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EXCHANGE RATES AND TAXES

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ABSTRACT

This paper demonstrates that different rates of taxation on interest income and exchange gains may bias results of hypothesis testing regarding critical aspects of exchange rate behavior. Two problems are discussed specifically. First, it is shown that omission of tax considerations may bias tests of the uncovered interest parity condition toward acceptance of a "risk premium" hypothesis, conditional on exchange market efficiency. Second it is shown that a rational solution for the exchange rate conditions the relationship between an exchange rate and its determinants on two regimes: (1) tax rates on interest income and foreign exchange gains and losses at home and abroad and (2) the degree of foreign exchange market intervention and sterilization of its effects on the monetary base practiced by central banks.

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I. Introduction

Empirical studies of exchange rate behavior during the first decade of 'floating' have suggested that exchange rates behave much like 'prices' in other asset markets: they are hard to 'explain' inside sample periods and virtually impossible to predict outside sample periods. These problems have been examined by, among others, Makin (1982) and by Meese and Rogoff (1983). The former examines theoretical bases for exchange rate forecasting difficulties and shows how policy-regime changes may be partly responsible while the latter shows that the out-of-sample performance of a broad class of empirical exchange rate models fails to yield any improvement over the random walk model. Among the culprits suggested by Meese and Rogoff to explain such dismal performance are money demand specifications, volatile time-varying risk premiums, volatile long run real exchange rates and poor measurement of inflationary expectations.

This paper examines the possibility that another culprit may be lurking in the structure that underlies exchange rate equations: tax asymmetries. Specifically, the possibility exists, first examined by Levi (1977), that different rates of taxation on interest income and exchange gains may bias results of hypothesis testing regarding critical aspects of exchange rate behavior.

Two examples are considered in this paper. First, it is shown that tests of the uncovered interest parity condition--nominal interest differential equals the expected change in the exchange rate--may be biased by omission of tax considerations. Such tests in turn carry important implications for a number of theoretical and policy issues. Significant deviations from uncovered interest parity are consistent with either foreign exchange market inefficiency, time varying risk premiums or both.

In turn the existence of varying risk premiums is consistent with imperfect substitutability between assets denominated in different currencies and, thereby--given risk aversion--with a significant effect on exchange rates of sterilized intervention.[1]

The second implication of tax treatment of interest income and exchange gains for empirical investigation of exchange rate behavior concerns estimation of exchange rate equations per se. Inclusion of an after-tax uncovered interest parity equation among the structural equations employed to derive a reduced-form expression for the equilibrium exchange rate embeds marginal tax rates--which may vary over time--in the coefficients that measure the impact upon the exchange rate of actual and expected changes in the variables that in turn determine the exchange rate. Therefore, empirical specifications of exchange rate equations which assume constant coefficients over some sample period may prove inadequate if effective marginal tax rates on interest income and exchange gains vary either absolutely or relative to each other over the sample period. Such possible variation in tax rates is also suggestive of a reason for poor post-sample performance of many exchange rate equations. In short a fiscal version of the 'Lucas critique' may apply to exchange rate equations. However, changes in effective marginal tax rates may be strictly exogenous and thereby suggestive of a means to improve the fit of exchange rate equations while testing an hypothesized impact from observable changes in tax rates on estimated coefficients in an exchange rate equation.

Viewed broadly, there are really two non-contradictory approaches to improving the fit of exchange rate equations emerging from the extensive and often innovative empirical investigations of exchange rate behavior over the past decade.[2] One is an 'omitted variables' approach related to examination of residuals of uncovered interest parity, purchasing power parity and, possibly, money demand equations while the other--related to possible changes in tax rates as well as to possible changes in intervention and/or sterilization policy (see Makin (1981, 1982, 1983))--amounts to an hypothesis that reduced-form coefficients in exchange rate equations may vary over time. Empirical tests under both approaches may be biased by failing to specify uncovered interest parity in after-tax terms. This paper identifies such possible biases and suggests some possible ways to eliminate them.

At the outset it should be made clear that the aim here is not to suggest that 'taxes are everything' or that all prior work that ignores tax considerations is invalid. That is not the case and, as we shall see, the evidence that after-tax covered interest parity always differs from before-tax covered interest parity is mixed at best. Rather the aim of this paper is more modest: to add to the list of possible reasons for poor empirical performance of exchange rate equations the need to consider changes over time in effective marginal tax rates on interest income and exchange gains.

II. Investigations of Uncovered Interest Parity

Investigations like Loopesko (1983) of possible realized profits from uncovered positions in assets denominated in different currencies jointly test two hypotheses: efficiency of foreign exchange markets and absence of a systematic risk premium or, equivalently, perfect substitutability among assets denominated in different currencies. It is shown here that tests of the efficiency-perfect substitutes (hereafter eps) joint hypothesis are conditional on the ratio of marginal tax rates applied to foreign exchange gains versus ordinary income. If those rates differ, examination of before tax realized profits from uncovered positions will be biased toward rejection of the eps joint hypothesis.

First we derive an after-tax covered interest parity equation from which can be derived an expression for realized profits on uncovered positions that enables empirical testing of the eps joint hypothesis. After-tax covered interest parity for country 1 investors is written as:[3]

$$(1) \qquad (1 + i_{1_t}) = (1 + i_{2_t})(1-\tau)(F_t/S_t)(1-\tau_k)$$

where: i_{1_t} = nominal interest rate in country 1 at time t.

i_{2_t} = nominal interest rate in country 2 at time t.

F_t = forward exchange rate: currency 1 price of currency 2 at time t for delivery at t+1 (one year ahead.)

S_t = spot exchange rate at time t.

τ = marginal tax rate on interest income in country 1.

τ_k = marginal tax rate on exchange gains in country 1.

Taking logs of both sides of (1) and rearranging terms gives:

$$(2) \qquad i_{1_t} - i_{2_t} = \beta(f_t - s_t)$$

where $\ln(1+i) \approx i$ for small i.

f_t = log of the forward rate at time t.

s_t = log of the spot rate at time t.

$$\beta = \frac{(1-\tau_k)}{(1-\tau)} \gtrless 0 \text{ as } \tau_k \lessgtr \tau.$$

Equation (2) says simply that if the tax on exchange gains τ_k is less than the tax on interest income then the interest differential between countries 1 and 2 will exceed the exchange gain or loss. Obviously if $\tau_k = \tau$, the considerations wash out and before and after-tax covered interest parity conditions are identical.

In most cases, the tax on exchange gains is below the income tax rate. See Peat, Marwick, Mitchell and Co. (1979) for a full discussion. For U.S. corporations $\tau_k = 0.30$ for positions held more than 12 months while $\tau = 0.48$ so that $\beta = 1.35$. In practice actual marginal income tax rates for corporations as well as households may be lower and may vary considerably over time. (See Tanzi (1982) and Estrella and Fuhrer (1983)).

Traditionally, deviations from covered interest parity expressed by equation (2) have been attributed to political risk and/or portfolio balance considerations.[4] Some current studies such as Ito (1983) have found results for Japan-U.S. which are generally consistent with $\beta = 1.0$ during the 1975-80 period and consistent with $\beta < 1.0$ thereafter. $\beta < 1.0$ is consistent with $\tau > \tau_k$, contrary to expectations based on the U.S. tax code. In contrast, Katz (1983) reports results for the United States and seven industrial countries which suggest $\beta > 1.0$ over the short run which is another odd result, since usually short run exchange gains are taxed at the same rate as interest income. Katz's results may be due partly to measurement error since he in effect uses expected inflation differentials to measure expected depreciation--thereby hypothesizing satisfaction of purchasing power parity--and then estimates what amounts to an uncovered interest parity equation. In sum, empirical evidence on β is inconclusive at this stage and probably deserves closer examinaiton with prior hypotheses modified to reflect the realities of the tax code.

Equation (2) can be employed to derive an expression for realized profits on uncovered 'foreign' asset positions. If assets denominated in currencies 1 and 2 are imperfect substitutes, a risk premium, RP_t^e, separates the log of the forward rate, f_t, from the log of the expected spot rate—at time t for time t+1, ${}_tS^e{}_{t+1}$.

$$(3) \qquad f_t = {}_tS^e{}_{t+1} + RP_t{}^e.$$

Likewise, a forecast error, ε_t, separates the actual spot rate at time t+1 from ${}_tS^e{}_{t+1}$.

$$(4) \qquad S_{t+1} = {}_tS^e{}_{t+1} - \varepsilon_t.$$

Substituting from (3) and (4) into (2) gives:

$$(5) \qquad i_{1_t} - i_{2_t} = \beta[S_{t+1}-S_t + RP^e{}_t + \varepsilon_t].$$

An expresion for pre-tax realized profits, x_t (the residual of uncovered interest parity) is given by subtracting the actual percent change in the exchange rate from both sides of (5):

$$(6) \qquad x_t = (i_{1_t}-i_{2_t}) - (S_{t+1}-S_t) = (\beta-1)(S_{t+1}-S_t) + \beta[\varepsilon_t+RP^e{}_t).$$

It is clear from equation (6) that pre and after-tax realized profits are identical only if $\beta=1$ with $\tau_k=\tau$. Otherwise x_t is an upwardly biased measure of realized profits or losses resulting in a bias toward rejection of the eps joint hypothesis.[5] Given $\beta > 1$ a rise in the spot rate creates an upwardly biased measure of true (after-tax) profits while a fall in the spot rate overstates true losses.

III. Impact of Taxes on Observable Exchange Rate Behavior

Here a rational expression for the equilibrium exchange rate is derived from a simple structure including money demand equations in two countries, purchasing power parity (which can be expanded to allow for 'real' exchange rate changes) and the after-tax, expanded uncovered interest parity equation (5). We also allow for official exchange market intervention and presence or absence of sterilization of effects of intervention on the monetary base.

The solution to the two country model after some algebra and iterative substitution is a parametized expression for the exchange rate in terms of: relative (exogenous portions of) money supplies, relative real output, a risk premium term that allows for consideration of assets that are imperfect substitutes and 'real' exchange rate changes. Parameters which determine the exchange rate in terms of current actual and expected future values of these variables include the income and interest elasticities of money demand in each country, degree of sterilization and intervention in each country and--of particular significance for the investigation proposed here--tax rates on interest income and foreign exchange gains and losses in each country.

The model can be estimated by specifying a time series process to determine future expected behavior of exogenous variables. Following Bilson (1979) and Makin (1981, 1983), for example, one can define growth of exogenous variables (log first differences) as an AR-1 process.

A basic solution employing the procedure just outlined, following Makin (1981, 1983) is obtained as follows. Based on log linear money demand equations in countries '1' and '2,' purchasing power parity and deviations therefrom ('real' exchange rate changes) an expression for the log of the spot exchange rate may be written as

$$(7) \qquad s_t(1-\phi) = \underline{de}_t - a\underline{y}_t + dz_t + b(i_{1_t}-i_{2_t}) + \underline{u}_t$$

where:

s_t = log of spot exchange rate (currency 1 price of currency 2).

$\underline{de}_t$ = log of exogenous portion of monetary base in country 1 less log of exogenous portion of monetary base in country 2.

$\underline{y}_t$ = log of real income in country 1 less log of real income in country 2.

z = vector of disturbances which systematically cause deviations from purchasing power parity.

$i_h (h=1,2)$ = the nominal interest rate in country h.

$\underline{u}$ = disturbance term in money demand equation for country 1 less same term for country 2.

a = income elasticity of money demand in country 1 (set equal to that in country 2).

b = interest elasticity of money demand in countries 1 and 2. (Note: 'a' and 'b' can be allowed to differ across countries.)

$\phi < 0$ = a term capturing sterilization and intervention behavior in countries 1 and 2. ($\phi = 0$ with free floating and no intervention in foreign exchange markets. See Makin (1981) for full derivation.)

Substituting from (4) and (5) into (7) for $i_1 - i_2$ and rearranging terms gives:

$$(8) \qquad s_t = \left(\frac{b\beta}{1+b\beta-\phi}\right) {}_t s^e_{t+1} + \left(\frac{1}{1+b\beta-\phi}\right) \left(\underline{de}_t - a\underline{y}_t + dz_t - b\beta RP^e_t + u_t\right)$$

Substituting iteratively to solve for ${}_t s^e_{t+1}$ equation (8) becomes:

$$(9) \qquad s_t = \left(\frac{1}{1+b\beta-\phi}\right) \left[\sum_{j=0}^{\infty} \left(\frac{b\beta}{1+b\beta-\phi}\right)^j {}_t\underline{de}^e_{t+j} - \right.$$

$$- \sum_{j=0}^{\infty} \left(\frac{ab\beta}{1+b\beta-\phi}\right)^j + {}_t y^e_{t+j} + \sum_{j=0}^{\infty} \left(\frac{db\beta}{1+b\beta-\phi}\right)^j {}_t z^e_{t+1}$$

$$+ \sum_{j=0}^{\infty} \left(\frac{b^2\beta^2}{1+b\beta-\phi}\right)^j {}_t RP^e_{t+1}]$$

where $\left(\frac{b\beta}{1+b\beta-\phi}\right)^j {}_t s^c_{t+j} \to 0$ as $j \to \infty$.

Equation (5) describes the spot exchange rate as being determined--in a manner set by parameters and tax rates--by current actual and expected future values of the set of exogenous variables, <u>de</u>, <u>y</u>, z and RP^e defined above.

A primary conclusion from the discussion of exchange rate determination summarized in equation (5) is the implied effect on the exchange rate of current and prospective policies regarding intervention, sterilization and tax rates applied to interest earnings and to foreign exchange gains and losses. Announcement of expected future changes in such policies will change the current equilibrium spot rate in the forward-looking foreign exchange market <u>even if current and prospective values of exogenous variables remain unchanged</u>.

Of particular interest in view of the forward-looking nature of the asset markets in which exchange rates are determined is the exact nature of the impact upon exchange rates of changes in $\beta = [(1-\tau_k)/(1-\tau)]$. The essential point emerges from examination of equation (8). As β rises--given $\beta>1$--the term describing the impact on the exchange rate of current, actual changes in exogenous variables $[1/(1+b\beta-\phi)]$ unambiguously falls in value while the current impact on the exchange rate of expected future shocks rises.[6] In other words, tax policy which taxes interest income at higher rates than it does exchange gains may result in more volatile exchange rates, particularly if changes in expectations about future values of exchange rate determinants are larger than changes in current actual values of the same determinants. Amplification or dampening by tax policy of exchange rate effects of changes in the more volatile—expected future—portion of exchange rate determinants may occur over time as effective marginal tax rates vary over time or across countries as tax treatment of interest income versus exchange gains varies, from country to country.[7]

A corollary to these propositions about the effects of tax rate changes on exchange rate volatility concerns a serious implied problem for estimation of exchange rate equations. In particular, sample periods that span changes in tax rates and/or changes in intervention or sterilization policies will produce poor fits since the true values of coefficients attached to exogenous variables will vary with such changes. Estimation procedures may be called for that allow coefficients in the exchange rate equation to vary over time. A time series on effective marginal tax rates amounts, in this context, to a time series on 'regime changes' required to identify an equation incorporating rational expectations. It would also be necessary to control for changes in intervention and/or sterilization policy under this procedure.

IV. Preliminary Tests: Variable Coefficients in Estimated Exchange Rate Equations

The model derived in Section III suggests that coefficients describing the impact on the exchange rate of the explanatory variables in equation (9) will vary over time as tax rates and sterilization/intervention policy changes over time. It will therefore be necessary to obtain detailing information on effective marginal tax rates over time as well as on any major changes in sterilization/intervention policy at major central banks since the advent of 'floating' in March of 1973. In particular, it would be necessary first to identify sample periods during which, say, American and 'foreign' sterilization/intervention policy remained reasonably stable as a background against which to test prior hypotheses about the effects of tax rate changes.

The task of identifying episodes of stable sterilization and intervention policy may be eased somewhat by the efforts of the Working Group on Exchange Market Intervention established at Versailles in June, 1982. Since early 1981 American policy has been particularly stable with virtually no intervention undertaken except, apparently, after the President was shot and on a very limited basis after mid-1983. Under such circumstances it is only necessary to identify sharp changes in sterilization/intervention policy by other major central banks in order to control for 'non-tax' sources of regime changes. If, for example, it were possible to document a period of stable sterilization/intervention policy by Japan or Germany that coincided with a period of little American official intervention in exchange markets, the conditions necessary to test hypotheses about the exchange-rate-equation-coefficient effects of tax rate changes would be largely met.

With sample period selection to control for sterilization/intervention policy changes completed, examination of the effect of tax rate changes requires time series on effective marginal tax rates on interest income and exchange gains in countries on both sides of a bilateral exchange market: in particular, American and 'other' country tax rates in order to examine tax effects on the dollar price of major currencies. Most desirable would be a country where both interest income and exchange gains are taxed at the same rate and where a relatively straightforward tax code results--barring exogenously legislated changes which could be identified and allowed for-- in fairly constant effective marginal tax rates over time. Japan is such a country, and it possesses the added attraction of focussing attention on the key yen-dollar rate which some feel has behaved strangely at times. Germany may also fulfill these objectives and conditions.

Controlling for official intervention and non-United States tax policy, it then becomes possible to examine the impact on exchange rate behavior--by way of effects on the coefficients specified in equation (9)-- of changes over time in effective, American, marginal, tax rates on interest income. This is made possible by two factors. Tax rates on realized exchange gains for positions held over a year have been constant at 30 percent.[8] Specific time series on effective marginal tax rates on interest income have been calculated by Tanzi (1982). Taken together these are sufficient to identify prior hypotheses on the movement over time of coefficients in equation (9).

Preliminary results of estimating equation (9) for the yen-dollar exchange rate fail to contradict the hypothesis that the true value of its coefficients ought to vary over time. It is too soon, however, to say anything definite about the exact manner in which the coefficients vary over time or whether such variation is consistent with that suggested by the actual behavior over time of effective U.S. marginal tax rates. Further examination of the yen-dollar rate and the DM-dollar rate is underway.

V. Concluding Remarks

Beyond the intrinsically difficult nature of problems associated with estimating equations determining asset prices in forward-looking markets, many barriers to successful identification of reasonable stable exchange rate equations remain. All of the unresolved questions surrounding a formidable list of problems--specification of money demand equations, real exchange rate movements, time-varying risk premia, market efficiency--remain to plague exchange rate equations even before addressing problems tied to regime changes linked to changes in intervention policy or effective marginal tax rates. Enumeration of these difficulties amounts to no more than another way of saying that the dismal performance of exchange rate equations whch leave some or all of such problems unaddressed--ably documented by Meese and Rogoff (1983)--should come as no surprise.

Overall, the discussion presented here suggests that a good deal of work remains to be done on estimating exchange rate equations that allow for in-sample structural shifts. Changes over time in effective tax rates--evident from time series data for such rates in the U.S.--suggest that allowing for such changes may improve the fit of exchange rate equations. Encouraging results of such tests for interest rate behavior have already appeared in Peek and Wilcox (1983).

FOOTNOTES

1. See Henderson et al. (1984) for a discussion of evidence on imperfect substitutability. On efficiency and related hypotheses see Hansen and Hodrick (1980).

2. For an excellent 'review of the troops' see the volumes edited by Frenkel (1983) and Hawkins, Levich and Wihlborg (1982).

3. If country 2 has an asymmetric tax treatment of exchange gains and interest income then equation (1) may hold without satisfying covered interest parity for country 2. This case is examined for Canada and the United States by Levi (1977). Such asymmetry raises the possibility of simultaneous two way capital flows and also raises an interesting question of how long run equilibrium is achieved. For now we assume that countries 1 and 2 have symmetric tax systems so that equation (1) describes covered interest parity for both or, alternatively that country 1 is so large relative to country 2 that it dominates markets sufficiently to preclude significant deviations from equation (1).

4. See Aliber (1973, 1975) and Frenkel and Levich (1975).

5. Loopesko (1983) reports strong rejection of the eps joint hypothesis based on tests using pre-tax daily data for six currencies against the U.S. dollar drawn from the 1975-81 sample period. Loopesko regresses pre-tax realized profits on lagged realized profits, cumulated intervention--no distinction appears to have been made between sterilized and unsterilized intervention--and lagged spot rates. If intervention were non-sterilized an impact on exchange rates would result even given perfect substitutability among assets denominated in different currencies.

6. The impact of a rise in β on sensitivity of exchange rates to expected future shocks is most easily seen by simply noting that if β>1 the effect of tax considerations, in effect, to raise b in [b/(1+b-)]. Ignoring the term $d/db[b/(1+b)] = [1/(1+b)^2]$ which is unambiguously positive. Effects of tax asymmetries on exchange rate behavior are more fully discussed in Kon (1984).

7. Large economies which tax long run realized exchange gains at capital gains rates below income tax rates include the United States, Canada and Great Britain. Most other countries tax exchange gains, like interest earnings, as ordinary income. For more detail see International Monetary Fund Working Paper FAD/83/3 and SM/83/113.

8. Since during the postwar period, effective marginal tax rates on ordinary income--applicable to realized short term exchange gains--have exceeded 30 percent in the United States, it seems likely that most firms would avoid realizing short term gains. The result would be to make the constant 30 percent rate that most typically applied to exchange gains.

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