NBER WORKING PAPER SERIES

THE DEGREE OF FISCAL ILLUSION IN INTEREST RATES: SOME DIRECT ESTIMATES

Joe Peek

James A. Wilcox

Working Paper No. 1358

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 1984

The research reported here is part of the NBER's research program in Financial Markets and Monetary Economics. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #1358
May 1984

The Degree of Fiscal Illusion in Interest Rates: Some Direct Estimates

ABSTRACT

This article demonstrates why the procedures used in previous studies do not permit inference about the relationship between interest rates and taxes. We present a model that leads to direct estimates of the degree to which interest rates respond to changes in tax rates. The empirical results imply that the adjustment of taxable interest rates has been large enough to render after-tax yields impervious to tax rate changes. Further, tax-exempt yields are unaffected by changes in tax rates. Thus, there is no evidence of fiscal illusion in interest rates.

Joe Peek
Department of Economics
Boston College
Chestnut Hill, MA 02167
(617) 552-3686

James A. Wilcox
350 Barrows Hall
U.C. Berkeley
Berkeley, CA 94720
(415) 642-3535

The Degree of Fiscal Illusion in Interest Rates: Some Direct Estimates

Joe Peek and James A. Wilcox*

Michael Darby (1975) and Martin S. Feldstein (1976) have suggested that, in the presence of income taxation, nominal interest rates would have to change by more than expected inflation to preserve expected after-tax real interest rates. The frequent empirical rejection of this hypothesis has often been attributed to the failure of interest rates to allow for interest income taxation, a characteristic Vito Tanzi (1980) has termed "fiscal illusion".[1] Here we investigate the degree of fiscal illusion by directly estimating the response of nominal interest rates to changes in tax rates. After deriving the reduced form for the interest rate in Section I, we demonstrate the difficulty in drawing inferences about fiscal illusion from existing estimates. In Section III, we present direct estimates of the extent of fiscal illusion. Section IV concludes.

I. The Model

The macromodel we use is similar to that of Joe Peek and James A. Wilcox (1983), augmented with a fiscal illusion parameter. The IS, LM, wage, and aggregate supply relations (deflated by Y^N) can be expressed as:

(1) $Y - Y^N = a_0 - a_1 r^* + a_2 \Delta Y + a3(X - Y^N) + a_4(M - P - Y^N) - a_5 SS - a_6 FB$

(2) $M - P - Y^N = b_0 + b_1(Y - Y^N) - b_2 i^* - b_3 FB$

(3) $W = c_0 + P^e - c_1 SS$

(4) $P = d_0 + W + d_1(Y - Y^N) + d_2 SS,$

where the coefficients of all the variables are positive, Y, Y^N, X, M, P, P^e, and W are real output, natural (i.e., potential) real output, the sum of real exports and real government expenditures, the nominal money supply, the price level, the expected price level, and the nominal wage, respectively (all in logs). ΔY is the percentage change in actual real output lagged one period, SS is a supply shock variable, FB is the domestic bonds held by foreigners, and r^* and i^* are tax-adjusted real and nominal interest rates. The nominal interest rate (i) is related to i^* and r^* by (5) and (6):

(5) $$i^* \equiv (1 - \theta t)i$$

(6) $$r^* \equiv i^* - \dot{p}^e$$

where t is the marginal tax rate on interest income, $\dot{p}^e$ is the anticipated inflation rate, and θ is the fiscal illusion parameter. A value of unity for θ implies that agents respond to after-tax, rather than pre-tax, interest rates and therefore do not suffer from fiscal illusion. A value for θ of zero, at the other end of the presumed range for this parameter, would imply that agents disregard taxes entirely, i.e., suffer from complete fiscal illusion.

Real expenditures depend on the real interest rate after allowance for taxes and for the degree of fiscal illusion, real exogenous export and government demand, a real balance effect, and an investment accelerator term. The opportunity cost of holding money is the tax-adjusted nominal interest rate. The wage and price equations embody the natural rate hypothesis. A supply shock, e.g., a sudden increase in the relative price of imported oil, lowers the IS curve through its effect on the demand for capital, and hence investment demand (see Wilcox (1983b)), shifts the aggregate supply equation by raising the cost of production, and reduces the equilibrium real wage. The FB variable is included to isolate the financial effects arising from the supply shocks. In the IS curve, FB serves as a proxy for any increase in the world saving rate that developed as real income was transferred to countries (OPEC) with higher saving propensities. Similarly, FB enters the LM equation to allow for the possibility that the demand for money will be reduced as wealth is transferred to agents who desire a wealth portfolio with a much higher proportion of U.S. government securities than domestic wealth-holders do.

Equations (1) - (6) yield the reduced-form equation for the after-tax nominal interest rate:

$$(7) \qquad i = \frac{A_0}{(1-\theta t)} + \underset{(+)}{A_1\tilde{p}^e} + \underset{(?)}{A_2\tilde{M}'} + \underset{(+)}{A_3\tilde{X}'} + \underset{(+)}{A_4\Delta\tilde{Y}} + \underset{(?)}{A_5\tilde{SS}} + \underset{(-)}{A_6\tilde{FB}} ,$$

where M' and X' are $(M - p^e - Y^N)$ and $(X - Y^N)$, respectively, and a ~ over a variable indicates that it has been divided by $(1-\theta t)$. The liquidity and real balance effects of an increase in the real money supply have offsetting effects on the interest rate resulting in an ambiguous sign for A_2. Likewise, the sign of A_5 is indeterminate a priori.[2]

The reduced-form effect of expected inflation on interest rates is:

$$(8) \qquad \frac{di}{dp^e} = \beta = \frac{A_1}{(1-\theta t)} = \frac{1}{(1-\theta t) \quad 1 + \left[\dfrac{b_2(1 + a_4 d_1)}{a_1(b_1 + d_1)} \right]}$$

Equation (8) highlights the fact that very little can be deduced about the presence or strength of tax effects on interest rates from estimates of β.[3] To test for the presence of tax effects, we disentangle the tax $(1-\theta t)$ and non-tax (A_1) terms that comprise β. We take the Darby hypothesis to be that $\beta = 1/(1-t)$. Equivalently, this is the joint hypothesis that $A_1 = 1$ and $\theta = 1$. We distinguish this from the simple hypothesis that $\theta = 1$, the "complete tax adjustment" or "absence of fiscal illusion" hypothesis. This hypothesis asserts only that individuals base their behavior on after-tax interest rates. An even less restrictive version of this hypothesis would be that tax rates are not completely ignored: $\theta > 0$.

Clearly, the existence of fiscal illusion ($\theta < 1$) would imply rejection of the Darby hypothesis. Rejection of the joint Darby hypothesis, however, does not necessarily imply rejection of the hypothesis of complete tax adjustment ($\theta = 1$). Nor does the finding that $\theta = 1$ imply that the Darby hypothesis holds, since A_1 will be less than unity, for example, if either the IS curve is horizontal or the LM curve is vertical (see(8)).

II. Previous Tests for Tax Effects

Early tests of the Darby hypothesis (e.g., Thomas F. Cargill (1977), John A. Carlson (1976), Jack Carr, James E. Pesando, and Lawrence B. Smith (1976)) estimated reduced-form nominal interest rate equations where tax effects remained embedded in the reduced-form coefficient, β. That hypothesis did not receive much empirical support.[4] Tanzi (1980) did separate β into its tax and non-tax components, employing $p^e/(1-t)$ as an explanatory variable. He rejected the hypothesis that the coefficient on this variable (our A_1) was unity and concluded that people suffered from fiscal illusion. From (8), however, we see that this procedure assumes $\theta = 1$ (i.e., the absence of fiscal illusion) and tests whether A_1 differs from unity, thereby precluding estimates of, tests for, or conclusions about the extent to which interest rates react to changes in tax rates.

Michael Melvin (1982) recognizes this difficulty. Using structural parameter estimates for a small macromodel similar to the one we presented in Section I, he obtains a value of 0.511 for A_1. This estimate, however, is conditioned on $\theta = 1$. Although Tanzi and Melvin obtain similar estimates, Melvin correctly notes that a coefficient below unity does not imply that taxes are ignored. On the other hand, his estimates do not imply that there are tax effects.

In another recent Review article, Robert Ayanian (1983) proposes an alternative test of the Darby hypothesis. His regression of the taxable on the tax-exempt yield provides a coefficient of 1.63 (s.e. = 0.04). He interprets this as an estimate of 1/(1-t) and concludes that there is "an unmistakable Darby effect" (p. 763). Although the spread between taxable and tax-exempt yields almost certainly reflects tax rates (and is, in fact, often used to obtain a proxy for them (see Darby (1975)), Ayanian's results do not indicate "whether or not the expected real rate was depressed by expectations of inflation" (p. 764), whether the taxable rate rises with taxes, whether the tax-exempt rate is invariant to tax rate changes, or whether the spread has responded to tax rate changes.

Using Davidson-MacKinnon (1981) model specification tests, Peek (1982) and Peek and Wilcox (1983) were able to distinguish between the tax-adjusted and non-tax-adjusted Fisher hypotheses. Faced with a choice between the two extremes of complete tax adjustment ($\theta = 1$) and complete fiscal illusion ($\theta = 0$), these tests implied the rejection of complete fiscal illusion and failure to reject the complete tax adjustment hypothesis. Although these conclusions are not based on θ-conditioned estimates of A_1, they provide no estimate of the degree of fiscal illusion.

III. Direct Estimates of the Degree of Fiscal Illusion

We obtain a direct estimate of the degree of fiscal illusion, θ, by nonlinear least squares estimation of (7). Table 1 presents the results. The estimates are based on semiannual monthly observations (June and December) to match the Livingston survey data. The sample extends from June

1952 through June 1979. This sample period avoids the pre-1952 pegging of interest rates by the Federal Reserve, the imposition of credit controls in 1980, and any structural changes associated with financial deregulation and monetary policy after June 1979. Monthly averages of the one-year Treasury bill bond-equivalent yield during June and December are used as the before-tax nominal interest rate measure (i) to match the maturity of the Livingston one-year anticipated inflation rate data.

The anticipated inflation rate series, PE, is the percentage change in the CPI expected over the next twelve months derived from the Livingston survey. This series was provided by the Federal Reserve Bank of Philadelphia. This measure of anticipated inflation has two advantages: it is a truly ex ante expectation and reflects whatever sophistication agents use to process information.

Second and fourth quarter observations are used for the remaining explanatory variables. The logarithm of the sum of real exports and real government expenditures on goods and services divided by the level of natural real output (X') and the percentage change in real GNP lagged one period (ΔY) are constructed from the National Income and Product Accounts data. We use the potential real GNP series constructed by the Council of Economic Advisors as our measure of natural real output. The logarithm of the nominal money supply deflated by the expected price level and natural real output (M') is constructed using the M1 definition of the money supply and the Livingston survey measure of the expected price level. The tax rate (t), the supply shock variable (SS), and the foreign holdings of bonds (FB) are described in detail in Peek and Wilcox (1983). The tax rate is calculated as a weighted average of the marginal personal income tax rate for each adjusted gross income class.[5] SS is measured by the ratio of the implicit price deflator for imports to the GNP deflator adjusted for exchange rate changes. FB is the ratio of foreign holdings to the sum of private domestic and foreign holdings of U.S. government short-term marketable securities.

Column 1 is obtained when (7) is estimated under the constraint that interest rates adjust completely to changes in tax rates (θ=1). The estimation method is ordinary least squares. Expected inflation, exogenous expenditures, the change in real income, supply shocks, and foreign demand for bonds each enter significantly. Column 2 allows for a freely-estimated fiscal illusion term, θ. The point estimate of 1.40 is insignificantly different from one. This estimate suggests that the adjustment to tax rate changes is complete: pre-tax interest rates rise by enough to preserve after-tax yields. Further, we can easily reject the hypothesis of complete fiscal illusion (θ=0).[6]

Columns 3 and 4 substitute alternative expected inflation measures, PEIN and PEOUT, for the Livingston survey measure, PE. PEIN and PEOUT are in-sample and out-of-sample forecasts based on information contained in earlier Treasury bill yields.[7] Using monthly data, inflation (twelve times the month over month change in the log of the CPI) is regressed on a constant and six lags of the one-month Treasury bill yield. PEIN is the vector of fitted values for June and December obtained using the entire 1952:06-1979:06 sample. The out-of-sample forecasts, PEOUT, are based only on prior information. Thus, the forecast during June depends on the six monthly-average Treasury yields from December to May and the forecast equation coefficients. These coefficients are obtained by regressing inflation on a constant and six lags of one-month Treasury yields over the forty-eight months ending two months before the forecast is made. Using coefficient estimates from a sample that edged closer to the forecast dates (June and December) would require more information than agents actually had. Most of the coefficients, especially those on the expected inflation measures themselves, are affected by this substitution. The estimates of the tax-adjustment parameter, θ, however, are virtually unchanged. Thus, the finding that interest rates respond completely to changes in tax rates is robust with respect to the measure of expected inflation.

Column 5 replaces the taxable Treasury bill yield with the one-year tax-exempt municipal bond yield, i_x, obtained from Salomon Brothers' Analytical Record of Yields and Yield Spreads. If after-tax yields are tax-invariant as indicated by column 2, we would expect tax-exempt yields to not respond to tax rate changes. The estimate for θ of -0.26, which is insignificantly different from zero, implies that those yields are hardly affected by taxes. Since our model does not indicate the appropriate specification for testing the effects of tax rates on tax-exempt yields, two additional forms were also estimated. Setting θ equal to zero, we re-estimated column 5 once adding t and once adding 1/(1-t) as explanatory variables. Their coefficients were 1.17 and 0.69 with t-statistics of 0.74 and 0.27, respectively. Thus changes in tax rates leave after-tax yields unaffected.

IV. Conclusion

We have argued that previous studies have not produced tests that permit inference about either the presence or the degree of fiscal illusion in interest rate determination. The specification we use allows us to estimate directly the extent to which interest rates adjust to changes in tax rates. The estimates based on taxable and on tax-exempt yields and on various measures of expected inflation imply that after-tax real yields are invariant with respect to tax rate changes. Thus, these results do not suggest there has been fiscal illusion.

TABLE 1

Reduced From Estimates for Interest rates
1952:06-1979:06, Semi-annual Observations
(absolute values of t-statistics in parentheses)

	Dependent Variable				
	i (1)	i (2)	i (3)	i (4)	i^x (5)
Constant	14.2 (4.92)	12.2 (3.81)	2.4 (1.25)	5.7 (1.93)	12.4 (2.22)
PE	0.821 (7.23)	0.654 (3.47)	-	-	0.681 (1.99)
PEIN	-	-	0.330 (4.20)	-	-
PEOUT	-	-	-	0.122 (1.83)	-
M'	1.94 (1.62)	1.48 (1.36)	-1.12 (1.86)	-3.91 (2.95)	2.06 (1.32)
X'	3.93 (2.16)	3.37 (2.05)	0.75 (0.51)	5.06 (2.05)	3.32 (1.52)
ΔY	7.00 (2.65)	5.47 (2.05)	3.64 (1.70)	5.33 (1.43)	2.51 (0.88)
SS	-3.22 (5.99)	-2.94 (5.55)	-1.26 (3.08)	-2.64 (3.84)	-2.55 (2.88)
FB	-4.68 (2.55)	-4.03 (2.47)	-1.10 (0.80)	-2.03 (1.03)	-4.84 (2.02)
θ	-	1.40 (3.57)	1.34 (3.77)	1.33 (2.21)	0.26 (0.19)
R^2	.909	.910	.931	.856	.851
DW	1.64	1.66	2.21	1.39	1.82
SEE	0.730	0.733	0.639	0.925	0.525

Not: Data and sources are given in text.

REFERENCES

Ayanian, Robert, "Expectations, Taxes, and Interest: The Search for the Darby Effect," American Economic Review, September 1983, 73, 762- 65.

Cargill, Thomas F., "Direct Evidence of the Darby Hypothesis for the United States," Economic Inquiry, January 1977, 15, 132-134.

__________ and Meyer, Robert A., "The Term Structure of Inflationary Expectations and Market Efficiency," Journal of Finance, March 1980, 35, 57-70.

Carlson, John A., "Expected Inflation and Interest Rates," Economic Inquiry, October 1979, 17, 597-608.

Carr, Jack, Pesando, James E., and Smith, Lawrence B., "Tax Effects, Price Expectations and the Nominal Rate of Interest," Economic Inquiry, June 1976, 14, 259-269.

Darby, Michael R., "The Financial and Tax Effects of Monetary Policy on Interest Rates," Economic Inquiry, June 1975, 14, 266-76.

Davidson, Russell and MacKinnon, James G., "Several Tests for Model Specification in the Presence of Alternative Hypotheses," Econometrica, May 1981, 49, 781-93.

Fama, Eugene F. and Gibbons, Michael R., "A Comparison of Inflation Forecasts," Journal of Monetary Economics, forthcoming.

Feldstein, Martin S., "Inflation, Income Taxes, and the Rate of Interest: A Theoretical Analysis," American Economic Review, December 1976, 66, 809-20.

Levi, Maurice D. and Makin, John H., "Anticipated Inflation and Interest Rates: Further Interpretation of Findings on the Fisher Equation," American Economic Review, December 1978, 68, 801-12.

Melvin, Michael, "Expected Inflation, Taxation, and Interest Rates: The Delusion of Fiscal Illusion," American Economic Review, September 1982, 72, 841-45.

Peek, Joe, "Interest Rates, Income Taxes, and Anticipated Inflation," American Economic Review, December 1982, 72, 980-91.

_________ and Wilcox, James A., "The Postwar Stability of the Fisher Effect," Journal of Finance, September 1983, 38, 1111-1124.

Salomon Brothers Inc., Analytical Record of Yields and Yield Spreads, New York.

Tanzi, Vito, "Inflationary Expectations, Economic Activity, Taxes, and Interest Rates," American Economic Review, March 1980, 70, 12-21.

Wilcox, James A., "The Effects of Inflation Uncertainty and Supply Shocks on Real Interest Rates," Economics Letters, 1983a, 12, 163-167.

_________, "Why Real Interest Rates Were So Low in the 1970s," American Economic Review, March 1983b, 73, 44-53.

U.S. Department of Commerce, Bureau of Economic Analysis, The National Income and Product Accounts of the United States, 1929-76 Statistical Tables. Washington, D.C.: USGPO, September 1981.

_________, Bureau of Economic Analysis, The Survey of Current Business, Washington, D.C.: USGPO, various Issues through July 1982.

FOOTNOTES

* Department of Economics, Boston College, Chestnut Hill, MA 02167, and School of Business Administration, 350 Barrows Hall, University of California, Berkeley, Berkeley, CA 94720. We are grateful to Eugene Fama, Richard Meese, Jeffrey Skelton, Janet Yellen and two anonymous referees for this Review for their comments. Josef Chytry provided fast and accurate typing. Any errors are solely our responsibility. Financial support was provided by a Boston College Summer Research Fellowship and NSF grant SES-8109093.

1. We feel that a more accurate term for this characteristic would be "tax illusion." Since it has already become widely known as "fiscal illusion," we will use this latter term.

2. The investment-real wage effects of supply shocks might be expected to dominate, suggesting a negative value for A_5. The results presented in Wilcox (1983a, 1983b) and Peek and Wilcox (1983) can be so interpreted.

3. This has been pointed out by Levi and Makin (1978), Melvin (1982), and Peek (1982).

4. Cargill and Meyer (1980) found significantly greater than unity estimates for the 1960s, but they disappeared when the sample period was extended into the 1970s. Wilcox (1983b) suggested a cause for this coefficient decline.

5. For the June observations we use the tax rate for that calendar year. For the December observations we use the average of the tax rates for the current year and for the upcoming year.

6. These point estimates differ somewhat from Peek and Wilcox (1983) due to minor data revisions and because here the dependent variable is calculated as the bond-equivalent yield as opposed to a discount factor. The results are not sensitive to the choice of yields. When the interest rate is calculated on a discount basis, the estimated value of θ is 1.23 (t = 2.65).

7. Fama and Gibbons (forthcoming) argue that forecasts based on interest rates may be superior to survey forecasts.