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A FISCAL FRAMEWORK FOR ANALYSIS OF INTEREST RATE BEHAVIOR IN OPEN ECONOMIES

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ABSTRACT

This paper derives a reduced-form expression for an interest rate in an open economy by incorporating after tax covered interest parity conditions into a simple neo-classical macro model. The result clearly demonstrates that the relationship between an interest rate and variables used to explain it is conditional on income tax rates at home and abroad and presence or absence of capital gains tax treatment of foreign exchange gains or losses. Effects of non-indexation of tax treatment of depreciation and inventories may also play a role. Any change in effective tax rates over a sample period employed to estimate interest rate (or exchange rate) equations may cause deterioration in the fit of a fixed coefficient model. Efforts are underway to employ a random coefficients approach to address this problem.

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I. Introduction

This paper develops a model for analysis of interest rate behavior in open economies. Feldstein's (1983) warning that "the failure to deal explicitly with the fiscal framework of monetary policy is a serious shortcoming of modern monetary theory" is taken seriously. The model developed incorporates domestic and foreign tax treatment of: interest income and expense, depreciation, and inventory valuation, and foreign exchange gains and losses. Applicable tax rates appear explicitly in a derived, reduced-form equation expressing an interest rate in terms of expected inflation at home and abroad, unanticipated changes in the money supply, unanticipated changes in the fiscal deficit, the stage of the business cycle, and uncertainty about the level of inflation. Changes in tax rates are shown to alter the relationship between interest rates and variables, like those listed above, employed to explain their behavior.

Most of the elements of the model presented here have appeared separately elsewhere. Darby (1975), Feldstein (1976) and Tanzi (1976) showed the necessity to incorporate tax treatment of interest income and expense into analysis of the responsiveness of interest rates to changes in anticipated inflation. Levi and Makin (1978) (1979) showed that the Fisher equation alone was not an adequate formulation to represent interest rate behavior and that interest rate equations are better represented as reduced forms deriveable from the macromodel whose structure determines the relationship between interest rates and exogenous shocks to the macromodel. Makin (1978) followed the same procedure to show that the impact on interest rates of changes in expected inflation would be reduced in an open economy. Peek (1982) and Peek and Wilcox (1983) incorporate changes over time in tax rates into their analysis of interest rate behavior. Blejer (1983) introduces taxes into the interest parity condition and the Fisher equation and examines implications for international capital flows thereby extending work by Tanzi and Blejer (1982) on capital movements between developed and developing countries. Hartman (1979) examines how the presence of taxation leads to reallocation of the real capital stock across countries.

Despite these many developments, there remains a need for a comprehensive model which both incorporates a full range of tax rates and recognizes integration of capital markets and the resultant after-tax interest parity condition. Such a tax-oriented, open economy model of interest rate behavior should prove particularly useful in highlighting implications for behavior of interest rates in more open economies arising from differences in domestic versus foreign tax policies. The effect arising from sharp changes abroad in expected inflation which result from enhancement or relaxation of policies of inflation control, can also be carefully considered.

As such, the model developed here is highly suggestive of non-neutralities resulting from both unanticipated and anticipated monetary disburbances where tax rates are applied to unindexed nominal, rather than real, magnitudes. The distortions which result from taxation of nominal interest rates and profits become particularly pronounced in a highly inflationary environment. Where such distortions are present in a large economy which plays a central role in international capital markets, they tend to be transmitted to other economies in a manner that is determined by the relationship between tax policies of other economies and those of the large economy. It is this behavior which the model developed here is particularly designed to analyze.

Section II briefly outlines a structural framework from which a reduced form expression for a representative rate of interest is derived. Section III discusses the effect of tax policy on the relationship between both nominal and expected after-tax real rates and a set of explanatory variables derived from the structural equations of the model. Section IV presents some concluding remarks.

II. Modeling Behavior of the Expected After-Tax Real Interest Rate in an Open Economy

The basic aim of this section is to demonstrate how expected and unexpected monetary policy actions will, along with other variables affect the expected after-tax real interest rate hereafter referred to as the after-tax real rate. The impact of monetary policy both domestically and abroad reflects two fundamental considerations. First, the behavior of savers, investors, exporters, importers, money holders, and foreign exchange market participants is determined along with other variables by expected after-tax returns. Second, tax policies differ across countries as well as with regard to interest income and expense versus foreign exchange gains and losses. Within the framework to be employed here it is useful to view expected monetary policy actions as being largely reflected by expected inflation. Unexpected monetary policy actions are measured as residuals from an ARMA (0,8) model of money (M1) growth. 1/

A shortcoming of many models of interest rate determination which do consider tax policy regarding interest income and expense is a failure to impose an after-tax interest parity condition. 2/ That condition may be written as: 3/

$$i_t (1-\tau) = i_t^F(1-\tau) + (1-\tau_k)(\pi_t-\pi_t^F) + (1-\tau_k)\ i_t^F\ (1-\tau)(\pi_t-\pi_t^F) \qquad (1)$$

where (an "F" superscript denotes "foreign")

i_t = nominal interest rate.

π_t = anticipated inflation over life of instrument on which i_t is to be paid.

τ = marginal tax rate applied to interest income and expense.

τ_k = marginal tax rate on foreign exchange gains.

1/ For a full discussion of this measure of money surprises and of alternative measures, see Makin (1983).

2/ After-tax interest parity is absent from Makin and Tanzi (1982.b), Makin (1983), Peek (1982), and Peek and Wilcox (1982). This omission is not particularly serious in these papers which investigate interest rate behavior in the United States. But for smaller more open economies this omission could be significant.

3/ This parity condition represents equilibrium for domestic investors but not necessarily for foreign investors. Simultaneous equilibrium for both requires that tax rates be equal in both countries. Otherwise, as is typically the case, two-way capital flows can result [See Levi (1977) and Blejer (1983).]

Equation (1) also satisfies purchasing power parity (PPP) since expected depreciation of domestic against foreign currency is measured by the difference between the expected rates of inflation at home and abroad. 1/

The last term in equation (1), the "interaction term," will be very small and is ignored. 2/ Dividing both sides of (1) by $(1-\tau)$ and omitting the small interaction term gives:

$$i_t = i_t^f + \frac{(1-\tau_k)}{(1-\tau)} (\pi_t - \pi_t^F) \qquad (2)$$

Equation (2) highlights the fact that after-tax interest parity will differ from pre-tax interest parity only in countries where interest income is taxed at a rate which differs from the rate applied to foreign exchange gains and losses. This condition is satisfied in the United States, Canada, and the United Kingdom where realized foreign exchange gains and losses are treated as capital gains and losses and the returns on assets held longer than a statutory minimum period are taxed at lower rates than interest earnings which are taxed as ordinary income. Most other industrial countries tax both interest income and exchange gains and losses as ordinary income.

1/ "Real" exchange rate changes, those in excess of changes implied by PPP could also be included here and their impact on after-tax real rates would be conditional on tax rates in equation (1). It has, however, proved very difficult to identify variables with a systematic impact on real echange rates and so no attempt to model real exchange rates explicitly is included here with the result that movements in real exchange rates are pushed into the residual of the interest rate equation (9) below.

2/ Given $i_t^F = 0.10$, $\tau_k = 0.25$, $\tau = 0.35$, and $(\pi_t - \pi_t^F) = 0.05$, the interaction term in (1) is 0.0024.

Substituting into equation (2) an expression for i_t^F written as an after-tax Fisher equation gives: 1/

$$i_t = [\frac{1}{1-\tau^F}]\ \overset{*}{r}{}_t^F + [\frac{(1-\tau_k)}{(1-\tau)}]\pi_t + [\frac{(1-\tau) - (1-\tau_k)(1-\tau_F)}{(1-\tau_F)(1-\tau)}]\pi_t^F \qquad (3)$$

Equation (3) captures, purchasing power parity, after tax interest parity, and the foreign after-tax Fisher equation. What remains is to derive an expression for the domestic after-tax real interest rate from a macroeconomic model, equate it to a foreign after-tax real rate and substitute the result into a domestic, after-tax Fisher equation. The result is an expression for the domestic nominal interest rate which simultaneously satisfies all of the equilibrium conditions of a typical macromodel, purchasing power parity, after-tax interest parity, and after-tax Fisher equations at home and abroad. 2/

1/ The after-tax Fisher equation abroad is written as

$$i_t^F = (\frac{1}{1-\tau_F})\ [r_t^F + \pi_t^F] \qquad (3.a)$$

where r_t^F is the expected, after-tax real interest rate abroad and τ_F is the foreign marginal tax rate applied to interest income and expense. Strictly speaking, equation (3.a) ought to be written as a full expression for nominal interest like that to be derived below for a domestic economy. In effect, we take the foreign expected after tax real interest rate to be exogenously fixed and equate the domestic after-tax real interest rate to it.

2/ Commodity arbitrage equilibrium (PPP) is assumed to be unaffected by taxation. This is because commodity arbitrage involves no exchange gains or losses since the commodity arbitrageur is assumed to purchase only the amount of foreign exchange required to purchase commodities abroad while they are less expensive than those available at home.

The macroeconomic framework consists of four structural equations typical of models in the familiar IS-FM format with a supply side included. The model is an extension of a framework employed in Makin (1982)(1983) and Makin and Tanzi (1982b) to include after-tax interest parity and purchasing power parity conditions. The log of total real expenditure not related to domestic income E_t (investment, exports plus domestic government expenditure) is written as:

$$E_t = \alpha_0 - \alpha_1 r_t^* - \alpha_2 \sigma^2{}_t + \alpha_3 X_t - \alpha_4 \pi_t + \alpha_5 GAP_t + e_{1t} \qquad (4)$$

$$(\alpha_i, 1 ... 5 > 0)$$

Where E_t = log of real investment plus real exports plus real domestic government expenditure.

r_t^* = expected after-tax real interest rate

σ_t^2 = a measure of inflation uncertainty.

X_t = log of a shift in the total real expenditure schedule.

π_t = anticipated inflation.

GAP_t = a measure of intensity of capacity utilization.

e_{1t} = an error term normally distributed with zero mean. (All error terms, e_i (i=1... 4) take this form.)

Total expenditure not related to domestic income, E_t is depressed by a rise in the after-tax real rate, r_t^* and by a rise in inflation uncertainty. The former effect is well known. The latter effect arises due to the positive association between inflation uncertainty and relative price uncertainty documented by Cukierman and Wachtel (1982). Since most capital is not adaptable to many uses, more like clay than putty, investment really represents an increased commitment to a given set of relative prices and is therefore made more risky by increased uncertainty about relative prices. 1/

The remaining variables in the expenditure equation are a shift variable, X_t, anticipated inflation and a measure of capacity utilization to capture an accelerator effect on investment. Expected inflation carries a negative sign to reflect negative pressure on investment owing to the depressing effect of inflation on corporate profits that arises from historic cost depreciation rules as noted by Feldstein and Summers (1978). 2/

The log of the sum of real saving, taxes, and imports, Z_t, is written:

$$Z_t = \gamma_o + \gamma_1 y_t - \gamma_2(m_t - p_t) + \gamma_3 \overset{*}{r}_t - \gamma_4 \sigma_t^2 + e_{2t}$$

$$(\gamma_1, \gamma_2, \gamma_3 > 0) \qquad (5)$$

where

y_t = log of real income (output).

$(m_t - p_t)$ = log of real money balances.

Equilibrium in the money sector is written as:

$$(m_t - p_t) = \beta_o + \beta_1 y_t - \beta_2(1-\tau)i_t + e_{3t} \qquad (6)$$

1/ It will be seen below, once the model is solved for the nominal interest rate, that the inflation uncertainty term in equation (4) implies a negative relationship between inflation uncertainty and the nominal interest rate. Hartman and Makin (1982) employ a utility-maximizing framework which provides an alternative rationale for this negative relationship.

2/ The depressing impact of actual inflation on corporate profits may be offset by a reduction in the real value of corporate debt, but only insofar as the actual inflation is unanticipated. See Makin and Tanzi (1982b).

The supply side of the model represents real income (output) as:

$$y_t = \phi_o + \phi_1(m_t - {}_{t-1}m_t^e) + \phi_2 y_{t-1} + e_{4t} \qquad (7)$$

$(m_t - {}_{t-1}m_t^e)$ = surprise money growth measured as the difference between the log of the current money supply and the log of the anticipated (as of t-1 for t) money supply 1/

Finally, the Fisher equation for the domestic country is written as:

$$i_t = \left(\frac{1}{1-\tau}\right) [r_t^* + \pi_t] \qquad (8)$$

Equations (4) through (7) and equation (3) can now be used to solve for r_t^*. Substituting the result into (8) yields a reduced-form equation for the nominal interest rate in terms of a constant term, expected inflation, money surprises, inflation uncertainty, expenditure disturbances, pressure on capacity, time and an error term.

$$i_t = \left(\frac{1}{1-\tau}\right) [\lambda_o + (1-\lambda_1)\pi_t - \lambda_2\pi_t^F - \lambda_3(m_t - {}_{t-1}m_t^e)$$

$$-\lambda_4\sigma_t^2 + \lambda_5 X_t - \phi_2\lambda_3 y_{t-1} + V_t] \qquad (9)$$

where, given

$$\Phi = [\gamma_1 + \frac{(1-\tau)}{(1-\tau_F)} \gamma_2\beta_2 + \gamma_3]$$

$$\lambda_o = [\alpha_o - \gamma_o + \gamma_2 (\beta_0 + \beta_1 \phi_o)]/\Phi$$

$$\lambda_1 = [\alpha_4 + \gamma_2\beta_2 (1-\tau_k)]/\Phi \qquad (0 < \lambda_1 < 1)$$

$$\lambda_2 = [\gamma_2\beta_2 \left(\frac{(1-\tau) - (1-\tau_k)(1-\tau_F)}{(1-\tau_F)}\right)]/\Phi \qquad (\lambda_2 > 0)$$

$$\lambda_3 = \phi_1[\gamma_1 - \gamma_2\beta_1]/\Phi \qquad (\lambda_3 > 0)$$ 2/

1/ In principle, based on inventory-stock considerations described by Binder and Fischer (1981) lagged money surprises could be included in equation (7).

2/ λ_3 is positive since γ_1, the elasticity of real saving plus imports and taxes with respect to real income, is unity given a constant

$\lambda_4 = (\alpha_2 - \gamma_4)/\Phi$ $\quad (\lambda_4 >< 0)$

$\lambda_5 = \alpha_5/\Phi$ $\quad (\lambda_5 > 0)$

$V_t = [e_{1_t} + \gamma_1 e_{4_t} + \gamma_2(\beta_1 e_{4_t} + e_{3_t}) - e_{2_t}]/\Phi$

III. Effect of Fiscal Policy on the Behavior of Nominal and After-Tax Real Interest Rates

The most significant feature of equation (9) regarding a fiscal framework for analysis of interest rate behavior is the implied effect of ordinary income tax rates both at home and abroad, τ and τ_F, on the relationship between the nominal interest rate and all explanatory variables. The tax rate on foreign exchange gains appears in the terms describing the impact on the nominal interest rate of domestic and foreign-expected inflation. In view of equation (9), it is little wonder that estimated Fisher equations employing data for different time periods or for different countries have produced largely unstable estimates of the relationship between nominal interest rates and inflation. Results have been further disturbed by omission of one or more of the relevant explanatory variables which ought to appear along with expected inflation in a propertly specified interest rate equation.

Also significant in equation (9) is the implied value of the term describing the impact of expected inflation on the nominal interest rate. A one per cent rise in domestic-expected inflation raises the

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2/ (continued from p. 9) ratio of saving plus taxes and imports to income, while β_1, the elasticity of demand for real balances with respect to real income and γ_2, the (elasticity) real balance effect on saving plus imports, are both fractions.

interest rate by $[(1-\lambda_1)/(1-\tau)$ per cent with $(0 < \lambda_1 < 1)$. The full magnification effect of anticipated inflation on interest, $[1/(1-\tau)]$, suggested by Darby (1975), Feldstein (1976), and Tanzi (1976) is dampened by the Mundell effect, proportional to $\gamma_2\beta_2$ and the Feldstein-Summers effect proportional to α_4. Both produce negative pressure on the after-tax real rate when expected inflation rises. The Mundell effect results from the lower stock of real money demanded when expected inflation rises. A lower stock of real cash balances depresses consumption (elevates saving) and ceteris paribus a drop in the after-tax real rate is required to raise real expenditure up to the higher level of saving flows. The Feldstein-Summers effect lowers the after-tax real rate given a rise in expected inflation by shifting down the expenditure function in the face of a reduction of expected after-tax profits caused by historical cost depreciation methods in U.S. tax law. 1/ These considerations suggest that the failure of most empirical studies to find a full magnification effect of $[1/(1-\tau)]$ running from changes in expected inflation results from operation of Mundell and Feldstein-Summers effects along with the configuration of tax rates represented in λ_1. Given a tax rate applicable to interest income and expense of $\tau = 0.30$, the full magnification effect would suggest that a 1.43 per cent rise in the interest rate would result

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1/ Tax treatment in this area and with regard to inventories varies considerably across countries and needs to be incorporated on a case-by-case basis. These policies are surveyed in Modi (1983). For the United States it has been calculated by Feldstein and Summers (1979) that excess taxes resulting from the use of historical cost depreciation and first-in-first-out (FIFO) inventory valuation have accounted for as much as 45 per cent of the taxes paid by nonfinancial corporation.

from a 1.0 per cent rise in expected inflation. However, allowing for the dampening effect of the λ_1 term in equation (9), and given some reasonable values of relevant parameters, the full equilibrium impact of a one per cent rise in expected inflation would be a 0.75 per cent rise in interest, or slightly over half of the full magnification effect. 1/

The expression for the λ_1 term in equation (9) suggests some specific hypotheses about implications of tax rates for sensitivity of interest rates to changes in expected inflation. A reduction in either foreign tax rates on interest income and/or a reduction in domestic tax rates applied to capital gains or losses will each unambiguously raise λ_1, thereby further dampening the magnification effect of expected inflation on interest rates, and resulting in less sensitivity of nominal interest rates to changes in expected inflation. The dampening will be due to the effect of such tax rates in enhancing the negative impact of changes in expected inflation on after-tax real rates.

The negative impact on domestic interest of a rise in expected inflation outside of a country is ceteris paribus due to the fact that higher expected inflation abroad coincides with a reduction in expected depreciation (increase in expected depreciation) of domestic currency. This in turn lowers the equilibrium level of domestic

1/ This result assumes: $\tau = 0.30$, $\tau_F = 0.25$, $\tau_K = 0.20$, $\alpha_1 = 0.25$, $\alpha_4 = 0.2$, $\gamma_2 = 0.2$, $\gamma_3 = 0.25$, and $\beta_2 = 0.5$. Obviously the result is sensitive to parameter values. The basis points being made here are that it is crucially tied to tax rates and less than that indicated by the full magnification effect.

interest rates relative to foreign. This effect would be more pronounced in countries where tax rates applied to capital gains and losses are higher relative to domestic tax rates on interest income. The corollary proposition is that countries such as the United States, Canada, and the United Kingdom, which apply lower tax rates to foreign exchange gains and losses would, ceteris paribus, tend to observe less sensitivity of domestic interest rates to changes abroad in expected inflation. Given parameter values like those in the footnote above, a rise in tax rates on foreign interest income would also tend to raise the responsiveness of domestic interest rates to changes in inflationary expectations abroad. Therefore, countries linked by security and commodity arbitrage to "foreign" countries where inflation and attendant bracket creep raise tax rates on interest income may find their own interest rates becoming more sensitive to changes in expected inflation in these "foreign" countries.

Turning to other variables in the interest rate equation (9), it is first worth noting that since all of the reduced-form coefficients (the λ_i) contain Φ as a denominator, the value of each will ceteris paribus rise given a rise in the ratio of domestic to foreign income tax rates (τ/τ_F). Countries with relatively high tax rates on interest income will tend to experience enhanced sensitivity of both nominal and real interest rates to unanticipated movements in money growth, expenditure schedule disturbances, inflation uncertainty, changes in the degree of capacity utilization and lagged changes in output.

Some general theoretical conclusions about implications of tax policy for behavior of interest rates in open economies emerge from this discussion. First, a rise in the ratio of domestic to foreign income tax rates (τ/τ_F) enhances the sensitivity of after-tax real rates to all variables save changes in foreign expected inflation where the impact is ambiguous. Second, a rise in (τ/τ_F) reduces the responsiveness of nominal interest rates to changes in domestic expected inflation since the enhanced sensitivity of the after-tax real rate provides more dampening of the simple magnification effect. Third, the sensitivity of nominal and after tax real rates to all real disturbances (surprise money growth, inflation uncertainty, expenditure schedule shifts, and intensity of capacity utilization, and lagged real output) is increased by a rise in (τ/τ_F) and is unaffected by tax rates applicable to foreign exchange gains and losses. Fourth, a rise in tax rates applicable to foreign exchange gains and losses will *ceteris paribus* increase sensitivity of domestic nominal interest rates to changes in expected inflation at home and abroad while reducing sensitivity of domestic nominal interest rates to changes in expected inflation at home and increasing sensitivity of after-tax real rates to changes in expected inflation abroad.

With tax rates taken as given, the impact on interest rates of the real variables mentioned above is extensively discussed in Makin and Tanzi (1982b). That discussion is repeated here, largely unaltered, for the convenience of the reader.

The hypothesized negative impact of money surprises on the real rate arises from their positive impact on real income which, in turn, elevates real saving and requires a drop in the real rate to produce an equilibrating rise in real investment. This effect outweighs the simultaneous upward pressure on the real rate that results from excess demand for real balances associated with elevated real income. Lagged real income (output) depresses the real rate, given its positive impact on current real income, by the same causal chain described for money surprises.

It is important to distinguish between the real income impact of a money surprise described here and an expectations effect like that reported by Mishkin (1982). Mishkin reports a positive relationship between quarterly money surprises and end-of-period short-term interest rates. The result arises, in Mishkin's view, from a positive impact of a money surprise on expected inflation. In contrast, this study employs period-average short-term rates as a dependent variable in order to capture the real income impact under way during the quarter, before comparison of an actual with an anticipated money supply gives rise to an expectations effect. A fuller discussion of Mishkin's results and their relationship with results obtained here is contained in Makin (1982c). An alternative liquidity rationale for a negative relationship between money surprises and short-term rates is discussed in Makin (1982b) and Khan (1980).

The impact of uncertainty about inflation on the equilibrium, after-tax real rate is ambiguous as discussed earlier. The negative impact of uncertainty about inflation on real investment is measured by α_2 in equation (4). The negative impact on real saving of uncertainty about inflation is measured by γ_4 in equation (5). The ambiguous impact on the interest rate is given by λ_4 in equation (9).

The impact of exogenous upward shifts in the expenditure schedule on the after-tax real rate is unambiguously positive. If there is an exogenous upward shift in aggregate demand, the after-tax real rate must rise to "crowd out" private investment in order to restore commodity market equilibrium. The model represented by equations (4) through (9) makes it clear that tests of the possible impact of fiscal deficits on interest rates cannot be conducted by inserting a measure of the actual fiscal deficit directly into an interest rate equation. Since tax proceeds rise with income, the built-in portion of deficits is endogenous and typically countercyclical. Interest rates are typically procyclical; therefore, the coefficient on the actual deficit (measured as a positive number) term in the interest rate equation will be downwardly biased and possibly negative. 1/

One way to avoid these difficulties is to test the impact on interest rates of unanticipated movements in the fiscal deficit. 2/ This approach purges the deficit of its systematic component which, as noted above, tends to bias downward its measured impact on interest rates. Further, given period-average short-term rates as the dependent

1/ This is confirmed by results reported in Makin and Tanzi (1982b). For a thorough discussion of government deficits and aggregate demand, see Feldstein (1982).

2/ Another way could be to use the full employment budget surplus.

variable, as with money surprises, it is possible to capture the impact on interest rates of higher-than-expected sales of government securities during the quarter. This impact should occur before the end of the quarter, when comparison of an actual with an anticipated fiscal deficit may give rise to an expectations effect. More specifically, a surprise increase in the deficit may cause market participants to expect higher money growth and therefore higher inflation. But if this expectations effect is already captured in the expected inflation term, the surprise deficit will appear to have no additional explanatory power. The use of a period-average interest rate as a dependent variable, as noted, avoids this problem of apparent redundancy of fiscal deficits in an interest rate equation. We expect that a surprise deficit will raise the period-average interest rate.

Intensity of capacity utilization, an accelerator argument in the expenditure equation, will be positively related to the after-tax real and nominal interest rates. As capacity limits are approached, capital formation is required and investment expenditure shifts upward. Ceteris paribus, a higher after-tax real rate is required to maintain equilibrium.

After consideration of all these factors, it is clear from equation (9) that regression of nominal interest on a constant, a surprise deficit, a money surprise, GAP, a measure of uncertainty about inflation, and expected inflation ought to (a) test the hypothesized positive impact on the after-tax real interest rate of an exogenous shock to aggregate demand (measured by an unanticipated deficit); (b) test the hypothesized negative impact of a money surprise on the after-tax real rate by checking to see if the coefficient on the surprise is significantly less than zero; 1/ (c) test the hypothesized negative impact of expected inflation on after-tax real interest by checking to see if the coefficient on expected inflation is significantly below $[1/(1-\tau)]$; (d) measure the net impact of uncertainty about inflation on the after-tax real rate; (e) test the impact of intensity of capacity utilization on the after-tax real rate; and (f) test the impact of expected inflation abroad on the after-tax real rate.

IV. Concluding Remarks

To date, much of the analysis of interest rate behavior, and particularly its relationship to changes in expected inflation, has focussed on the United States. 2/ Tax policy regarding interest income and expense has been introduced into most models since its relevance was pointed out by Darby (1975), Feldstein (1976), and Tanzi (1976). Less attention has been paid to formulation of open economy models which permit analysis of transmission of monetary disturbances from abroad and which consequently must incorporate tax policies relevant to determination of equilibrium after-tax interest arbitrage conditions. In addition, little has been done to include tax policies regarding depreciation and inventory allowances in models of interest rate behavior.

This paper has developed a model that, it is hoped, will include all of these relevant aspects of tax policy in a framework useful for

1/ See Makin (1982a) for a full discussion of effects of money surprises.

2/ A notable exception is the paper on Canada by Carr, Pesando and Smith (1976).

analysis of interest rate behavior in medium-sized or smaller economies where "foreign" variables refer to events in larger economies. This framework may prove useful as a means to analyze along with relevant domestic variables the impact on interest rates in smaller and medium sized economies of monetary and fiscal policy policies in large economies.

Perhaps with this framework in hand, empirical investigation of interest rate behavior outside of the United States will be expanded. There remain some difficulties regarding availability of time series data on relevant tax rates and measures of anticipated inflation. The latter problem may be mitigated by employment of time series modeling to obtain measures of expected inflation where survey data, such as the widely used Livingstone data for the United States, is not available. Current studies underway within the Fiscal Affairs Department and elsewhere, particularly at the National Bureau of Economic Research, may eventually provide time series on relevant tax rates.

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