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INTERNATIONAL CAPITAL MOBILITY AMONGST THE MAJOR INDUSTRIALISED COUNTRIES: TOO LITTLE OR TOO MUCH?*

Atish R. Ghosh

This paper examines capital flows amongst the major industrialised countries with a view to assessing Feldstein and Horioka's claim that international capital mobility is limited. It argues that saving-investment correlation tests are inherently flawed, and propose an alternative methodology for testing the degree of international capital mobility. It finds that capital flows have been *excessive*, in the sense that they are driven by speculative forces rather than by economic fundamentals.

The assumption that capital is perfectly mobile between countries underlies many, perhaps most, recent contributions to open economy macroeconomics. Surprisingly, however, empirical work has failed to validate this assumption. On the contrary, in a controversial paper in this JOURNAL, Feldstein and Horioka (1980) claimed that, even amongst the major industrialised nations, capital mobility may be severely limited (see, also, Feldstein (1983)). While numerous studies have confirmed their findings of a high positive correlation between savings and investment, some authors refuse to accept their interpretation, arguing that it is difficult to reconcile the empirical results with the seemingly high, and ever increasing, integration of financial markets.[1]

Tests of capital mobility based on the savings–investment correlations reject the null of high capital mobility if the correlation is 'too high'. One problem with savings–investment tests of international capital mobility is that perfect capital mobility does not necessarily imply a zero correlation. As argued by Obstfeld (1986*a*) and Cardia (1991), a variety of shocks can induce a positive correlation between savings and investment even in a small open economy. A persistent (but not permanent) productivity shock, for example, would raise savings because wages are temporarily high, but would also raise investment since capital is more productive. Economies subject to productivity shocks, therefore, would exhibit a positive correlation between savings and investment. Simulation studies by Cardia (1991) suggest that it is possible to generate correlations as high as those observed empirically. *Thus a positive correlation between savings and investment does not, in itself, provide evidence against capital mobility.*

What is needed is a benchmark correlation: an estimate of what the correlation *should* be, given the assumption of perfect capital mobility and given the shocks hitting the economy. Alternatively, one can work with the variance

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[1] Cross-sectional tests of capital mobility based on the savings–investment correlation include Feldstein and Horioka (1980), Feldstein (1983), Murphy (1984), Penati and Dooley (1984), Dooley *et al.* (1987). Time-series evidence is provided by Obstfeld (1986*a*), Frankel (1986), and Tesar (1991).

of the current account rather than the correlation between savings and investment. (A low variance, relative to the benchmark value, would be interpreted as indicating low capital mobility since, at the margin, a shock to savings or investment is not being reflected in a corresponding movement of the current account.) Certain subtle econometric problems – which appear to have been ignored in most savings–investment correlation tests – make it preferable to work with the variance of the current account rather than the savings–investment correlation. Typically, the time series for savings and investment are non-stationary; the correlation coefficient between them is therefore meaningless. Either savings and investment are co-integrated, in which case their asymptotic correlation is unity, or they are not co-integrated, in which case their asymptotic correlation is zero (see Engle and Granger (1987)). Some authors have attempted to circumvent this problem either by detrending the data, or by expressing both savings and investment as fractions of GDP. As Mankiw and Shapiro (1985) have shown, however, if variables are really stationary in first differences, then detrending the data is inappropriate and may result in incorrect inferences. Moreover, expressing savings and investment as proportions of GDP does not always seem to work: at least for our data set, we are unable to reject unit roots in either series (the two right-hand columns of Table 1 report Dickey–Fuller statistics for the national-

Table 1

Tests for Unit Roots

	Test statistics					
	t c_t	t $y_t-i_t-g_t$	t CA_t	DW CRDW	t S/GDP	t I/GDP
United States						
1960–88	0·16	0·49	−3·27	0·43	−0·63	−0·17
Japan						
1960–88	−2·38	−0·17	−1·92	0·46	−0·23	−0·67
Germany						
1962–88	−0·23	−0·35	−2·31	0·20	−0·52	−0·87
1960–83	−0·47	−0·75	−3·36	0·34		
United Kingdom						
1960–88	0·51	0·06	−3·16	0·47	−0·38	0·04
Canada						
1960–88	0·15	−0·14	−3·59	0·43	−0·33	0·18

t is the t-statistic on $\mathbf{z}_{t-1}$ from the regression:

$$\Delta \mathbf{z}_t = \alpha_0 \mathbf{z}_{t-1} + \sum_{j=1}^{6} \alpha_j \Delta \mathbf{z}_{t-j},$$

where $\mathbf{z}$ is c_t, $y_t-i_t-g_t$, CA_t, S/GDP, or I/GDP respectively.

CA_t is the consumption-smoothing component of the current account, defined as $CA_t \equiv y_t-i_t-g_t-\Theta c_t$.

CRDW is the Durbin–Watson statistic from the cointegrating regression of $y_t-i_t-g_t$ on c_t.

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savings-to-GDP ratio and the investment-to-GDP ratio).[2] We show below that the current account measure we use (the consumption-smoothing component of the current account) will be a stationary series, even though savings and investment may not be, so that standard statistical tests can be legitimately applied to the variance of the current account.[3]

The purpose of this paper is to re-examine the evidence against international capital mobility, taking account of these criticisms of the savings–investment correlation tests.[4] The difficulty, of course, lies in determining the benchmark variance of the current account against which the actual variance can be compared. Our approach is to construct a time series for the optimal current account which should have been observed, given the actual shocks to the economy. Once such a series has been constructed, of course, there is no reason just to compare the variances of the actual current account to that of the benchmark current account. The two series themselves can be compared, both visually and statistically. Under the null hypothesis, that of perfect capital mobility (together with the ancillary assumptions made to construct the optimal current account series), the two series should be identical. Disturbances such as productivity shocks will affect both the actual current account and the constructed optimal current account series and will not, therefore, lead to a spurious rejection of the capital mobility hypothesis.

We use the modern intertemporal model of current account determination to construct the benchmark series. This model combines the assumptions of perfect capital mobility and of consumption-smoothing behaviour to predict that the current account acts as a buffer to smooth consumption in the face of shocks to output, investment, and government expenditure (see Sachs (1981; 1982)).[5] By focusing on the consumption-smoothing component of the current account, we avoid the econometric problems described above because the consumption-smoothing current account will typically be a stationary series. We can test whether capital has been insufficiently mobile by comparing the variance of the optimal consumption-smoothing current account to the consumption-smoothing component of the actual current account. Our test for capital mobility is therefore a *joint* test of the intertemporal model of the current account and the assumption of perfect capital mobility.

[2] That is not to imply that S/GDP and I/GDP are indeed non-stationary since, as is well known, unit root tests typically exhibit low power. It does suggest, however, that working with series for which there are sound theoretical reasons and strong empirical evidence for stationarity may be a more satisfactory approach.

[3] As Sachs (1982) argues, current account movements can be decomposed into two components: the *consumption-tilting* motive which occurs when the subjective discount rate differs from the world interest rate; and the *consumption-smoothing* motive whereby the current account buffers consumption in the face of shocks to output, investment, or government expenditure. The main focus here will be on the role of the current account in buffering consumption and will thus be on the consumption-smoothing component.

[4] The other major criticism of savings investment tests is the 'maintained external balance hypothesis' of Summers (1985), Caprio and Howard (1984), Fieleke (1982) and Tobin (1983). It is hypothesised that governments react systematically to imminent capital flows by using fiscal variables to offset these potential movements. In the face of a current account deficit, for example, the government may reduce its expenditure.

[5] This is essentially the permanent income hypothesis applied to countries rather than to individuals. The econometric techniques we use are a straight-forward extension of work done in the PIH in a closed economy context.

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The plan of the paper is as follows. Section I sets out the theoretical model used to construct the benchmark current account series. Section II undertakes the estimation of the actual and benchmark current account series for the five major industrialised countries. Section III provides some brief concluding remarks.

I. THE INTERTEMPORAL APPROACH TO THE CURRENT ACCOUNT

In order to construct the benchmark series of the current account, a theoretical model of current account determination must be adopted. The model used here emphasises not the intratemporal trade balance (emphasised in the early literature) but rather the intertemporal trade implied by the divergence of savings and investment. As Sachs (1982) argues, the current account can be separated into two components. The first is the consumption-*tilting* motive, whereby a country tilts its consumption toward the present or toward the future, depending upon the relative magnitudes of its subjective discount rate and the world interest rate. The second component is the consumption-*smoothing* motive, which stabilises consumption in the face of shocks to output, investment, or government expenditure. A temporary unanticipated increase in government expenditure, for example, would be associated with a current account deficit as the country tries to smooth consumption by borrowing in international capital markets. Likewise, an investment boom would result in a current account deficit as the investment was financed by the world capital markets rather than by squeezing domestic consumption. Indeed, assuming that capital is mobile, consumption would rise with an investment boom as the higher investment portends greater national wealth. This is in sharp contrast to the fall in consumption that would be observed were the economy closed (or were the current account not used for consumption-smoothing purposes).

It is important to note that in intertemporal models of the current account, what matters for the determination of the current account is agents' *expectations* of the shocks to the economy, rather than the shocks themselves. Suppose, for example, that private agents expect an increase in government expenditure in the future. The intertemporal model of the current account would predict an immediate current account surplus as the country saves for higher expenditure in the future. The current account would be in surplus (or show a smaller deficit) even if the increase in government expenditure never actually took place. Comparing *actual* movements in government expenditure to movements in the current account would, in this example, lead one to believe that the current account was excessively volatile.

To construct a meaningful benchmark series, therefore, we must capture agents' expectations of future shocks to such variables as output and government expenditure. This is a daunting task. The simplest approach would be to project government expenditure on past values of itself, but this is unlikely to be adequate. Individual agents will, in general, have a much richer information set on which to base their expectations. Such additional information could include knowledge about political or other exogenous events

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that produce changes in expenditure and that, obviously, cannot be captured by merely projecting on past values of expenditure. In general, it is very difficult for the econometrician to re-create the information set used by agents in making their optimal choices. Nonetheless, it turns out that under the null hypothesis (that the intertemporal smoothing model is true and the capital is perfectly mobile) it *is* possible to include all the information used by private agents. This is because, as shown by Campbell and Shiller (1987) in a different context, the current account itself reflects this information. Therefore, by including the current account in the conditioning information set, we can capture agents' expectations of shocks to output, investment, and government expenditure.

The primary focus of our analysis is on the consumption-smoothing component of the current account: the consumption-tilting component is removed and disregarded. This is done for two reasons. First, while it is simple to model the consumption-smoothing motive (and therefore the optimal current-account movement), it is considerably more difficult to identify how much a country *should* borrow in order to tilt consumption. Second, the component of the current account that reflects consumption-tilting will be non-stationary so standard statistical inferences are not valid. In contrast, the consumption-smoothing component is usually stationary and is therefore more amenable to econometric analysis.

It is useful to define *national cash flow* as output minus government expenditure minus investment. Then the consumption-smoothing motive, induced by the concavity of the utility function, implies that fluctuations in national cash flow only affect consumption by the expected present value of such fluctuations. Current account movements will be deemed inconsistent with the twin assumptions of perfect capital mobility and of consumption-smoothing if national consumption fluctuates by more than the expected present discounted value of shocks to national cash flow.

Following Sachs (1982), we use the standard model of international borrowing and lending – its horizon infinite; its economy small and open – as our theoretical framework. This has the advantage of analytical simplicity and allows us to exploit the econometric techniques developed by Campbell (1987) who studies the Hall equation in the closed-economy context. Undoubtedly, for some of the countries in the sample, the assumption of a small open economy is unrealistic. It is clear, however, that assuming a small open economy when the country is, in fact, large in the international capital markets, should make the rejection of the null easier, since the variance of the actual current account will be smaller when the country is large.[6]

The economy is assumed to be populated by a single, infinitely-lived, representative agent whose preferences are given by:

$$\sum_{t=0}^{\infty} \beta^t \mathrm{E}[u(c_t)] \quad 0 < \beta < 1, \tag{1}$$

[6] This becomes obvious when the large country is the whole world, for which the variance of the actual current account must be zero.

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where β is the subjective discount rate, $u(\cdot)$ the instantaneous utility function, and c_t the consumption of the single good. With a view to empirical implementation, a quadratic form for $u(\cdot)$ is imposed.[7] The assumption that agents are infinite-lived rules out any role for government deficits in determining the current account. As shown in Ghosh (1989), relaxing this assumption by adopting Yaari–Blanchard agents (Blanchard, 1985) does not materially alter any of the empirical conclusions.

It is simplest to work in terms of the social planner's problem, though the competitive equilibrium yields equivalent results. The planner maximises (1) subject to the economy's dynamic budget constraint:

$$b_{t+1} = (1+r)\,b_t + q_t - c_t - i_t - g_t, \tag{2}$$

where b is the level of foreign assets held by the economy, r is the fixed world interest rate, q is the level of output or GDP, i is the level of investment, and g is the level of government expenditure.

We assume that uncovered real interest parity holds at all times. Therefore, the assumption that the country is small in the world capital markets means that the economy will exhibit the important property of Fisherian separability: investment should be chosen in order to maximise the present discounted value of the country's wealth, regardless of the consumption profile. As discussed by Cooper and Sachs (1985), in a small open economy, investment is undertaken until the marginal product of capital equals the world interest rate, so that the investment rule is independent of consumption. In turn, this implies that investment and output may be treated as exogenous when choosing the optimal path for consumption. (More generally, when investment is subject to costs of installation, investment depends upon Tobin's q so that the entire future path of discounted marginal products of capital enter the investment decision. Nonetheless, the separability between consumption and investment remains, because the interest rate is exogenous to the country. Investment, i_t, should be interpreted as total expenditure, inclusive of installation costs, on investment.)[8] In contrast, this separation is not possible in a closed economy, since a rise in consumption necessarily reduces investment, for given output and government expenditure. We assume throughout that government expenditure is exogenous.

Maximising (1) subject to (2) and the 'no-Ponzi games' constraint yields:

$$c_t^* = \left[1 - \frac{1}{\beta(1+r)^2}\right]\left\{(1+r)\,b_t + \mathrm{E}_t\left[\sum_{i=0}^{\infty}(1+r)^{-i}(q_{t+i} - i_{t+i} - g_{t+i})\right]\right\}.$$

[7] One obtains very similar theoretical and empirical results for certain other tractable utility functions; Ghosh and Ostry (1992), for example, consider the case of constant absolute risk aversion.

[8] Note that this separability let us write output as exogenous to the *consumption* decision, but not (necessarily) to investment decisions. Specifically, if output is given by $q_t = \Psi_t f(k_t)$, where Ψ is a productivity shock, $f(k)$ is the production function, and k is the capital stock, then a shock to Ψ_t affects current output, but not investment, while a future shock to productivity, $\psi_{t+j}, j > 0$, affects investment, and future output (both by changing productivity and by changing the capital stock), but leaves current output unaffected.

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Or, letting

$$\Theta \equiv \frac{\beta(1+r)r}{[\beta(1+r)^2-1]},$$

$$c_t^* = (r/\Theta)\left\{b_t + (1+r)^{-1}\mathrm{E}_t\left[\sum_{i=0}^{\infty}(1+r)^{-i}(q_{t+i}-i_{t+i}-g_{t+i})\right]\right\} \tag{3}$$

where Θ is a constant of proportionality reflecting the consumption-tilting dynamics of consumption, and c_t^* denotes the optimal path for consumption. The term in braces in the country's net productive wealth, as of time t. Permanent income is simply r times wealth since the interest rate is assumed to be constant. Consumption is therefore proportional to permanent national cash flow; for $\Theta < 1$ the country is consuming more than its current permanent cash flow, i.e. it is tilting consumption towards the present. For $\Theta > 1$, the country is tilting consumption towards the future, and if $\Theta = 1$ there is no consumption-tilting component to the current account. As mentioned above, the current account movements associated with the consumption-tilting motive are not included in the analysis.

Define the optimal consumption-smoothing current account by:

$$CA_t^* \equiv y_t - i_t - g_t - \Theta c_t^* \tag{4}$$

where y_t is national income (GNP), equal to output or GDP (q_t) plus net factor payments (rb_t). Substituting (3) into (4) yields:

$$CA_t^* = y_t - i_t - g_t - r\left\{b_t + (1+r)^{-1}\mathrm{E}_t\sum_{i=0}^{\infty}(1+r)^{-i}(q_{t+i}-i_{t+i}-g_{t+i})\right\}. \tag{5}$$

Simplifying (5), gives:

$$CA_t^* = -\mathrm{E}_t\sum_{i=1}^{\infty}(1+r)^{-i}\Delta(q_{t+i}-i_{t+i}-g_{t+i}). \tag{6}$$

Expression (6) writes the optimal current account as the expected present discounted value of changes in output, investment, and government expenditure.[9] The expression for the optimal current account, CA_t^*, embodies the intertemporal approach to the current account in a simple and clear manner. Shocks to output, government expenditure, or investment which are expected to be permanent have no effect on the current account since their expected change is zero. A purely temporary increase in output, or a decrease in either investment or government expenditure, leads to a large improvement in the current account since the change in national cash flow will occur in the next period. Transitory shocks which last for a few periods will have a smaller impact because the change in national cash flow is discounted at the rate $(1+r)$ for each period that the shock persists.

[9] For example, if there are no adjustment costs to investment, one unit of investment which pays exactly $(1+r)$ in the next period (so that the change in GDP for a unit change in investment, dq_{t+1}/di_t, equals $1+r$) will deteriorate the current account by exactly one unit (see Sachs (1982)):

$$dCA_t^*/di_t = -1 + r/(1+r) \times (1-r)/(1+r)^2 dq_{t+1}/di_t = -1.$$

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To create this optimal current account series we need to calculate the expected present discounted value of changes in national cash flow, where the expectation is conditional on the information set used by individual agents. We follow the techniques of Campbell and Shiller and first estimate an unrestricted VAR in CA_t and $\Delta(q_t - i_t - g_t)$, where CA_t is the actual consumption-smoothing component of the current account:

$$CA_t \equiv y_t - i_t - g_t - \Theta c_t \tag{7}$$

(we explain below how an estimate of Θ may be obtained). The vector autoregression may be written:[10]

$$\begin{bmatrix} \Delta(q_t - i_t - g_t) \\ CA_t \end{bmatrix} = \begin{bmatrix} \phi_1 & \phi_2 \\ \phi_3 & \phi_4 \end{bmatrix} \begin{bmatrix} \Delta(q_{t-1} - i_{t-1} - g_{t-1}) \\ CA_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}. \tag{8}$$

Or,

$$\mathbf{Z}_t = \mathbf{\Phi} \mathbf{Z}_{t-1} + \mathbf{U}_t,$$

where $\mathbf{Z}_t \equiv [\Delta(q_t - i_t - g_t), CA_t]$ and $\mathbf{\Phi}$ is the transition matrix of the VAR.

A typical term in the infinite sum (6) is $E_t \Delta(q_{t+k} - i_{t+k} - g_{t+k})$ which can be written $[1 \quad 0] E_t Z_{t+k}$, so that:

$$E_t \Delta(q_{t+k} - i_{t+k} - g_{t+k}) = [1 \quad 0] E_t \mathbf{Z}_{t+k} = [1 \quad 0] \mathbf{\Phi}^k \mathbf{Z}_t. \tag{9}$$

The infinite sum in (6) is thus:

$$CA_t^* = -[1 \quad 0][\mathbf{\Phi}/(1+r)][\mathbf{I} - \mathbf{\Phi}/(1+r)]^{-1} \begin{bmatrix} \Delta(q_t - i_t - g_t) \\ CA_t \end{bmatrix}. \tag{10}$$

The expression is valid as long as the infinite sum in (6) converges, which it will if the variables in the VAR are stationary. Assuming that $(q_t - i_t - g_t)$ is I(1) its first difference will be stationary; since the current account is a discounted sum of $\Delta(q_t - i_t - g_t)$ it, too, will be stationary.

An important implication of (6) is that the current account should, in general, Granger cause subsequent changes in national cash flow. If agents have more information about the evolution of national cash flow than is contained in its own past values then this additional information should be reflected in the current account. If, for example, a change in administrations portends higher future government expenditure then the country should run a current account surplus. This current account surplus will then Granger cause the change in national cash flow.[11]

It remains only to describe how to calculate the consumption-tilting parameter, Θ so that the actual data on the current account can be corrected to purge the consumption-tilting component. As argued above, the optimal current account series, CA_t^* will be an I(0) process. Under the null hypothesis that the actual consumption-smoothing component of the current account is equal to CA_t^*, the (consumption-smoothing component of the) actual current

[10] It is simple to generalise this expression for higher order VARs by writing a pth order VAR in first order form (see Sargent (1987)).

[11] This corresponds to the 'saving for a rainy day' hypothesis of Campbell (1987) in his study of the permanent income hypothesis.

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account is also I(0). This means that the LHS of (7) is I(0) and, therefore Θ may be obtained as the cointegrating parameter between c_t and $y_t - i_t - g_t$. We thus regress $(y_t - i_t - g_t)$ on c_t using ordinary least squares regression.

Once the optimal current account series CA^* has been calculated a number of tests may be performed. First, as noted above, the model predicts that the current account should Granger cause subsequent changes in national cash flow. This provides a simple test of the model.

To test the model more formally, re-write (10) as:

$$CA_t^* = [\Gamma_Y \, \Gamma_{CA}] \begin{bmatrix} \Delta(q_t - i_t - g_t) \\ CA_t \end{bmatrix}. \tag{11}$$

Under the null hypothesis, the weight Γ_{CA} on CA_t should be unity and the weight on $\Delta(q_t - i_t - g_t)$, Γ_Y, should be zero.[12] Note that (11) is *not* a regression equation. Rather, the model precisely determines the coefficients Γ_Y and Γ_{CA} as non-linear functions of the VAR parameters and implies the restrictions $\Gamma_Y = 0$ and $\Gamma_{CA} = 1$. The standard errors of these coefficients are computed numerically, as described below, and the estimated values of Γ_Y and Γ_{CA} are compared to their theoretical values of zero and one.

Third, the variances of the actual (consumption-smoothing) current account and the optimal current account should be equal. If the latter exceeds the former then the actual current account has not varied sufficiently to allow capital flows to smooth consumption in light of fluctuations in national cash flow.

Finally, the sample correlation between CA_t and CA_t^* may be examined to determine whether current account movements have at least been broadly consistent with the twin assumptions of capital mobility and the intertemporal consumption-smoothing model of the current account.

II. ESTIMATION AND RESULTS

Five major industrialised countries (United States, Japan, Germany, United Kingdom, and Canada) were used in the analysis; the sample period extended from 1960 to 1988 (1962 to 1988 in the case of Germany). All data are from the International Monetary Fund's *International Financial Statistics*, are quarterly data at annual rates, and are expressed in billions of 1985 local currency.[13]

The first step in the analysis is to verify that both c_t and $(y_t - i_t - g_t)$ are I(1) and that they are cointegrated. Table 1 provides unit-root test statistics for each country over the sample period.[14] Two cointegration tests are reported: the Dickey–Fuller statistic from the residual of the cointegrating regression, and the cointegrating regression Durbin–Watson statistic (CRDW). Notice that,

[12] Again, the generalisation to higher order VARs is straight-forward: the weight on the contemporaneous CA_t should be unity and the weights on all other variables should be zero.

[13] Private consumption, c, line 96f; Government expenditure, g, line 91ff; Investment, i, lines 93ee+93i; GNP, y, line 99a; GDP, q, line 99b; $CA \equiv y - c - i - g$. All data are converted into real terms by dividing by the implicit GDP deflator.

[14] These tests are described more fully in Engle and Granger (1987).

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from (7), the residual from the cointegrating regression of $y-i-g$ on c is equal to our definition of the consumption smoothing component of the current account. Accordingly, if c_t and $y_t-i_t-g_t$ are cointegrated, the (consumption smoothing component of the) current account is stationary. In general, the sub-samples (1960–74 and 1975–88) are too short to reject the null of no cointegration. Germany is the only country for which neither the Dickey–Fuller test on the residual from the cointegrating regression nor the CRDW can reject the null of no cointegration over the full sample. The problem appears to arise during the period 1983–8: neither test can reject the null of no cointegration for the period 1983–8. This failure to reject the null of no cointegration probably reflects two factors. First, the German current account surpluses have been increasing very rapidly over this sample period so that, at least over short periods, consumption and income may not even be cointegrated processes. Second, as is well known, unit-root tests generally have low power to reject the null of a unit root so that the span of the sample may simply be too short.

The implied values of Θ, the parameter describing the degree of consumption-tilting, are given in Table 2. For the United States, there is

Table 2

Consumption-Tilting Parameter

	Θ	se (θ)
United States		
1960–88	0·994	0·006
1960–74	1·006	0·005
1975–88	0·84	0·013
Japan		
1960–88	1·04	0·006
1960–74	1·04	0·012
1975–88	1·16	0·02
Germany		
1962–88	1·08	0·014
1962–74	1·14	0·020
1975–88	1·15	0·06
United Kingdom		
1960–88	0·98	0·015
1960–74	0·95	0·25
1974–88	0·90	0·04
Canada		
1960–88	0·96	0·006
1960–74	1·01	0·015
1975–88	0·97	0·018

Θ is the coefficient from the cointegrating regression of $(y_t-i_t-g_t)$ on c_t.

difference between the early and late sub-samples: Θ is slightly greater than unity in the first sample (1·005) and considerably lower in the period 1975–88 (0·84). This reflects the shift in the trend of the US current account from surpluses in the immediate post-war era to substantial deficits in the 1980s.

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Table 3
VAR Parameters

	US		JP		GE		UK		CA	
	Δz_t	CA_t	Δz_t	CA_t	Δz_t	CA_t	Δz_t	CA_t	Δz_t	CA_t
Δz_{t-1}	−0·09	−0·18	−0·40	−0·44	−0·45	0·06	−0·56	−0·14	−0·23	−0·21
(t-stat)	−1·01	−2·29	−2·30	−2·71	−3·50	0·54	−4·05	−1·02	−2·46	−2·45
Δz_{t-2}			0·18	0·11	−0·35	−0·04	−0·22	−0·14		
(t-stat)			2·00	1·29	−2·57	−0·35	−2·33	−1·54		
Δz_{t-3}					−0·17	0·13				
(t-stat)					−1·61	1·54				
CA_{t-1}	−0·17	0·87	−0·08	0.87	0.01	0·75	−0·12	0·55	−0·07	0·85
(t-stat)	−3·75	21·3	−0·41	4·89	0·06	5·85	−0·83	3·92	−1·10	14·76
CA_{t-2}			−0·01	0·03	0·09	0·32	0·073	0·28		
(t-stat)			−0·11	0·16	0·50	2·01	0·51	2·00		
CA_{t-3}					−0·14	−0·15				
(t-stat)					−0·93	−1·18				
R^2	0·12	0·81	0·35	0·74	0·19	0·83	0·32	0·47	0·07	0·65
DW	2·01	2·14	1·88	1·89	1·99	2·06	1·98	1·98	1·92	1·90

Column variables regressed on row variables.
$\Delta z_t \equiv \Delta(q_t - i_t - g_t)$.
US, United States (1960–88); JP, Japan (1959–88); GE, Germany (1962–88); UK, United Kingdom (1960–88).

Germany and Japan have Θ values considerably greater than unity, since, on average, they have been increasing their stock of foreign assets, whereas Canada and the United Kingdom have had deficits.

If one took the theoretical model of section I – with its infinitely-lived representative agent who has a constant subjective discount rate – literally, then Θ should be constant over the whole sample period. Moreover, Θ values different from unity – though not at all inconsistent with the theoretical model – would have the troubling implication that the most patient country will eventually own the entire world. We do not believe that such an extreme conclusion is necessarily warranted. Instead, we view the use of the infinite-horizon, constant discount-rate model as a simple abstraction. The model provides a practical means of removing the trend in the current account which results from, *inter alia*, shifts in demographic factors that are not captured here and allows us to focus on the consumption-smoothing aspect of the current account, which is our primary interest.

Table 3 reports the VAR coefficients from the system (8). The choice of lag length was made by starting with five lags and successively eliminating lags which were statistically insignificant (judged by F-tests on the exclusion restrictions); the final VAR's have between one and three lags.[15]

[15] In calculating the present discounted value formulas we also need an estimate of $(1+r)$. The results reported are for $1/(1+r) = 0{\cdot}98$ although various interest rates between 2 and 6% p.a. gave very similar results.

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Tests of the Model

The first test of the model (and the hypothesis that capital flows have responded to consumption-smoothing behaviour) is the Granger causality test. Recall that, if agents have more information about the evolution of National Cash Flow than is contained in past values of that variable then the current account should Granger cause $\Delta(q-i-g)$.[16] In this respect the VAR estimates are none too encouraging for the formal validity of the model, since the United States is the only country for which there is a significant coefficient of the current account, CA_{t-1}, in the equation explaining the change in national cash flow, $\Delta(q_t-i_t-g_t)$. It is theoretically possible, though it would appear unlikely, that agents had no additional information available to forecast changes in national cash flow beyond that contained in its own history. Table 4 presents

Table 4
Granger Causality Tests

	F	p-value
United States		
1960–88	13·1	0·0004
1960–74	1·51	0·204
1975–88	4·06	0·023
Japan		
1960–88	0·58	0·62
1960–74	0·58	0·56
1975–88	1·26	0·29
Germany		
1962–88	0·38	0·76
1962–74	1·81	0·16
1975–88	0·14	0·86
United Kingdom		
1960–88	0·39	0·68
1960–74	0·11	0·90
1974–88	3·34	0·07
Canada		
1960–88	0·93	0·40
1960–74	1·30	0·28
1975–88	0·51	0·48

Test that CA_t Granger causes $\Delta(q_t-i_t-g_t)$.

formal Granger causality tests (which are just F-tests that all coefficients on current and lagged current account variables in the cash flow equation are jointly zero). For the United States, we can comfortably reject the null of no

[16] It is *not* an implication of the model that changes in national cash flow should Granger cause the current account. If, however, $\Delta(q_{t-1}-i_{t-1}-g_{t-1})$ is a significant explanatory variable for $\Delta(q_t-i_t-g_t)$ then the cross-equation restrictions imply that it should also help explain CA_t (and this coefficient should have the same sign as the coefficient explaining $\Delta(q_{t-1}-i_{t-1}-g_{t-1})$). This condition is satisfied in virtually all of the VAR estimates presented in Table 3, and provides some modest additional evidence in favour of the estimated model.

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Table 5
Variance of CA, CA and their Ratio*

	var (*CA*)	var (*CA**)	Ratio	χ^2	Corr (*CA*, *CA**)
United States					
1960–88	1,159	2,156	1·86	0·44	0·998
1960–74	106	211	2·00	1·04	0·978
1975–88	1,063	1,288	1·21	0·03	0·999
Japan					
1960–80	$1{\cdot}38 \times 10^7$	$6{\cdot}6 \times 10^6$	0·48	0·46	0·996
1960–74	$5{\cdot}3 \times 10^6$	$1{\cdot}26 \times 10^6$	0·23	14·9***	0·929
1975–88	$1{\cdot}64 \times 10^7$	$3{\cdot}43 \times 10^6$	0·20	25·1***	0·955
Germany					
1962–88	627	96	0·15	14·5***	0·81
1962–74	163	143	0·88	0·01	0·87
1975–88	1,000	32	0·03	370***	0·85
United Kingdom					
1960–88	25·40	4·82	0·19	50***	0·70
1960–74	14·52	0·42	0·03	37,000***	0·10
1974–88	32·75	13·5	0·41	5·4**	0·93
Canada					
1960–88	20·6	3·05	0·15	51·1***	0·98
1960–74	11·1	2·74	0·25	11·7***	0·99
1975–88	25·7	2·11	0·08	235***	−0·74

Ratio = Var (*CA**)/Var (*CA*).
χ^2 is the test statistic, with one degree of freedom, for the null that the ratio of the variances equals unity.
*** Reject at 1% or higher, ** Reject at 2·5%.

Granger causality for the entire sample, and for the late sub-sample (1975–88). The UK late sample is the only other one for which the F-test rejects the no-causality null, though at a barely significant level of 7%.

In Table 5 we examine whether capital mobility has been too limited to allow consumption-smoothing behaviour. The results are surprising. For the United States, the variance of the optimal current account is slightly higher than that of the actual current account ($2,156 versus $1,159) but their ratio is not significantly different from unity. For the remaining countries, the variance of the actual current account *exceeds* that of the optimal current account by statistically significant margins. For Japan, actual current account movements have been about twice as large as would have been necessary for consumption-smoothing, while for the United Kingdom, Germany, and Canada, the movements have been almost five times too large. In various sub-samples, this ratio becomes even worse; the United Kingdom in the period 1960–74, and Canada and Germany in the period 1975–88 experienced current account movements which were ten times as large as those predicted by the consumption-smoothing model. That is, capital flows to and from these countries have been much more volatile than would be justified by expected changes in national cash flow.

The same point is made visually in the time-series plots of CA_t and CA_t^* given in Figs. 1–5: the plots for CA_t are generally much more volatile. If the model

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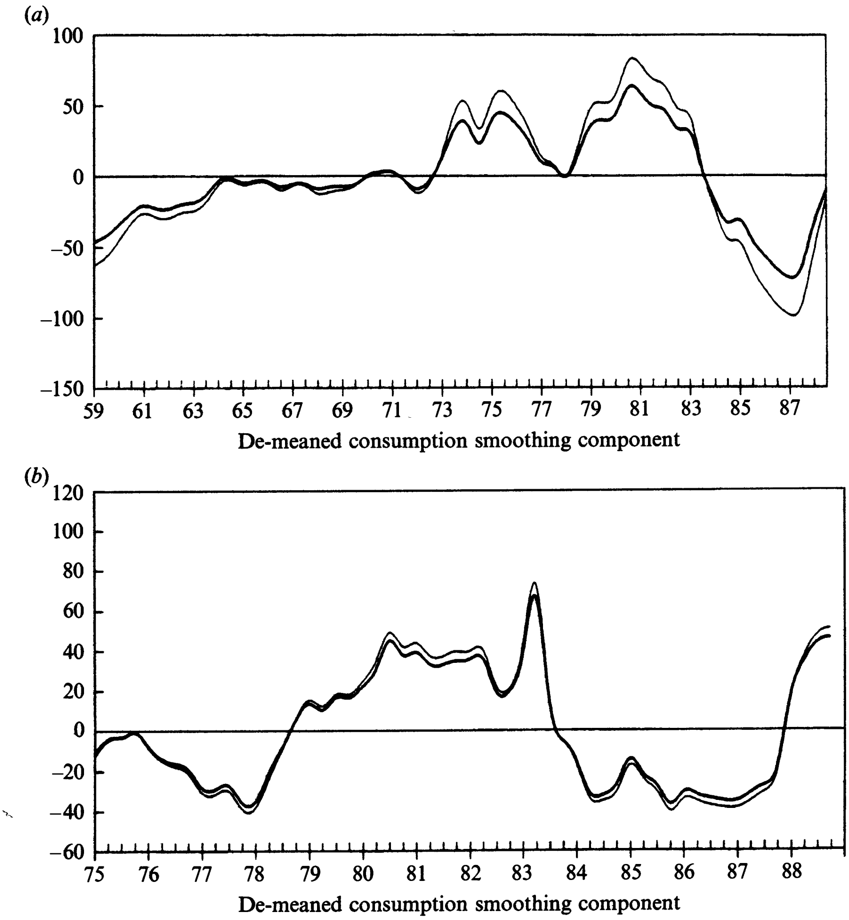

Fig. 1. United States, predicted and actual current account. (*a*) 1959–88; (*b*) 1975–89. ——, predicted; ——, actual.

were exactly correct then Γ_Y would equal zero and Γ_{CA} would equal unity (which is formally tested below) so that the two time-series plots would match perfectly. More generally, these plots allow us to assess informally the extent to which capital flows have deviated from the current account movements implied by the twin assumptions of perfect capital mobility and consumption-smoothing behaviour. Disregarding the *magnitude* of actual flows (i.e. the volatility of the actual current account) it is quite remarkable how highly correlated the two series are. Bearing in mind the various assumptions we have made – a single infinitely-lived consumer with a constant discount rate, a quadratic utility function, and a one-good world – the model does extraordinarily well in tracking current account movements. The sample correlations between CA_t and CA_t^* are presented in Table 5. For the full samples, these range from +0·998 for the United States (0·996 and 0·979 for Japan and Canada, respectively) to +0·691 for the United Kingdom. Even in the worst case, therefore, the model does reassuringly well in explaining the major

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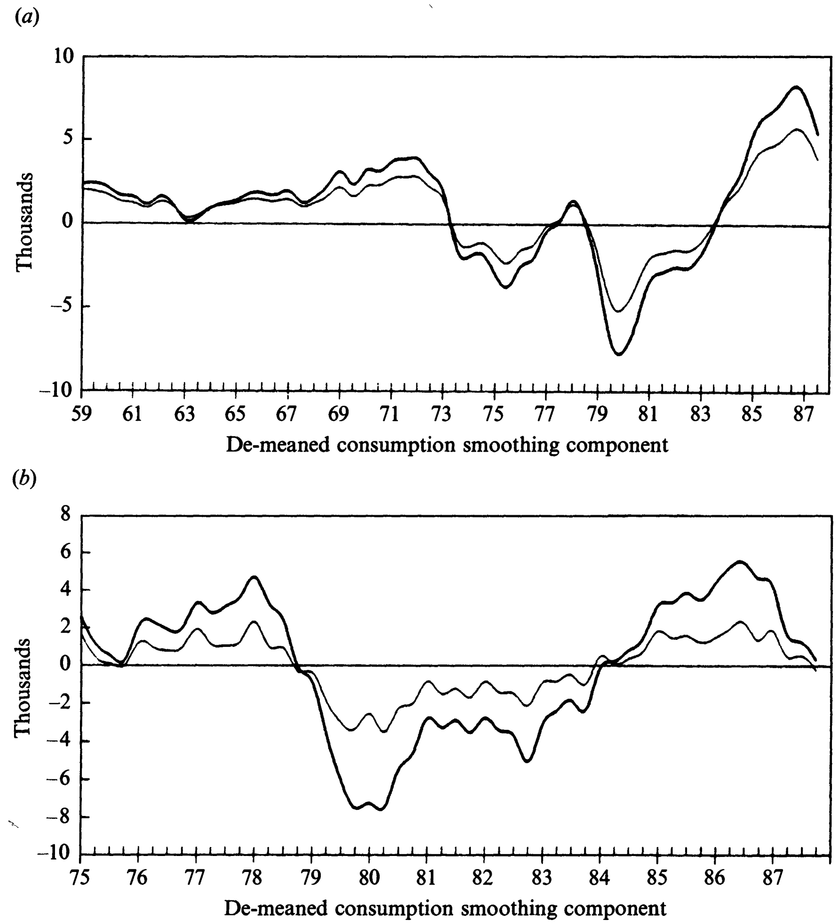

Fig. 2. Japan, predicted and actual current account (*a*) 1959–1987; (*b*) 1975–88. ——, predicted; ——, actual.

current account movements (though not necessarily the magnitude of those movements).

Certain shortcomings of the model are also apparent from the time-series plots. The model, for example, underestimates the Japanese current account deficit following the second oil shock in 1979. To the extent that the shock was perceived as being a permanent fall in output, the consumption-smoothing model would dictate an immediate adjustment, with no current account deficit.[17] In practice, however, the requisite adjustment in consumption was spread over several quarters, and the Japanese current account deficit was larger than the model's prediction. Perhaps in the presence of so large a shock, a model that incorporates some 'habit persistence' in the utility function would

[17] In fact, if the oil shock reduced the marginal product of capital in Japan, investment would fall, and, in an extreme case, a current account surplus could be generated.

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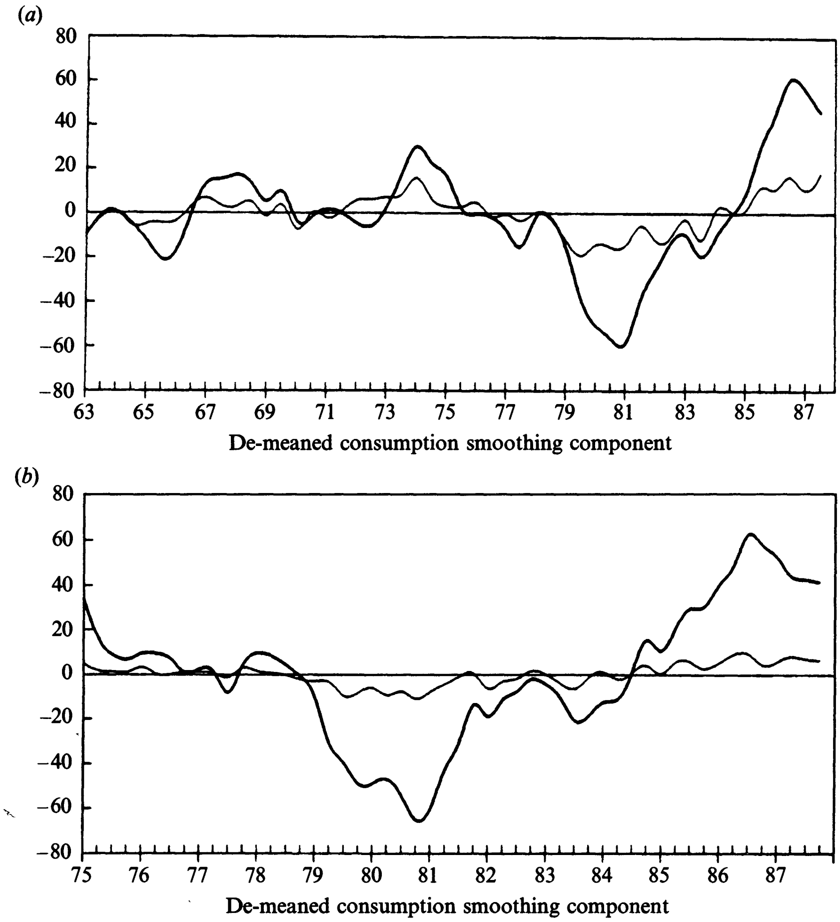

Fig. 3. Germany, predicted and actual current account. (*a*) 1963–87; (*b*) 1975–88.—— , predicted; ——, actual.

be better able to explain the slow adjustment in consumption even in the presence of permanent shocks.

Table 6 presents a formal statistical test of the model. If the consumption-smoothing model and the perfect capital mobility hypothesis are both correct, then the coefficient on CA in (11), Γ_{CA}, should be unity while the coefficient on $\Delta(q_t - i_t - g_t)$ should be zero (in a higher-order system, the coefficient on the contemporaneous CA_t should be unity and all other coefficients should be zero). Standard errors are calculated numerically as $\mathbf{\nabla\Gamma'\Sigma\nabla\Gamma}$ where $\mathbf{\Sigma}$ is the variance–covariance matrix of the parameters of the VAR, and $\mathbf{\nabla}(\mathbf{\Gamma})$ is the gradient of $[\Gamma_Y \quad \Gamma_{CA}]$ with respect to the VAR parameters.[18] The Wald

[18] The standard errors reported are White heteroscedastic standard errors, calculated as:

$$\underset{ij}{\Sigma} = (\mathbf{x}'\mathbf{x})^{-1}(\mathbf{x}'\epsilon_i\epsilon_j\mathbf{x})(\mathbf{x}'\mathbf{x})^{-1}$$

where ϵ_i and ϵ_j are the residuals from the ith and jth equation of the VAR.

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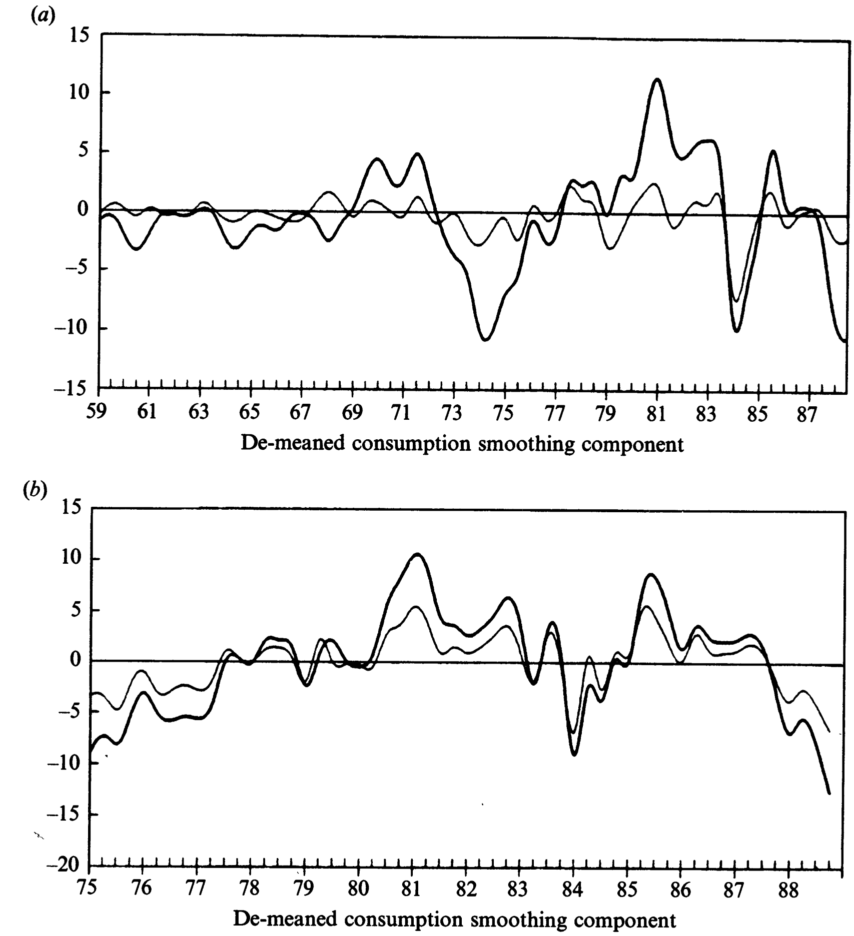

Fig. 4. United Kingdom, predicted and actual current account (*a*) 1959–87; (*b*) 1975–89. ——, predicted; ——, actual.

statistic for the joint test that Γ_{CA} is unity and the other coefficients are zero has a χ^2 distribution with degrees of freedom equal to the number of restrictions. The formal test confirms the findings above: only for the United States can the model not be statistically rejected at standard significance levels.

We undertook two tests of robustness of the results for the United States. First, to gauge the sensitivity of the results to the decomposition between the consumption-tilting and consumption-smoothing components we force Θ to equal unity and re-estimate the model. This appears to make little difference to the results: the correlation between CA and CA^* remains very high, at 0·99, and the χ^2 test for the overall fit of the model is $\chi^2 = 1{\cdot}002$ which does not allow us to reject. Over the second sub-sample, where the estimated Θ is significantly different from unity, the χ^2 statistic rises to 0·145 (from 0·008) but this is not statistically significant. Second, we break the national cash flow variable into its sub-components (q, i, and g) and estimate the VAR in terms of these

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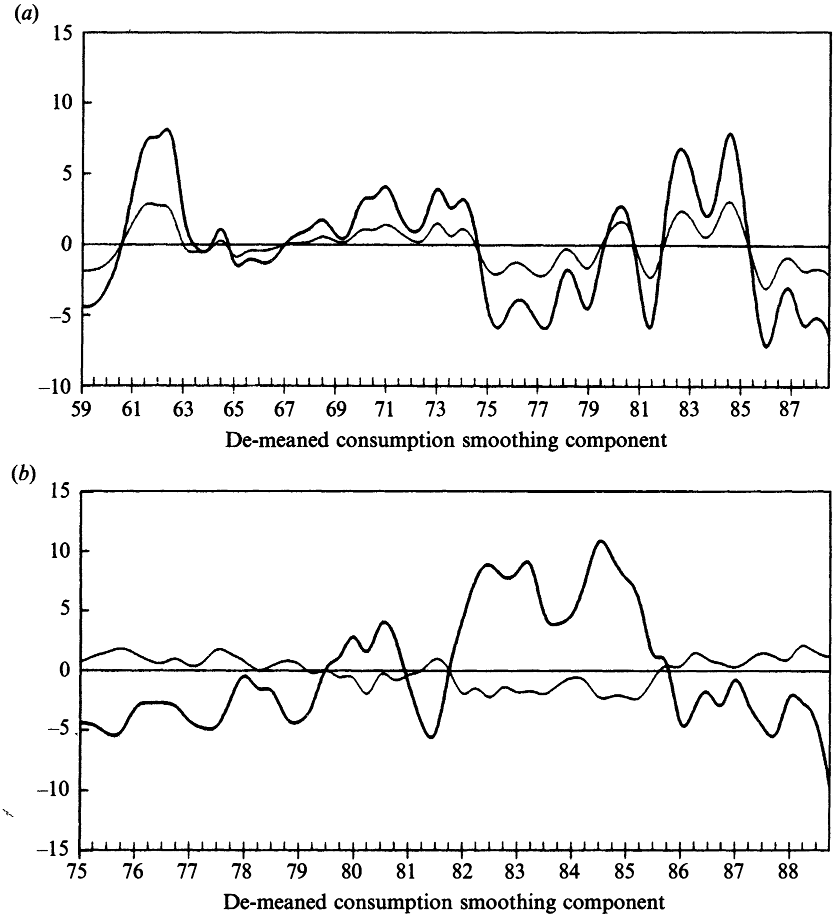

Fig. 5. Canada, predicted and actual current account. (*a*) 1959–88; (*b*) 1975–89. ——, predicted; ——, actual.

variables separately. The expression for the optimal current account now becomes:

$$CA_t^* = -[1 \quad -1 \quad -1 \quad 0]'[\Phi/(1+r)]\,[I-\Phi/(1+r)]^{-1}\begin{bmatrix}\Delta q_t\\ \Delta i_t\\ \Delta g_t\\ CA_t\end{bmatrix}$$

The correlation between CA_t^* and CA_t remains very high at +0·994, and the χ^2 test for the overall fit of the model is $\chi^2 = 2{\cdot}4$, which, with four degrees of freedom, fails to reject the model.

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Table 6
Wald Tests of the Model

	Γ_{CA}	SE (Γ_{CA})	χ^2	D.F.
United States				
1960–88	1·35	0·47	1·19	2
1960–74	1·49	0·42	13·1**	4
1975–88	1·10	0·52	0·08	2
Japan				
1960–80	0·67	0·56	75**	6
1960–74	0·37	0·24	222***	4
1975–88	0·38	0·33	198***	4
Germany				
1962–88	0·17	0·30	90***	6
1962–74	0·70	0·60	20***	6
1975–88	0·14	0·16	65***	2
United Kingdom				
1960–88	0·14	0·24	464***	4
1960–74	−0·03	0·10	410***	2
1974–88	0·47	0·27	73**	2
Canada				
1960–88	0·36	0·17	95***	2
1960–74	0·47	0·24	5·04***	2
1975–88	−0·28	0·14	590***	2

χ^2 is the Wald test statistic for the overall fit of the model.
*** Reject at 1% or higher, ** Reject at 2·5% level.

III. CONCLUSIONS

Previous tests of international capital mobility, based on the correlation between savings and investment, have suggested that capital does not flow freely even among the major industrialised countries. We have argued that such tests are fundamentally flawed, because even perfect capital mobility does not necessarily imply a zero correlation. Instead, we have proposed an alternative criterion for measuring capital mobility. If capital is indeed mobile, then it should smooth consumption in the face of shocks to national cash flow. This consumption-smoothing model performs extremely well in characterising the direction and turning points of the current accounts of all five of the countries studied. For the United States, moreover, the model accounts well for the magnitude of movements in the consumption-smoothing components of the current account. Indeed, the model cannot be statistically rejected, and the correlation between the fitted and actual values exceeds 0·99. Comparing the variance of this optimal current account to that of the actual current account suggests that there are no important capital market barriers, and that the US current account has not been excessively volatile.

The model also fits the Japanese data well, although the actual current account deficit following the second oil crisis was larger than that predicted by the consumption-smoothing model, and recent surpluses have been larger than would be justified by the consumption-smoothing hypothesis. Similarly, the German surplus has been growing more rapidly than would be expected, given

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expected changes in national cash flow. Although consumption-smoothing was clearly not the primary motivation for capital flow from the United Kingdom during the period 1960–74 (and capital movements were more volatile than consumption-smoothing would suggest), the model does much better over the period since the mid-1970s. Finally, throughout the sample period, Canadian current account movements have been much larger than would have been necessary to smooth consumption (moreover, in the second sub-sample the estimated value of Γ_{CA} is negative, as is the correlation between CA^* and CA).[19]

There are, however, several caveats to the analysis. First, as noted above, we are testing several joint hypotheses: consumption-smoothing behaviour, perfect capital mobility, a quadratic utility function, and a one-good world. As always, rejection of the model cannot necessarily be attributed to any one of the individual hypotheses. Second, we have adopted a very simple model of current account determination; oil shocks, in particular, which may have had a very important role during the sample period, only enter the model by affecting output or investment (presumably via the marginal product of capital). Third, we have assumed that each country is a small open economy. As observed earlier, however, to the extent that the countries are large in the world capital markets, this assumption makes it easier to reject the null of perfect capital mobility. Since we find that the variance of the actual current account generally exceeds that of the benchmark series, this appears to be an innocuous assumption. Fourth, the power of our test may be low because of the 'maintained external balance' hypothesis (see Summers (1988) for a discussion of this explanation of the Feldstein–Horioka results). We have assumed throughout that government expenditure is exogenous. Suppose, instead that the government lowers its expenditure in the face of imminent capital outflows and that the private sector understands the government reaction function. Since we include the actual current account in the VAR, we incorporate the private sector's entire information set when calculating the benchmark current account (see Campbell and Shiller (1987)). Therefore, if the government had an external balance objective, neither the actual current account nor the benchmark series would show a deficit. The economy would effectively be closed but our test could not detect this 'barrier'. While this could result for a low power of the test, it could *not* explain why the variance of the actual current account far exceeds the variance of the benchmark series for most of these countries. Indeed, the maintained external balance hypothesis, if true, makes the excess volatility finding even *more* puzzling: If governments really adjust expenditure in the face of imminent current account movements then there would be no need (from a consumption-smoothing perspective) for the observed capital flows.

One possibility is that these excessive current account movements are caused by short-term capital flows that respond to speculation in the foreign exchange

[19] Recall that we have already removed the trend in the current account by focusing only on the consumption smoothing component. Why the consumption smoothing model does so poorly here is not clear; for the case of Britain (1960–74) frequent speculative attacks on sterling may have led to more volatile capital account movements than would correspond to a consumption smoothing current account.

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market. Inasmuch as these private capital flows are not absorbed in reserves, they must be reflected in the current account. Yet the sheer magnitude and volatility of these capital flows suggests that they are much larger than would be necessary to smooth real shocks to consumption arising from shocks to government expenditure, investment, or output. That is, speculative capital flows may be wagging the current account, rather than the capital account reflecting the need for capital to act as a buffer when agents try to smooth consumption.[20] More work obviously needs to be done in extending the theoretical model used to create the benchmark series, and in calibrating the power of the test. What seems clear, however, is that the Feldstein–Horioka finding of insufficient capital mobility is not the puzzle which needs to be solved: the real puzzle lies in accounting for the excessive capital flows among the major industrialised countries.

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[20] There have been many episodes in which capital flows have been obviously excessive. On 5 May 1971, for example, more than $1bn flowed into Germany, in the first hour of foreign exchange trading (German GDP at the time was approximately $150bn). Similarly, during speculative attacks on sterling in the late 1960s massive capital flows – far in excess of any real shocks – were observed. Clearly, some of the flows were absorbed by reserves rather than the current account; yet to the extent that capital flows cannot be sterilised they will have an impact on the domestic economy by raising credit and stimulating demand. Likewise, consumption may need to adjust to capital outflows if the country has insufficient reserves so that the country is forced to run a larger current account surplus (or smaller deficit) than it would have chosen were it simply smoothing consumption.

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