathcal{Z}_t \tag{13}$$

of the linearized system and follow Zadrozny (1998) to compute a solution.[8] The matrices $\mu\mathcal{M}$ and $\mu\mathcal{Z}$ of (13) are two-by-two and two-by-three matrices of coefficients to be determined by our numerical solution and $\mathcal{Z}_t = [\varepsilon_t \; \tilde{g}_t \; \tilde{q}_t]'$. The vector of state variables $\mathcal{S}_t = [\mathcal{M}_t{}'\mathcal{Z}_t{}']'$ drives the "flow" vector

$$\mathcal{C}_t = \pi_{\mathcal{S}}\mathcal{S}_{t,} \tag{14}$$

where $C_t = [\tilde{C}_t \; \tilde{I}_t \; \tilde{N}_t \; \tilde{Y}_t]'$ and $\pi_{\mathcal{S}}$ is a four-by-five matrix.

Our simulation exercises adapt the Bayesian methods of DeJong et al. (1996). This requires us to calibrate prior distributions for the parameters of our small open economy-RBC model. Since the prior distributions induce probability distributions for the moments of interest (the tests of the PVM) implied by the theoretical model, we can measure the fit of the theoretical model to the actual data.

Priors for γ, σ_ε, g^*, ρ_g, σ_η, q^*, ρ_q, and σ_ξ are based on sample observations. We impose a degenerate prior on the deterministic growth rate of technology, γ, calibrating it to 0.0024, the sample mean of $\Delta\ln[A_t]$. The prior of its standard deviation, σ_ε, is assumed to be normal, centered on its sample mean of 0.0120 with a 95% coverage interval of [0.0115, 0.0125]. The sample mean of the government spending–output ratio, 0.2326, serves as the mean of the prior of g^*, while the means of the priors of the slope coefficient and standard deviation of the fiscal shock are calibrated from the relevant AR(1) estimates, $[\rho_g \; \sigma_\eta] = [0.9923 \; 0.0127]'$. This gives 95% coverage intervals for g^*, ρ_g, and σ_η of [0.2062, 0.2593], [0.9609, 0.9983], and [0.0121, 0.0133], respectively. These intervals are drawn from normal distributions, except for ρ_g whose prior is based on a log-normal distribution.

The priors of the parameters of the exogenous world real interest rate process are set in the same way. The mid-point of the prior of q^* is set at 0.0071 (or 2.87% on an annual basis), $[\rho_q \; \sigma_\xi] = [0.9076 \; 0.0040]'$ is calibrated from AR(1) estimates of q_t, and normal distributions produce the 95% coverage intervals for q^*, ρ_q, and σ_ξ of [0.0058, 0.0084], [0.8580, 0.9567], and [0.0035, 0.0045], respectively.

Priors for the technology and utility function parameters follow standard RBC calibration practice. We center the prior of capital's share of income, θ, on 0.35 and draw its 95% coverage interval, [0.3201, 0.3802], from a normal distribution. The prior of the depreciation rate, δ, is also based on a normal distribution with a median of 0.02, which yields a 95% coverage interval of [0.0149, 0.0250]. The prior of the installation cost (on the flow) of new capital parameter, α, is based on a normal distribution that is centered on 0.0503, with 95% coverage interval of [0.0301, 0.0703]. This covers calibrations found in the international RBC literature (e.g., Baxter and Crucini, 1993; Correia et al., 1995). The degenerate prior of the utility function parameter ϕ, 0.3716, is consistent with the steady

[8] Zadrozny employs an eigenvalue method of undetermined coefficients to solve for the elements of $\mu\mathcal{M}$ of the linear vector stochastic difference Eq. (13). Given this solution, the forward-looking moving average component of the two-sided linear vector stochastic difference equation imposes restrictions on the elements of the matrix $\mu_{\mathcal{Z}}$.

state of the labor market optimality condition. Given a normal distribution, the 95% coverage interval of ϕ is [0.3498, 0.3941]. We set the mid-point of the risk aversion parameter ψ at two to be consistent with the international RBC literature. The 95% coverage interval of ψ, drawn from a normal distribution, is [1.5025, 2.5100].

The degree of international capital mobility is parameterized with the risk premium parameter φ. For example, the risk premium in the world real interest rate generating Eq. (7) of the small open economy shows that a debtor (creditor) faces a higher (lower) world real interest rate, r_t, because its risk premium rises (falls) with φ. This drives the steady state bond–output ratio to zero as φ increases. The problem is that the literature provides little guidance for choosing a prior for φ. In our canonical RBC model, capital is perfectly mobile internationally, suggesting that $\varphi=0.0$. However, in order to avoid the well-known problems associated with a unit root in the bond accumulation process (e.g., Lundvik, 1992; Correia et al., 1995; Senhadji, 2003; Lindé, 2004; Schmitt-Grohé and Uribe, 2003) we cannot set $\varphi=0$.[9] Thus, we assume that the risk premium is "small", just one basis point at an annual rate (which implies $\varphi=0.000140$) at the steady state, in this case.

Under imperfect international capital mobility, we calibrate the prior of φ to Canadian data. Clinton (1998) and Fung et al. (1999) report estimates consistent with risk premia between 10 and 90 basis points at an annual rate on medium- to long-term Canadian bonds in global financial markets. We fix φ in the middle of this range, implying a risk premium of 50 basis points. This yields $\varphi=0.0070$ at the mean of the Canadian bond–output ratio (about -0.35). We also assume that in 19 out of 20 replications the risk premium ranges from 25 to about 75 basis points, which implies a 95% coverage interval of $\varphi\in[0.0038, 0.0104]$, given a normal distribution.

Under this prior, the effects of the risk premium are similar to those of Backus et al. (1992) and Bergin's (2001) estimate of the costs of current account flows. Our risk premium lowers the net exports–output ratio by less than 0.03% at the sample mean of our Canadian data. Cole and Obstfeld (1991) argue that the benefits associated with consumption smoothing can be outweighed by even small barriers to perfect capital mobility.

4. Understanding rejections of the present-value model of the current account

Given the approximate linear equilibrium law of motion of the state vector, (13) the associated flow relationship (14), and priors of our model, we construct distributions of the test statistics of the PVM from artificial time series. These series are generated by Bayesian Monte Carlo experiments.

4.1. Monte Carlo strategy

We measure the fit of our small open economy-RBC model using PVM test statistics (described in Section 2) as our "moments" of interest. Monte Carlo experiments generate

[9] This problem does not necessarily arise for non-linear solution methods when $r^*<(1-\beta)/\beta$, but does arise for linear approximate solution methods irrespective of the relationship of r^* and β.

$\mathcal{J} = 5000$ replications of the multivariate artificial time series $\{\mathcal{W}_{\mathcal{T},\mathcal{K}}\}_{\mathcal{K}=1}^{140}$, where $\mathcal{T}$ denotes an object conditional on the RBC model.[10] An unrestricted VAR(4) is estimated on the synthetic data to compute $\mathcal{H}_{\mathcal{T}}$, its Wald statistic, and $\text{CA}_{f,\mathcal{T},t}$.[11] In addition, a regression of $\mathcal{CA}_{\mathcal{T},t+1}$ on $\mathcal{W}_{\mathcal{T},t-1}$ is used to test the orthogonality condition. The empirical distributions, denoted $\mathcal{E}$, are posterior distributions of the actual data's PVM moments. We produce these $\mathcal{E}$ distributions using Bayesian simulation techniques described by Geweke (1999a). Geweke (1999b) argues that to measure the fit of a dynamic stochastic general equilibrium model to the data requires an explicit statistical model. In our case, the statistical model is the unrestricted VAR or the orthogonality regression. The statistical models link population PVM moments implied by $\mathcal{T}$ distributions to the actual data's $\mathcal{E}$ distributions of the same moments.

An obvious requirement for our analysis is a metric of "closeness". Consider our comparison involving the individual elements of $\mathcal{H}$. The distance between $\mathcal{T}(\mathcal{H}_i)$ and $\mathcal{E}(\mathcal{H}_i)$ is measured by the difference in their ensemble averages, $\mathcal{H}_{\mathcal{T},i}$ and $\mathcal{H}_{\mathcal{E},i}$, normalized by the latter ensemble's standard deviation. DeJong et al. (1996) refer to this as the standardized difference of means (SDM) statistic. Since the SDM statistic gauges how close the probability distribution of $\mathcal{T}(\mathcal{H}_i)$ is to $\mathcal{E}(\mathcal{H}_i)$ for each element of $\mathcal{H}$, a large value for this t-ratio-like statistic indicates our small open economy-RBC model fits the actual data poorly.

A second comparison of the $\mathcal{T}$ and $\mathcal{E}$ distributions examines the validity of the PVM cross-equation restrictions and the orthogonality condition. This is measured with non-parametric probability densities estimates of (i) the Wald statistic and (ii) the LM statistic, $T \times R^2$.[12] The $\mathcal{T}$ and $\mathcal{E}$ non-parametric densities of the Wald and LM statistics are used to judge goodness of fit in two ways. First, we display plots of estimated $\mathcal{T}$ and $\mathcal{E}$ densities, which should overlap and be close if the RBC model is a good fit to the data. Second, we use the confidence interval criterion (CIC) statistic developed by DeJong et al. (1996). The CIC measures the intersection of $\mathcal{T}$ and $\mathcal{E}$ distributions of the LM or Wald statistics. Given a $1-\omega$ percent confidence level, the CIC measures the fraction of $\mathcal{T}$ and $\mathcal{E}$ distributions that reside in an interval from the (lower) 0.5ω quantile L to the (upper) $1-0.5\omega$ quantile $\mathcal{U}$.[13] The larger the CIC the better the theoretical RBC model fits the actual data. In their study of a proto-type RBC model, DeJong, Ingram, and Whiteman regard CIC statistics of 0.30 or greater as indicating support for the theoretical model.

We focus on the orthogonality condition of the PVM that accounts for a transitory demand shock, rather than the orthogonality condition of the exact PVM. It will always be rejected by the RBC model no matter its configuration. This is not surprising in light of the model's structure and linearized solution. We discuss this point in the appendix.

[10] We generate 315 synthetic observations, but drop the first 175 observations to remove dependency to initial conditions.

[11] The simulations use the mean of synthetic realizations of $\{r_{\mathcal{K}}\}_{\mathcal{K}=1}^{140}$ to calibrate the non-stochastic world real interest rate.

[12] We follow Silverman (1986) to estimate the non-parametric densities; see the appendix for details.

[13] This is $\text{CIC}_x = (1-\omega)^{-1}\int_{\mathcal{L}}^{\mathcal{U}} \mathcal{T}(x_j)\text{d}x_j$, where x is either the LM or Wald statistic. DeJong, Ingram, and Whiteman normalize the CIC by $1-\omega$ so that it equals $\int_{\mathcal{L}}^{\mathcal{U}} \varepsilon(x)\text{d}x_j$. We always set $\omega = 0.10$.

4.2. The canonical RBC model

We begin with a “canonical” version of our small open economy-RBC model outlined in Section 3. This model features perfect international capital mobility, a fixed world real interest rate, and a country-specific technology shock that dominates business cycle fluctuations. Our canonical model generates predictions that are often close to the actual data, and hence violate the restrictions the PVM places on the current account.

As noted above, the design of our canonical model rules out several of our “usual suspects”, such as fiscal policy shocks and an internalized risk premium. Seven parameter restrictions on the full model imply the canonical model. The household discount factor β equals $1/(1+q^*)$, which approximates the permanent income hypothesis restriction and is always in effect. The restrictions $[g^* \rho_g \sigma_\eta]' = [0.0 0.0 0.0]'$ remove the fiscal shock from the model.[14]

The upper panels of Fig. 2 plot the distribution of the LM statistics from the $\mathcal{T}$ and $\mathcal{E}$ densities. There are two important elements to evaluating these densities, the comparison between: (1) the synthetic data and the theoretical orthogonality prediction (how far to the left of the sample test statistic is the $\mathcal{T}$ density?), and (2) the synthetic data and the actual data (how much do the $\mathcal{T}$ and $\mathcal{E}$ densities overlap?).

First, we see that the canonical RBC model with separable utility has little problem satisfying the theoretical orthogonality prediction. The model produces $\mathcal{T}$ densities of the LM statistic that are mostly to the left of the sample LM statistic. Thus, this version of the canonical RBC model is consistent with the theoretical prediction that lags of ΔNY_t and CA_t have no power to forecast $\mathcal{CA}_{t+1}$. Since this prediction is rejected for non-separable utility (the CIC statistic is 0.90), it suggests separable utility is in part responsible for the observed rejections of the PVM.

The probability densities of the Wald statistic appear in the bottom panels of Fig. 2. The version with separable utility generates a distribution for $\mathcal{H}$ that resembles the PVM’s theoretical cross-equations restrictions, as indicated by the fact that the density lies to the left of the sample Wald statistic. In this case, the overlap with the $\mathcal{E}$ distribution is substantial, given the CIC = 0.70. With non-separable utility, the $\mathcal{T}$ density of the Wald statistic is close to uniform, and hence matches neither the basic PVM theory nor the actual data well at all. Its CIC statistic is 0.02.

Table 1 displays the ensemble means of the elements of $\mathcal{H}_\mathcal{T}$ and their SDM statistics. As shown in column 1, the canonical RBC model with the separable and log period utility function yields estimates of $\mathcal{H}_{\mathcal{T},i}$ that are 0.1 or less (in absolute value), except the second, fifth and sixth elements which, at -0.25, 0.76 and 0.33, are nearly -1.15, 1.50, and 2.30 standard deviations away from the associated sample estimates, respectively. These estimates reveal a current account forecast that exhibits excess

[14] Still, our synthetic DGP must possess two fundamental disturbances because the PVM assumes a VAR in ΔNY_t and CA_t. The first is naturally the country-specific unit root technology shock. We assume the second shock in the canonical RBC model is ξ_t, the innovation to the exogenous component of the world real interest rate, q_t. However, to maintain the spirit of the PVM, we make ξ_t “small”, given the point mass prior of $\sigma_\xi = 2.110 \times 10^{-5}$ (its calibrated value is 0.004) and eliminate persistence in q_t with $\rho_q = 0.0$. Also, since international capital mobility cannot literally be perfect, we employ the degenerate prior, $\omega = 0.000140$, which sets the steady state risk premium to one basis point (at an annual rate).

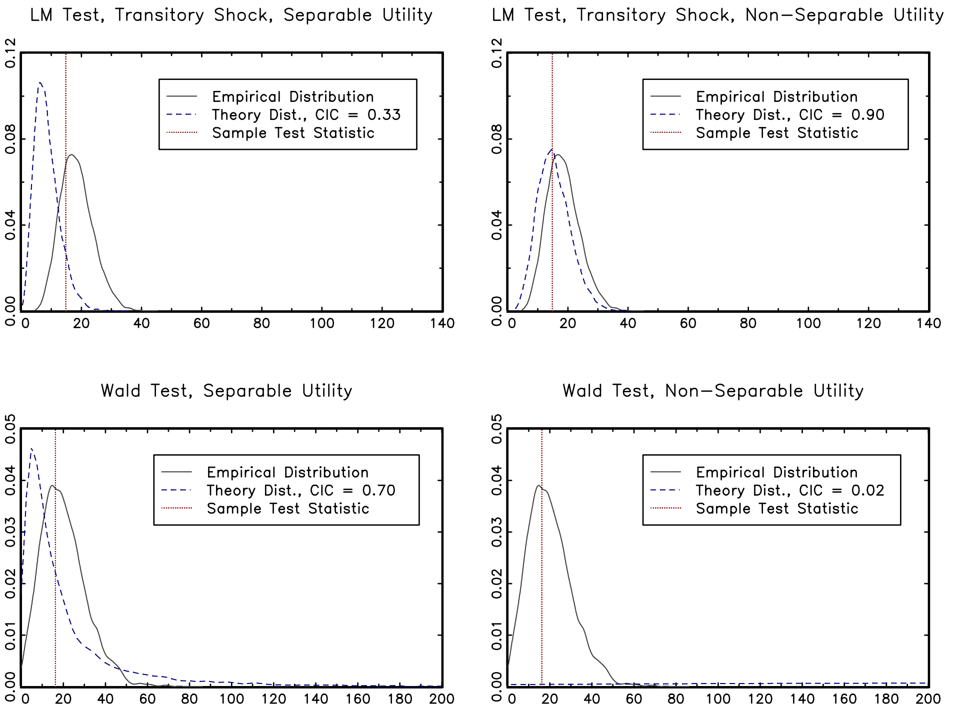

Fig. 2. Fit of the Canonical RBC model.

sensitivity to the first lags of net output growth and the current account. Note also $\mathcal{H}_{\mathcal{T},5}$ is about three-fourths of the theoretical PVM value of unity, but $\mathcal{H}_{\mathcal{T},5}$ through $\mathcal{H}_{\mathcal{T},8}$ sum to 0.90. These estimates and SDM statistics suggest the canonical RBC model will match the actual data very well.

The canonical RBC model with the non-separable period utility function fails to replicate the theoretical PVM predictions. This cannot be explained by excess sensitivity of $\mathrm{CA}_{f,t}$ to net output growth, its lags, or lags of the current account. The relevant estimates are between -0.16 and 0.20, with SDM statistics 0.88 or less (in absolute value). However, this non-separable utility function moves the canonical model closer to the data, as $\mathcal{H}_{\mathcal{T},5} = 0.41$.

The final piece of evidence about the fit of the canonical RBC model appears in the top row of Fig. 3. This displays the actual Canadian current account (the solid plot) and the 5th and 95th percentiles of the Bayesian Monte Carlo pointwise probability bands (dot-dash plots) of the PVM forecast of the current account from the canonical RBC model with separable utility, the left-side window, and with non-separable utility, the right-side window.[15] The model with separable preferences matches the actual PVM forecasts because the 90% probability bands of $\mathrm{CA}_{f,t}$ contains the actual current account for the

[15] The 90% probability bands use the two largest principal components of the covariance matrix of the $\mathrm{CA}_{f,t}$ ensemble.

Table 1
Tests of the canonical and alternative SOE-RBC models

	Experiment				
	Separable utility	Non-separable utility	Transitory fiscal shock	World interest rate shock	Imperfect capital mobility
$\mathcal{H}_{\mathcal{T},1}$	−0.01 (−0.41)	0.03 (−0.27)	−0.36 (2.23)	0.11 (0.09)	−0.15 (−1.19)
$\mathcal{H}_{\mathcal{T},2}$	−0.25 (−1.13)	−0.16 (−0.68)	−0.31 (−1.46)	0.11 (0.77)	0.18 (1.14)
$\mathcal{H}_{\mathcal{T},3}$	−0.09 (−0.17)	−0.07 (−0.03)	−0.07 (0.05)	0.06 (0.92)	0.07 (1.06)
$\mathcal{H}_{\mathcal{T},4}$	0.01 (−0.78)	−0.03 (−1.22)	0.07 (−0.09)	0.02 (−0.59)	−0.00 (−0.89)
$\mathcal{H}_{\mathcal{T},5}$	0.76 (1.47)	0.41 (0.80)	0.63 (1.22)	1.20 (2.31)	1.32 (2.54)
$\mathcal{H}_{\mathcal{T},6}$	0.33 (2.29)	0.20 (1.20)	0.22 (1.36)	−0.08 (−1.00)	−0.40 (−3.60)
$\mathcal{H}_{\mathcal{T},7}$	−0.10 (−0.54)	−0.01 (0.20)	−0.25 (−1.83)	0.11 (1.18)	0.07 (0.89)
$\mathcal{H}_{\mathcal{T},8}$	−0.10 (0.10)	−0.01 (0.88)	−0.08 (0.22)	0.06 (1.56)	0.09 (1.84)

The canonical RBC specification employs log separable utility, $\beta_j = 1/(1+q_j^*)$, point mass priors of $g^* = \rho_g = \rho_q = \sigma_\eta = 0$, $\varphi = 0.000140$, $\sigma_\xi = 2.110 \times 10^{-5}$ The non-separable utility specification employs a prior on the risk aversion parameter of $\psi \in [1.50, 2.51]$ centered on two. Imperfect international capital mobility is achieved with the prior $\varphi \in [0.0038, 0.0104]$ centered on $\varphi = 0.0070$. The prior on the transitory shock to the government spending–output ratio are $\rho_g \in [0.9609, 0.9983]$ and $\sigma_\eta \in [0.0121, 0.0133]$. The Monte Carlo experiment with a transitory exogenous world real interest rate is based on the priors $\rho_q \in [0.8580, 0.9567]$ and $\sigma_\xi \in [0.0035, 0.0045]$. Details about the priors of the model parameters are discussed in Section 3.3 of the text. The simulation experiments rely on 5000 replications of 140 artificial observations of ΔNY_t and the CA_t generated by the linearized solution of our small open economy-RBC model over the priors of the model's parameters. The SDM($\mathcal{H}$) statistics appear in parentheses and are computed as $\left[\mathcal{H}_{\mathcal{T},1} - \mathcal{H}_{\varepsilon,i}\right]/\mathrm{STD}\left(\mathcal{H}_{\varepsilon,i}\right), i = 1, \ldots, 8$, where $\mathrm{STD}\left(\mathcal{H}_{\varepsilon,i}\right)$ is the standard deviation of $\mathcal{H}_{\varepsilon,i}$.

entire sample period. With non-separable utility, the actual Canadian current account lies at or above the upper 90% probability band of $CA_{f,t}$ during the 1960s and early 1970s, the mid-1980s, and mid-1990s. The actual current account is close to the lower 90% probability band only briefly. Thus, the fit of the canonical RBC model to the actual Canadian current account depends on restrictions on utility.

In sum, we show that in artificial data generated by the canonical small open economy-RBC model, the familiar PVM predictions for the current account are often not rejected. In retrospect, this finding ought not to come as a surprise given the restrictions on the canonical model. We also show that the theoretical forecast of the canonical model with separable preferences does a relatively good job explaining the actual Canadian current account data. Although this indicates that the canonical RBC model serves as a good approximation to the true DGP of the current account, this model predicts excess sensitivity to the first lags of net output growth and the current account. This is a puzzle because the canonical RBC model is designed to satisfy the PVM restrictions. In the next section, we see if incorporating our "usual suspects"

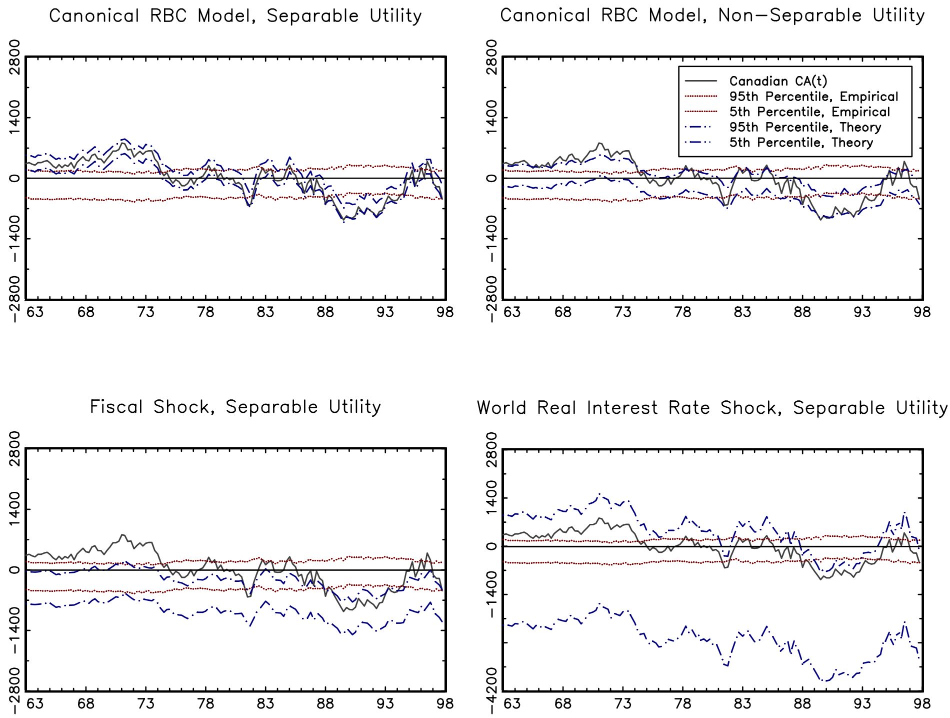

Fig. 3. PVM forecast and RBC models.

into the canonical RBC model resolves this quandary and improves its fit to the actual data.

4.3. The usual suspects

We investigate the impact of each of the usual suspects by introducing them one-by-one into the canonical RBC model with the separable utility function (3). The suspects are transitory shocks to fiscal policy and the world real interest rate, and imperfect international capital mobility. When we introduce a suspect, the rest of the priors are the same as for the canonical model with separable, log period preferences.

The transitory shock to fiscal policy is specified by the AR(1) process (11). We set up the fiscal policy experiment with priors on the parameters of the AR(1) government spending–output ratio process, its steady state, g^*, the slope coefficient ρ_g, and the standard deviation σ_η. These priors reflect observations from Canadian data and are described in Section 3.3. Movements in the transitory component of government spending exhibit a substantial amount of persistence and volatility. The prior on ρ_g is a near unit root and its 95% coverage interval implies that the half-life of an innovation to g_t ranges from 3.5 to more than 100 years. Transitory shocks to fiscal policy possess more volatility than either technology shocks or shocks to the exogenous component of the world real interest rate. Innovations to g_t, η_t, are more than three times as volatile as innovations to q_t. The fiscal policy experiment highlights the role of a country-specific demand shock for current account fluctuations.

In the interest rate experiment, shocks to the exogenous component of the world real interest rate, q_t, focus attention on the response of the current account to changes in the rate at which the rest of the world is willing to move consumption intertemporally. Although q_t is persistent, it is not as persistent as fiscal shocks. The 95% coverage interval of the prior of ρ_q implies that the half-life of a shock to q_t is between 1 year and 4 years. The prior on the standard deviation of the innovation ξ_t of q_t, σ_ξ, makes this shock the least volatile of the model.

Fig. 4 contains densities of the LM and Wald statistics of the fiscal policy and exogenous world real interest shock experiments. The fiscal policy experiment yields a $\mathcal{T}$ density of the LM statistic that has the most overlap and is closest to the $\mathcal{E}$ density of the LM statistic (top left window), with a CIC statistic of 0.59. This statistic is 0.36 in the exogenous world real interest rate experiment (top right window).

The bottom panels of Fig. 4 depict the $\mathcal{T}$ and $\mathcal{E}$ densities of the Wald statistic for the interest rate and fiscal policy experiments. These generate CIC statistics of 0.92 and 0.53, respectively, which suggest an exogenous shock to the world real interest rate helps to explain rejections of the PVM. This is consistent with the empirical work of Bergin and Sheffrin (2000), who report that adding a consumption-based real interest rate to the standard VAR used in PVM tests produces fewer rejections of its predictions. Since our experiments distinguish between different potential sources of interest rate movements, our results help to uncover the underlying reasons for Bergin and Sheffrin's findings.[16]

The $\mathcal{H}_\mathcal{T}$ distributions of the interest rate and fiscal policy experiments are qualitatively similar to one another, and similar to those of the canonical RBC model, with one exception. Columns 3 and 4 of Table 1 show the only substantive difference appears in the all-important fifth element of $\mathcal{H}_\mathcal{T}$. The fiscal policy experiment generates $\mathcal{H}_{\mathcal{T},5}$ =0.63, with SDM=1.22. In the interest rate experiment, $\mathcal{H}_{\mathcal{T},5} = 1.20$, which is more than two standard deviations larger than its $\mathcal{H}_{\varepsilon,5}$ counterpart. Thus, fiscal policy shocks move the model closer to the actual data according to this test of the PVM.

The 90% probability bands that are associated with the $\mathcal{T}$ and $\mathcal{E}$ distributions of CA_f appear in the bottom row of Fig. 3 along with the actual Canadian current account. We see that the world real interest rate experiment generates $\mathcal{T}$ 90% probability bands (the dot-dash plot) that always cover the actual current account (the solid plot) and contain zero except from 1988–1993. The $\mathcal{T}$ bands associated with the fiscal policy experiment, on the other hand, include the actual current account only during the late 1980s and early 1990s (lower left window of Fig. 3).

As noted in Section 3.3, imperfect international capital mobility is identified with the risk premium, $-\varphi B_t/Y_t$. As φ increases, the steady state bond–output ratio goes to zero. Hence, greater imperfections in international capital mobility raise the cost of

[16] Schmitt-Grohé (1998) finds that terms-of-trade and U.S. business cycle shocks help to explain aggregate fluctuations in Canada. The outcomes of our experiments are consistent with her results to the extent that our calibration of q_t captures the shocks she identifies.

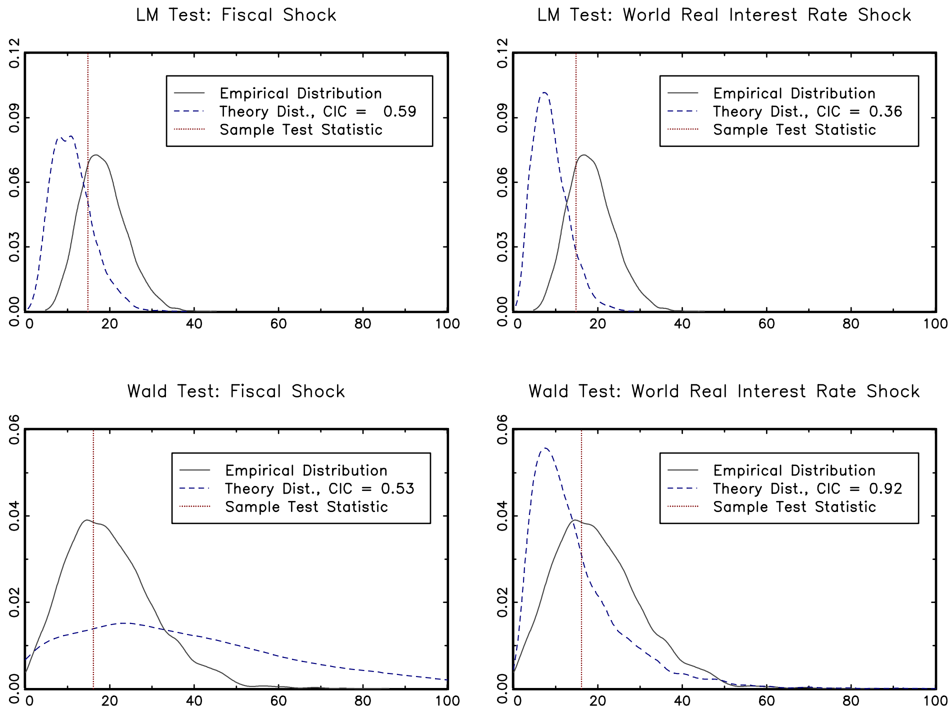

Fig. 4. PVM tests and the RBC models.

accumulating debt, and so raise the option value a small open economy derives from using the current account to smooth consumption.

There are two factors that drive this value for a debtor small open economy, such as Canada. First, the interest rate the small open economy faces, r_t, is higher than the common world real interest rate, q_t. This creates a flow of asset income out of the small open economy, generating current account fluctuations as households try to smooth consumption. Second, a larger risk premium is synonymous with a larger debt–output ratio (more negative B_t/Y_t) for the economy, which implies a smaller current account on average. Thus, the current account exhibits more sensitivity to any shock that affects the debt–output ratio. This increases the volatility of the current account and the costs of using it to smooth consumption.

This prediction is supported by our Bayesian simulation experiments. When imperfect capital mobility is incorporated into our canonical RBC model, it induces additional variability in the current account. The left-side window of Fig. 5 reflects this clearly.

As seen in the right-side windows of Fig. 5, the imperfect international capital mobility experiment produces $\mathcal{T}$ densities of the LM and Wald statistics with CICs of 0.32 and 0.71, respectively. These lie in the range of those of the world interest rate and fiscal policy experiments.

The ensemble averages of $\mathcal{H}_{\mathcal{T}}$ and the SDM statistics of the imperfect international capital mobility experiment appear in the final column of Table 1. These statistics indicate that $\mathcal{H}_{\mathcal{T},5}$ and $\mathcal{H}_{\mathcal{T},6}$ are much further away from their empirical counterparts than in the canonical RBC model or in the fiscal policy and world real interest rate shock experiments. Thus, this experiment generates a larger response of the current account forecast to contemporaneous current account movements than predicted by the PVM, as indicated by $\mathcal{H}_{\mathcal{T},5}=1.32$, which is more than 2.50 standard deviations greater than the sample distribution. Although $\mathcal{H}_{\mathcal{T},5}$ and $\mathcal{H}_{\mathcal{T},6}$ sum to unity, the lagged revision to the forecast is large and negative, $\mathcal{H}_{\mathcal{T},6}=-0.40$, and 3.60 standard deviations below its sample counterpart. This suggests substantial volatility in the 90% probability bands. Thus, there is mixed evidence on the importance of departures from perfect capital mobility in explaining rejections of the PVM. According to the LM and Wald tests, imperfect capital mobility is nearly as important a suspect as transitory shocks to fiscal policy and shocks to world interest rates. However, the forecasted current account from the model with imperfect capital mobility exhibits considerably more variability than is consistent with the data.

4.4. One that almost got away: the internalized risk premium

The previous section reports that adding the usual suspects of non-separable utility, transitory shocks to fiscal policy and the world real interest rate, or imperfect international

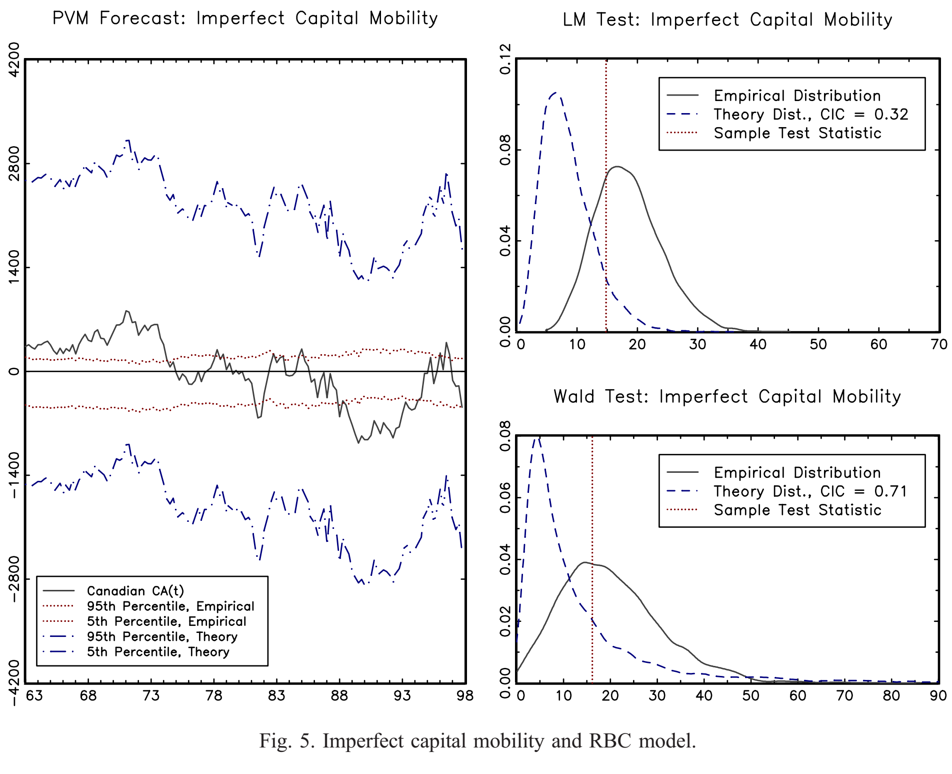

Fig. 5. Imperfect capital mobility and RBC model.

capital mobility to the canonical small open economy-RBC model does not help it to better fit the data or push it closer to the PVM theory. The latter result is a conundrum because the PVM restrictions are embedded in the RBC model.

To investigate this further, begin by noting that there is no explicit connection between the labor market of the canonical small open economy-RBC model, the current account, and the PVM. One interpretation of the PVM is that the labor supply is perfectly inelastic and therefore has no impact on current account dynamics. Although this is not true of the canonical RBC model, it is not apparent from the model's labor market optimality condition

$$\frac{N_t}{1-N_t} = \phi\left(\frac{1-\theta}{1-\phi}\right)\left(\frac{C_t}{Y_t}\right)^{-1}. \tag{15}$$

The optimality condition (15) states that the equilibrium path of labor is the inverse (or negative) of movements in permanent income. This implies that in the canonical RBC model, consumption is smoothed with labor market decisions (i.e., variation in labor supply and demand), rather than with the current account.[17] In this case, the current account is smoother than the PVM predicts, as we observe in the Canadian data.

The key to labor market dynamics in the optimality condition (15) is the consumption–output ratio. If we combine the resource constraint, the law of motion of the unit discount bond (6), and the world real interest rate (7), impose the permanent income hypothesis, and assume $\exp\{\gamma\} < 1 + q^* - 2\varphi(B/Y)^*$ to satisfy the relevant transversality condition, the consumption–output generating equation is

$$\left(\frac{\tilde{C}}{Y}\right)_t \approx C_B^*\left(\frac{\tilde{B}}{Y}\right)_t + C_{\mathrm{NY}}^*\sum_{j=0}^{\infty}\left(\frac{\gamma^*}{R^*}\right)^j \mathbf{E}_t\left(\frac{\widetilde{\mathrm{NY}}}{Y}\right)_{t+j} - C_\gamma^*\sum_{j=0}^{\infty}\left(\frac{\gamma^*}{R^*}\right)^j \mathbf{E}_t\tilde{\gamma}_{Y,t+j} + C_q^*\tilde{q}_t, \tag{16}$$

where the first-order approximation is taken around steady state ratios (i.e., $(B/Y)^*$), the growth rate of output is $\gamma_{Y,t+1} = Y_{t+1}/Y_t$, its steady state is $\gamma^* = \exp\{\gamma\}$, $R^* = 1 + q^* - 2\varphi(B/Y)^*$, $C_B^* = (B/C)^*(R^* - \gamma^*)$, $C_{\mathrm{NY}}^* = C_B^*\,(\mathrm{NY}/B)^*/R^*$, $C_\gamma^* = C_B\gamma^*/R^*$, and $C_q^* = C_B^*(1+q^*)/(R^* - \gamma\rho_q)$.

Eq. (16) is a permanent income rule. It contains standard and non-standard elements. The response of consumption to the return on the bond, the present value of net output (to output), and output growth connect the labor market to consumption smoothing. For a debtor small open economy, a fall in bond returns and the expected future paths of net output and output growth causes employment to rise to offset the income loss. Thus, the labor market provides consumption smoothing services, rather than the current account. Note the exogenous component of the world real interest rate is the final term and lowers consumption, especially if q_t is persistent, because of future debt

[17] Bean (1986) also discusses the impact of labor market decisions on current account dynamics.

finance costs. However, the impact of q_t in the consumption rule (16) is negligible for the canonical RBC model.

The labor market optimality condition and the consumption–output rule (16) reveal the strengths and weaknesses of the fit of the canonical RBC model to the data and the PVM theory. It also explains the inability of transitory shocks to fiscal policy and the world real interest rate and imperfect international capital mobility to improve the match to the PVM predictions and the fit to the data. This analysis suggests that to move the canonical RBC model closer to the PVM theory requires shutting down the labor market response to permanent income shocks.

The internalized risk premium alters the labor market response to permanent income shocks. When the risk premium (7) is internalized by the small open economy, its equilibrium decision rules for capital and bonds account for changes in the risk premium, $\varphi(B_t/Y_t)$. Thus, the internalized risk premium differs from imperfect capital mobility because the latter is about the wedge portfolio allocation costs drive between returns on foreign and domestic assets, not considering the impact on the optimization problem of the small open economy. In the rest of this section, we study the extent to which the decisions of the small open economy affect current account fluctuations through the risk premium.

Under an endogenous risk premium, the labor market optimality of the small open economy is

$$\left(\frac{1-\phi}{\phi}\right)\frac{N_t}{1-N_t} = (1-\theta)\left(\frac{C_t}{Y_t}\right)^{-1}\left[1+\varphi\left(\frac{B_t}{Y_t}\right)^2\right]. \tag{17}$$

Eq. (17) equates the marginal rate of substitution between leisure and consumption to the marginal product of labor, gross of the response of the risk premium to a change in employment. Along an equilibrium path, employment is higher for the small open economy when it internalizes the risk premium, than otherwise, because the internalized risk premium produces a negative income effect. Hence, the internalized risk premium ties demand for foreign assets to employment, which alters its response to permanent income shocks.

The endogenous component of the internalized risk premium in the labor market optimality condition is the bond–output ratio. Its generating process follows from the resource constraint, the law of motion of the unit discount bond, and the world real interest rate

$$\left(\frac{\tilde{B}}{Y}\right)_t \approx \frac{\gamma^*}{R^*}\sum_{j=0}^{\infty}\left(\frac{\gamma^*}{R^*}\right)^j \mathbf{E}_t\tilde{\gamma}_{Y,t+j} - \left(\frac{\mathrm{NX}}{B}\right)^* \frac{1}{R^*}\sum_{j=0}^{\infty}\left(\frac{\gamma^*}{R^*}\right)^j \mathbf{E}_t\widetilde{\left(\frac{\mathrm{NX}}{Y}\right)}_{t+j} - \frac{1+q^*}{R^*-\gamma^*\rho_q}\tilde{q}_t. \tag{18}$$

The bond–output Eq. (18) shows international trade flows contribute to employment fluctuations, under the internalized risk premium. Assuming $(\mathrm{NX}/B)^*>0$, a drop in the

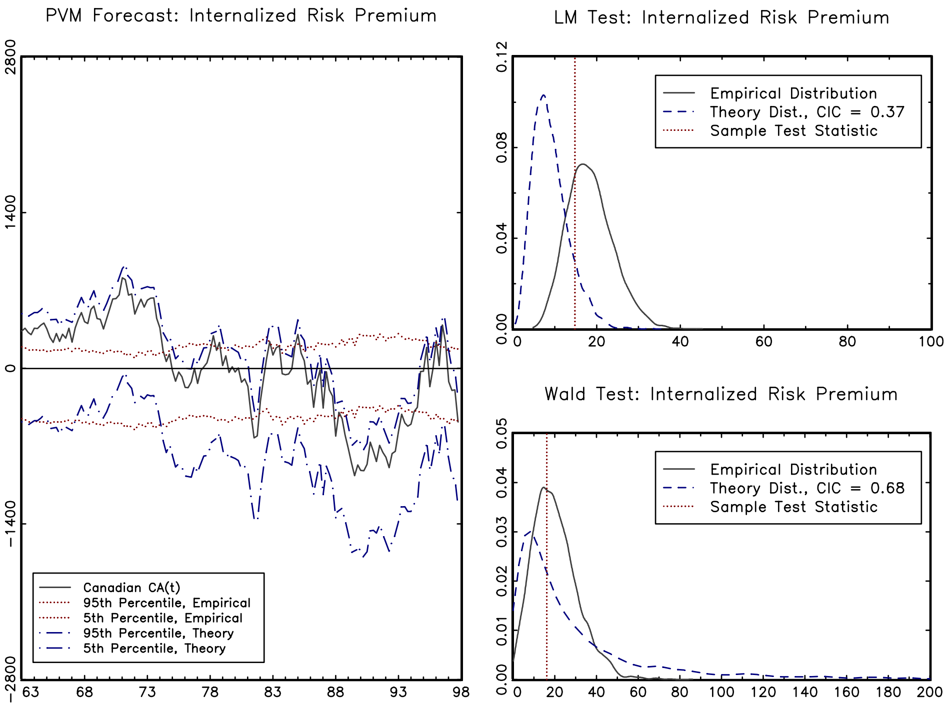

Fig. 6. Internalized risk premium and RBC model.

expected present value of net exports forces debt to rise relative to output for the small open economy.[18] Since the internalized risk premium ties employment to current account fluctuations, movements in the bond–output ratio reduces the consumption smoothing powers of the labor market.

We report the results of simulating the internalized risk premium-RBC model in Fig. 6 and the first column of Table 2. The internalized risk premium model is calibrated in the same way as the canonical model. In particular, the prior of φ implies the 95% coverage interval of [0.0019, 0.0052].

Plots of the distributions of the LM and Wald statistics from $\mathcal{T}$ and $\mathcal{E}$ densities under separable utility (13) are contained in the right side windows of Fig. 6. These densities are nearly identical to those found in Fig. 2, which are generated by the canonical RBC model. For example, the difference across the relevant CIC statistics of Figs. 2 and 6) is no larger than 0.06.[19]

We report the ensemble means of the elements of $\mathcal{H}_{\mathcal{T}}$ and the SDM statistics of the internalized risk premium-RBC model in column 1 of Table 2. This version of the model,

[18] This condition holds for the calibration of the small open economy-RBC model to the Canadian data, under the degenerate prior.

[19] Under the internalized risk premium, non-separable utility continues to be responsible for the best fit in terms of the LM test and the poorest fit for the Wald test. This reinforces the role separable utility plays in helping to produce observed rejections of the PVM. These results are available on request.

Table 2
Tests of the internalized risk premium combined with the remaining usual suspects

	Experiment		
	Separable utility	Transitory fiscal shock	World interest rate shock
$\mathcal{H}_{\mathcal{T},1}$	−0.20 (−1.44)	−0.09 (−0.87)	0.11 (0.09)
$\mathcal{H}_{\mathcal{T},2}$	−0.20 (−0.88)	−0.10 (−0.32)	0.11 (0.79)
$\mathcal{H}_{\mathcal{T},3}$	−0.04 (0.21)	−0.04 (0.20)	0.05 (0.90)
$\mathcal{H}_{\mathcal{T},4}$	0.03 (−0.57)	0.02 (−0.69)	0.02 (−0.57)
$\mathcal{H}_{\mathcal{T},5}$	0.97 (1.87)	0.68 (1.33)	1.24 (2.39)
$\mathcal{H}_{\mathcal{T},6}$	0.14 (0.72)	0.02 (−0.18)	−0.16 (−1.66)
$\mathcal{H}_{\mathcal{T},7}$	−0.13 (−0.81)	−0.06 (−0.25)	0.15 (1.59)
$H_{\mathcal{T},8}$	−0.03 (0.77)	−0.05 (0.54)	0.04 (1.37)

Details about the priors of the usual suspects are in the notes at the bottom of Table 1. Otherwise, the priors of the model parameters are discussed in Section 3.3 of the text.

which has the separable and log period utility function, reproduces the PVM restrictions. Its estimates of $\mathcal{H}_{\mathcal{T},i}$ are all close to zero, except $\mathcal{H}_{\mathcal{T},5}(=0.97)$, which is close to the theoretical value of unity. The SDM statistics indicate that the internalized risk premium-RBC model appears not to mimic the actual data. In particular, $\mathcal{H}_{\mathcal{T},5}$ is nearly two standard deviations above $\mathcal{H}_{\mathcal{E},5}$.

The fit of the internalized risk premium-RBC model to the sample current account forecast appears in the left side window of Fig. 6. The actual Canadian current account (the solid plot) and the fifth and 95th percentiles of the Bayesian Monte Carlo pointwise probability bands (the dot-dash plots) of the PVM forecast of the current account are displayed along with the actual current account. The model generates 90% probability bands of $\mathrm{CA}_{f,\mathcal{T}}$ that contain the actual PVM forecasts and zero, except for a brief episode in the early 1980s and then during the late 1980s and early 1990s. Thus, the internalized risk premium-RBC model yields a poor fit to the actual Canadian current account.

The internalized risk premium-RBC model generates synthetic data that typically match the PVM restrictions. The labor market response to permanent income shocks is negated by the internalized risk premium, as we show with the optimality condition (17) and the bond–output Eq. (18). This begs the question which, if any, of the other usual suspects combined with the internalized risk premium yield a good fit to the data and mimic the PVM predictions. If we can find such a combination, it suggests that the true DGP for the current account is more complex than the canonical RBC model. Thus, we integrate into the internalized risk premium-RBC model the remaining usual suspects: transitory shocks to fiscal policy and the world real interest rate. Separable utility is used throughout.

Results from the fiscal and world interest rate experiments are depicted in Figs. 7 and 8, respectively. The right-hand side windows display the densities of the LM and Wald statistics. Once again, the canonical and internalized risk premium models produce results that are nearly indistinguishable, as the overlap of the $\mathcal{T}$ and $\mathcal{E}$ densities of these statistics differ by no more than 0.08 (in the case of the LM statistic for the fiscal shock experiment). The left-hand side windows contain the 90% probability bands associated with the $\mathcal{T}$ and $\mathcal{E}$ distributions of CA_f. The $\mathcal{T}$ bands for the fiscal policy experiment (Fig. 7), fail to contain the actual current account except during the late 1980s and early 1990s. The striking feature of these plots is that the world real interest rate experiment (Fig. 8) generates $\mathcal{T}$ 90% probability bands (dot-dash plot) that almost always contain the actual current account (solid plot) and often do not cover zero or the $\mathcal{E}$ piecewise 90% probability bands (dots plot). This suggests that the world real interest rate shock in the bond–output generating equation matters for current account fluctuations.

The interaction of the internalized risk premium with the fiscal policy or interest rate shock mostly have a small impact on the distributions of $\mathcal{H}_{\mathcal{T}}$. Columns 2 and 3 of Table 2 list estimates with few differences, except for $\mathcal{H}_{\mathcal{T},5}$. The estimates of $\mathcal{H}_{\mathcal{T},5}$ are 0.68 and 1.24 for the fiscal and interest rate policy experiments, respectively. The relevant SDMs are 1.33 and 2.39. Once again, the fiscal policy experiment is closer to the actual data according to $\mathcal{H}_{\mathcal{T}}$.

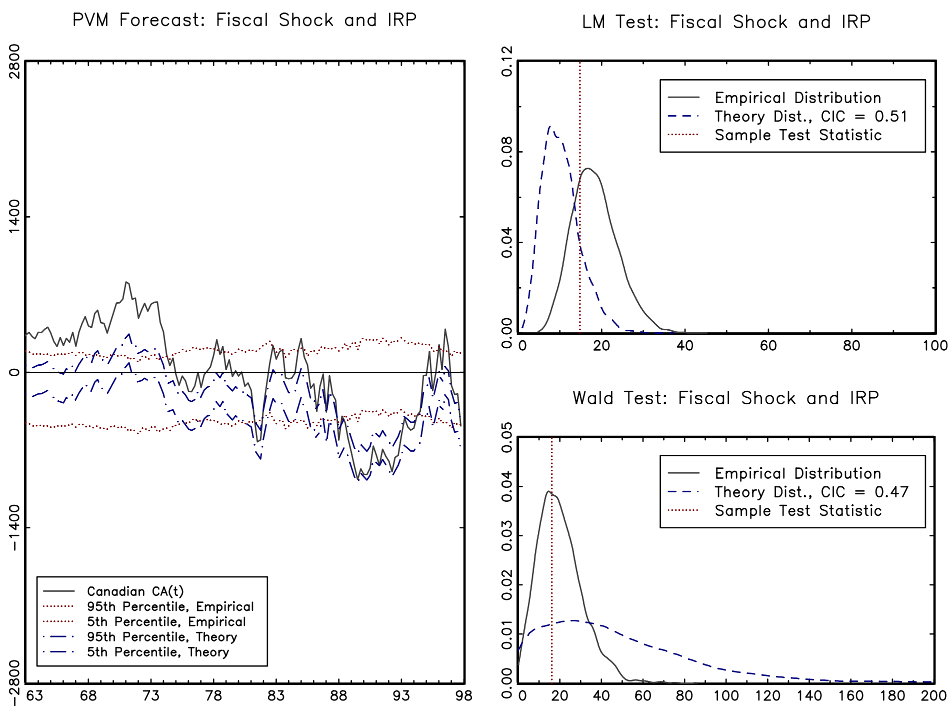

Fig. 7. Fiscal shock and IRP-RBC model.

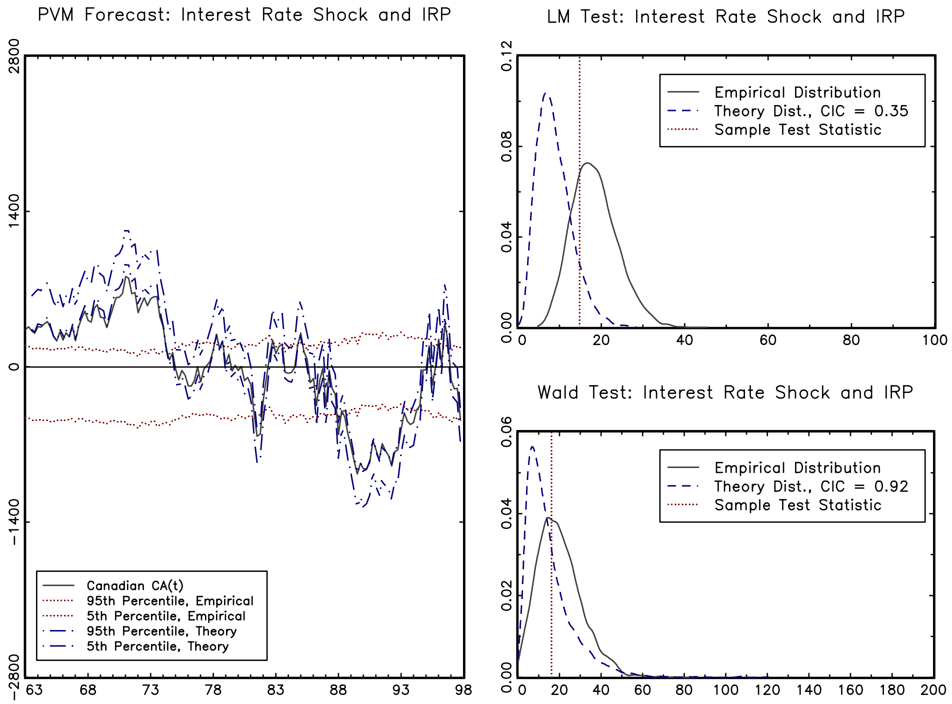

Fig. 8. Interest rate shock and IRP-RBC model.

In simulation results that are available on request, we show that incorporating non-separable utility or imperfect capital mobility into our internalized risk premium-RBC model worsens the fit to the actual data. In particular, imperfect capital mobility induces additional current account variability.

This section shows that a small open economy that internalizes the risk premium approximates the PVM predictions. Thus, the internalized risk premium negates the consumption smoothing role employment plays in the canonical model. However, the internalized risk premium-RBC model generates a current account forecast that is as likely to be zero as it is to equal the actual current account. When we combine the world real interest rate shock with the internalized risk premium, the model produces 90% confidence bands of the current account forecast that almost always contain the actual current account, but not zero. This reveals the importance of the world real interest rate for current account fluctuations.

4.5. Caveats

As with any applied study of this topic, our results could be affected by plausible extensions of our framework. Our RBC model has no monetary sector. This allows us to avoid the well-known difficulties associated with modeling money demand, the behavior of price setters, and the instruments, targets, and objectives of monetary policy in the open economy. The omission of a monetary sector from our model is unlikely to affect our results. This is surely a reasonable starting point, given that we expect monetary shocks to have only a minor effect on real variables beyond the short-run and remembering that PVM tests place weight on the medium and long-run as well as the short-run. It might also be argued that non-monetary foreign demand shocks ought to play more of a role. In earlier versions of this paper, we appended to the law of motion of the international bond an additive term that we interpreted as a foreign demand shock. We found that the effect of this shock was negligible, and hence dropped it from our list of suspects.[20] We also considered a terms-of-trade shock–a multiplicative shock to net exports in the aggregate resource constraint (8)–that acts as a taste shock and causes domestic households to act as if they are extremely patient. Thus, the current account of the small open economy is larger, on average, which fails to fit the Canadian data.[21] Adding a non-tradables sector to the small open economy model could also improve the fit to the data. However, there is reason to suspect that this channel might have only minor effects too. When the Glick and Rogoff (1995) model is extended to include non-traded goods, the responses of both the current account and investment to relative price shocks (the terms of trade and nominal exchange rates) are insignificant (e.g., İşcan, 2000). Finally, one might consider incorporating physical trading costs of the type identified by Obstfeld and Rogoff (2000) as going a long way to resolve several major puzzles in international macroeconomics. However, the results of the two-country complete markets model of Backus et al. (1992) suggest that trading frictions may not be able to improve the fit of the intertemporal model to observed current account fluctuations. Continued progress on these fronts will undoubtedly shed more light on the questions that are raised in this literature.

5. Conclusion

We study the importance of various explanations for the poor empirical performance of a basic intertemporal model of the current account, the present value model (PVM). First, we confirm the results of existing papers that reject the cross-equation restrictions and orthogonality conditions of the PVM, in our case using a sample of post-war Canadian data. To understand these rejections, we construct a small open economy-real business cycle model. We show that a "canonical" version of the model is consistent with the actual data, but not the theoretical PVM predictions.

The usual suspects we study, non-separable preferences, shocks to fiscal policy and the real interest rate, imperfect international capital mobility, and an internalized risk premium, are portrayed in the literature as potential explanations of rejections of the PVM. We conduct Bayesian Monte Carlo experiments to generate evidence about the culpability of our suspects. Although each matters in some way, we find the more parsimonious canonical model is close to the data, but far from the PVM restrictions.

[20] Bergin's (2003) variance decomposition for Canada shows that at the 10 quarter horizon the sum of money demand and supply shocks account for under 20% of current account variability while foreign demand shocks account for 7%.

[21] Terms-of-trade shocks of this sort emphasize substitution effects over income effects.

This is explained with labor responses to permanent income shocks in the small open economy. We show that the portfolio decisions of the internalized risk premium-RBC model negate the labor market response to permanent income movements, which allows the model to replicate the PVM predictions. Since this model is far from the data in some ways, we add each of the remaining suspects one-by-one to the internalized risk premium-RBC model. It is the addition of the world real interest rate shock that moves this model closest to the actual data.

Our results indicate that the attention paid to transitory movements in domestic fiscal policy to explain the current account while appropriate may have missed other important factors. The internalized risk premium and exogenous world real interest rate shocks are two of the leading factors that we identify. Thus, future research should look for additional underlying macroeconomic factors that drive the current account. Finally, our results suggest that current account movements have a larger common, cross-country element than is perhaps usually suspected, at least in the case of Canada.

The intuition for our results rests with households hedging against country-specific permanent income shocks through the current account. Any transitory shock to consumption generates current account fluctuations independent of movements in permanent income and hence could produce rejections of the PVM. Shocks to the world real interest rate, for example, produce these sorts of current account fluctuations, whether they come from an internalized country-specific component, an exogenous world shock, or an endogenous common world component. This is especially important because ever since Cole and Obstfeld (1991) pointed out that even small imperfections in international capital markets can wipe out the (consumption smoothing) benefits of international portfolio diversification, the sources and causes of such imperfections have eluded researchers. We hope this paper invigorates this research agenda.

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