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International Financial Market Integration and Linkages of National Interest Rates

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This article finds that even in the 1980s, when barriers to international capital mobility had been largely eliminated, there was no measurable tendency for real interest rates between the U.S. and the major industrial countries to converge. Moreover, the estimated short-run responses of both short-term and long-term real interest rates to one another have been exceedingly weak. As a consequence, it appears that U.S. and foreign central banks have been able to influence their domestic interest rates quite independently from the influence of interest rates abroad, despite a high degree of international capital mobility.

The international integration of financial markets has increased dramatically in the last two decades. In the 1970s government-imposed barriers to the international flow of capital in the major industrialized countries were gradually relaxed, and by the 1980s they had been substantially eliminated.[1] Moreover, the development and growth of new financial instruments, such as currency and interest rate swaps, have further stimulated international financial integration by giving investors a wider range of choices than traditionally available in purely domestic financial markets.

It might be presumed that the international integration of financial markets would reduce divergences between interest rates at home and abroad and increase the degree to which yields in different national markets move together over time. If so, the ability of central banks to influence national interest rates might be importantly constrained by international flows of capital. This presumption would appear to be supported historically by the domestic integration of local financial markets. For example, the development of national money and capital markets in the United States during the latter part of the 19th century reduced regional disparities among interest rates and made these rates increasingly responsive to national as opposed to local conditions. Moreover, after the establishment of the Federal Reserve System in 1914, it became apparent that, because of the ease of capital flows between different regions, monetary policy needed to be made on a national, rather than a regional, basis.

International financial integration need not always work to equalize interest rates between different countries, however. If exchange rates between currencies are fixed, then international financial integration has much the same effect on interest rates as regional financial integration. But if exchange rates are flexible, exchange rate expectations and exchange rate risk may prevent a convergence of real interest rates. As barriers to financial flows across national borders were reduced in the 1970s, the system of exchange rates applying to the major currencies changed from one of fixed to flexible rates. In fact, the flexibility of rates probably contributed to reductions in barriers to financial flows by reducing the need for capital controls to manage payments imbalances. As a result, at the same time that one

1. See, for example, Akhtar and Weiller (1987).

source of interest rate divergence was reduced, another one increased. Earlier empirical studies have provided mixed evidence on whether real interest rates have tended to converge in recent years.[2]

This article uses cointegration tests and error-correction modeling to examine the issue. It first reviews the theoretical literature on the short- and long-run connections between the international mobility of capital and the equalization of national interest rates. It then explains how exchange rate expectations and exchange rate risk in a system of flexible exchange rates can create divergences between real interest rates even in the absence of institutional or governmental barriers to capital flows across national borders. Finally, it examines empirically the linkages between U.S. and foreign real interest rates.

It finds that even in the 1980s, when barriers to international capital mobility had been largely eliminated, there was no measurable tendency for real interest rates between the U.S. and the major industrial countries to converge. Moreover, the estimated short-run responses of both short-term and long-term real interest rates to one another have been exceedingly weak. As a consequence, it appears that U.S. and foreign central banks have been able to influence their domestic interest rates quite independently from the influence of interest rates abroad, despite a high degree of international capital mobility.

I. INTEREST RATE DIFFERENTIALS IN THE SHORT AND LONG RUN

This section reviews the analytics of international interest rate linkages in the short and the long run under flexible exchange rates. The sources of differences between nominal interest rates at home and abroad can be summarized by the following identity:

$$(1) \quad i - i^* = 1/n\ \%s^e + CRISK + DOM + BAR$$

i and i^* are, respectively, nominal interest rates in home and foreign currency denominated assets of a given maturity (n); The variable $\%\ s^e$ is the expected percentage depreciation in the value of the home currency over the maturity of the investment; *CRISK* constitutes the part of the differential due to the uncertainty in returns from investing in a foreign asset due to the risk of changes in the exchange rate over the period of the investment; *DOM* is the portion of the differential that is due to differences in the characteristics of the assets besides maturity, such as liquidity, credit risk, or tax treatment, which can occur in purely domestic markets; finally, *BAR* represents the part of the differential that is due to government policies and institutional imperfections that effectively impede financial flows across national jurisdictions.[3]

Nominal interest rates are equalized if all the right-hand-side terms of the identity are equal to zero. If *CRISK*, *DOM*, and *BAR* are all equal to zero, then U.S. and foreign assets can be said to be perfect substitutes. In this case, investors are indifferent between domestic and foreign assets, and their expected yields in a common currency are equalized. In addition, if portfolio adjustments are instantaneous, so that the yields in a common currency are equalized continuously, then there is said to be perfect capital mobility. Finally, if $\%s^e$ is zero, then expectations are static in the sense that the exchange rate expected in the future is the same as the current exchange rate. Only if all these conditions are met, giving perfect capital mobility and static exchange rate expectations, will nominal interest rates be equalized continuously at home and abroad under flexible exchange rates.

The well-known Mundell-Fleming model of an open economy assumes that the conditions of perfect capital mobility and static exchange rate expectations hold in the short run under flexible exchange rates.[4] The implications of these conditions would be that monetary policy influences aggregate demand entirely through its effect on the exchange rate, rather than interest rates, and that fiscal policy "crowds out" other expenditures entirely through the exchange rate instead of interest rates. These implications are clearly at variance with even the most casual observation. In the U.S. and other industrialized countries, actions by monetary authorities clearly can alter interest rates in the short run, and fiscal policy appears to have influenced interest rates as well. Therefore, to better understand the behavior of interest rates in the short run, the Mundell-Fleming framework needs to be amended.

The Mundell-Fleming model essentially extends the widely used IS-LM model of income determination to an open economy. Both models assume the price level is fixed in the short run. The Mundell-Fleming model is described by the following set of equations:

2. Pigott (1993-1994) presents evidence to show that the dispersion in national real interest rates has fluctuated considerably over time but without any systematic tendency to decline. Despite this evidence, some observers have argued that integration has increased the synchronization of interest rate movements over the last decade; see, for example, Frankel (1989) and Bank for International Settlements (1988). However, Kasman and Pigott (1988) find no consistent increase in this tendency using different but equally plausible measures of synchronization.

3. For further discussion of the various factors underlying this identity, see Kasman and Pigott (1988).

4. The Mundell-Fleming model was developed in the early 1960s. Mundell's contributions are collected in Mundell (1968). For Fleming's contribution, see Fleming (1962).

(2) $$Y = A(i) + NX(s)$$

(3) $$M/P = L(i,Y)$$

(4) $$i = i^*$$

The first equation describes equilibrium in the goods market. It states that real aggregate output (Y) is equal to real domestic expenditures (A), which vary inversely with the nominal interest rate i, plus net exports, which vary inversely with the value of the home currency. The second equation gives equilibrium in the money market. The supply of real money balances, M/P, equals the demand for them, $L(i,Y)$. The last equation describes the conditions of perfect capital mobility and static expectations for a small country, which produce an equality between the home (i) and an exogenously determined foreign (i^*) interest rate.

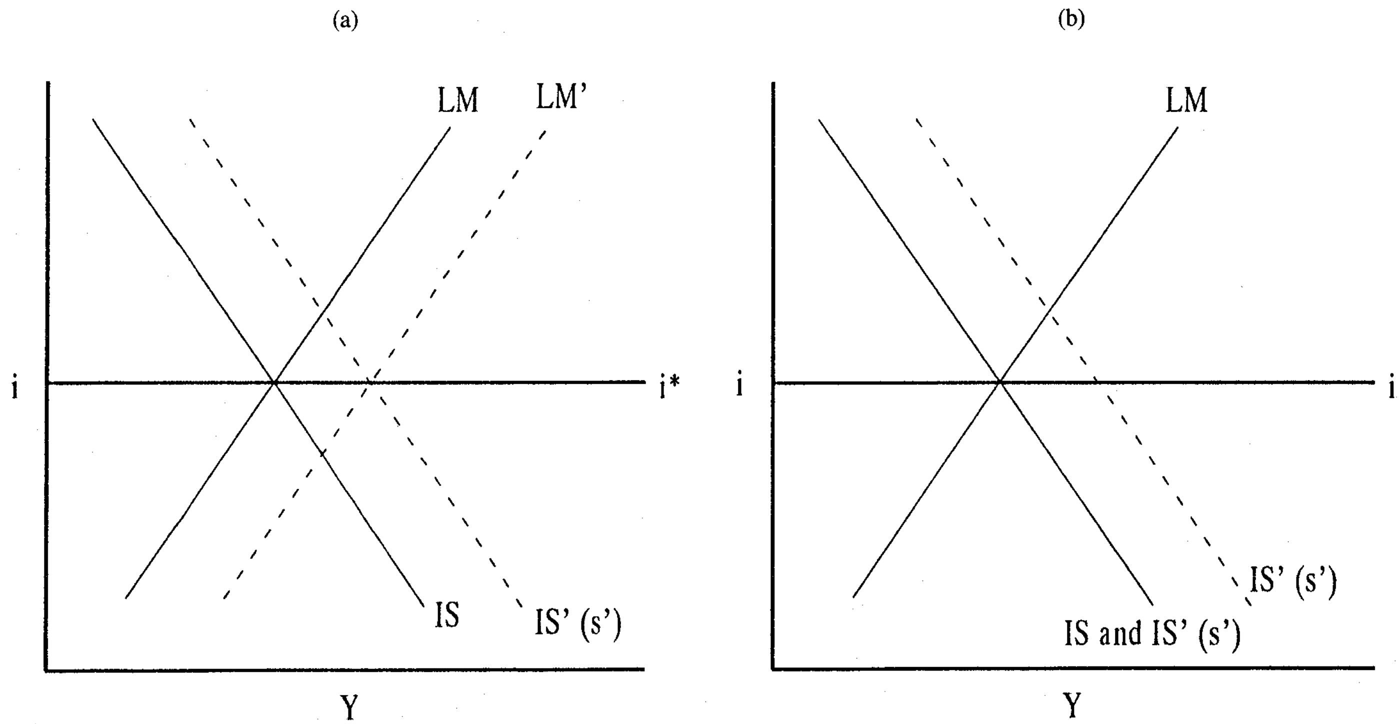
Figure 1 illustrates the behavior of interest rates in the short run in the Mundell-Fleming model with static expectations and perfect capital mobility. In Figure 1a, a shift to the right in the LM schedule because of, say, an action by the monetary authority to expand the money supply initially tends to depress the interest rate at home. But because the expected return on investing at home then would be less than that from investing abroad, the value of the home currency is depressed by capital outflows. Then as soon as the trade balance adjusts to the lower value of the home currency, the IS schedule shifts to the right until the home interest rate is pulled back up to the level of the foreign rate. In this process, there is no net change in the home interest rate. As a result, monetary policy influences aggregate demand entirely through its effect on the exchange rate.

Alternatively, a shift in the IS schedule to the right as in Figure 1b because of, say, an expansionary fiscal policy initially pushes the home interest rate above the foreign interest rate. But the resulting capital inflow then moves up the value of the home currency and reduces net exports until the home interest rate falls back down to the level of the foreign rate. In the process, the fiscal expansion "crowds out" other expenditures entirely through its effect on the exchange rate.

The Mundell-Fleming model assumes a small country. But relaxing this assumption does not change its conclusions with respect to the differential between interest rates.

FIGURE 1

MUNDELL-FLEMING MODEL



This would still tend to zero except for the period during which the trade balance adjusts. However, in practice, the period required for the trade balance to adjust lasts for up to around two years, so that in calendar time the period over which one can say that perfect capital mobility may exist is not trivial.[5] Because of this, the Mundell-Fleming model has limited applicability for periods shorter than two years.

A further important limitation of the Mundell-Fleming model for the short run is its assumption of static expectations. Still retaining the assumption of perfect capital mobility for the relevant time frame, when expectations are not static the identity of equation (1) becomes:

$$i - i^* = 1/n \ \%s^e \qquad (5)$$

or

$$\ln s = E(\ln s) + n(i - i^*) \qquad (6)$$

where $E(\ln s)$ is the expected value of the natural log of the exchange rate. Furthermore, if $E(\ln s)$ and i^* are fixed, then the value of the home currency, s, becomes simply a function of the home interest rate. This situation is shown in Figure 2, where both i and s are now plotted on the vertical axes. The IS schedule is flatter than before because movement along it now includes the effects on aggregate demand of movements in both the exchange rate and the interest rate, rather than just the interest rate alone.

Consider now the effects of monetary and fiscal policy manifested in shifts in the LM and IS schedules. An expansionary monetary policy that shifts the LM schedule to the right (as in Figure 2a) now drives down the home interest rate even after there has been time enough for the trade balance to adjust to the lower value of the home currency. The differential that is opened up between the home and foreign interest rate is proportional to the expected appreciation of the home currency and would not change as long as the current price level, the expected exchange rate, and the expanded money supply persist. If the economy initially had been at full employment, in the long run the adjustment of the price level and expectations would eventually drive the system back to its original equilibrium with the same IS and LM schedules as before. Even with forward looking rational expectations, however, a differential between real interest rates would persist during the gradual adjustment of the price level until the full employment equilibrium is restored.[6] As a result, monetary disturbances can create persistent and time-varying differentials in real interest rates even with perfect capital mobility while this longer-run adjustment takes place.

A fiscal expansion similarly causes persistent effects on interest rate differentials when expectations are not static. Lower taxes and/or higher government expenditures shift the IS schedule to the right (as in Figure 2b). Now, rather than just the exchange rate changing, as in the pure Mundell-Fleming model, both the interest rate and the exchange rate are driven up. With the expected value of the exchange rate fixed, a gap is opened up between the home and foreign interest rate that is proportional to the expected depreciation in the value of the home currency. This gap and both the higher interest rate and increase in real output will last as long as fiscal policy remains expansive and the expected exchange rate is unchanged.

As long as the fiscal policy remains expansive, however, the actual exchange rate will be above that which was expected. Then, expectations of the exchange rate may be revised up. If so, the current exchange rate would rise with any given interest rate differential, breaking the original linkage between the interest rate and the exchange rate. The rise in the expected value of the home currency would then shift the IS schedule back toward its original position. It is only at this point that the differential between home and foreign interest rates would be eliminated. This analysis generalizes to any shift in the IS schedule, not just those caused by fiscal policy. Thus, interest differentials could exist more or less continuously and vary considerably under flexible exchange rates due to a variable IS function, as well as a variable LM function, even with relatively perfect capital mobility.

Further relaxing the assumptions of the Mundell-Fleming model, consider now the case of imperfect substitutability between home and foreign assets due to currency risk (*CRISK*), differences in the characteristics of home and foreign assets (*DOM*), or governmental and institutional barriers to international capital flows (*BAR*). These put interest rates in the home country at a premium or discount compared with foreign rates. For simplicity, suppose initially there is no differential between interest rates at home and abroad. A rightward shift in the IS schedule to IS′(s), caused by a fiscal deficit or an investment boom, would put upward pressure on the home interest rate relative to that abroad (Figure 3). With imperfect substitutability of assets, however, the resulting inflow of capital from abroad would tend to raise the required return on U.S. assets relative to foreign assets. The premium would be required in order for investors to absorb a larger proportion of home assets into their portfolios, since the stock of home relative to foreign assets is increased by both the larger capital inflow and the appreciation of the home currency. Instead of being shifted back to IS′(s), the IS schedule would shift back only to IS′(s') due to the appreciation of the home currency. At this point the home interest rate would be

5. For evidence on the speed of adjustment of the trade balance, see, for example, Throop (1989).

6. See Dornbusch (1976).

FIGURE 2

NONSTATIC EXPECTATIONS

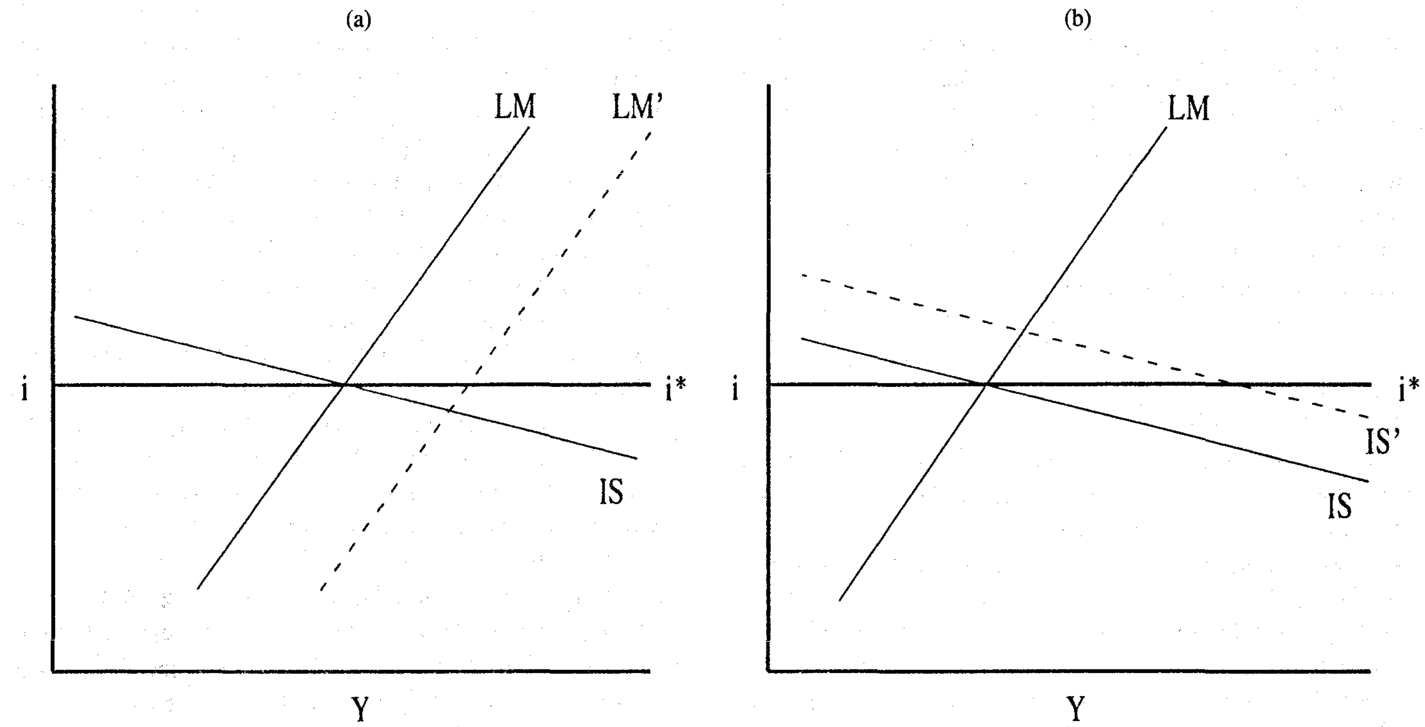
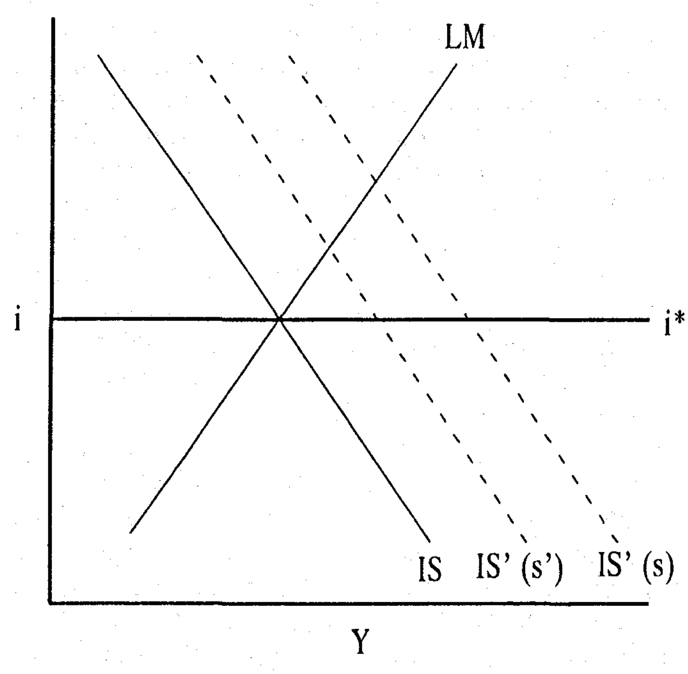


FIGURE 3

IMPERFECT SUBSTITUTES



brought down to the level of the foreign interest rate plus a premium. Here again, the differential between interest rates would vary over time.

Even with a high degree of international financial market integration so that *DOM* and *BAR* are close to zero, imperfect substitutability can still be created by currency risk (*CRISK*). As a result, even with highly integrated markets under flexible exchange rates, home and foreign interest rates may be kept apart not only by expected changes in currency values but also by currency risk.

Finally, and particularly for purposes of empirical implementation, it is necessary to relax the assumption of constant prices in the Mundell-Fleming model. The identity of equation (1) still holds. But it is convenient to rewrite it in real terms as[7]

(7) $r - r^* = 1/n\ \%q^e + CRISK + DOM + BAR,$

7. The identity of equation (1) can be written as:

$$i_t - i_t^* = 1/n\,[\ln s_t - E_t(\ln s_{t+n})] + CRISK_t + DOM_t + BAR_t.$$

By definition $\ln s_t = \ln q_t + \ln p_t^* - \ln p_t$, where q is the real exchange rate and p^* and p are foreign and domestic price levels, respectively. Also by definition,

$$E_t(\ln s_{t+n}) = E_t(\ln q_{t+n}) + \ln p_t^* + n\pi_t^* - p_t - n\pi_t,$$

where r and r^* are *real* interest rates (nominal interest rates less expected inflation) at home and abroad, $\%q^e$ is the expected percent change in the *real* exchange rate over the maturity of the investment, and the other terms are the same as before.[8] In the case of perfect substitutability and static expectations (with respect to the real exchange rate), capital would flow from one country to another until real interest rates at home and abroad were equalized. In the case of imperfect substitutability, the real interest at home would tend to be equated with the foreign one plus a premium or minus a discount, which itself could vary over time. But with nonstatic expectations, the real exchange rate becomes a function of the real interest rate at home relative to that abroad. Movements of the IS and LM schedules create a variable differential in real interest rates (plus a premium or minus a discount) that is proportional to the expected change in the real value of the exchange rate as it moves towards its equilibrium in the long run.

II. REAL INTEREST RATE RELATIONSHIPS

A trend toward the liberalization of capital controls has been clearly evident since the early 1970s, and in recent years it has become even more pronounced.[9] In fact, by the 1980s both official and institutional barriers to international capital flows had been largely eliminated in the major industrialized countries, at least for large borrowers and lenders. At the short end of the market, this is indicated by a close equality between U.S. and major foreign interest rates when the latter are covered against exchange rate risk in the forward market.[10]

Forward markets are most developed at the 3-month maturity and do not exist at maturities greater than two years, even among well-traded currencies. But in the 1980s the currency swap market became sufficiently developed to hedge exchange rate risk for long-term investments as well. A currency swap is an agreement to exchange a stream of payments in one currency for a stream of payments in another. Like a forward contract, a currency swap allows a domestic investor to hold a foreign currency denominated asset without currency risk. Deviations from a covered parity in interest rates appear to be somewhat larger among long-term assets than among short-term assets, but for the major currencies the differences are small. Moreover, current deviations from covered parity of both short- and long-term interest rates are small compared with periods when capital controls have been considered important. Thus, the increase in international financial capital mobility of the last decade has not been limited to the markets for short-term assets.[11]

With official and insitutional barriers to international capital flows largely eliminated, this leaves only currency risk and expected changes in currency values as sources of differences between real interest rates on similar assets. Figure 4 shows ex ante real U.S. and trade-weighted foreign 3-month money market rates and the differential between them, as well as the corresponding rates and differentials with Canada, Japan, Germany, and the U.K. for the period 1981 to the present. Figure 5 plots the real rates and differentials for the same countries with respect to long-term government bonds. Expected inflation is measured by the percent change in the CPI over the previous year for short rates and by a centered 3-year moving average of CPI inflation for long rates. As other researchers have shown, a contemporaneous equality of ex ante real interest rates, whether short-term or long-term, is easily rejected.[12] Even during the period of relatively high capital mobility in the 1980s, substantial differentials in both short and long real rates existed for significant periods of time. This result is consistent with a Mundell-Fleming model in which exchange rate expectations are not static, so that movements in the IS and LM schedules create variable real interest rate differentials that are proportional to the expected change in the currency towards its equilibrium real value in the long run. Variable premia for currency risk also could produce this result.

The more interesting and also more difficult question to answer is whether shocks to the IS and LM schedules are infrequent and transitory enough, and variations in currency risk premiums small enough, that a tendency towards a convergence of real interest rates can be observed over the longer run. Evidence suggesting that this may *not* be the case is that real interest rate differentials have been shown to be an important force moving real

where π_t^* and π_t are the market's expectations at time t of the inflation rate over n periods at home and abroad, respectively. Substituting these two relationships into the identity gives:

$$(i_t - \pi_t) - (i_t^* - \pi_t^*) = 1/n\,[\ln q_t - E(\ln q_{t+n})] + CRISK + DOM + BAR.$$

8. The real value of the home currency, s, is defined as: $q = s(p/p^*)$, where p and p^* are the home and foreign price levels, respectively.

9. This trend is documented in International Monetary Fund's annual report on *Exchange Arrangements and Exchange Restrictions*.

10. For the evidence on covered returns on short-term assets, see Pigott (1993-1994), Caramazza et al. (1986), and Frankel (1988).

11. Evidence on the covered returns on long-term assets is provided by Popper (1990).

12. See, for example, Cumby and Obstfeld (1984), Mishkin (1984), Merrick and Saunders (1986), and Gaab, Granziol, and Horner (1986).

FIGURE 4

U.S. AND FOREIGN SHORT-TERM REAL INTEREST RATES AND THEIR DIFFERENTIALS

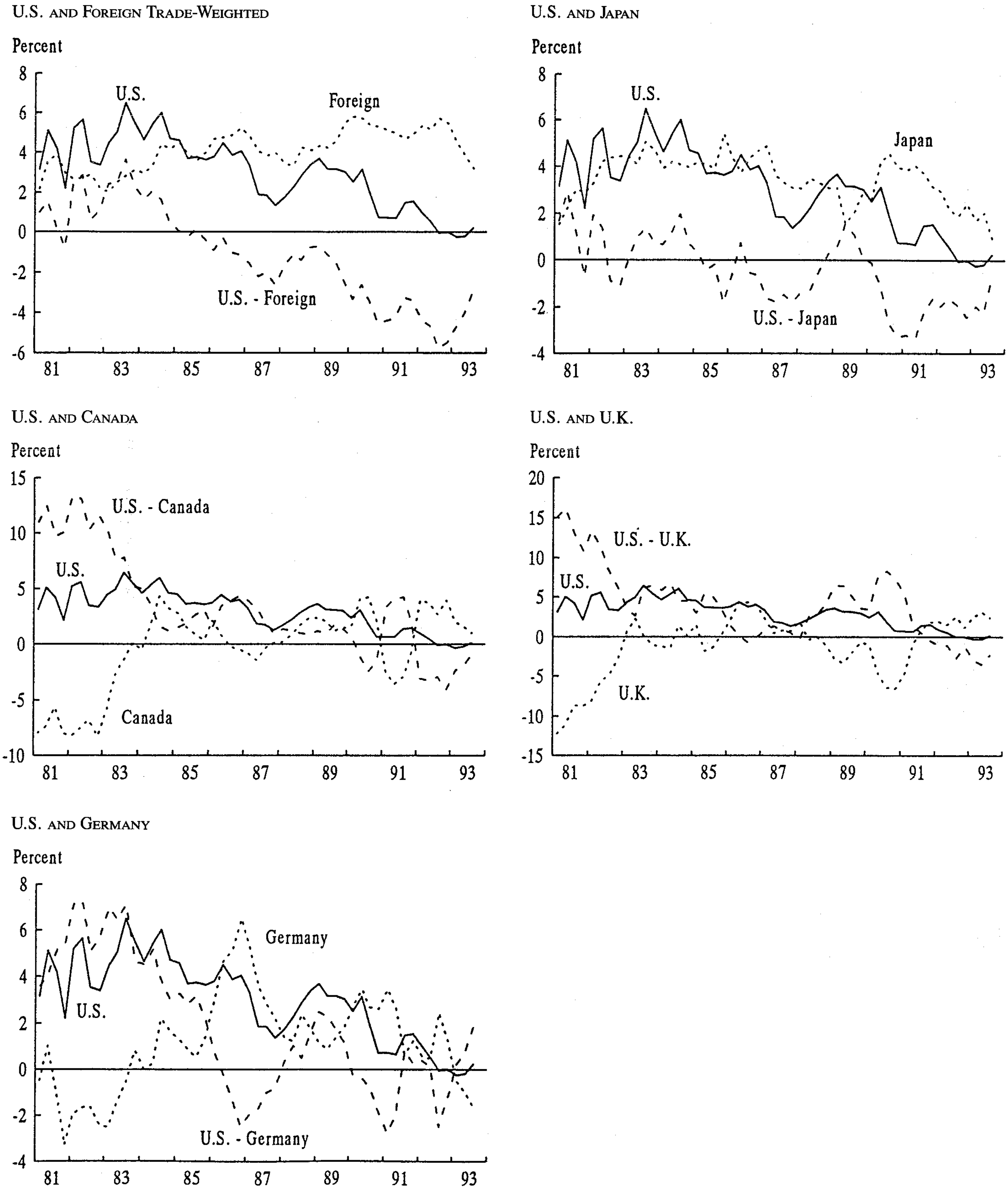
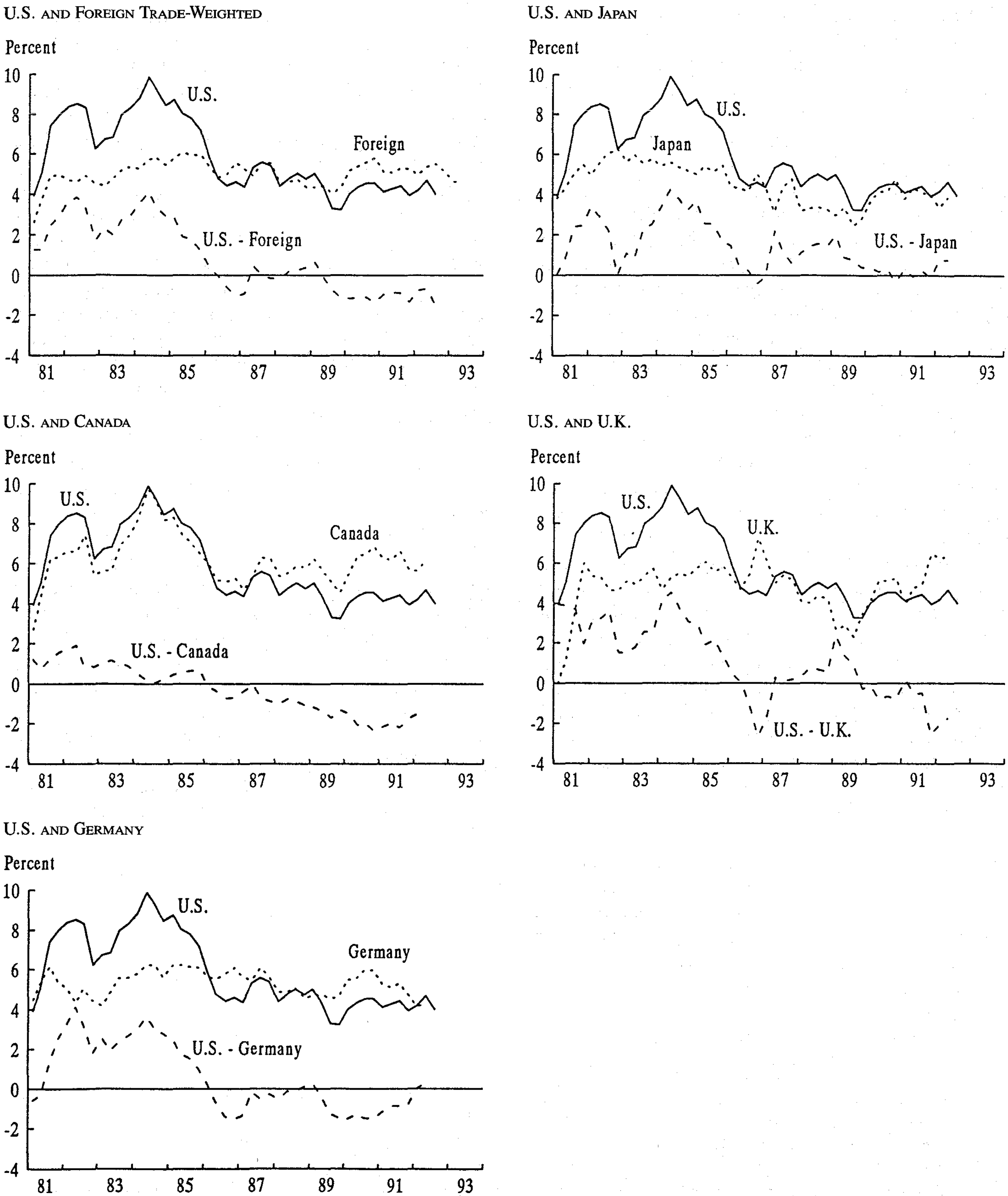


FIGURE 5

U.S. and Foreign Long-Term Real Interest Rates and their Differentials



exchange rates over extended periods in the 1970s and 1980s, consistent with an assumption of nonstatic expectations in the Mundell-Fleming model.[13] This has been especially true for the U.S. dollar in the first half of the 1980s, when a combination of easy fiscal policy and tight monetary policy in the U.S. pushed up U.S. real interest rates relative to those abroad. As a result, it may be that tendencies for the equalization of national real interest rates are not easily discernible in this period.

This analysis looks at tendencies toward the convergence of real interest rates for both the period of relatively high capital mobility since the early 1980s as well as the whole period of floating exchange rates since 1973 since the former period may be too short to uncover such tendencies. If there were a significant tendency for real interest rates to converge over the longer period but not the shorter one, one could say that capital controls in the 1970s were not sufficient to offset the tendency towards convergence, but that convergence can take quite a long time under flexible exchange rates. On the other hand, if there were no significant tendency observable in either period, all that could be said would be that although a tendency towards convergence could not be found for the period of high capital mobility since the early 1980s, such a tendency might be uncovered if a longer period of high capital mobility with flexible exchange rates could be observed.

The strongest hypothesis with respect to long-run convergence of national real interest rates would be that there is a tendency towards equality. Statistically, this would imply that real interest differentials are stationary, i.e., they do not have a tendency to trend either up or down through time. Stationarity of both short- and long-term real interest rate differentials for both the short period of full financial market integration since the early 1980s and the longer period of floating rates since 1973 was examined using the augmented Dickey-Fuller test.[14] The null hypothesis of nonstationarity was accepted at the 1 percent level of significance in all cases.

Thus, only a weaker form of convergence may exist. A weaker hypothesis would be that real interest rates at home and abroad are cointegrated in the sense that they do not tend to drift apart over time. Statistically, this means that a linear combination of the two interest rates would be stationary. Thus, if r and r^* are cointegrated, then the cointegrating vector, $r-\alpha_0-\alpha_1 r^*$, would be stationary. For long-run equality, $\alpha_0=0$ and $\alpha_1=1.0$. But different national tax rates could cause α_1 to be different from 1.0, and currency risk premiums or other factors might cause α_0 to differ from zero. So cointegration would appear to be a better criterion for convergence than equality.

The Engle-Granger two-step procedure could be used to test for the cointegration of pairs of real interest rates. This procedure would estimate $r=\alpha_0+\alpha_1 r^*$ by ordinary least squares and test for the stationarity of the residuals by means of the Dickey-Fuller test.[15] But a more powerful test is the Johansen procedure, which estimates the cointegrating vector within the context of a complete error-correction model.[16] Estimation of this type of model also has the advantage of providing estimates of the dynamics of the response of one interest rate to another, and therefore the time it takes for the system to reach a long-run equilibrium.

This vector error-correction model consists of regressions of changes in each of the two real interest rates on past changes in its own rate, past changes in the other rate, and a lagged error-correction term equal to the cointegrating vector. Assuming that the real interest rates are nonstationary, the regressions are in change form (except for the error-correction term) in order to avoid spurious correlations that otherwise might result from unit roots in the data. The error-correction term is included in the regressions if it can be shown that the real interest rates are cointegrated, in the sense that they tend toward a stable long-run equilibrium relationship. The error-correction term is equal to the difference between the actual and long-run predicted values of each interest rate. This ensures that the system moves toward a long-run equilibrium if one exists. Using this two equation system, impulse-response functions are derived to examine the estimated short- and long-run responses of each real interest rate to shocks to either rate. Formally, this two-equation system is written as:[17]

$$\Delta r = \sum_{i=1}^{4} B_{11i}\Delta r^*_{-i} + \sum_{i=1}^{4} B_{12i}\Delta r_{-i} + P_1(r-\alpha_0-\alpha_1 r^*)_{-1} + e_1 \quad (8)$$

$$\Delta r^* = \sum_{i=1}^{4} B_{21i}\Delta r^*_{-i} + \sum_{i=1}^{4} B_{22i}\Delta r_{-i} + P_2(r-\alpha_0-\alpha_1 r^*)_{-1} + e_2. \quad (9)$$

13. See Throop (1993) and references therein to the extensive literature on the subject. Besides confirming the importance of real interest rate differentials in explaining the behavior of real exchange rates since 1973, Throop (1993) also shows that the market's expectation of the long-run equilibrium of the real value of the dollar tends to be importantly affected by the real price of oil, budget deficits, and the relative price of traded versus nontraded goods.

14. For a discussion of the augmented Dickey-Fuller test, see Charemza and Deadman (1992), chapter 5.

15. See Engle and Granger (1987), Engle and Yoo (1987), and Charemza and Deadman (1992), chapter 5.

16. See Johansen and Juselius (1990).

17. Four lags on past changes in rates were used in estimating the cointegrating vector. Also, constant terms in the vector autoregressions were restricted to zero, maximizing the chance of finding cointegration.

Augmented Dickey-Fuller tests indicate that all short-term and long-term real interest rates are nonstationary in levels, but stationary in first differences for the period 1981 to the present, as well as for the full period of the float, consistent with regressions in first difference form. To determine whether error-correction terms should be included in each of the regression equations, we test for cointegration between pairs of real interest rates. If a linear combination of the two (nonstationary) interest rates is stationary, then they are cointegrated. Tables 1 and 2 compare the maximum eigenvalue and trace statistics of the Johansen test for cointegration with their critical values. These statistics show that the foreign trade-weighted short-term real interest rate is the only foreign rate that is cointegrated with the U.S. real short-term rate for the period of high capital mobility in the 1980s. If the sample period is extended to the period of the full float, the foreign trade-weighted short-term real rate ceases to be cointegrated with the U.S. rate, presumably because of increased barriers to capital mobility, but the Japanese real rate now becomes cointegrated with the U.S. real rate, despite such barriers.

These results suggest that on average there was a statistically significant long-run linkage between U.S. and for-

TABLE 1

Johansen Test for Cointegration: Short Real Rates

Maxiumum Eigenvalue Test			Statistic		Critical Values	
U.S. and:	Null	Alternative	1981.Q1–1993.Q3	1974.Q1–1993.Q3	5%	10%
Canada	r = 0	r = 1	11.3	7.8	15.8	13.8
	r ≤ 1	r = 2	2.5	4.8	9.1	7.6
Germany	r = 0	r = 1	8.2	8.7	15.8	13.8
	r ≤ 1	r = 2	3.6	6.8	9.1	7.6
Japan	r = 0	r = 1	11.2	17.5**	15.8	13.8
	r ≤ 1	r = 2	1.2	4.9	9.1	7.6
U.K.	r = 0	r = 1	10.8	7.2	15.8	13.8
	r ≤ 1	r = 2	2.5	6.3	9.1	7.6
Trade-weighted	r = 0	r = 1	26.3**	7.1	15.8	13.8
	r ≤ 1	r = 2	3.4	3.7	9.1	7.6
Trace Test						
U.S. and:						
Canada	r = 0	r > 1	13.7	12.6	20.2	18.0
	r ≤ 1	r = 2	2.5	4.8	9.1	7.6
Germany	r = 0	r > 1	11.8	15.5	20.2	18.0
	r ≤ 1	r = 2	3.6	6.8	9.1	7.6
Japan	r = 0	r > 1	12.4	22.5**	20.2	18.0
	r ≤ 1	r = 2	1.2	4.9	9.1	7.6
U.K.	r = 0	r > 1	13.3	13.5	20.2	18.0
	r ≤ 1	r = 2	2.5	6.3	9.1	7.6
Trade-weighted	r = 0	r ≥ 1	29.7**	10.9	20.2	18.0
	r ≤ 1	r = 2	3.4	3.7	9.1	7.6

Note: ** indicates statistical significance at the 5% level.

eign trade-weighted real short-term interest rates in the period of high capital mobility. However, examination of the estimated cointegrating vector, shown in Table 3, reveals that the U.S. and foreign trade-weighted short-term rates are estimated to have moved *inversely* with one another in the long run. This is not consistent with a tendency toward convergence of real interest rates. On the other hand, in the case of the Japanese short rate over the longer period, the U.S. and Japanese rate are estimated to move *positively* with one another in the long run, consistent with convergence. However, a Chi Square test rejects the restriction that the foreign real interest rate is equal to the home real interest rate in the long run in both cases, and it also rejects the restriction that the foreign interest rate differs from the home interest rate by at most a constant. So even where a tendency towards the long-run convergence of interest rates is found, as in the case of Japan, it is relatively weak.

Turning to long rates, there is no evidence of any significant cointegration between U.S. and foreign real rates in the period of high capital mobility since the beginning of the 1980s (see Table 2). But significant cointegration between the real long-term U.S. rate and the corresponding rates abroad is indicated for Germany and Japan for the full

TABLE 2

JOHANSEN TEST FOR COINTEGRATION: LONG REAL RATES

MAXIMUM EIGENVALUE TEST			Statistic		Critical Values	
U.S. and:	Null	Alternative	1981.Q1–1992.Q2	1974.Q1–1992.Q2	5%	10%
Canada	$r = 0$	$r = 1$	8.6	6.5	15.8	13.8
	$r \leq 1$	$r = 2$	5.4	4.0	9.1	7.6
Germany	$r = 0$	$r = 1$	10.1	14.1*	15.8	13.8
	$r \leq 1$	$r = 2$	6.3	4.3	9.1	7.6
Japan	$r = 0$	$r = 1$	9.9	17.1**	15.8	13.8
	$r \leq 1$	$r = 2$	1.8	7.2	9.1	7.6
U.K.	$r = 0$	$r = 1$	5.4	11.5	15.8	13.8
	$r \leq 1$	$r = 2$	4.8	4.0	9.1	7.6
Trade-weighted	$r = 0$	$r = 1$	7.6	8.1	15.8	13.8
	$r \leq 1$	$r = 2$	5.4	4.2	9.1	7.6
TRACE TEST						
U.S. and:						
Canada	$r = 0$	$r > 1$	14.1	10.8	20.2	18.0
	$r \leq 1$	$r = 2$	5.4	4.0	9.1	7.6
Germany	$r = 0$	$r \geq 1$	16.4	18.4*	20.2	18.0
	$r \leq 1$	$r = 2$	6.3	4.3	9.1	7.6
Japan	$r = 0$	$r \geq 1$	11.7	24.3**	20.2	18.0
	$r \leq 1$	$r \geq 2$	1.8	7.2	9.1	7.6
U.K.	$r = 0$	$r \geq 1$	10.3	15.5	20.2	18.0
	$r \leq 1$	$r = 2$	4.9	4.0	9.1	7.6
Trade-weighted	$r = 0$	$r \geq 1$	13.0	12.3	20.2	18.0
	$r \leq 1$	$r = 2$	5.4	4.2	9.1	7.6

NOTE: ** and * indicate statistical significance at the 5 and 10 percent levels, respectively.

TABLE 3

JOHANSEN TEST FOR RESTRICTION ON COINTEGRATING VECTOR

COUNTRY	PERIOD	RATES	ESTIMATED COINTEGRATING VECTOR	CHI-SQUARE TEST ON (1.0, 0.0, −1.0) RESTRICTION	CHI-SQUARE TEST ON (1.0, α_0, −1.0) RESTRICTION
Trade-weighted	1981.Q1–1993.Q3	Short	(1.0, −11.3, 2.1)	23.5 (.005)	22.6 (.005)
Japan	1974.Q1–1993.Q3	Short	(1.0, 5.6, −2.4)	10.8 (.005)	8.5 (.005)
Japan	1974.Q1–1992.Q2	Long	(1.0, −76.1, 16.0)	10.8 (.005)	8.5 (.005)
Germany	1974.Q1–1992.Q2	Long	(1.0, 7.8, −2.6)	5.5 (.050)	9.9 (.005)

NOTE: Significance levels are in parentheses.

period of the float. The German and the U.S. long rates are estimated to be *positively* related in the long run, consistent with convergence. But a *negative* long-run relation is found between U.S. and Japanese real long-term interest rates. Moreover, the restriction of either a one-to-one long-run relationship between U.S. and foreign real long-term rates or a constant difference between them is rejected by a Chi Square test in both cases (Table 3).

Impulse-response functions from the estimated vector error-correction systems are examined next. The response of the foreign rate to a shock to the U.S. rate is determined by shocking the error term, e_1, in equation (8) by one percentage point. It is assumed that any correlation between e_1 and e_2 in equations (8) and (9) is attributable to an effect of e_2 on e_1, rather than the other way around. This implies that e_2 is not affected by this shock and that the foreign rate is influenced only through the remaining terms in equation (9). This procedure avoids a possibly spurious element of contemporaneous causation in the simulated response, but it also may underestimate the effect of the U.S. rate on the foreign rate if there is in fact some contemporaneous causation of e_2 by e_1. Similarly, in the case of the response of the U.S. rate to the foreign rate, it is assumed that any correlation between e_1 and e_2 is attributable to the effect of e_1 on e_2. However, if it is assumed that the causation between the correlated elements of the error terms runs in opposite directions, the simulated impulse-response functions are not changed to any significant extent.

For short rates, estimates are for the period of high capital mobility since the early 1980s, except in the case of Japan where there was a stronger linkage of interest rates for the full period of the float. Error-correction terms are included in the systems for the U.S. and foreign trade-weighted rates and for the U.S. and Japanese rates, although in the former case the signs of the coefficients in the error-correction term are not consistent with a positive association between interest rates in the long run. The impulse-response functions for long-run rates also are from the period since the beginning of the 1980s, except for Germany and Japan, which are for the full period of the float. Error-correction terms are included in the case of those two countries as well. But only in the case of Germany do the signs of the coefficients indicate a positive association between interest rates on U.S. and foreign assets in the long run.

Figure 6A shows the simulated impact on the foreign rate over 16 quarters of a permanent 1 percentage point shock to the U.S. real short-term interest rate, while Figure 6B plots the simulated response of the U.S. real short rate to a permanent 1 percentage point shock to the foreign rate. The dotted line indicates a 95 percent confidence interval around the estimated impulse-response functions.[18] The response of foreign short rates to a shock to the U.S. short rate is not significantly different from zero for either the trade-weighted rate or the four national interest rates. The response of the U.S. short rate to a shock to the U.K. short rate is significantly positive but small, after 16 quarters. But the response of the U.S. short rate to the foreign trade-weighted short rate is significantly negative, and the response of the U.S. short rate to the three other national rates is not significantly different from zero.

The impact of a shock to the U.S. rate on the U.S. rate after 16 quarters is generally not significantly different

18. This confidence interval was established by replicating the impulse-response 1,000 times according to the observed distribution of errors. Lags on past changes in rates were reduced to two in the case of short rates and three for long rates due to a lack of statistical significance of longer lags. This helped to tighten up the confidence bands around the impulse-response functions.

FIGURE 6

IMPULSE-RESPONSE FUNCTIONS: SHORT-TERM RATES

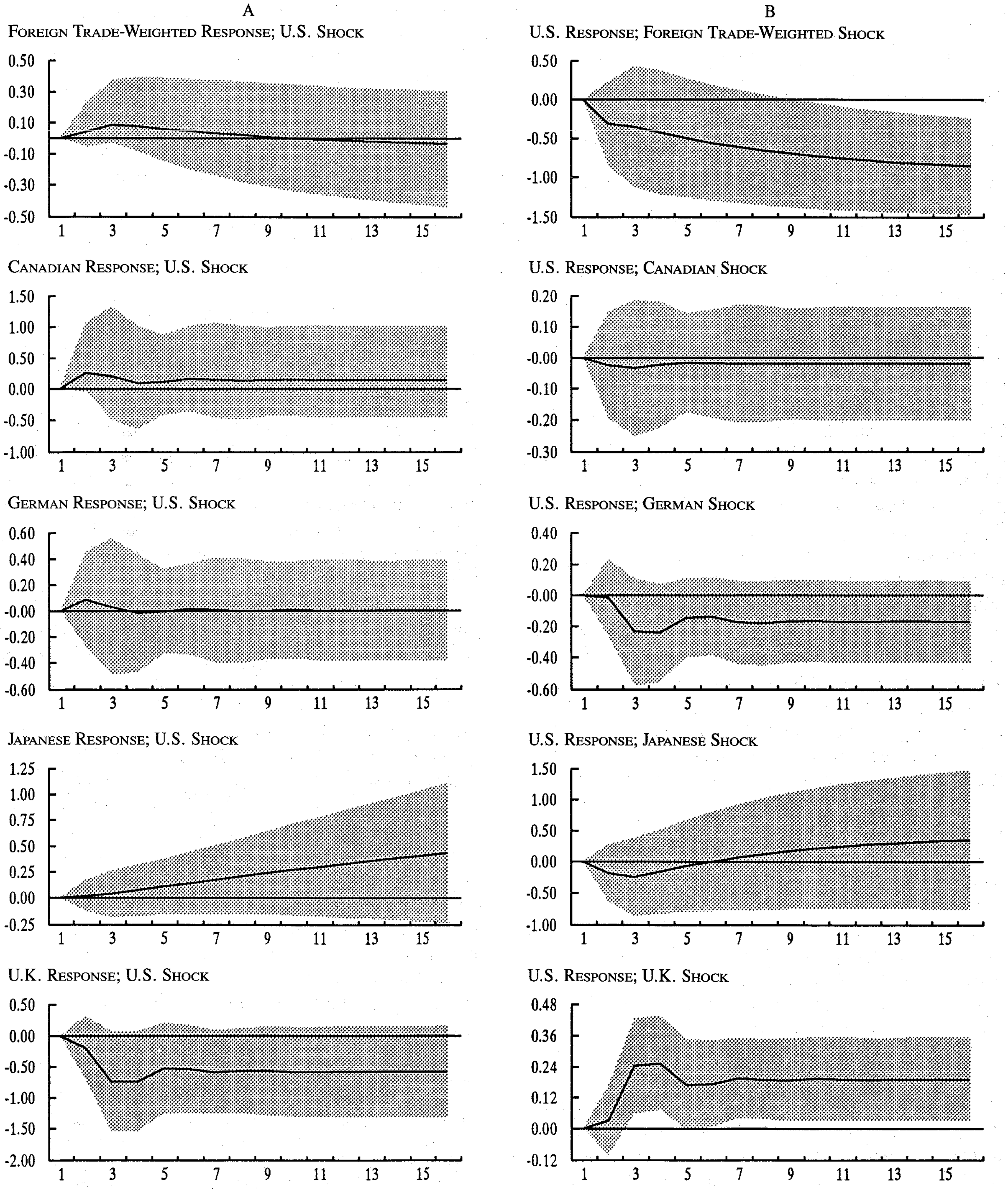
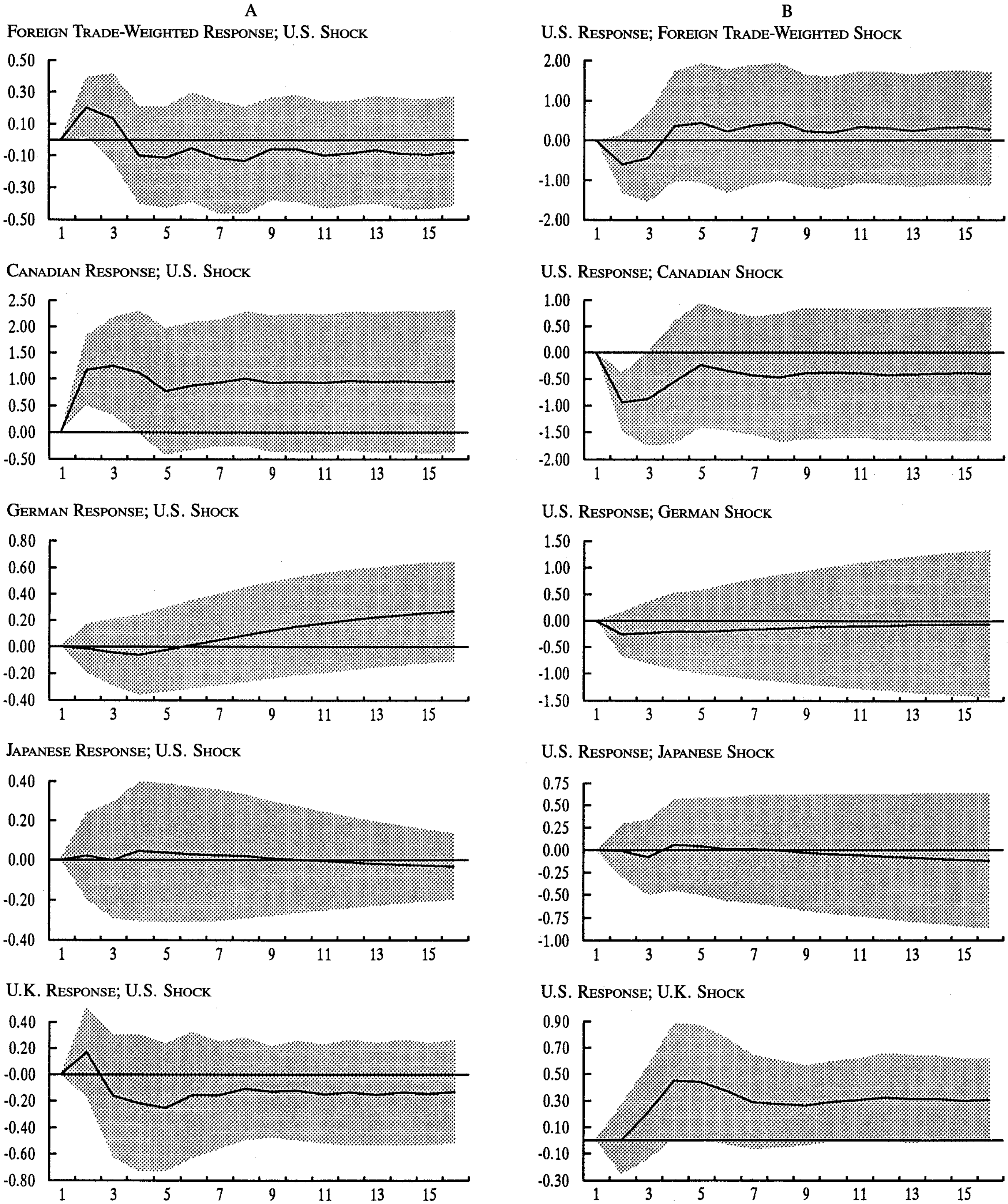


FIGURE 7

Impulse-Response Functions: Long-Term Rates



from 1 percentage point, as is the response of the foreign rates to a 1 percentage point shock to them. As a result, there is no significant tendency for real short rates to come back together once they have been pulled apart by a shock. This appears to be due to the absence of static expectations and a time-varying currency risk premia in a sample that is too short to allow one to observe the long-run interest-equalizing effects of capital mobility.[19]

Figure 7 shows the responses of real long-term interest rates to shocks to real long-term rates in other countries. As before, the effect of a 1 percentage point shock after 16 quarters on the rate that is shocked is never significantly different from 1 percentage point. But the effect of that shock on the other real long-term interest rate is never significantly different from zero. So once a shock drives national real long-term interest rates apart, there is no measurable tendency for them to be brought together again. Again this is not evidence against capital being highly mobile internationally among the major countries. However, it does indicate that such mobility tends to make real interest rates converge only over very long periods of time.

III. SUMMARY AND CONCLUSION

The impulse-response functions that have been examined in this study show that there have been virtually no causal linkages between U.S. and foreign short-term or long-term real interest rates for periods of up to 16 quarters. Moreover, in instances where longer-run linkages could be identified, the association between U.S. and foreign real rates was positive only half of the time. Yet, since the early 1980s differentials between U.S. and foreign interest rates when covered for exchange rate risk in either the forward market or by currency swaps have been close to zero. This eliminates government or institutional barriers to capital mobility as sources of disparities between real interest rates on similar assets and leaves only exchange rate expectations and premia for exchange rate risk as the contributing factors.

It is difficult to gauge the relative importance of these two factors with precision. But there is independent evidence that both factors have been important to some extent. The evidence for the importance of expectations is that real interest rate differentials have been shown to be an important force driving real exchange rates away from their long-run equilibrium values for extended periods of time. This has been especially true for the U.S. dollar in the first half of the 1980s when the combination of easy fiscal policy and tight monetary policy in the U.S. raised U.S. real interest rates relative to foreign rates. As a result, the real value of the dollar deviated significantly from its expected long-run equilibrium value, and the condition of static expectations required for a short-run equalization of real interest rates was far from satisfied.

The importance of premia for exchange rate risk in contributing to divergences in real interest rates is suggested by evidence from surveys of market expectations of future exchange rates. If exchange risk premia were small, we would expect that differences in anticipated returns on comparable assets calculated using survey data as a measure of expected exchange rate changes would be fairly small. But in fact this is not the case.[20] Therefore, changing currency risk premia probably also contribute to variation in differentials between real national interest rates. Unfortunately, however, empirical studies to date have had little success in isolating the fundamental economic factors that tend to cause changes in these currency risk premia.[21]

19. Using multivariate time-series modeling of real interest rate *differentials,* as opposed to the real rates themselves, Modjtahedi (1988) reaches quite different conclusions with respect to one-month Eurocurrency rates over fairly short sample periods (1973 through 1979 and 1979 through 1986). First, he finds that national real interest rates are generally cointegrated, although not always equal in the long run. Second, he estimates that it takes approximately six months for the differentials to converge to their long-run values. This estimated speed of adjustment is difficult to square with the approximately two years that it takes for the trade balance to adjust to changes in the exchange rate, and hence also to changes in interest rates. Rapid adjustment also is inconsistent with extended swings in the real value of the dollar that have been observed to be associated with similar movements in real interest rate differentials.

20. See, for example, Pigott (1993-1994).

21. Studies on the existence of exchange risk premia include Frankel (1982), Hansen and Hodrick (1983), Hsieh (1982), Hodrick and Srivasta (1984), and Fama (1984). Attempts to explain exchange risk premia in terms of the capital asset pricing model include Engle and Rodrigues (1989) and Lewis (1988).

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Finite Horizons and the Twin Deficits

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This paper uses Blanchard's (1985) model to study the relationship between budget deficits and trade deficits. The model is applied to annual post-war data from the U.S., Japan, and Germany. I find that in all three countries there is a significant link between trade deficits and budget deficits, holding constant expected changes in GNP and government expenditure. However, the implied planning horizons are quite different across countries. In particular, the implied planning horizon in the U.S. is only about 3 to 4 years, whereas in Japan it is 71 years and in Germany it is 31 years.

The United States has run merchandise trade deficits for eighteen straight years. Including trade in services and net interest receipts alters the picture only slightly, for it shows the current account in deficit for fifteen of the past eighteen years. Many policymakers and journalists regard this recent experience as symptomatic of some combination of closed foreign markets and a secular decline in the "competitiveness" of U.S. products. Given this diagnosis, the remedy then appears obvious—first, pry open foreign markets where necessary through a process of aggressive tit-for-tat bargaining, and second, prevent a further erosion of U.S. technological leadership by providing government support to those industries that are deemed to be on the cutting edge of new technology, especially if their foreign counterparts are being subsidized.

This paper will argue that these policy prescriptions represent bogus cures for a nonexistent illness. Rather than reflecting a nefarious plot on the part of foreign governments to keep out U.S. products, or a gradual waning of American hegemony, recent U.S. trade imbalances represent to a large extent the predictable outcome of macroeconomic policies that have as much to do with the actions of Congress as they do with the actions of foreign governments. In particular, much of the size and persistence of aggregate trade imbalances can be attributed to shifts in national fiscal policies that in turn lead to shifts in national savings rates. If (at a constant interest rate) changes in fiscal policy do not systematically affect domestic investment rates, then, via a well-known accounting identity, equating current account deficits to the excess of domestic investment over national savings, fiscal policy will necessarily affect the current account. In particular, budget deficits will lead to trade deficits.

The assertion that budget deficits lead to trade deficits is not new. In fact, it has become the conventional wisdom within the economics profession. As with other policy issues, however, the economics profession has not been entirely successful at getting the message across. This lack of success can be ascribed to two factors, one theoretical and one empirical.

First, from a theoretical standpoint, there is no necessary link between budget deficits and trade deficits. Specifically, there will be no link if "Ricardian Equivalence" holds, that is, if individuals fully capitalize the implied future taxes associated with budget deficits, either because they expect to live long enough to pay the future taxes themselves, or because at the margin they value the wealth of their descendants as much as they do their own. If Ricardian Equivalence holds, then budget deficits that simply reflect the intertemporal shifting of (lump-sum) taxes will not affect national savings and the current account, because changes in private saving will fully offset changes in government saving (see Barro 1974). Moreover, we might observe a positive relationship between budget deficits and trade deficits for reasons unrelated to how the government finances its expenditures. For example, a budget deficit might not in fact signal higher future taxes if individuals expect the government to restore a balanced budget by cutting future government expenditures. In this case, the anticipated reduction in government expenditures raises private sector wealth and consumption, and therefore increases the trade deficit.[1] Alternatively, suppose a budget deficit occurs because the government reduces taxes on investment. In this case, even with full tax discounting we would expect to observe a current account deficit, not because national saving declines, but because domestic investment increases. The point is that these theoretical ambiguities provide ammunition for those who want to argue that the twin deficits are either an illusion or a coincidence. For example, conservatives tend to resist the idea because they fear it will be used as an argument for raising taxes. With perfectly valid economic arguments on both sides of the issue, the door is then left wide open for those who prefer the spurious arguments associated with foreign trade barriers or declining national "competitiveness." Clearly, the extent to which individuals discount future taxes is an empirical question, which can be settled only by empirical work. This brings us to the second factor behind the economics profession's failure to convince the public that it is macroeconomic policy that is to blame for persistent U.S. trade deficits.

On the face of it, existing empirical evidence against Ricardian Equivalence and thus in favor of the notion that budget deficits produce trade deficits is surprisingly weak, despite the apparently strong evidence presented by the experience of the U.S. during the 1980s.[2] Studies that examine different time periods or different countries have failed to produce reliable evidence that budget deficits are significantly related to trade deficits.[3] Part of the reason for this mixed evidence is undoubtedly due to difficulties that plague all empirical work in economics, e.g., difficulties in measuring the relevant theoretical concepts (in this case the budget deficit), and difficulties in adequately controlling for the many factors that simultaneously influence the variables of interest. However, I believe that in the case of the twin deficits, part of the reason also stems from a failure to conduct empirical tests within the context of a clearly specified intertemporal optimization model.[4]

An intertemporal approach makes it clear that if we simply regress current account deficits on contemporaneous values of budget deficits and on control variables like government spending, investment, and GNP, we should *expect* ambiguous results because the coefficients in this sort of reduced-form relationship are complicated functions of underlying parameters in the economy. Moreover, this ambiguity arises from the inherently dynamic nature of the twin deficits issue and in particular does not derive from the usual sorts of simultaneity bias that clouds econometric inference. For example, regardless of the horizon of individuals, or of whether Ricardian Equivalence holds, the coefficients on control variables like government spending can be either positive or negative, depending on the relationship between the horizon of individuals and the perceived persistence of government spending changes. Similarly, while the model in this paper predicts that the (partial) correlation between current account deficits and budget deficits is unambiguously positive, the magnitude of this correlation can be arbitrarily large or small for any finite horizon of individuals, depending on the perceived persistence of budget deficits. In other words, the size of the coefficient on budget deficits does not by itself tell us the extent to which individuals discount future taxes. Instead, a clear picture of the twin deficits relation requires a joint estimation of the process generating the current account and the processes generating budget deficits and the control variables, since economic theory places cross-equation restrictions on these processes.

The remainder of the paper is organized as follows. The next section develops a discrete-time version of Blanchard's (1985) model. In this model all individuals face the same

1. Yi (1993) argues that there is some evidence that the U.S. trade deficit of the 1980s occurred because individuals expected future government purchases to decline.

2. For surveys of the empirical evidence on Ricardian Equivalence, see Bernheim (1987) and Seater (1993). Bernheim tends to stress evidence contradicting Ricardian Equivalence, while Seater tends to focus on studies that support Ricardian Equivalence.

3. For example, using a standard reduced-form regression approach, Bernheim (1988) shows that inferences about the strength of the twin deficits relationship depend critically on the country and time period, as well as on the conditioning information set.

4. A notable exception is the work of Leiderman and Razin (1988), who construct and test a model that is quite similar to the one in this paper. They apply the model to monthly data from Israel during the early 1980s and fail to reject the Ricardian Equivalence proposition.

constant probability of death. This probability imparts a finite horizon to individuals, and serves to parameterize the extent to which Ricardian Equivalence holds and the extent to which budget deficits affect the current account. Estimation of this parameter will be a primary focus of the paper. Section II discusses the data I use to estimate the model. Briefly, I apply the model to the U.S., Japan, and Germany, using as long a time series as I could obtain for each country. Section III presents the empirical results. Unrestricted estimates reveal a statistically significant (partial) correlation in all three countries between current account deficits and budget deficits. Restricted estimates, which allow us to infer the effective planning horizon of individuals, suggest wide disparities in the extent to which individuals internalize the government's budget constraint. The estimates range from a 3- to 4-year horizon in the U.S. to a 71-year horizon in Japan. Perhaps not surprisingly, however, the horizons are not estimated very precisely. In particular, their standard errors do not allow us to reject the hypothesis that the horizons are short and equal across countries. Section IV discusses some caveats and possible extensions to the paper.

I. The Twin Deficits in a Model of "Perpetual Youth"

This section briefly outlines a discrete-time version of Blanchard's (1985) model. The analysis and notation borrow heavily from the work of Frenkel and Razin (1987), and the interested reader is urged to consult their book for full details.

The model will be developed in four steps. First, I discuss the model's demographic assumptions. Second, I solve the intertemporal optimization problem confronting individual agents in the economy. Third, I aggregate the individual decision rules to arrive at an aggregate consumption function. In the fourth step, I incorporate domestic and foreign government borrowing, and derive an equilibrium law of motion for the economy's current account balance.

Demographics

Consider a world in which a new cohort of individuals is born each period. Without loss of generality, normalize the size of each new cohort to be one. All members of this cohort have the same probability of surviving from one period to the next, and more importantly, this survival probability remains constant throughout an individual's life. In other words, an individual's lifetime is like a sequence of coin tosses, the probability of living for another year being completely independent of the individual's current age. Clearly, these demographic assumptions are motivated by analytical convenience rather than by descriptive realism.[5] In particular, the assumptions that the survival probability is the same for everyone and that it remains constant over time greatly facilitate aggregation. In this world, the only redistributions that matter are between the currently living and the yet unborn. If allowance were made for more realistic individual life-cycle dynamics, then we would also need to worry about how government policy redistributes resources among all those who are currently living, each of whom will respond to the policy in a different way because of age differences.

Although the assumption of constant and identical survival rates is important, the particular values chosen for the birth rate and the death rate are inessential. For example, we know from Weil (1989) that virtually identical results can be derived in a framework in which individuals live forever and new (unrelated) individuals are born each period. In Weil's model the birth rate rather than the survival rate becomes the key parameter. In fact, by reinterpreting the parameters, the two models become observationally equivalent. Specifically, Blanchard and Weil's models will produce identical results if we set the birth rate in Weil's model equal to the death rate in Blanchard's, and then increase the interest rate in Weil's model by Blanchard's death rate.[6] Thus, a finite horizon per se is not the crucial issue here, although it provides a convenient story for debt nonneutrality. Instead, as noted by Buiter (1988), the crucial issue is that new individuals enter the economy each period, and that these individuals are unrelated (in utility terms) to currently alive individuals. These unborn individuals introduce a wedge between the government's future tax base and the future tax base of those who are currently living. This wedge then causes social and private discount rates to diverge, and it is this distortion that is the fundamental source of debt nonneutrality and the twin deficits.

Following Frenkel and Razin (1987), let γ denote an individual's probability of surviving from one period to the next. Then, from the previous assumptions, γ^t is the probability that an individual will live for t more years, and more generally, an individual's expected lifetime is

$$\sum_{j=1}^{\infty} j\gamma^j = \gamma/(1-\gamma)^2.$$

5. Blanchard cites evidence that survival rates are high and relatively constant from ages 20 to 40, but start to decline rapidly thereafter, reaching .99 at age 50, .97 at age 60, .84 at age 80, and .33 at age 100. To accord with this evidence on individual survival rates, Blanchard suggests an alternative interpretation of the model in which the basic unit of analysis is a dynastic household, and the survival rate refers to the probability that some member of the family continues to live.

6. See Glick and Rogoff (1994) for an application of Weil's model to issues in international macroeconomics.

Thus, in a very simple and convenient way, γ parameterizes the horizon of individuals. Finally, from our normalization that the size of a new cohort is one, the total population at any given time is constant and equal to $\sum_{j=0}^{\infty}\gamma^j=1/(1-\gamma)$ (assuming that each cohort is large enough for the law of large numbers to apply).

Individual Optimization

Individuals are assumed to maximize their expected lifetime utility,

$$(1) \qquad \max_{\{c_t\}} \tilde{E}_0 \sum_{t=0}^{\infty} \delta^t U(c_t),$$

where δ denotes the individual's subjective rate of time preference and c_t denotes consumption during period t. The expectation operator in (1), $\tilde{E}_0$, reflects uncertainty over both the duration of the individual's lifetime and his or her future resources. The previous demographic assumptions allow us to write this as,

$$(2) \qquad \max_{\{c_t\}} E_0 \sum_{t=0}^{\infty} (\gamma\delta)^t U(c_t)$$

where now the expectation operator, E_0, only reflects uncertainty about future resources, and the consumer's effective discount rate has increased.

Individuals receive an exogenous stochastic labor income stream, $\{y_t\}$, which is assumed to be identical across individuals, and must pay a stochastic lump-sum tax of τ_t to the government during period t. In general, variation over time in disposable income will cause individuals to want to borrow and lend. However, no one will be willing to lend to an individual unless he or she receives a "risk premium" to cover the probability that the borrower will die before the debt is paid off. Specifically, let $R=(1+r)$, where r denotes the risk-free market interest rate. Then, in competitive equilibrium, the (gross) rate of interest on personal loans will be R/γ, since this guarantees an expected return equal to the risk-free rate.[7] Therefore, the individual's flow budget constraint is

$$(3) \qquad c_t = y_t - \tau_t + b_t - R/\gamma\, b_{t-1}$$

where b_t denotes period t issues of (one-period) private sector debt.

In solving for the individual's optimal consumption/saving plan, I assume the individual's period utility function is quadratic. Specifically,

$$(4) \qquad U(c_t) = \alpha c_t - \tfrac{1}{2}c_t^2$$

Maximizing (2) subject to (3) then gives the following linear, age-independent consumption function (assuming $\delta R=1$),[8]

$$(5) \qquad c_t = [(R-\gamma)/R]\,[H_t-(R/\gamma)b_{t-1}]$$

where H_t denotes the capitalized value of the individual's expected future disposable income,

$$(6) \qquad H_t = E_t \sum_{j=0}^{\infty} \left(\frac{\gamma}{R}\right)^j (y_{t+j}-\tau_{t+j}).$$

Aggregation

Since it is assumed that labor, income, and taxes are the same for everyone, and the demographics imply an age independent consumption function, the only issue in aggregating concerns private sector indebtedness. Letting B_t denote aggregate per capita private sector debt, we have

$$(7) \qquad B_t = (1-\gamma) \sum_{a=0}^{\infty} \gamma^a b_{a,t},$$

where now $b_{a,t}$ denotes the debt at time t of individuals who are a years old. Aggregating both sides of the individual's budget constraint in (3) yields,

$$(8) \qquad B_t = R\cdot B_{t-1} + C_t - (Y_t - T_t),$$

where C_t, Y_t, and T_t denote aggregate per capita consumption, labor income, and taxes which, from our previous assumptions, are the same as c_t, y_t, and τ_t.

The point to notice is that at the *aggregate level*, the rate of return on private debt is just the risk-free market interest rate. From the law of large numbers, the risk premium is cancelled by those who die each period.

The Government

For simplicity, I assume the country in question is "small" in the sense that it takes as given the world interest rate, R. The main implication of this assumption is that application of the model to large countries will tend to exaggerate the effect of fiscal policy on the current account. This is because in large countries part of the effect of fiscal policy is reflected in the (world) interest rate.

At this point I also remind the reader of a second important assumption implicit in the above setup, namely, the

7. Following Yaari (1965), an alternative but effectively equivalent arrangement would have individuals buy life insurance policies in which insurance companies honor the debts of the deceased or receive their assets, whatever the case may be. Under this setup, borrowing and lending takes place at the risk-free rate, but adding in the individual's insurance premiums leads to an identical expected rate of return on human capital.

8. See, e.g., Frenkel and Razin (1987).

assumption that domestic output evolves exogenously, independent of both the current account and the government's fiscal policy. In principle, of course, we should make output endogenous by introducing a production function and modeling investment and labor supply decisions. After all, as was noted earlier, the current account balance is by definition the difference between investment and national saving. My strategy in this paper, however, is to see how much of the dynamics in the current account can be explained solely on the basis of fiscal policy-induced savings rate dynamics. The danger with this strategy is the potential of getting a misleading picture of the underlying reason why fiscal policy affects the current account, if indeed fiscal policy simultaneously influences both saving and investment.[9]

Having said this, we can now move on and derive an equation for the current account balance. First, define CA_t to be the economy's current account surplus. Remember that this is simply the economy's net acquisition of foreign assets during period t. Therefore, an economy will have a current account surplus when it spends less than it produces during a given period. That is,

$$CA_t = Y_t - G_t - C_t + rF_{t-1}, \tag{9}$$

where G_t denotes government purchases during period t, and F_t denotes the economy's *stock* of net external assets at the end of period t.

Now, if we difference both sides of the accounting identity in (9), and use the fact that, by definition $CA_t = F_t - F_{t-1}$, we get

$$CA_t = R \cdot CA_{t-1} + \Delta Y_t - \Delta G_t - \Delta C_t. \tag{10}$$

Next, aggregate the consumption function given in (5) and substitute it into (10), using the following three facts. First, note that by definition the sum of aggregate private sector indebtedness, B_t, and government debt, D_t, is equal to net external debt, $-F_t$. That is, $B_t + D_t = -F_t$. This allows us to write the aggregate consumption function in terms of aggregate per capita human capital, H_t, net external assets, F_t, and government debt, D_t. Second, use the government budget constraint,

$$D_t = R \cdot D_{t-1} + G_t - T_t \tag{11}$$

to write H_t in terms of expected future values of Y_t, D_t, and G_t. Third, note that the change in government debt, ΔD_t, is by definition equal to the government's (interest inclusive) budget deficit. Specifically, letting BS_t denote the government's time t budget surplus, we have $BS_t = -\Delta D_t$. Doing all this yields the following expression for the equilibrium current account balance,

$$\begin{aligned} CA_t = {} & \gamma CA_{t-1} + \frac{\gamma}{R} E_{t-1}(\Delta Y_t - \Delta G_t) \\ & + \left(\frac{R-\gamma}{R}\right) E_{t-1} \sum_{j=1}^{\infty} \left(\frac{\gamma}{R}\right)^j (\Delta G_{t+j} - Y_{t+j}) \\ & + (1-\gamma)\left(\frac{R-\gamma}{R}\right) E_{t-1} \sum_{j=0}^{\infty} \left(\frac{\gamma}{R}\right)^j BS_{t+j} + u_t. \end{aligned} \tag{12}$$

This equation is the main result of the model. It explains the current account balance in terms of five driving forces. The first component on the right-hand side of (12) represents an autoregressive effect which links persistence in the current account to the horizon of individuals. Specifically, the longer is the effective planning horizon, the more persistent are fluctuations in the current account. The second component on the right-hand side of (12) is a current period demand effect, which simply says that, all else equal, the current account surplus increases when available output increases this period more than does the government's demand for it. The third and fourth terms on the right-hand side of (12) are more interesting. The third term is a wealth effect arising from *expected* changes in government spending and output. If individuals expect government spending to rise faster than output, then private sector wealth declines. The decline in wealth reduces *current* consumption, and therefore increases the current account surplus (i.e., individuals begin to save now for the anticipated decline in their future disposable income). The fourth term on the right-hand side of (12) is what sets this model apart from standard applications of the Permanent Income Hypothesis to current account dynamics.[10] Specifically, it implies that budget deficits produce current account deficits. This, of course, is the "twin deficits" phenomenon. There are two points to notice about this component. First, it disappears when individuals have infinite horizons (i.e., when $\gamma = 1$). Holding current and future government spending constant, budget deficits just represent the intertemporal shifting of taxes. If individuals fully capitalize these future taxes then such tax shifting causes no wealth effects, which in this model is the only way fiscal policy can influence the path of the current account. The second point is that the effect of budget surpluses on the current account depends not just on the current realization of the government's budget surplus, but also on the *entire expected*

9. Glick and Rogoff (1992) develop an intertemporal optimizing model of the current account that simultaneously incorporates saving and investment dynamics. They focus their attention, however, on the importance of distinguishing global and country-specific productivity shocks, rather than on the effects of budget deficits.

10. See, e.g., Sheffrin and Woo (1990).

future path of the budget surplus. Finally, the last term in (12), u_t, represents revisions between period $t-1$ and period t of individual's expectations concerning future values of income, government spending, and the budget deficit. If expectations are rational, this term will be uncorrelated with anything in the time $t-1$ information set and will also be serially uncorrelated. Therefore, u_t is a valid regression equation error term.

Because the current account depends on expected future values of BS_t, Y_t, and G_t, in order to implement equation (12) empirically we must take a stand on the nature of the stochastic processes generating these variables. In general, there is every reason to believe that these variables are jointly determined within some larger economic system, and therefore should be forecasted using some sort of VAR. However, in the interests of simplicity, I employ the following univariate time series specifications for these variables:[11]

$$(13)\qquad BS_t = \alpha_1 + \alpha_{BS}\, BS_{t-1} + \epsilon_{1t}$$

$$(14)\qquad \Delta Y_t = \alpha_2 + \eta e^{\mu t} + \alpha_Y \Delta Y_{t-1} + \epsilon_{2t}$$

$$(15)\qquad \Delta G_t = \alpha_3 + \eta e^{\mu t} + \alpha_G \Delta G_{t-1} + \epsilon_{3t}.$$

Using these to evaluate the forecasting problems in (12) gives us

$$(16)\quad CA_t = \alpha_0 + \gamma CA_{t-1} + \alpha_{BS}\left[\frac{(1-\gamma)(R-\gamma)}{R-\gamma\alpha_{BS}}\right]BS_{t-1} + \alpha_Y\left[\frac{\gamma}{R} - \frac{\alpha_Y(R-\gamma)}{R-\gamma\alpha_Y}\right]\Delta Y_{t-1} - \alpha_G\left[\frac{\gamma}{R} - \frac{\alpha_G(R-\gamma)}{R-\gamma\alpha_G}\right]\Delta G_{t-1} + u_t.$$

Equations (13)–(16) clearly illustrate the nature of the cross-equation restrictions implied by the model. In particular, note that the response coefficients in the current account equation depend on the autoregressive coefficients in the equations governing the evolution of BS_t, ΔY_t, and ΔG_t. As noted in the introduction, this makes it difficult to interpret single-equation regressions of the current account on other variables. For example, note that the response of the current account to changes in output and government spending can go either way, depending on the relative magnitudes of the horizon parameter, γ, and the persistence of changes in output and government spending, as determined by the parameters α_Y and α_G.

11. Note, G_t and Y_t are assumed to share a common (deterministic) trend which, from inspection of (12), cancels out of the current account equation.

Also note that the persistence of budget deficits plays an important role in determining the (contemporaneous) response of the current account to a budget deficit. In particular, the more persistent a budget deficit is expected to be, the more likely it is that currently alive individuals will die before taxes are raised, and therefore the larger is the wealth effect. However, as pointed out by Poterba and Summers (1987), even if budget deficits are very persistent, the wealth effect and therefore the (contemporaneous) response of the current account are small if individuals have "long" but finite horizons. For example, suppose $\gamma=.87$ and $R=1.02$, so that individuals have approximately a 51-year horizon and the real interest rate is 2 percent. Then, even in the limit as $\alpha_{BS}\uparrow 1.0$, the coefficient on BS_t is only .13.

Before concluding that the model produces small effects from budget deficits, however, it should be remembered that in a dynamic multivariate model, contemporaneous responses may understate the potential of budget deficits to affect the current account. This is because an initial response may cumulate over time before it begins to die out. Such amplification occurs in this model if $\gamma+\alpha_{BS}>1$. For example, suppose that $\gamma=.87$ and $\alpha_{BS}=.7$. In this case, the initial response of the current account to a budget deficit shock will only be about 15 percent the size of the response after just two periods.

II. THE DATA

The model in Section I is applied to annual post-war data from the U.S., Japan, and Germany. Of course, none of these countries satisfies the "small" country assumption of the model, but except for the U.S. during the 1950s and 1960s, the assumption might not be too bad. Due to data availability problems, the sample varies from country to country. For the U.S., the sample extends from 1950–1993, while for Japan and Germany I was forced to use shorter samples, 1960–1992 and 1968–1993, respectively. Data are from NIPA for the U.S., and from the OECD for Japan and Germany.

Without a doubt, the variable in the model that is most difficult to measure is the government budget deficit. In this paper I make no attempt to correct the standard reported series for any of the many potential biases to which these data are subject. Four points about the budget data should be made, however. First, for all three countries I measure deficits in reference to the "general" or "consolidated" government. That is, state and local balances are added to federal or central government balances. Second, since I define the budget deficit as the change in the government's debt, I use data on the interest inclusive deficit (as opposed to the primary deficit). Third, the data include social security payments and tax revenues. This becomes important for the U.S. and Japan starting in the late 1970s. Fourth, rather than express everything in real terms, I simply divide both sides of equation (16) by nominal GNP, and express everything as a share of nominal GNP.

Plots of the current account and budget surplus as a share of GNP are contained in Figures 1–3. These figures suggest that while there appears to be some sort of relationship between the twin deficits, the strength of the relationship varies over time. In general, the relationship appears to be closer in all three countries during the 1980s. The figures also illustrate that the two series are not always "in phase". These two facts suggest that it is important to control for other factors that are influencing the current account balance and to allow for some dynamics.

To get a better sense of the dynamics in the data, Figure 4 presents impulse responses computed from unrestricted bivariate VAR(2) models consisting of the current account and the budget surplus (both expressed as a share of GNP).[12] Note that in all three countries a positive shock to the budget surplus produces a current account surplus that peaks after two to three years, and then gradually moves back toward balance—a dynamic version of the twin deficits story. The main difference across countries is that Germany's response appears to be weaker and shorter-lived than in the U.S. and Japan, while the U.S. response appears to be more persistent than in Japan and Germany.

III. EMPIRICAL RESULTS

This section presents joint maximum likelihood estimates of the system of equations (13)–(16). In addition to the usual assumptions about the error terms, I remind the reader of two important statistical assumptions that are made when computing the estimates that impose restrictions on the nature of the economic equilibrium. First, remember that I am assuming output is exogenous. Of course, this cannot literally be true. Imports and exports affect GNP, just as GNP affects imports and exports. Still, what is important is that this feedback not be too strong. Otherwise we can expect to obtain inconsistent parameter estimates. The second assumption is that there is no feedback from an economy's external balance to its fiscal policy variables. Again, I regard this as a reasonable assumption, although some observers have argued that external balance considerations influence congressional budget deliberations. As noted in the introduction, however, most members of Congress seem to see other culprits behind the persistent

12. The equations are ordered so that changes in the budget surplus have no contemporaneous effect on the current account.

FIGURE 1

U.S.: CURRENT ACCOUNT AND BUDGET SURPLUS AS A SHARE OF GNP

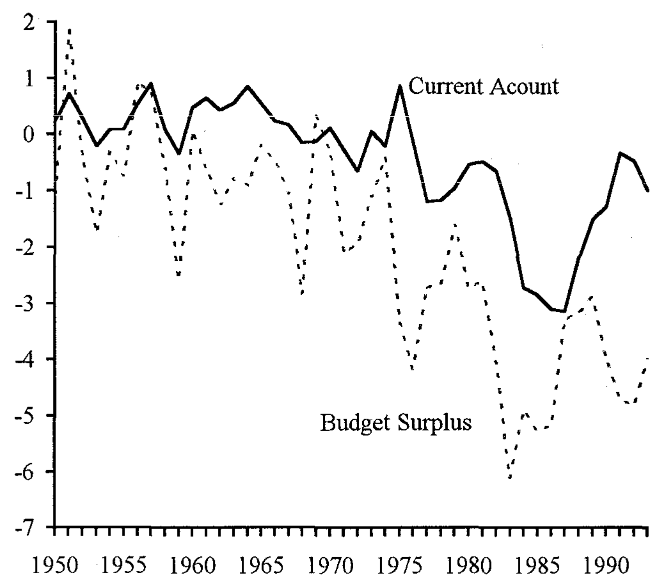


FIGURE 2

JAPAN: CURRENT ACCOUNT AND BUDGET SURPLUS AS A SHARE OF GNP

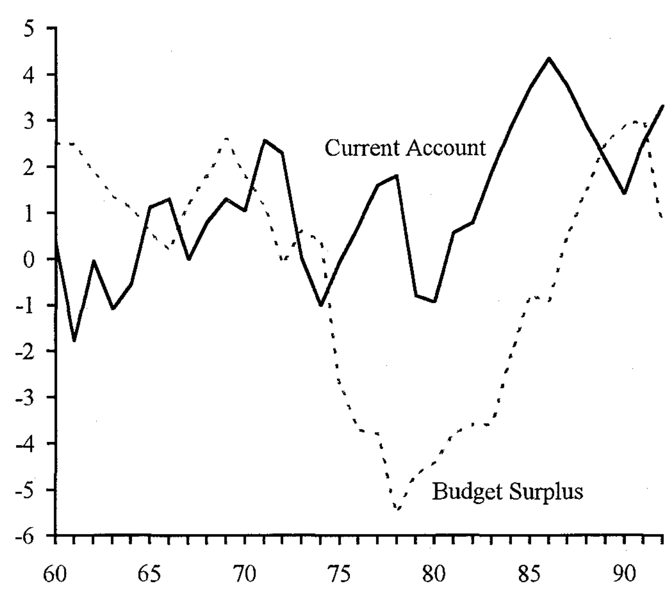


FIGURE 3

GERMANY: CURRENT ACCOUNT AND BUDGET SURPLUS AS A SHARE OF GNP

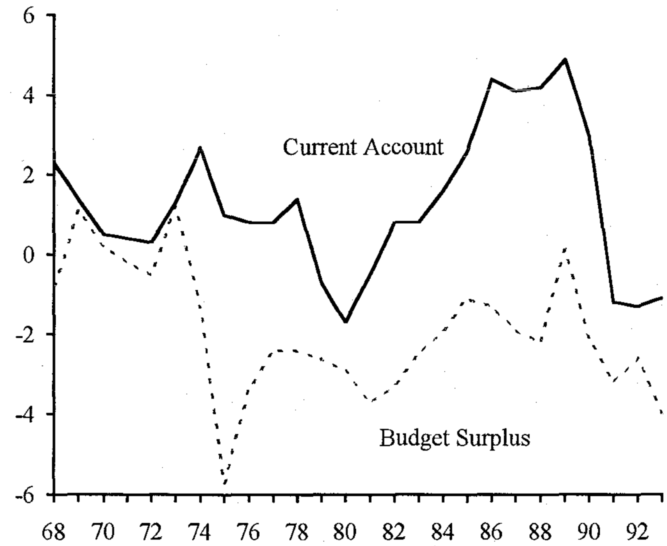
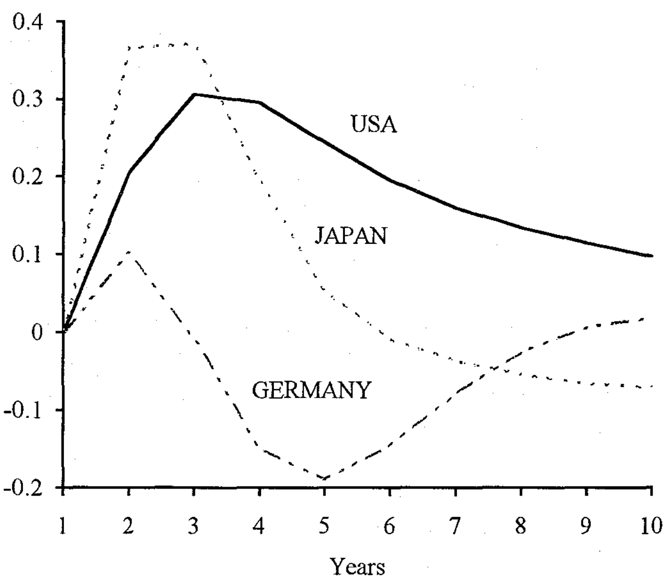


FIGURE 4

RESPONSES OF CURRENT ACCOUNT TO A SHOCK IN THE BUDGET SURPLUS (UNRESTRICTED VAR(2))



U.S. trade imbalance. In any case, if instrumental variables can be found, these exogeneity assumptions can be tested via a Hausman test, for example. If this test rejects we should resort to an Instrumental Variables estimator.

Before presenting estimates of the restricted system, let me briefly describe the results of unrestricted estimation of the current account equation. (Actually, I estimate the current account equation jointly with the other equations to take advantage of potential correlation among the error terms. I refer to the estimates as unrestricted because I do not impose the cross-equation constraints on the coefficients.) As noted earlier, only in the case of the budget surplus do we have any expectation concerning the sign of the coefficient. In particular, if the twin deficits hypothesis is valid, the coefficient on BS_t should be positive. This is indeed the case. Unrestricted estimates of the budget surplus coefficient are .266, .064, and .515 for the U.S., Japan, and Germany, respectively. The associated t statistics are 5.26, 0.82, and 2.68.

Finally, Table 1 contains estimates of the underlying parameters, derived by imposing the cross-equation restrictions. In each case I simply fix the value of the interest rate to be 2 percent, i.e., $R=1.02$.[13] The first point to notice is that the fit of the model appears to be reasonably good, in the sense that the current account equation explains 82 percent of the variation in the U.S. current account, and about 60 percent of the variation in the Japanese and German current accounts. On the down side, however, note that for Germany the cross-equation restrictions are soundly rejected, as the 5 percent critical value for a $\chi^2(3)$ random variable is only 7.81. Also note that for the U.S. and Germany there is borderline evidence against the hypothesis of no residual (first-order) autocorrelation. This casts doubt, beyond the usual small sample considerations, on the validity of the standard errors.

Turning to estimates of the horizon parameter, γ, note that while this parameter appears to be relatively precisely estimated, when we feed these estimates into the formula for an individual's expected lifetime (i.e., $\gamma/(1-\gamma)^2$), we get far less precise estimates of the effective planning horizon. For example, the 95 percent confidence intervals reported below the horizon estimates indicate that we cannot even reject Ricardian Equivalence (i.e., an infinite horizon) for Japan and Germany. This is because the

13. From (12), what matters is the effective discount rate, γ/R. Raising R should increase our estimate of γ by the same percentage. For example, if initially $R=1.02$ and we estimate $\gamma=.8$, then increasing R by 1 percent to 1.0302 should lead to an estimate of $\gamma=.808$. I tried estimating the model for a 1 percent and 3 percent real interest rate and found that the results changed little and in the predicted direction.

formula starts to become quite sensitive to small variations in γ once γ starts to reach about .80. Of course, this is not too surprising since, with discounting, it makes very little difference whether we calculate present values including 50 years or including 100 years. In other words, we will never be able to tell reliably whether individuals have 50-year planning horizons or whether they have 100-year planning horizons. Fortunately, this sort of distinction is rarely important in economic policymaking. Of potentially more importance, however, are differences like that exhibited by the U.S. and Japan, in which the U.S. is estimated to have a horizon of only a few years, while Japan is estimated to have a horizon of about 70 years. Of course, differences of this magnitude should manifest themselves in other data sets. Thus, it would be of interest to cross-check these results with other studies. One example of a study yielding results on the implicit planning horizon of individuals is Hayashi's (1982) paper on the Permanent Income Hypothesis. Using time-series data on aggregate U.S. consumption and income, Hayashi's estimates imply roughly a 10-year planning horizon. One potential explanation of this relatively short horizon, pursued by Hayashi, is that part of the U.S. population is subject to liquidity or borrowing constraints, making their behavior appear myopic. For example, his estimates suggest that approximately 17 percent of the U.S. population faces binding liquidity constraints. However, while liquidity constraints might explain a low-horizon estimate for a particular country, such constraints seem ill-suited to explain the cross-sectional difference between the U.S. and Japan. That is, it seems implausible that capital market imperfections are more severe in the U.S. than in Japan.

TABLE 1

RESTRICTED ESTIMATES OF EQUATIONS (13)–(16)

	USA	JAPAN	GERMANY
Sample	1952–1993	1962–1992	1970–1993
γ	.596 (.078)	.888 (.063)	.836 (.131)
αBS	.738 (.077)	.908 (.061)	.553 (.137)
αY	.894 (.082)	.473 (.153)	.395 (.147)
αG	.775 (.109)	.772 (.094)	.208 (.194)
Horizon	3.66 (1.40, 12.2)	71.3 (13.4, ∞)	31.1 (3.2, ∞)
R^2	.82	.59	.56
h stat	1.95	1.01	1.82
LR(3)	6.31	3.69	20.7

NOTES:
Asymptotic standard errors in parentheses.
Horizon computed as $\gamma/(1-\gamma)^2$.
R^2 and h stat pertain to the current account equation.
LR(3) is the likelihood ratio statistic for the system's three overidentifying restrictions.

IV. CONCLUSION

This paper developed and estimated a dynamic econometric model of the current account. This model links persistence in trade imbalances to the effective planning horizons of individuals. The longer their horizons (as measured by their "expected lifetimes"), the more persistent will be the economy's aggregate trade imbalances. The model also illustrates the importance of individuals' horizons to the notion of the "twin deficits". All else equal, the longer individuals' horizons are, the weaker will be the relationship between budget deficits and trade deficits. This is because budget deficits affect the economy solely by altering the timing of taxes. Shifting taxes to the future by running a budget deficit will not create much of a wealth effect if individuals expect to be around to pay the higher future taxes.[14] Not surprisingly, it is difficult to estimate this parameter precisely using relatively short time-series data. Nonetheless, the point estimates suggest wide disparities in planning horizons among the U.S., Japan, and Germany. Specifically, the U.S. seems to have a much shorter effective planning horizon than Japan, with Germany somewhere in the middle. It would be interesting to cross-check these results using more direct, and probably more reliable, micro data sets.

Finally, in deriving these results I have made many simplifying assumptions. Future work along these lines should attempt to relax some of these to make sure the inferences hold up. Probably the two most important extensions would be, first, to "endogenize" output movements by modeling investment, and second, to relax the "small country" assumption by allowing a country's fiscal policy to affect the equilibrium world interest rate.

14. Or they expect their children, or other people they care about, to be around.

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Capital Flight, External Debt, and Domestic Policies

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The international debt crisis of 1982 revealed that unrecorded private capital outflows from developing countries occurred simultaneously with borrowing from international commercial banks. Current interest in capital flight has been generated by the possibility that the resurgence of private capital inflows to these countries may be limited to the return of flight capital. A simple public finance model shows that simultaneous capital outflows and inflows can be explained as the result of private international arbitrage of domestic policies. The paper discusses the welfare consequences of gross two-way capital flows that take advantage of opportunities to avoid taxation or generate subsidy income.

In the aftermath of the 1982 international debt crisis, economists were surprised to learn that a large part of the borrowing of developing countries from international commercial banks was matched not by net imports of goods and services, but instead by unrecorded private capital outflows from developing countries. A satisfactory explanation for why residents of a country *simultaneously* borrow and lend on international markets clearly calls for a model that explains patterns of financial intermediation rather than conventional models for net investment opportunities in different countries.

This article focuses on a measure of "capital flight" developed in Dooley (1986) that captures unrecorded private capital outflows and on a number of theoretical models that might help understand this measure of capital flight. Interest in capital flight recently has been rekindled by the resurgence of private capital inflows to developing countries after nearly a decade of very limited capital flows. At issue is whether this reflects a "discovery" of emerging markets by residents of industrial countries or a return of capital flight by residents of the developing countries. In either case, it is a private capital inflow. But if the "home bias" of portfolios of industrial countries really is being reduced, then the potential for continued inflows seems very large; in contrast, if the "home bias" of residents of developing countries is being increased by a reduction of capital flight claims on industrial countries, the scope for continued private inflows is quite limited. The data seem more consistent with the second interpretation.

We are concerned with the sources of capital flight and with the welfare consequences of capital flight in the presence of the policy and institutional environment that gives rise to it. The next section elaborates on the definition and estimation of capital flight and reports estimates of capital flight from 1971–1991 for a sample of 84 developing countries. Section II presents a simple public finance model to discuss the effects of different tax treatments for resident and nonresident holders of claims on domestic assets. Section III analyzes capital flight using this model and emphasizes that capital income taxation that varies de facto by residence and source leads to two-way gross financial capital flows. The model incorporates a welfare-improving role for capital income taxes. The welfare consequences of capital flight in this model are due to the restrictions its possibility imposes on the effectiveness of these taxes and, therefore, on the fiscal instruments for a social welfare-maximizing government.

Section IV discusses the welfare effects of capital flight in the presence of financial market imperfections. In this case, capital flight can lead to inefficient international allocations of physical capital stocks. In Section V, subsidies to foreign lenders and their contribution to capital flight are discussed. Section VI concludes.

I. DEFINITION AND MAGNITUDE OF CAPITAL FLIGHT

We define "flight capital" as the accumulation of residents' claims on nonresidents that escape control by domestic governments—that is, that are not subject to taxation, regulation, or, in extreme circumstances, confiscation.

The method for estimating capital flight (Dooley 1986, 1988) involves calculating the total stock of external claims: Specifically, sum recorded claims on nonresidents less direct investments abroad using balance of payments data, cumulated errors and omissions from the balance of payments accounts, and an estimate of the unrecorded stock of external claims. The starting value for the cumulated balance of payments data is estimated by capitalizing investment income receipts for the initial year; errors and omissions are included because they often are associated with accumulations of financial claims on nonresidents that might include unrecorded capital flows along with many other forms of assets.

The balance of payments data are known to underestimate seriously the full stock of external debt (using the World Bank data, among other sources). If these data are correct, then some sort of balancing transactions also must be underestimated. These can include any type of foreign transaction, including imports of goods and services or purchases of financial claims on nonresidents financed by the accumulation of unrecorded external debt. Since the type of transaction cannot be discerned, we assume that all of the unrecorded debt increases are balanced by increases in private claims on nonresidents that are not reported in the balance of payments records.

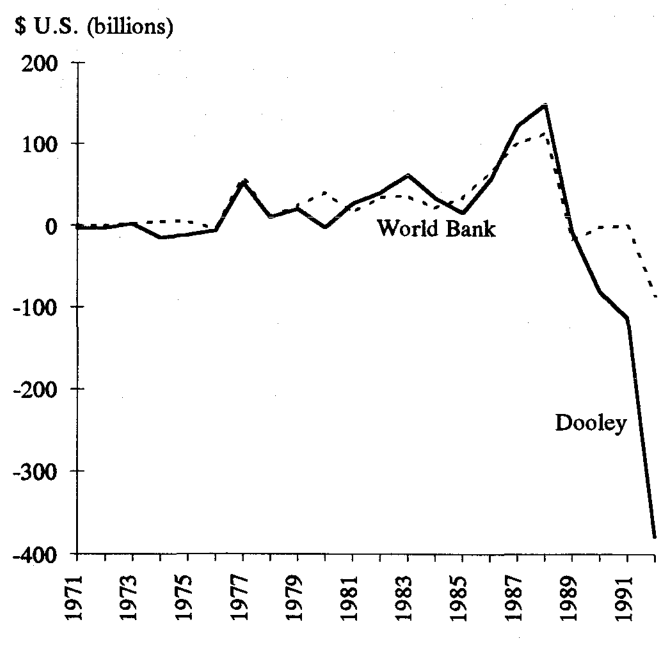
Next we subtract the stock of claims implied by investment income receipts and market interest rates. Because this stock of claims represents the portion that earns income reported in the balance of payments accounts, and therefore is within the control of domestic authorities, it can be considered to result from normal portfolio diversification motives rather than from capital flight.

Dooley (1986) compares the yield implied by reported investment income to the accumulated external claims from the balance of payments data and to the estimated total of external claims for several major debtor countries. These estimates suggest that a significant share of the income earned from claims on nonresidents is not reported in the balance of payments system and therefore is attributable to the returns to flight capital. The difference between the estimate of total external claims by nonresidents excluding direct investment abroad and the estimate of assets on which interest earnings are reported is the estimate of capital flight intended to measure claims on nonresidents that are beyond the control of the home government. This procedure leads to larger estimates of capital flight than of unrecorded external debt accumulations plus errors and omissions.

Claessens and Naude (1993) updated estimates of capital flight using this definition ("the Dooley Measure") for 84 developing countries between 1971 and 1991; their results are summarized in Figure 1, which also shows an estimate of capital flight sometimes used by the World Bank (the "World Bank Residual Measure"). The comparison of these two measures is interesting because they are conceptually identical except that the "Dooley Measure" subtracts gross claims for which interest income is reported in the balance of payments.

FIGURE 1

COMPARISON OF MEASURES OF CAPITAL FLIGHT IN ANNUAL FLOWS



Clearly, this distinction made little difference for the quantitative measure of capital flight for this group of countries until 1990 and 1991. The dramatic reversal of capital flight in 1990 and 1991 according to the "Dooley Measure" helps explain the large recorded capital inflows that have dominated recent developments in emerging markets. Indeed, to the best of our knowledge, this finding is the only direct evidence in support of numerous speculations that what appear to be purchases of emerging market assets by residents of industrial countries are in fact the return of flight capital.

As Claessens and Naude point out, the divergence between the two measures reflects the fact that reported investment income in 1991 was double that level for 1989, while interest rates on dollar-denominated instruments fell by about 30 percent. Our interpretation of these data is that residents of developing countries have sold off their capital flight positions in order to purchase assets denominated in their home countries' domestic currencies. This is incorrectly recorded as an increase in liabilities to nonresidents in the developing country's balance of payments. The correct entry would be a reduction of private residents' claims on nonresidents. About half of this inflow has been offset by official exchange market intervention or by an increase in official claims on nonresidents. Since the interest income on official reserves is recorded in the balance of payments, the "Dooley Measure" correctly captures the decline in the stock of private flight capital. Moreover, the magnitude of the reversal of capital flight in 1990–1991 is *greater than* OECD estimates of all private borrowing by non-OECD countries on international capital markets. While interesting in themselves, these data tell us nothing about the motivation behind two-way capital flows that have dominated international financial markets for the past 20 years. For that, we turn to alternative models of international financial intermediation in the following sections.

II. Public Finance Model

The analytical framework for capital flight developed in this section emphasizes the role of policies adopted by the domestic government and residents' opportunity to avoid the impact of those policies on the net income from their asset holdings. Policies often treat resident and nonresident holders of claims on domestic assets differently. As a consequence, capital flight and external capital inflows can be seen as an outcome of international arbitrage of domestic policies. In practice, the types of policies that can lead to capital flight vary by residence of the investor, and can include explicit capital income taxes, restrictions on the menu of assets available to residents different from those available to nonresidents, subsidies—including contingent ones—to investment by nonresidents, and outright confiscation.

The effective taxation of capital income frequently varies both by its source and by the residence of its recipient. In many cases, domestic investors' total tax burden on capital income exceeds that of foreign holders of domestic claims. When residents hold assets beyond the reach of their home government, they will tend to realize higher risk-adjusted post-tax returns for claims on nonresidents than for claims on domestic assets. Under these circumstances, foreign creditors can have an incentive to invest in domestic assets when residents do not. Such differences in effective rates of taxation of asset income will lead to gross capital outflows and inflows that are unrecorded in balance of payments data exceeding any net capital flow.

It is often much more difficult to avoid paying residence-based capital income taxes on income earned from domestic assets than from claims on nonresidents unreported to domestic fiscal authorities. Such taxes become both residence-based and source-based, de facto applying only to domestic capital income earned by residents. The taxes that can lead to differential burdens for residents and foreign holders of domestic claims may be anticipated rather than statutory. For example, in many cases residents can hold only deposits in the domestic banking system that are denominated in the domestic currency and are subject to a reserve requirement, while foreign investors can acquire claims on domestic intermediaries denominated in foreign currency that do not require the holding of non-interest-bearing reserves. Resident savers usually receive below-market interest rates on reserves and face potential inflation taxes on these deposits, so that nonresidents receive a higher anticipated post-tax rate of return for claims on domestic capital.

More generally, when residents do not have access to the same range of domestic financial instruments as do nonresidents, the contingent taxes imposed by and subsidies provided by domestic authorities differ for the two types of creditors. For example, external debt may be denominated in foreign currency while domestic deposits may only be available denominated in local currency. Nonresidents can purchase an asset yielding a different distribution of returns than residents can. As a consequence, the risks and returns associated with domestic claims differ by the residence of the investor. This leads to international portfolio diversification, but it does not by itself lead to capital flight. Capital flight arises when residents avoid anticipated taxation of domestic deposits (for example, through inflation) and of the gross earnings on reported foreign assets. Acquisition of assets abroad for both groups then represents international arbitrage of these tax rules or anticipated levies. The extent to which residents take advantage of such opportunities is estimated by a measurement of the claims on nonresidents that are unreported in the balance of payments records.

One concern over capital flight is that private external debts are socialized, or the payments on these debts are subsidized by the government. These can lead to the accumulation of private claims on nonresidents by residents that do not provide foreign exchange earnings available to the public sector for debt interest payments. Such subsidies, which often are contingent liabilities for the government, provide benefits for foreign lenders and, possibly, private domestic investors.

These ideas can be addressed more formally in a stylized two-period model of a small open economy with a single composite good that can be used for private consumption, public consumption, and investment. In the first period, the country has an initial endowment of the good, and households choose a consumption and saving allocation. Domestic saving can be allocated to investment in home capital or used to purchase claims on nonresident capital earnings. External borrowing also is possible, allowing nonresidents to acquire claims on income produced by domestic capital. In the second period, output and net income from investment abroad are allocated to private and public consumption. The government provides public consumption goods and raises revenue using non-lump-sum taxes. The instruments available to the fiscal authority include taxes on labor income, source-based taxes on domestic capital income, and residence-based taxes on investment income. Taxes can be levied at positive or negative rates (subsidies).

Fiscal authorities face difficulties enforcing compliance with taxes on foreign source income. We assume that domestic residents are able to invest in foreign claims providing income that is beyond the control of national authorities and therefore untaxable in practice. The model also allows domestic capital income paid to foreign residents to be taxed at different rates from home source capital income paid to residents.

Production of output requires inputs of labor and capital using a standard concave technology, given in labor-intensive form by $f(k)$. The household sector is represented by a single household with the utility function

$$U = u(c_1, c_2, l) + v(g) \tag{1}$$

where c_1, c_2, l, and g are first-period consumption, second-period consumption, leisure consumption, and public goods consumption, respectively. The initial endowment of leisure is L. For simplicity, household preferences are additively separable between public goods and private goods consumption.

Domestic claims on nonresidents are denoted by B, and foreign claims on domestic capital are denoted K^f. The share of the domestic capital stock owned by residents is the difference between K and K^f. Note that foreign claims on residents and residents' claims on foreigners are gross. This model parallels that of Razin and Sadka (1989), but they do not allow nonresident claims on residents.

The household budget constraints in each period, respectively, are given by

$$c_1 + B + (K - K^f) = y, \tag{2}$$

and

$$\begin{aligned} c_2 = {} & B\,(1 + r^*(1 - z\,t_r)) \\ & + (K - K^f)\,(1 + r(1 - t_r)\,(1 - t_s)) \\ & + wl\,(1 - t_l). \end{aligned} \tag{3}$$

The tax rate on capital income by residence is given by t_r, the tax rate on domestic source capital income is given by t_s, and the tax on labor income is given by t_l. The rate of compliance with residence-based capital income taxes for assets held abroad is measured by z, which takes values between zero and unity: When z is zero, domestic fiscal authorities are unable to tax any of the earnings from claims on nonresidents held by residents; when z is unity, evasion of investment income taxes is not possible. The initial endowment of the composite good is y, the wage rate is w, the domestic (pre-tax) interest rate is r and the foreign interest rate is r^* (net of any foreign source-based taxes).

Suppose that international financial capital mobility is unrestricted and that this country is small relative to the rest of the world. Then foreign savings always will flow into the domestic economy if the post-tax rate of return to foreign capital is less than the rate of return to domestic capital after source-based taxes. In equilibrium, the post-tax rate of return to foreign capital, r^*, must be at least as great as the post-source-based-tax rate of return to domestic capital, $(1-t_s)r$. Therefore, foreign savers will hold claims on domestic capital only if these two net rates of return are equal. If r^* exceeds $(1-t_s)r$, then domestic residents also earn a higher return to claims on foreign capital than on domestic capital after source-based and residence-based taxes are imposed, so that the domestic capital stock would be zero.[1] Therefore, assuming that the Inada conditions[2]

1. This holds for any z between zero and one as long as t_r is non-negative. It also holds for a residence-based subsidy (t_r negative) when z is one. When a subsidy is paid, z should be one, since rational savers would comply fully.

2. These are that $f'(k)$ tends to infinity as k tends to zero and $f'(k)$ tends to zero as k tends to infinity. We also assume that $f(k)$ is strictly concave.

hold for $f(k)$, we have in equilibrium under perfect financial capital mobility that

$$r^* = (1 - t_s)r. \tag{4}$$

If z is less than one, then we also have that

$$r^* (1 - z\,t_r) > (1 - t_s)(1 - t_r)\, r. \tag{5}$$

Equilibrium demand for capital by the firm in the home country is determined by equality of the marginal product of capital and the pre-tax rate of interest:

$$f'(k) = r. \tag{6}$$

Household optimization yields consumption demands that depend upon the tax rates through their effects on the income and the relative price of second-period consumption.

III. CAPITAL FLIGHT AND THE PUBLIC FINANCE PROBLEM

Suppose that domestic savers cannot avoid residence-based capital income taxes by purchasing claims on nonresidents. In this case, a small country social planner choosing to maximize the welfare of the representative household optimizes by financing public goods spending using a combination of a labor income tax and a residence-based capital income tax. In the solution, the rate of source-based capital income taxation is zero, so that the first-order condition for an optimum

$$f'(k) = f^{*\prime}(k^*) \tag{7}$$

is satisfied.

The solution for the optimal tax and public goods supply problem when there is no issue of tax compliance is well-known. The rates of tax imposed on labor income and on interest income of residents are chosen so that the disutility of the last unit of revenue raised from each is equal when both taxes are positive. We skip elaborating this rule analytically. It should be noted that such an equilibrium plan is not Pareto efficient if labor supply is not perfectly elastic, since all taxes are distortionary.

Now suppose that both source-based and residence-based taxes are available to domestic fiscal authorities, but that residents are able to avoid taxes on claims on foreign capital earnings ($z = 0$). In this case, any positive rate of residence-based capital income tax implies that no domestic claims are held by residents and all domestic capital income is paid to foreign claimants. In the absence of controls on financial capital outflows, the government collects no revenue from residence-based capital income taxes, and all public consumption spending must be financed by taxes on capital earnings that distort the international allocation of production activities and on labor income that distort consumption-leisure choices and labor supply. Source-based taxes are assumed to be enforceable, but these result in different marginal productivities of capital at home and abroad. Again, the optimal tax rule is found by straightforward maximization of representative household utility subject to the necessary conditions for private optimization by the household and firm and the constraint that residence-based taxes raise no revenue.

Social welfare is reduced by the possibility of capital flight in this model. This is because capital flight is a consequence of the ability of households to avoid capital income taxes levied on a residence basis. The effective marginal tax rate on capital that can be achieved on a residence basis is zero. Reducing the residence-based capital income tax rate to zero can eliminate capital flight in this model (for arbitrarily small transactions costs associated with the acquisition of foreign assets) and results in no loss of tax revenue. The restriction in the set of distortionary fiscal instruments available to the government results in lower maximized social welfare. Capital flight is another consequence and the channel through which residents escape the control of national fiscal authorities.

It should be noted that both enforceable residence-based and source-based capital income taxes affect the net external asset position of the country. In general, an increase in a source-based tax will lead to a net capital outflow, an increase in a residence-based tax will cause a net capital inflow, and with enforceable taxes of both types, the net and gross capital outflow will be equal. However, this is not the case when residents cannot be effectively taxed on foreign asset earnings. In the case of this model with no constraints on external financial capital inflows, all domestic saving goes abroad if t_r is positive and all domestic capital income is owed to foreign residents. The gross outflow is much larger than the net capital outflow, which may be positive or negative. This is because domestic authorities can only effectively tax domestic capital income, although at different rates for nonresident and for resident claimants.

Given that capital flight is possible, the social welfare-maximizing government would choose to impose controls on financial capital outflows. Such restrictions can help to resolve the public finance problem for the government by reducing the ability of residents to acquire assets earning income that cannot be taxed. Imposing a complete (assuming enforceability) ban on the acquisition of all claims on nonresidents leads to a domestic marginal product of capital that is no greater than the foreign rate of interest:

$$(1 - t_s) f'(k) = r^*, \text{ if } K^f > 0, \text{ and}$$
$$(1 - t_s) f'(k) < r^*, \text{ if } K^f = 0. \tag{8}$$

The equilibrium domestic interest rate can be below the foreign interest rate when no residence-based and source-based capital income taxes are imposed if domestic savings are adequate to finance all domestic capital. In this case, an appropriate choice of the residence-based, or equivalently, source-based, capital income tax can be made so that the marginal productivity of capital is equal across borders.

However, even if enforceable capital controls are feasible the potential for capital flight still can pose a public finance problem. The optimal policy for a government that maximizes the household's utility is to impose capital controls at some positive level and a residence-based capital income tax along with a positive rate of labor income tax in the general case for this model. It will never be optimal to choose capital income taxes that lead to the inequality

(9) $$f'(k) < r^*.$$

That is, such a government will not want to impose a source-based or residence-based tax (with the caveat that this applies only to residents' holdings of domestic financial assets) and level of capital control that results in a marginal productivity of capital below the foreign marginal productivity of capital. If it did, it could relax the quantitative restraint on capital outflows and/or the rate of taxation of domestic capital income and tax rate on labor income to reduce the home capital stock and achieve a more efficient allocation of domestic saving and global production.

The optimal tax and quantitative restriction on capital outflows can lead to an equilibrium in which domestic saving and investment are equal and the marginal productivity of domestic capital is less than the foreign interest rate. The reason is simply that the optimal level of public goods spending and distortionary effect of a labor income tax with no capital outflow imply a higher rate of taxation on domestic capital than allowed by the restriction that $f'(k)$ equal r^*, when k equals equilibrium domestic saving per unit of labor. Capital controls are a second-best fiscal policy instrument to enforceable taxes on capital income from all sources for residents in such cases. When the optimum allows the equality

(7) $$f'(k) = f^{*\prime}(k^*)$$

to be satisfied, then full tax compliance and perfect capital controls are substitutes.[3]

IV. PREFERENCES OF INTERMEDIARIES FOR INVESTING AT HOME OR ABROAD

In addition to the problem of efficient revenue collection to finance public spending programs, other welfare costs can be associated with capital flight induced by domestic taxes. One such cost may be due to intermediaries' preferences to invest in projects in their home country. For example, it is reasonable to think that intermediaries face lower costs of acquiring information about a borrower's actions and appealing to the power of the state to ensure contractual compliance when they lend within their home country. When information is imperfect, so that monitoring is costly, intermediaries may not invest abroad, even if the otherwise risk-adjusted expected rate of return is higher.

In the presence of such intermediation bias, claims on nonresidents will tend to increase foreign capital stocks and reduce domestic capital stocks, ceteris paribus. A simple model illustrates the point. Suppose that foreign intermediaries require a premium for investment returns in the small country over the interest they are able to earn at home. In an equilibrium with positive external inflows of financial capital,

(10) $$r^* + p = r,$$

where p is this premium.

Consider a special case in which domestic saving and investment are equal and the rates of interest at home and abroad are equal in the absence of any capital income taxes in the home country. Suppose that the domestic government now imposes a residence-based capital income tax such that

(11) $$r^* > (1 - t_r)(r^* + p),$$

and (10) holds. This implies that capital flight occurs according to the definition used in this paper. Imposition of the tax reduces the domestic capital stock per worker, raising $f'(k)$ from r^* to $r^* + p$. If a tax rate low enough to reverse the inequality in (11) is imposed, then we have

(12) $$r^* = (1 - t_r)\, r,$$

3. Razin and Sadka derive the optimal restriction on capital outflows for their model in which domestic capital cannot be purchased by foreign residents. When residents' foreign capital income cannot be taxed at the same rate as their income from domestic capital, optimal capital controls are set so that the equilibrium capital stock exceeds that which is optimal if all capital income of residents can be taxed. This is due to a distortion caused by the tax on domestic capital income and the production distortion (marginal reduction in national income) caused by capital controls.

This result does not follow in our model since the domestic capital stock is determined by the marginal conditions for foreign investors. For a given source-based capital income tax, binding controls on capital outflows lead to a one-for-one substitution of nonresident for resident ownership of capital. The optimal source-based tax does not depend on whether or not foreign capital earnings of domestic residents can be taxed at the same rate as their domestic capital income.

in equilibrium, and there are no capital inflows, although there is a net capital outflow as residents acquire claims on nonresidents.

The presence of financial market imperfections of this type implies that capital flight—defined as a consequence of domestic policies and access to opportunities to avoid their impact on private net asset income—has welfare implications. It leads to an inefficient allocation of capital across countries and welfare losses for the home country. These welfare losses arise because domestic savers are induced to place their assets abroad to avoid taxation by the home country. The preferences of intermediaries abroad over claims in the two countries differ from those of domestic intermediaries. This means that the supply of capital abroad rises with capital flight while the stock of capital at home declines. This contrasts with the case of perfect international capital mobility in which foreign lenders simply took over the task of intermediating between domestic savers and domestic investors.

One policy remedy when capital income taxation is desirable is to impose capital controls as before. Again, in contrast with the analysis of the previous section, imposition of a residence-based capital income tax does not leave the domestic rate of interest equal to the foreign rate of interest. Foreign intermediaries will not purchase domestic claims until the domestic pre-tax rate of interest has risen sufficiently to overcome the additional costs of monitoring investments in another country.

An interesting extension of this result is the case in which domestic intermediaries do a very poor job of credit selection, perhaps because of government controls on lending decisions. In this case, moving funds offshore might increase the effective level of domestic investment assuming foreign intermediaries can overcome information costs and make better investment decisions.

V. SUBSIDIZATION OF FOREIGN LENDERS

Capital flight often is linked to the socialization of private external debt or the subsidization of payments on these debts. This issue was raised by Diaz Alejandro (1984), who argued that the foreign exchange earnings accruing to private assets placed abroad were unavailable to the government that is obliged to make interest payments to nonresidents. Private external debt appears to have financed the accumulation of claims on nonresidents that are placed outside the reach of domestic governments. When these debts are subsidized, the government bears a burden while foreign investors and the private domestic claimant receive the benefits.

Subsidies to foreign capital inflows often take the form of contingent subsidies, providing insurance to nonresidents that is unavailable to residents. Private intermediaries frequently have been able to borrow from abroad under explicit or implicit government guarantees of the debts to the foreign creditors. These guarantees can have adverse incentive effects for investment choices by the intermediaries, thus leading to the standard arguments for public monitoring of investment actions by publicly insured intermediaries. Domestic intermediaries have an incentive to invest in risky projects since they receive returns only in the upper tail of the distribution for returns. In the absence of adequate monitoring of the actions of domestic investors, domestic savers may anticipate that domestic external borrowing will lead to higher tax rates in the future because, as domestic intermediaries maximize their expected returns by selecting risky projects, the value of the contingent liability of the government rises. Anticipated future capital income taxes will induce capital flight if it is possible to place assets beyond the reach of domestic authorities. Eaton (1987) presents a model based on these notions in which there are multiple equilibria, one of which involves no capital flight and private debt repayment and another which involves capital flight and private default.

The role of subsidies to foreign investors for capital flight can be discussed in the model used to analyze the effects of taxes on capital income accruing to residents. Subsidies available to nonresident asset holders but not to resident investors under perfect international financial capital mobility will lead to an increase in the domestic capital stock and cause all domestic savings to be placed abroad, since equilibrium requires that

$$r^* = (1 + s)f'(k), \tag{13}$$

where s is the subsidy rate. By itself, this is not sufficient to cause capital flight as defined here. Domestic residents have an incentive only to purchase claims on nonresidents, but not to place these outside the control of the domestic government.

Subsidies differ from capital income taxes in that the limits on the magnitude of the gross flows are different. The gross capital outflow under perfect international capital mobility when a capital income tax is levied only on residents is given by the total of domestic savings. The opportunity return on domestic assets held by residents is less than the return to flight capital, but the opportunity interest cost of borrowing externally is the same as the interest received by relending. If foreign borrowing is subsidized, then the limit on resources that might be available for investing abroad at a net gain is the extent to which the subsidy will be offered, that is, the extent to which the government will subsidize borrowing from abroad to purchase claims on nonresidents that it cannot tax. This might be called the "extent of the government's stupidity."

Policies that subsidize nonresident holders of domestic assets lead to capital flight if the subsidies allow external debt to finance residents' purchases of claims on nonresidents that generate income untaxable by the government. Such subsidies may occur through contingent liabilities for the government. In this case, the social cost of the subsidies is the utility reduction due to a loss of national income equal to the total subsidy paid to foreign lenders. There also can be domestic distributional effects that may be of concern to policymakers in a world with heterogeneous households (Alesina and Tabellini 1989). It should be noted that this process also could concern foreign investors. As the tax base for raising the revenue needed for repayment erodes and the likelihood that the government will realize large contingent liabilities rises, foreign holders of domestic claims enjoying public guarantees may anticipate renegotiation by the government. That is, foreign investors may realize the ability and willingness of the government to honor these explicit or implicit contingent commitments. Anticipating the possibility of such capital levies, nonresidents should behave in a time-consistent fashion.

The possibility that subsidies and guarantees generated lending to developing countries that led up to the 1982 debt crisis suggests that recent large private capital inflows to developing countries also might be a cause for concern. It seems likely to us that once again private capital inflows are being sustained not only by the more favorable investment climate, but also by opportunities generated by the governments of developing countries. The form of the incentive is a little different from the external debt-capital flight pattern that led up to the 1982 debt crisis.

But in one important respect the recent private capital inflows are similar in that they are sustained by a contingent claim on the government. The distinguishing feature this time is that recent private capital inflows to developing countries have taken the form of domestic-currency-denominated instruments including equities, corporate bonds, bank deposits, and government securities (Gooptu 1993). This is certainly different from the dollar-denominated, government-guaranteed, syndicated credits that comprised the debt buildup before 1982.

In the current pattern of capital flows it is less obvious that the government of the borrowing country has provided a guarantee. However an *implicit guarantee* is provided by the increasingly popular use of the exchange rate as an anchor for inflationary expectations. In basing its credibility on the maintenance of a fixed or managed exchange rate, the government, in effect, provides an exchange rate guarantee for the investor in domestic-currency-denominated instruments.

This, of course, seems to leave the investor with a credit risk. But in most emerging markets the government is very likely to provide a credit guarantee as well as the exchange rate guarantee. In cases where international investors buy government securities, the guarantee is explicit. Commercial bank deposits also are guaranteed, especially where the deposit is denominated in domestic currency.

Finally, even the liabilities of domestic nonfinancial corporations carry a strong government backup. This is because such firms are heavily indebted to the domestic banking system. If nonresident creditors want out, these firms can be expected to ask for and receive credit from the domestic banks. To refuse would depress the market value of the banks' existing claims on the domestic firms and call into question the solvency of the domestic banking system.

What limits this process? As long as the developing country's central bank maintains domestic nominal interest rates at levels above those available on similar foreign assets then, in principle, there is no limit to the private capital inflows generated. Of course, in reality the government's resources are limited. At some point the market will begin to doubt the government's ability to maintain the exchange rate peg and the negative carry resulting from the low return earned on reserves relative to that paid on the domestic liabilities issued in sterilized exchange market intervention. But the scale of private capital inflows necessary to exhaust the central bank's expected net worth can be very large indeed.

VI. CONCLUSION

We define flight capital as the accumulation of claims on nonresidents by residents that escape control of the domestic government. Capital flight by this definition is estimated by a calculation of gross external claims that generate income that is not reported in the balance of payments data.

Our approach emphasizes the importance of public policies and anticipated policies for the domestic government in the presence of international capital mobility and possible evasion of taxation or appropriation by the home government by domestic savers. Capital flight represents an arbitrage of the different treatment of resident and nonresident investors by domestic authorities.

The policies that give rise to capital flight are distortionary in the model presented here, but they are not necessarily simply undesirable. In the case of optimal public goods supply without lump-sum taxes, a residence-based capital income tax is part of the efficient policy, if tax compliance is perfect. The problem of social welfare losses arises because tax avoidance (or evasion) is possible. The second-best solution with capital controls includes residence-based taxes. Without feasible capital controls, the residence-based capital income tax is entirely ineffective for raising revenue under perfect international capital mobility. In this case, the social cost of capital flight is the welfare cost of losing a useful instrument of fiscal policy. Capital flight also can result from the adoption of distortionary policies that are not welfare-improving. In these instances, it can exacerbate the welfare losses.

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