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Current Account and Real Exchange Rate Dynamics in the G-7 Countries

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Abstract

The canonical predictions of intertemporal open-economy macro models are tested by a structural VAR analysis of Group of Seven countries. The analysis is distinguished from the previous literature in that it adopts minimal assumptions for identification. Consistent with a large set of theoretical models, permanent shocks have large long-term effects on the real exchange rate but relatively small effects on the current account; temporary shocks have large effects on the current account and exchange rate in the short run, but not on either variable in the long run. The signs of some impulse responses point toward models that differentiate tradables and nontradables.

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I. Introduction

The modeling of real exchange rate and current account balance determination has been, and remains, one of the most enduring and challenging topics of research in open-economy macroeconomics. However, until quite recently, studies of the two variables have proceeded on largely separate tracks. On the one hand, the typical examination of the real exchange rate has relied upon either interest rate and purchasing power parity conditions (as in Edison and Pauls, 1993) or trends in productivity (as in DeGregorio and Wolf (1994) or Chinn (1997)). On the other hand, the econometric analysis of the current account balance has often been couched in terms of a composite-good world (Sheffrin and Woo, 1990), at least when the framework is intertemporal in nature. Notable exceptions do exist, as in Ahmed (1987).

This paper bridges this gap by utilizing one of the canonical implications of the intertemporal approach to current account, namely that temporary shocks have no long-run effect on the real exchange rate. We also make the assumption that global shocks have no effects on either of these variables; only country-specific ones have an effect. These are two powerful identifying assumptions and are consistent with a broad spectrum of open-macro models. Incorporating them, we can then test other short-run predictions of the models, including the economically interesting hypothesis that temporary shocks are a central factor inducing movements in the current account.

In terms of identification, we only require that temporary shocks have no long-run effect on the real exchange rate. This assumption is consistent not only with earlier intertemporal models of current account but also with recent intertemporal models of open economy. For instance, it is trivially consistent with the original model of Obstfeld and Rogoff (1996), because the real exchange rate is constant in their model by the assumption of purchasing power parity. In the models by Betts and Devereux (2000) and Chari and others (1998), monetary shocks induce short-run fluctuations in the real exchange rate, via the pricing-to-market effect; however, such effects dissipate in the long run. The key identification assumption is consistent with a very broad class of open-macro models.

Although it is possible to impose different and more numerous identifying restrictions involving more variables, we believe that a bivariate model can be very useful in validating several presumptions in open-economy macroeconomics with a minimum of arbitrariness. Furthermore, other studies with more elaborate structural equations often fail to identify statistically significant impulse-response functions.[2] The conclusions one can then reach are correspondingly less persuasive, despite offering evidence on more variables.

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[2] For instance, Prasad and Kumar (1997) allow for a larger set of shocks and find that demand shocks have little independent effect on the exchange rate, except for the United States, Canada, and Italy. In Bergin (2001), the core structural restrictions are rejected for one out of the three countries examined. Both of these approaches, however, offer a richer set of results pertaining to multiple variables.

To anticipate our results, the estimated impulse-response functions are much in line with the model's predictions. A permanent shock, which we interpret as a technology innovation, induces a permanent appreciation of the real exchange rate. There is some effect on the current account, although it is often statistically insignificant. A temporary shock, which we associate with a monetary innovation, induces a temporary depreciation of the real exchange rate and a concurrent improvement in the current account. Our results lend empirical support to the basic tenet of recent open macro models and thus lend empirical content to these models that have been judged to have superior micro-based foundations. In addition, the results highlight the limitations of existing models, thereby pointing out avenues for future research.

II. The Identification Strategy

We identify temporary and permanent shocks by resorting to long-run restrictions, as pioneered by Blanchard and Quah (1989). We first discuss the econometric specification, and then present an illustrative theoretical model that motivates our interpretation of shocks so identified.

A. Econometric Specification

The premise of our identification assumptions can be presented in moving average (MA) representation as follows. When we designate country-specific permanent shocks as ε_t^P and country-specific temporary shocks as ε_t^T and denote

$$\varepsilon_t = \begin{bmatrix} \varepsilon_t^P \\ \varepsilon_t^T \end{bmatrix},$$

the first-differenced real exchange rate (Δq_t) and the current account (b_t) can be represented by the following MA process.

$$\begin{bmatrix} \Delta q_t \\ b_t \end{bmatrix} = \sum_{L=0}^{\infty} B(L) \begin{bmatrix} \varepsilon_{t-L}^P \\ \varepsilon_{t-L}^T \end{bmatrix} \qquad (1)$$

with $E(\varepsilon_t) = 0$, $E(\varepsilon_t \varepsilon_t') = I$, and $E(\varepsilon_t \varepsilon_s') = 0$ when $t \neq s$. The restriction that temporary shock does not have a long-run effect on the real exchange rate can be written as:

$$\left[\sum_{L=0}^{\infty} B(L) \right]_{(1,2)} = 0. \qquad (2)$$

To apply the identification restriction (2), we estimate the following bivariate VAR from data.

$$\begin{bmatrix} \Delta q_t \\ b_t \end{bmatrix} = C(L) \begin{bmatrix} \Delta q_t \\ b_t \end{bmatrix} + \begin{bmatrix} \eta_t^q \\ \eta_t^b \end{bmatrix} \quad (3)$$

Denoting

$$\eta_t = \begin{bmatrix} \eta_t^q \\ \eta_t^b \end{bmatrix},$$

the MA representation can be written as:

$$\begin{bmatrix} \Delta q_t \\ b_t \end{bmatrix} = \sum_{L=0}^{\infty} D(L) \eta_{t-L} \quad (4)$$

with $E(\eta_t) = 0$, $E(\eta_t \eta_t') = V$, $E(\eta_t \eta_s') = 0$ for $t \neq s$.

In a conventional VAR analysis, system (4) will be identified by Choleski factorization of the covariance matrix V. When the system is ordered with the exchange rate ahead of the current account, for example, such identification amounts to assuming that the exchange rate innovation has the contemporaneous effect on the current account but that the current account innovation has no contemporaneous effect on the exchange rate. While always subtle, such a block diagonality is particularly difficult to envisage in the relationship between the current account and the exchange rate. No theoretical model would predict that the innovation in the exchange rate (current account) has no contemporaneous effect on the current account (exchange rate). In contrast, our identification assumption summarized in equation (2) enables us to identify the system on the basis of a criterion that is consistent with a wide spectrum of intertemporal open macro models.

Under our identification assumption, theoretical representation (2) and empirical estimate (4) are linked by the following relation.

$$V = B(0)(B(0))'. \quad (5)$$

Because $\eta_t = B(0)\varepsilon_t$, using $B(L) = D(L)B(0)^{-1}$ ($L = 1, 2, 3, \ldots$), we can write equation (2) as

$$\left[\sum_{L=0}^{\infty} D(L) B(0)^{-1} \right]_{(1,2)} = 0. \quad (6)$$

Then equations (5) and (6) enable us to find the matrix $B(0)$, thereby uncovering the entire MA representation of the real exchange rate and current account in terms of permanent and temporary shocks. So far, the identification depends on the assumption that temporary shocks have no long-run effect on the exchange rate, regardless of other characteristics of underlying shocks.

B. A Theoretical Interpretation

In order for the empirical results to be readily interpretable in economic terms, one needs to link the restrictions to a theoretical framework. While it is natural to interpret temporary shocks as monetary shocks and permanent shocks as productivity shocks in a broad class of models, we present an illustrative small open-economy model that helps to clarify this interpretation.

The economy is populated by a unit mass of agents with the following instantaneous utility function.

$$\frac{\sigma}{\sigma-1} C_s^{\frac{\sigma-1}{\sigma}} + \chi \log \frac{M_s}{P_s} - \kappa_N y_{Ns} \text{ at time } s,$$

where

$$C_s = \left[\gamma^{\frac{1}{\theta}} C_{Ts}^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} C_{Ns}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}},$$

$$C_{Ns} = \left[\int_0^1 c(N,s,z)^{\frac{\alpha-1}{\alpha}} dz \right]^{\frac{\alpha}{\alpha-1}} \text{ and } C_{Ts} = \left[\int_0^1 c(T,s,z)^{\frac{\alpha-1}{\alpha}} dz \right]^{\frac{\alpha}{\alpha-1}}.$$

The consumption basket is composed of tradables (T) and nontradables (N), and money enters through utility function. This is a small economy version of new open economy models, introduced by Obstfeld and Rogoff (1996). The intertemporal elasticity of substitution of consumption (C_s) is σ, and the intratemporal elasticity of substitution between tradables and nontradables consumption (C_{Ts} and C_{Ns}) is θ. Tradables and nontradables are again divided into different varieties, with elasticity of substitution among them equal to α. The corresponding price aggregators are:

$$P_s = \left[\gamma P_{Ts}^{1-\theta} + (1-\gamma) P_{Ns}^{1-\theta} \right]^{\frac{1}{1-\theta}},$$

$$P_{Ns} = \left[\int_0^1 p(N,s,z)^{1-\alpha} dz \right]^{\frac{1}{1-\alpha}} \text{ and } P_{Ts} = \left[\int_0^1 p(T,s,z)^{1-\alpha} dz \right]^{\frac{1}{1-\alpha}}.$$

The representative agent maximizes the lifetime utility

$$\sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{\sigma}{\sigma-1} C_s^{\frac{\sigma-1}{\sigma}} + \chi \log \frac{M_s}{P_s} - \kappa_N y_{Ns} \right]$$

subject to flow budget constraint

$$P_{Tt} F_{Tt} + M_t = P_{Tt}(1+r) F_{t-1} + M_{t-1} + (\varpi + \pi) y_{Nt} + P_{Tt} \bar{y}_{Tt} - P_{Nt} C_{Nt} - P_{Tt} C_{Tt}$$

for each period t.

In addition to money (M), consumers hold interest-paying bonds (F) that is denominated in tradable goods and internationally traded. The supply of tradables is assumed to be fixed ($\bar{y}_{Tt}$), but nontradables are supplied by producers in a monopolistically competitive market that is characterized by the downward-sloping demand schedules for each product.

$$y^d(N,t,z) = \left(\frac{p(N,t,z)}{P_{Tt}} \right)^{-\alpha} C_{Tt} .$$

This monopolistically competitive market for each variety is critical for generating a demand-determined equilibrium under price rigidity.

After some algebra, the first-order conditions can be written as follows.

$$\frac{C_{Ts+1}}{C_{Ts}} = \left(\frac{P_{Ts+1} / P_{s+1}}{P_{Ts} / P_s} \right)^{\sigma-\theta}$$

The growth rate of tradables consumption depends on the balance between the intertemporal rate of substitution (σ) and the intratemporal rate of substitution (θ), as was first observed insightfully by Dornbusch (1983).

$$\frac{C_{Ts}}{C_{Ns}} = \frac{\gamma}{1-\gamma} \left(\frac{P_{Ts}}{P_{Ns}} \right)^{-\theta}$$

$$M_s = P_s \chi C_s^{\frac{1}{\sigma}} \left(\frac{1+i_s}{i_s} \right) \text{ where } 1+i_s = \frac{P_{s+1}}{P_s}(1+r)$$

$$\kappa_N = \frac{\alpha - 1}{\alpha} \frac{P_{Ns}}{P_s} C_s^{\frac{-1}{\sigma}}$$

The last equation characterizes the equilibrium condition for the nontradables market, where κ_N can be interpreted as the *inverse* of the level of productivity in the nontradables sector (or alternatively, a transformation of the relative level of productivity in the tradables sector). We can derive implicitly the expression for the real exchange rate in the steady state with balanced trade ($C_T = \bar{y}_T$) under full price flexibility.

$$\kappa_N = \frac{\alpha - 1}{\alpha} \left[\gamma \left(\frac{P_T}{P_N} \right)^{1-\theta} + (1-\gamma) \right]^{\frac{-1}{1-\theta}} \left\{ \frac{\bar{y}_T}{\gamma} \left[\gamma \left(\frac{P_T}{P_N} \right)^{1-\theta} + (1-\gamma) \right]^{\frac{-\theta}{1-\theta}} \left(\frac{P_T}{P_N} \right)^{\theta} \right\}^{\frac{-1}{\sigma}}$$

The real exchange rate (P_T/P_N) is determined implicitly by the level of productivity, with monetary factors having no influence at all, reflecting price flexibility. The lower is the nontradables productivity, the higher is the relative price of nontradables, resulting in real appreciation. To confirm this relationship, we take the log of the above equation. When $p \equiv \frac{P_T}{P_N}$,

$$\log \kappa_N = -\frac{1}{1-\theta} \log\left[\gamma p^{1-\theta} + (1-\gamma)\right] + \frac{\theta}{\sigma(1-\theta)} \log\left[\gamma p^{1-\theta} + (1-\gamma)\right] - \frac{\theta}{\sigma} \log p \ .$$

Differentiating the equation and normalizing the real exchange rate to equal 1, we get

$$\frac{\partial \log \kappa_N}{\partial p} = -\frac{1}{\sigma}\left[\theta(1-\gamma) + \gamma\sigma\right]$$

which is negative for all parameter values.

When price rigidity is introduced—especially in this model with infinite-horizon life-cycle consumers—monetary shocks have some long-term effects, as the level of net foreign assets changes in response. The typical finding, however, is that the long-run effect of monetary shocks on net foreign assets is small, and that the long-run exchange rate effect of monetary shocks is even smaller. A similar conclusion holds in our model, so that here the long-term exchange rate response is of lower order of magnitude than the already small current account response.

To demonstrate this assertion, assume—consistent with Obstfeld and Rogoff (1996)—that prices of nontradables are fixed for one period, and that the prices can be adjusted to the new equilibrium one period after the monetary shock. To log-linearize the deviation around the steady state, let $\hat{X}$ denote the change in variable X from the old to the new steady state, and $\breve{X}$ denote the change in variable X from the old steady state to the transitional value when prices are kept at their old values. For example, in response to the permanent change in money supply ($\hat{M} > 0$), prices will adjust by $\hat{P}_T$ and $\hat{P}_N$ in the long run, and by $\breve{P}_T$ and $\breve{P}_N$ in the short run. (By assumption, $\breve{P}_N = 0$.)

The intertemporal budget constraint dictates that the steady-state consumption changes by the amount of interest income (or burden) of the change in the net foreign assets.

$$\hat{C}_T = r\frac{dF}{C_0}$$

Since the domestic supply of tradables is assumed constant, the short-run current account balance equals the change in short-run consumption.

$$\frac{dF}{C_0} = -\breve{C}_T$$

This short-run current account response depends on several parameter values, including the balance between intertemporal and intra-temporal elasticities of substitution ($\sigma - \theta$). We relegate the presentation of this expression to the appendix, and focus on the possible magnitude of the long-term exchange rate effect.

When money supply is increased permanently, the long-term change in the real exchange rate can be written in terms of short-run changes in consumption—which is the other side of short-run current account—as follows.

$$\hat{P}_T - \hat{P}_N = \frac{r}{\sigma\gamma + (1-\gamma)\theta}\breve{C}_T$$

The long-term real exchange rate change is a fraction of change in net foreign assets ($\breve{C}_T$), which in turn cannot exceed the change in money supply. When both elasticities are equal to 1 ($\sigma = \theta = 1$), the long-run real exchange rate effect of monetary shocks cannot exceed several hundredths (that is, the real interest rate) of the original shock. Taking into account the fact that the short-term current account effect itself is a fraction of the monetary shock, the actual real exchange rate effect will be even smaller.

This conclusion is not a peculiarity of this specific model. The long-term exchange rate effect of monetary shocks is found to be small or zero in more general models as well. Indeed, Obstfeld and Rogoff (1996, p. 682) point out that long-run nonneutrality of monetary shocks on the exchange rate should be viewed with caution. Moreover, they draw attention to the fact that the long-run real exchange rate effect of monetary shocks dissipates in dynamic open macro models with overlapping generations of finite-horizon consumers. Given that the long-run effect of monetary shocks is small or zero in various open macro models, we take the view that our interpretation is approximately correct, as was proved by Blanchard and Quah (1989) in their technical appendix.[3]

In contrast, the productivity shock has large long-term effect, although under price rigidity, the effect of productivity differs somewhat from the closed-form solution obtained under the assumption of full price flexibility. The long-term real exchange rate effect of productivity can be linked to short-term changes in consumption as follows.

$$\hat{P}_T - \hat{P}_N = \frac{1}{(\sigma-\theta)(1-\gamma)}\left(r + \frac{\sigma}{\sigma\gamma + (1-\gamma)\theta}\right)\breve{C}_T .$$

The magnitude of the long-term exchange rate effect can be very large relative to the short-term current account effect.

III. Empirical Implementation

A. Data

We examine exchange rate and current account dynamics for the United States, Canada, the United Kingdom, Japan, Germany, France, and Italy. For the real exchange rate, we use the CPI-deflated real exchange rate series from the IMF's *International Financial Statistics* (hereafter *IFS*). This series is a multilateral, trade-weighted index, available at the monthly or quarterly frequency. Since the real exchange rate data are only available for the period after 1979 or 1980, the sample period stretches from 1979/80 to 2000. The current account data and the GDP data—available at the quarterly frequency—are also obtained from *IFS*. We convert the reported dollar denominated current account figures into the respective national currencies by using the average bilateral exchange rate of each period, and divide that by nominal GDP. The current account to GDP ratio series is then seasonally adjusted by regressing it on a series of quarterly dummy variables. In the estimation procedure, we use the log of the real exchange rate—in first difference—and the ratio of the current account to GDP.[4]

[3] An alternative long-term identification assumption, exploiting the fact that monetary shocks have no long-term effect on the current account, has been advocated by some, starting with Lane (2001). For our exercise, however, this identification assumption provides no discriminatory power. In models where the stock of net foreign assets is constant in a steady state, it is trivially true that shocks of all sources have no long-term effect on the current account.

[4] See Lee and Chinn (1998) for a discussion of issues relating to the stationarity of the series.

B. Estimating the VAR

We use two lags for each country, striking a balance between the lag lengths chosen by Schwartz information criterion (SIC) and Akaike information criterion (AIC). Typically, the SIC chooses 1 or 2 lags, with 1 slightly preferred. The only exception is Japan where 1 and 2 are equally preferred. The AIC, on the other hand, usually selects 2 or 3 lags, or longer lags in certain cases. When long lags such as 5 are used in the estimation, however, the coefficient estimates enter with very low statistical significance. We opted to use the shorter lag structures suggested by the SIC.

The estimation results are reported in Table 1. In general they accord with one's priors. It is more difficult to explain movements in real exchange rates than in current account balances. The R^2's for the exchange rate change equations range from 0.09 to 0.16, while those for the current account balance take on values from 0.69 to 0.82. First differences of the real exchange rate exhibit some serial correlation, but in no case does the coefficient on the lagged difference exceed 0.37 (Italy's coefficient), and for the United States, the estimate is not statistically significant. In contrast, the current account balance exhibits substantial persistence, with the coefficient on the first lag taking on values as high as 0.83 (for the United States).

The lagged cross-correlations in some ways provide even more interesting patterns. The coefficient relating the current account balance to the lagged change in the real exchange rate is statistically significant only in Germany and the United Kingdom. However, the coefficient for the United Kingdom is positive, rather than a negative value that one might expect from a simple income-absorption view. The response of the U.K. exchange rate difference to the once lagged current account balance is also at variance with the other countries' estimates. In contrast to the other estimates, the coefficient here is negative (-0.56), and almost statistically significant. Hence, one might expect the resulting U.K. estimated dynamics to differ somewhat from those of the other countries.

C. Impulse Response Functions

The impulse-responses to temporary and permanent shocks are displayed in Figure 1. The four columns show, from the left to the right, the response of the current account to temporary shocks (CA: temp), the response of the current account to permanent shocks (CA: perm), the response of the exchange rate to temporary shocks (ER: temp), and the response of the exchange rate to permanent shocks (ER: perm). The seven rows correspond to the seven countries, comprising four panels for each country. Within each panel, the solid line shows the impulse response, with dotted lines depicting one-standard-deviation band obtained by a bootstrap of 1000 replications.

The results from the impulse response functions (IRFs) are broadly consistent with most conventional models of the open economy, when one interprets temporary shocks to be monetary shocks and permanent shocks to be productivity shocks. Consider first the results for the United States. The current account improves in response to temporary shocks, while its response to permanent shocks is mixed. The level of the real exchange rate immediately depreciates in response to a temporary shock, then gradually tapers off to a zero effect. The permanent shock induces a gradual and continuous exchange rate appreciation. These patterns, in addition to the long-run interpretation that was discussed in the previous section, invite us to interpret the temporary shock as a money shock, and the permanent shock as a productivity shock. The money shock depreciates the currency so much that the current account improves over the short term (one to three quarters), while over a longer term, the current account effect fades away as the exchange rate effect erodes.[5]

In all countries, permanent shocks appreciate the real exchange rate, boding well for the predictions of most models including ours. The responses of the current account, however, pose a small puzzle. As the real exchange rate appreciates, the current account balance also improves. This positive comovement between the exchange rate and the current account does not accord well with predictions of single-sector models. Regardless of whether the permanent shock captures the productivity shock—or the portion of monetary shock that affects the long-run real exchange rate—in single-sector models, current account improvement is associated with real exchange rate depreciation.[6]

This pattern of results has a better chance of being reconciled with models that distinguish between tradables and nontradables, thereby indirectly favoring such models over single-sector models. The illustrative model of this paper, however, does not offer a full resolution. In our model, short-run improvement in the current account is associated with long-run appreciation in the real exchange rate, when the intertemporal elasticity is larger than the intratemporal elasticity within a bound (see appendix for the formula). But the same parameter restriction implies that in response to temporary shocks, short-run current account deterioration is associated with short-run real depreciation, a pattern that neither shows up in our result nor is implied in most other models. This limitation, however, might very well be a consequence of highly stylized nature of our model in capturing gradual price adjustment.[7]

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[5] This interpretation of temporary shock is approximately correct, as discussed in the previous section.

[6] Nor can this be easily explained by possible over-aggregation of multiple shocks to two—temporary and permanent ones. Blanchard and Quah (1989) and Faust and Leeper (1997) discuss how two-shock representation of multiple shocks may undermine economic interpretation of VAR results. In our results, one might suspect that permanent effects of monetary shocks are stronger than is viewed in the literature. Stronger permanent effect of monetary shocks, however, would tend to ameliorate the positive association between the current account and the exchange rate that is induced by permanent shocks.

[7] Going beyond our simple model, one could consider other kinds of permanent shocks that might generate the desired correlation. One example would be a permanent preference shock in favor of home exports.

Except for the United States, most countries exhibit the same pattern of results (Canada, Japan, Italy, Germany, and France). In fact, to the extent that the impulse response functions of the current account to the permanent shock are indistinguishably different from zero, the results for Canada, Italy, and Germany are more favorable to standard (single-sector) models.

The United Kingdom provides some anomalous results. Once again the current account improves in response to a temporary shock; however, the level of the exchange rate also appreciates, rather than depreciates. The response of the current account and the exchange rate to the permanent shock is more in accord with theory—the exchange rate immediately appreciates, while the current account appears to deteriorate, although the impulse response function is within one standard error of no effect.

It is of interest to compare our results with those of other studies. Using bilateral real exchange rates, Clarida and Gali (1994) obtain similar results for the U.S.-German system; in a manner inconsistent with their theoretical model, the real exchange rate appreciates in response to a productivity shock.[8] On the other hand, the exchange rate depreciates in the U.S.-Japan system. In a study of multilateral real exchange rates, Prasad and Kumar (1997) find that both supply and demand shocks (which are permanent in nature) depreciate the currency in real terms. In our system with only a single temporary and a single permanent shock, we find that the permanent shock appreciates the currency. This finding is consistent with results from the regression and cointegration based literature on the real exchange rate/productivity link (Chinn, 1997).

D. Historical Decompositions

While the direction of impulse-responses can easily differ from predictions of specific models, an important ingredient of most intertemporal open macro models is that temporary shocks play a bigger role in accounting for the dynamics of the current account. To assess the empirical relevance of this insight for the past decades, we calculate the historical decompositions based on the estimated VARs. The results are shown in Figures 2 and 3. For most countries, the movement of current account is attributed largely to temporary shocks while the movement of the exchange rate is attributed largely to permanent shocks. However, the results for the United States differ somewhat. The deterioration in the current account over the mid-1980s is largely due to permanent factors, as is the improvement in the early 1990s due to the Gulf War transfers. The U.S. real exchange rate changes are characterized by greater dominance of temporary shocks than would be expected from the time series literature on exchange rate behavior. These historical simulations indicate that for most other currencies, permanent shocks dominate in exchange rate changes. This asymmetry in findings suggests that the behavior of the U.S. real exchange rate differs from those of other

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[8] In their paper, the permanent shock reduces domestic prices, and thus cannot be the positive productivity shock to the foreign country.

G-7 currencies. One possibility is that the substantial swing in the U.S. real exchange rate during the mid-1980s differentiates the U.S. experience.

The differing roles of temporary and permanent shocks uncovered in our analysis offer some explanation for the difficulty in empirical attempts to uncover the relationship between the exchange rate and the current account. While many theories suggest that the real depreciation should generate an improvement in the current account, strong evidence for it has been rare. According to our results, a tight relationship would have been uncovered, had most of the exchange rate fluctuations been due to temporary shocks. An example of this may be the U.S. experience during the eighties, as discussed by Krugman (1991). In most countries and periods, however, we find that permanent shocks are prime causes for the movement of the real exchange rate. Their effects on the current account are small or sometimes even in the opposite direction to that of temporary shocks.

In other words, most fluctuations in the real exchange rate come from shocks that affect the current account little or in the direction opposite to the common prediction of theory. Hence, attempts to establish tight linkages between the real exchange rate and the current account are bound to generate mixed results, as far as they do not successfully control for permanent shocks that drive the bulk of the movement in the real exchange rate. At the same time, weak evidence of such correlations should not be viewed as invalidating the theory that a real depreciation caused by certain (temporary) shocks can improve the current account.

This interpretation can be viewed as an empirical extension and vindication of the theoretical insight of Backus and others (1994). In a competitive dynamic model with no price rigidity, they showed that the source of shocks makes a difference to the correlation between terms of trade and net exports. We show empirically that the correlation between the real exchange rate and current account can differ with sources of shocks, on the basis of identification assumption consistent with models with or without price rigidity in the following sense. Monetary shocks—which is the prime candidate for our temporary shocks—have no effect on the (long-term) real exchange rate under models without price rigidity, and have negligible—approximately zero—effect on the long-term real exchange rate under models with price rigidity.

IV. Conclusion

Working with the minimal identifying assumptions that apply to most intertemporal open-macro models, we find that the basic implications of the literature are validated in the data. With the exception of the United States, temporary shocks play a larger role in explaining the variation in the current account balance, while permanent shocks play a larger role in explaining the variation in the real exchange rate. With the exception of the United Kingdom, temporary shocks depreciate the real exchange rate and improve the current account balance. Permanent shocks appreciate the real exchange rate and, in some countries, improve the current account balance in contradiction to many extant models. While these results lean favorably toward two-sector models, further empirical and theoretical analysis is left for future research.

Table 1. Vector Autoregressions

	Canada		France		Germany		Italy		Japan		UK		USA	
	DEC	CAY	DEC	CAY	DEC	CAY	DEC	CAY	DEC	CAY	DEC	CAY	DEC	CAY
DEC(-1)	0.32	0.04	0.25	-0.07	0.31	-0.13	0.37	-0.08	0.27	0.00	0.27	0.06	0.16	-0.03
	(0.11)	(0.05)	(0.11)	(0.06)	(0.12)	(0.07)	(0.12)	(0.05)	(0.11)	(0.01)	(0.11)	(0.03)	(0.12)	(0.02)
DEC(-2)	-0.03	-0.03	-0.11	0.05	0.06	0.04	-0.08	0.04	-0.19	0.04	-0.10	-0.03	-0.09	-0.02
	(0.11)	(0.05)	(0.11)	(0.05)	(0.12)	(0.07)	(0.11)	(0.05)	(0.11)	(0.01)	(0.11)	(0.03)	(0.12)	(0.02)
CAY(-1)	-0.17	0.79	0.42	0.43	0.20	0.69	0.40	0.53	1.84	0.61	-0.56	0.59	0.72	0.83
	(0.23)	(0.11)	(0.21)	(0.10)	(0.19)	(0.11)	(0.28)	(0.11)	(0.94)	(0.11)	(0.38)	(0.11)	(0.82)	(0.11)
CAY(-2)	0.29	0.07	-0.41	0.49	-0.14	0.25	-0.23	0.36	-0.94	0.20	0.37	0.30	0.17	0.16
	(0.24)	(0.11)	(0.21)	(0.10)	(0.19)	(0.12)	(0.28)	(0.11)	(0.87)	(0.10)	(0.38)	(0.11)	(0.86)	(0.12)
C	0.0032	-0.0038	-0.0023	0.0003	-0.0020	0.0005	0.0024	-0.0015	-0.0120	0.0039	-0.0005	-0.0014	0.0136	-0.0007
	(0.0053)	(0.0026)	(0.0017)	(0.0008)	(0.0020)	(0.0012)	(0.0035)	(0.0014)	(0.0104)	(0.0012)	(0.0042)	(0.0012)	(0.0053)	(0.0007)
R-squared	0.12	0.69	0.10	0.75	0.15	0.82	0.15	0.75	0.14	0.79	0.09	0.74	0.16	0.89
Akaike AIC	-4.83	-6.27	-5.51	-6.95	-5.36	-6.35	-4.65	-6.45	-3.31	-7.69	-3.80	-6.28	-4.20	-8.18
Schwarz SC	-4.68	-6.12	-5.36	-6.80	-5.22	-6.21	-4.50	-6.30	-3.16	-7.54	-3.66	-6.14	-4.05	-8.03
Observations	84		80		82		79		79		84		78	
Akaike AIC	-10.98		-12.33		-11.70		-10.99		-10.87		-10.00		-12.25	
Schwarz SC	-10.69		-12.04		-11.41		-10.69		-10.57		-9.71		-11.95	

DEC refers to the log-differenced exchange rate, and CAY refers to the ratio of current account to GDP.
Standard errors are in parentheses.

Figure 1. Impulse Responses

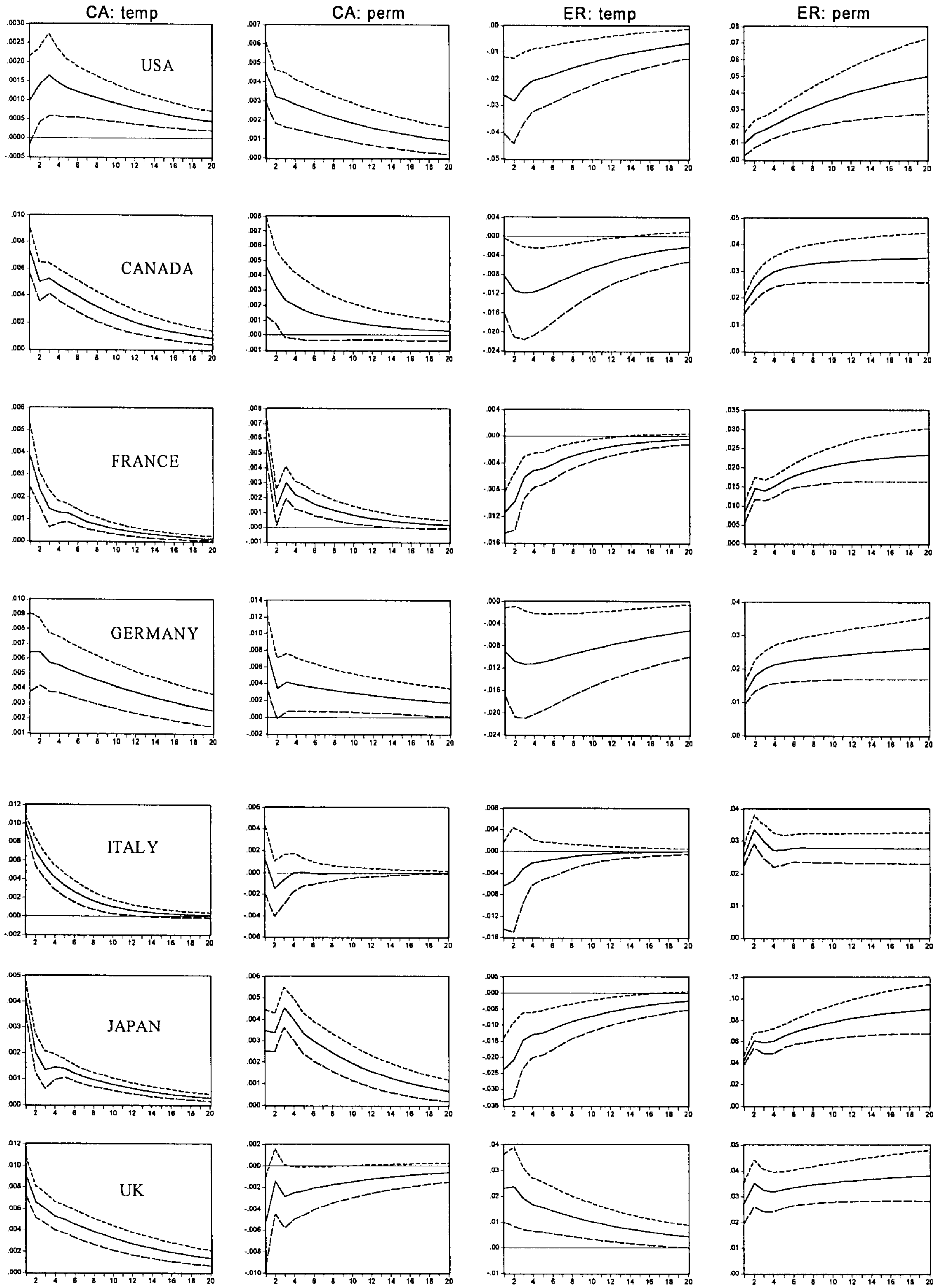


Figure 2. Decomposition: Current Account

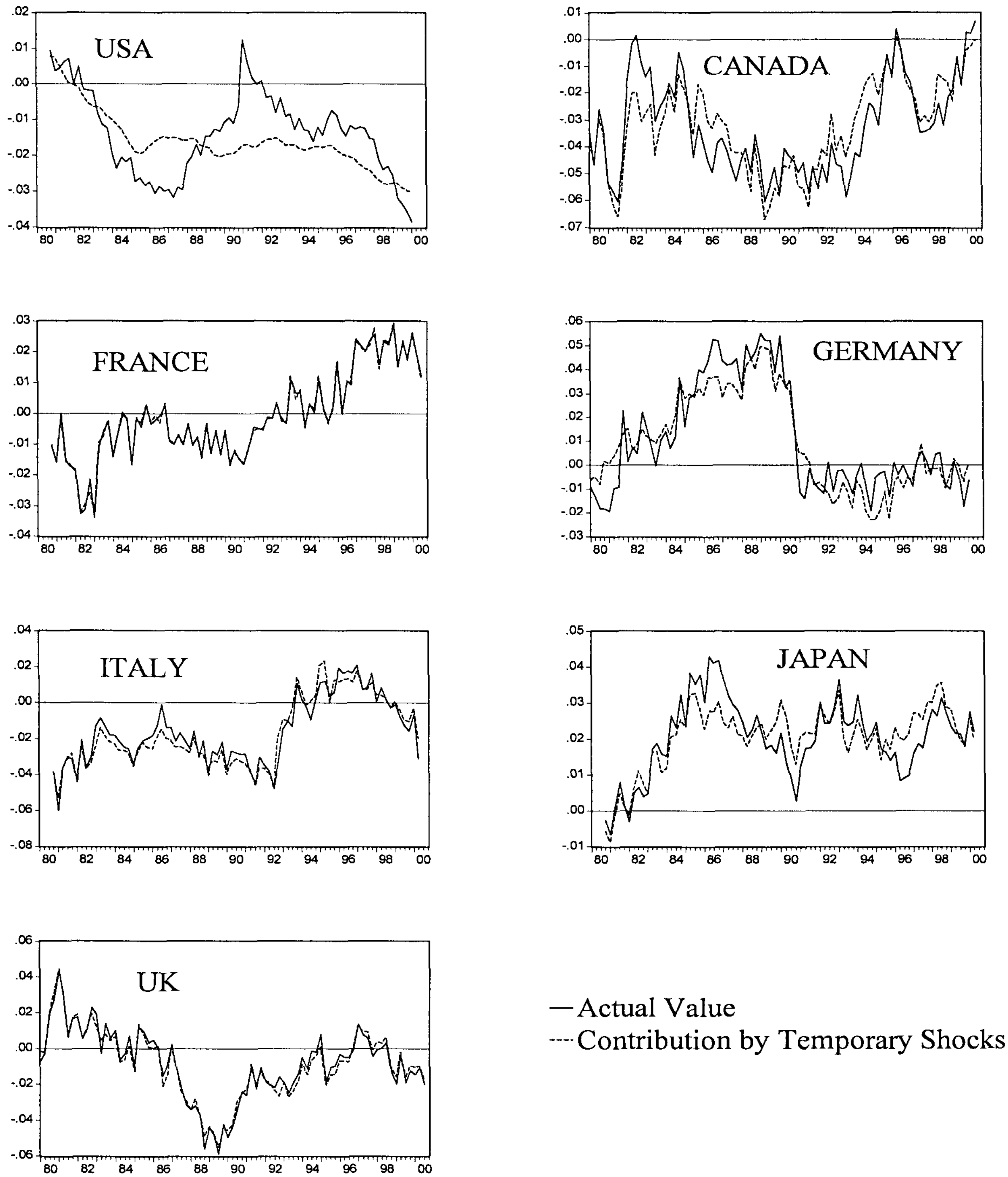
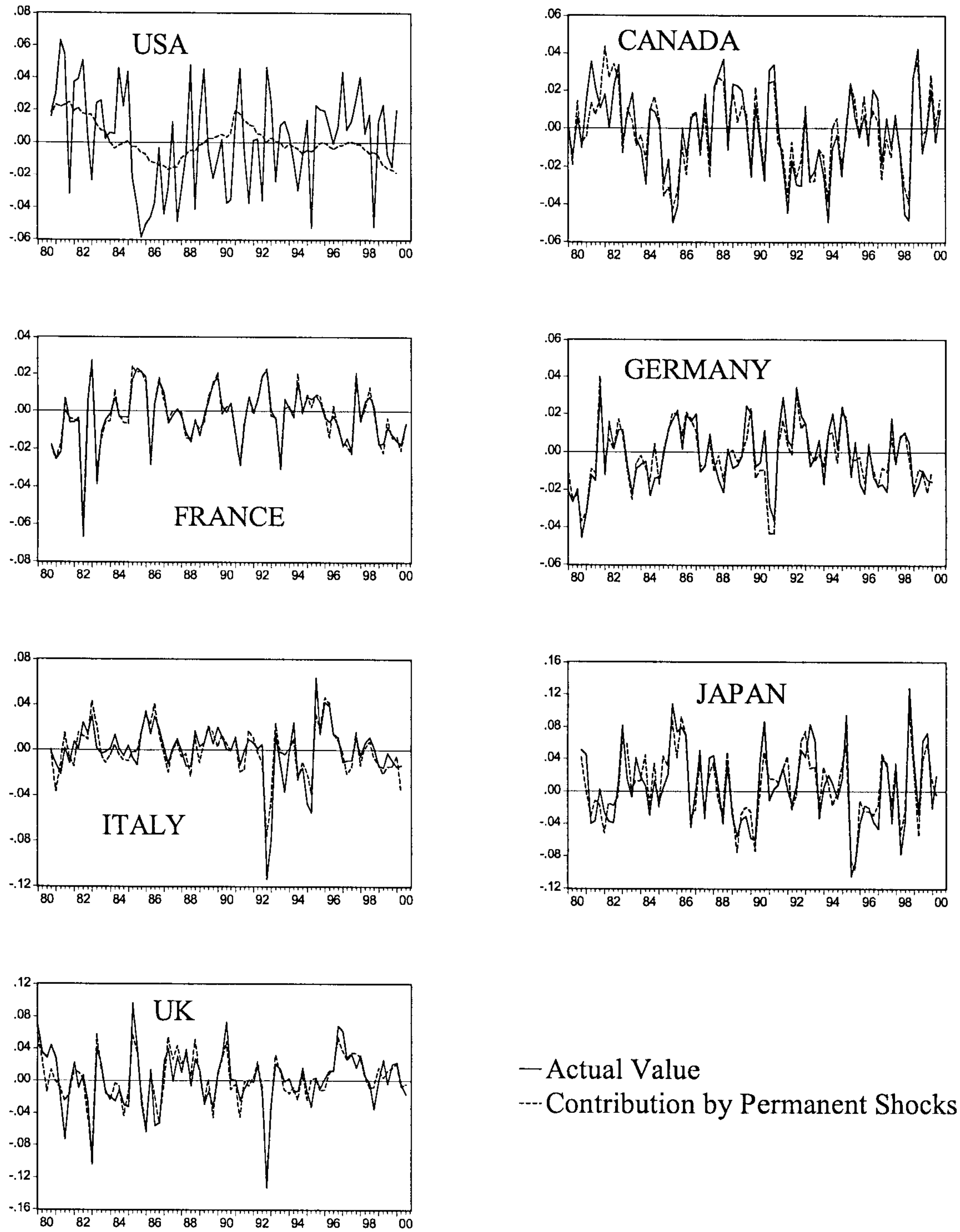


Figure 3. Decomposition: Exchange Rate Changes



Solving the Log-Linear Approximation

The following equations can be derived by log-linearizing the model.

$$\hat{C}_T - \breve{C}_T = (\sigma - \theta)\left[\left(\hat{P}_T - \hat{P}\right) - \left(\breve{P}_T - \breve{P}\right)\right]$$

$$\hat{C}_T = -r\breve{C}_T$$

$$\hat{C}_T - \hat{C}_N = -\theta\left(\hat{P}_T - \hat{P}_N\right)$$

$$\breve{C}_T - \breve{C}_N = -\theta\breve{P}_T \text{ (on the assumption that } \breve{P}_N = 0\text{)}$$

$$\hat{\kappa}_N = \hat{P}_N - \hat{P} - \frac{1}{\sigma}\hat{C}$$

$$\hat{M} = \frac{1}{\sigma}\hat{C} + \hat{P}$$

$$\breve{M} = \frac{1}{\sigma}\breve{C} + \breve{P} - \frac{1}{r}\left(\hat{P}_T - \breve{P}_T\right)$$

In particular, by normalizing so that $P_T = P_N$, the following equations follow.

$$\hat{P} - \hat{P}_N = \gamma\left(\hat{P}_T - \hat{P}_N\right)$$

$$\hat{C} - \hat{C}_N = \gamma\left(\hat{C}_T - \hat{C}_N\right)$$

Permanent Monetary Shock

This is equivalent to assuming $\hat{\kappa}_N = 0$. The solutions for the real exchange rate and current account are:

$$\hat{P}_T - \hat{P}_N = \frac{r}{\sigma\gamma + (1-\lambda)\theta}\breve{C}_T$$

$$\breve{P}_T = \frac{\sigma(r+\gamma) + \theta(1-\gamma)}{(\sigma-\theta)(1-\gamma)[\sigma\gamma + \theta(1-\gamma)]}\breve{C}_T$$

$$\breve{C}_T = \frac{(\sigma - \theta)\sigma(1+r)(1-\gamma)}{(\sigma-\theta)r(1-\gamma)[\sigma(r+\gamma)+\theta(1-\gamma)+1]+(1+r)\sigma}\hat{M}$$

Permanent Productivity Shock

This is equivalent to assuming $\hat{M} = \breve{M} = 0$. The solutions are:

$$\hat{P}_T - \hat{P}_N = \frac{1}{(\sigma-\theta)(1-\gamma)}\left(r + \frac{\sigma}{\sigma\gamma + (1-\gamma)\theta}\right)\breve{C}_T$$

$$\breve{P}_T = \frac{1}{\sigma\gamma + (1-\lambda)\theta}\breve{C}_T$$

$$\breve{C}_T = -\frac{(\sigma-\theta)(1-\gamma)[(1-\gamma)\theta + \sigma\gamma]}{(\sigma-\theta)(1-\gamma)+r[(1-\gamma)\theta+\sigma\gamma]+\sigma}\hat{\kappa}_N$$

Discussion

The balance between two elasticities ($\sigma - \theta$) plays an important role in determining the response of the current account to both monetary and productivity shocks. When the intertemporal elasticity is relatively large—$\sigma > \theta$ or $\sigma < \theta$ within a bound (that is, without too large a difference)—a positive monetary shock leads to short-term current account deficit and a negative (positive) shock to the nontradables (tradables) productivity leads to a short-term current account surplus. The correlation between the responses in the current account and the real exchange rate also varies with the balance between the two elasticities. However, the predictions on the correlation between them need to be taken with a grain of salt, given the highly stylized nature of this model in describing the price adjustment process.

References

Ahmed, Shaghil, 1987, "Government Spending, the Balance of Trade, and the Terms of Trade in British History," *Journal of Monetary Economics*, Vol. 20 (September), pp. 195–220.

Backus, David K., Patrick J. Kehoe, and Finn E. Kydland, 1994, "Dynamics of the Trade Balance and the Terms of Trade: The J-Curve?" *American Economic Review*, Vol. 84 (March), No. 1, pp. 84–103.

Bergin, Paul R., 2001, "Putting the New Open Economy Macroeconomics to a Test" (unpublished; Davis: University of California at Davis).

Betts, Caroline and Michael Devereux, 2000, "Exchange Rate Dynamics in a Model of Pricing-to-Market," *Journal of International Economics*, Vol. 50 (February), pp. 215–44.

Blanchard, Olivier and Danny Quah, 1989, "The Dynamic Effects of Aggregate Demand and Supply Disturbances," *American Economic Review*, Vol. 79 (September): 655–73.

Chari, V.V., Patrick Kehoe, and Ellen McGrattan, 1997, "Monetary Shocks and Real Exchange Rates in Sticky Price Models of the International Business Cycle," NBER Working Paper No. 5876 (Cambridge: National Bureau of Economic Research).

Chinn, Menzie, 1997, "Sectoral Productivity, Government Spending and Multilateral Real Exchange Rates: Evidence from the OECD Countries," NBER Working Paper No. 6017 (Cambridge: National Bureau of Economic Research).

Clarida, Richard and Jordi Gali, 1994, "Sources of Real Exchange-Rate Fluctuations: How Important are Nominal Shocks?" Carnegie-Rochester Conference Series on Public Policy, Vol. 41 (Amsterdam: North-Holland) pp. 1–56.

Dornbusch, Rudiger, 1983, "Real Interest Rates, Home Goods, and Optimal External Borrowing," *Journal of Political Economy*, Vol. 91 (February), pp. 141–53.

Edison, Hali and B. Dianne Pauls, 1993, "A Re-assessment of the Relationship Between Real Exchange Rates and Real Interest Rates," *Journal of Monetary Economics*, Vol. 31 (April), pp. 165–87.

Evans, M.D. and James Lothian, 1993, "The Response of Exchange Rates to Permanent and Transitory Shocks under Floating Exchange Rates," *Journal of International Money and Finance*, Vol. 12 (June), pp. 563–86.

Faust, Jon and Eric M. Leeper, 1997, "When Do Long-Run Identifying Restrictions Give Reliable Results?" *Journal of Business and Economic Statistics*, Vol. 5 (July), pp. 345–53.

Krugman, Paul, 1991, "Introduction," in *International Adjustment and Financing: The Lessons of 1985–1991*, ed. by C. Fred Bergsten (Washington: Institute for International Economics).

Lane, Philip R., 2001, "Money Shocks and the Current Account," in *Money, Factor Mobility and Trade: Essays in Honor of Robert Mundell*, ed. by G. Calvo, R. Dornbusch and M. Obstfeld, (Cambridge: MIT Press).

Lee, Jaewoo and Menzie D. Chinn, 1998, "The Current Account and the Real Exchange Rate: A Structural VAR Analysis of Major Currencies," NBER Working Paper No. 6495 (Cambridge: National Bureau of Economic Research).

Obstfeld, Maurice and Kenneth Rogoff, 1995, "Exchange Rate Dynamics Redux," *Journal of Political Economy*, Vol. 103, pp. 624–60.

———, 1996, *Foundations of International Macroeconomics* (Cambridge: MIT Press).

Prasad, Eswar and Manmohar Kumar, 1997, "International Trade and the Business Cycle," (unpublished; Washington: International Monetary Fund).

Rogers, John, 1995, "Real Shocks and Real Exchange Rates in Really Long-Term Data," International Finance Discussion Papers No. 493 (Washington: Board of Governors of the Federal Reserve System).

Sheffrin, Steven, and Wing Thye Woo, 1990, "Present Value Tests of an Intertemporal Model of the Current Account," *Journal of International Economics*, Vol. 29 (November), pp. 237–53.