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INFLATION, HEDGING AND THE FISHER HYPOTHESIS

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INFLATION, HEDGING AND THE FISHER HYPOTHESIS[*]

by

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Abstract

This paper presents an interest rate equation which makes use of the "inverted Fisher hypothesis", as well as paying special attention both to modelling the capital risk and hedging premiums and to the dynamics of interest rate behavior. Empirical evidence from Canada, the U.K. and the U.S.A. gives strong support to the resulting specification.

1. INTRODUCTION

The failure of the Fisher hypothesis to explain interest rate movements in the 1970´s and 1980´s has inspired fairly intensive research on the roles of different macroeconomic variables assumed to be responsible for the changes in the real rate of interest. These variables typically include taxes and different proxies for innovations in money supply, aggregate demand and supply, and inflation uncertainty (cf. e.g. Makin (1983) and Peek and Wilcox (1983)). Even if empirical analysis augmented by these kinds of variables makes sense from the viewpoint of a standard macroeconomic (IS/LM) model, and even if the explanatory power of the resulting equations has become much better, many questions and problems still remain unresolved. First, the effects of almost all additional variables are theoretically ambiguous, making the interpretation of empirical results rather tedious. Second, the relationships thus far obtained do not seem to be stable and, furthermore, there is absolutely no guarantee that the models represent proper dynamic specifications. (The values of the D-W statistics associated with the fitted models are often well below 1. This has been either totally ignored or a mechanical use of the Cochrane-Orcutt procedure has been considered a proper response). Finally, the original Fisher equation and the corresponding augmented forms make no distinction between capital and financial assets, whereas a sharp distinction is made between money and financial assets. Thus, the (constant) nominal return on money is assumed to have no effect on the nominal return on financial assets. Even if this assumption might be intuitively acceptable, it should not be taken for granted when carrying out empirical analyses.

This paper tries to provide an explanation for the observed puzzling behavior of interest rates, not by using different additional macroeconomic variables in the Fisher equation but by relaxing the basic Fisherian assumption on close substitution between capital and financial assets (and poor substitution between financial assets and money). In doing this, we explicitly consider the implications of the purchasing power risk (due to the uncertain price level) for the portfolio demand for money and bonds. Thus, we end up with an interest rate equation which takes into account a positive capital risk premium and a negative hedging premium. This equation - together with the "competing Fisher equations" - is estimated in the form of different dynamic specifications using data from three countries, Canada, the United Kingdom and the United States. Section 2 presents the specifications of the interest rate equations. Results of estimating the equations are reported in section 3. Finally, some concluding remarks follow in section 4.

2. THEORETICAL CONSIDERATIONS

If taxes are ignored, the Fisher equation simply reads:

$$(1) \qquad R_t = r_t + p_t^e$$

where R_t is the nominal interest rate, r_t the (unobserved) real interest rate and p_t^e the anticipated inflation rate. As pointed out by Carmichael and Stebbing (1983), this equation is based on the implicit assumption that financial assets and capital are close substitutes and financial assets and money poor substitutes. One can, of course, question this assumption, or even argue that the opposite assumption is more plausible. Then the nominal rate of return on money, which, by convention, is regulated to be zero, would determine the nominal interest rate on bonds and other financial assets, the real rate fluctuating inversely one for one with the inflation rate (Carmichael and Stebbing call this possibility the "inverted Fisher hypothesis").

Now, if we think about the portfolio choice between money and, say, bonds, we should notice that the nominal interest rate of bonds is not the only thing which determines the outcome of this choice. As pointed out by Boonekamp (1978), the presence of purchasing power risk implies that the demand for bonds and money depends on the capital risk and hedging properties of bonds, or to be more explicit, on the variance of nominal returns and on the covariance between nominal returns and the rate of inflation (and, of course, on the expected nominal returns).1)

If we consider the determination of nominal bond returns, we can conclude that these returns should correspond to these two variables, and possibly to a premium that must be paid to the holders of bonds to compensate them for the loss of monetary services. If we assume that the latter premium is constant, we can specify the following interest rate equation:

$$(2) \qquad R_t = a_0 + a_1 v_{r,t} + a_2 COV_t$$

where $v_{r,t}$ denotes some measure for the variability of nominal (bond) returns and COV_t the corresponding covariance between nominal returns and the inflation rate. Given some plausible assumptions on the magnitude of the Arrow-Pratt measure of relative risk aversion, parameters a_0 and a_1 should be positive and a_2 negative.

Even if we are ready to accept the "inverted Fisher hypothesis" as a starting point of our empirical analysis, we still face the problem that there can be some degree of substitutability between financial assets and capital. Obviously, this would imply some kind of composite model so that (2) would be complemented by the expected inflation rate variable, and perhaps also by additional variables controlling the changes in the real rate of interest. From the point of view of econometric testing this kind of composite model, say, for instance, equation (3), could be viewed as a way of testing the Fisher hypothesis against the "inverted Fisher hypothesis" in the encompassing framework (cf. Mizon and Richard (1983)):

$$(3) \qquad R_t = b_0 + b_1 p_t^e + b_2 v_{r,t} + b_3 COV_t$$

Equations (1) and (3) implicitly assume that the real rate of interest in the Fisherian framework is constant. As pointed out earlier, this is not necessarily the case. To take into account this possibility, we arrange some sort of test for the constancy proposition by estimating the following augmented Fisher equation:

$$(4) \qquad R_t = c_0 + c_1 p_t^e + c_2 s_{p,t} + c_3 m_t + c_4 y_t$$

where $s_{p,t}$, m_t and y_t denote proxies for inflation uncertainty, unanticipated money supply and aggregate demand shocks, respectively. As pointed out by, for instance, Makin (1983) and Kreicher (1981), there are obvious problems in signing these variables. Accordingly, we do not impose any a priori sign restrictions here.

The interest rate equations thus far presented are all static. Even though static specifications are used almost without exception in empirical analyses of interest rates, there are no strong reasons for specifying the models in this way. Hence, we do not take the static specifications for granted but, rather, test them against some reasonable dynamic alternatives. These alternatives include a standard partial adjustment model, a nonlinear specification corresponding to the Cochrane-Orcutt transformation and, finally, an unrestricted dynamic specification (of the Houthakker and Taylor (1966) type; see their equation (55) on p. 20).

3. ESTIMATION RESULTS

Quarterly data for three countries, Canada, the United Kingdom and the United States, are used in the empirical analysis. The data cover the period 1960.1-1982.4 and are seasonally unadjusted. Seasonality is taken into account by using four-quarter differences in constructing different variables (see Appendix 1 for details); the interest rates were found to be free from seasonality. Two interest rate variables are used: the interest rate on a three-month Treasury bill, TB, and the yield on a long-term government bond, GB. All data are taken from an IMF tape.[2)]

We turn now to the estimation results. OLS estimates for the Fisher equation (1) are presented in Table 1. A brief look reveals two facts: first, the coefficient of the anticipated inflation variable p_t^e is significantly below one (because of taxes this coefficient should, in fact, be above one to be consistent with the original Fisher hypothesis;

TABLE 1 OLS ESTIMATION RESULTS OF THE FISHER EQUATION

	Constant	p^e_t	R^2	D-W	r_1	r_2	r_3	r_4
USA:GB	.035	.667	.658	.187	8.67	7.51	6.33	4.55
	(11.08)	(13.16)						
	(17.99)	(12.45)						
UK:GB	.056	.530	.716	.408	7.67	4.92	2.39	0.13
	(16.21)	(15.08)						
	(18.75)	(13.36)						
CAN:GB	.040	.727	.762	.237	8.43	7.41	6.79	5.97
	(14.24)	(16.99)						
	(16.87)	(12.15)						
USA:TB	.022	.742	.659	.415	7.59	5.57	5.00	3.89
	(6.36)	(13.18)						
	(8.85)	(10.35)						
UK:TB	.046	.422	.470	.363	8.18	5.94	3.88	2.40
	(9.91)	(8.93)						
	(12.77)	(7.73)						
CAN:TB	.017	.938	.694	.288	8.20	6.76	5.96	5.26
	(4.02)	(14.27)						
	(5.07)	(10.50)						

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t-ratios are in parentheses immediately below the coefficient estimates, below them are White's heteroscedasticity adjusted t-ratios. r_i's indicate the Breusch-Pagan Lagrange multiplier test statistics for autocorrelation up to the fourth order. The relevant distribution under H_0 is N(0,1)

TABLE 2 OLS ESTIMATION RESULTS OF THE AUGMENTED FISHER EQUATION

	Constant	P_t^e	$s_{p,t}$	m_t	y_t	R^2	D-W	r_1	r_2	r_3	r_4
USA:GB	.034	.556	.543	-.036	-.029	.667	.180	8.75	7.51	6.16	4.40
	(9.99)	(6.18)	(1.52)	(0.27)	(0.19)						
	(15.64)	(4.76)	(1.06)	(0.19)	(0.15)						
UK:GB	.015	.322	.899	.037	-.137	.769	.367	8.03	5.60	3.02	0.40
	(14.36)	(5.53)	(4.04)	(0.59)	(1.38)						
	(15.20)	(5.34)	(4.44)	(0.59)	(1.19)						
CAN:GB	.048	.883	-1.693	-.018	-.194	.846	.586	6.91	4.81	3.53	1.92
	(18.53)	(18.28)	(6.18)	(0.85)	(2.35)						
	(23.53)	(15.80)	(5.71)	(1.08)	(2.27)						
USA:TB	.024	.918	-.805	-.297	.033	.691	.424	7.65	5.95	4.97	4.14
	(6.38)	(9.54)	(2.10)	(2.03)	(0.20)						
	(8.75)	(6.98)	(1.50)	(1.51)	(0.19)						
UK:TB	.041	.293	.633	-.189	-.335	.550	.390	8.14	6.11	4.18	1.98
	(8.39)	(3.67)	(2.07)	(2.23)	(2.48)						
	(9.70)	(3.76)	(2.45)	(2.15)	(2.33)						
CAN:TB	.032	1.253	-3.195	-.034	-.214	.842	.837	5.69	1.83	0.40	2.18
	(9.00)	(18.93)	(8.52)	(1.17)	(1.89)						
	(11.88)	(13.94)	(7.00)	(1.40)	(1.99)						

TABLE 3 OLS ESTIMATION RESULTS OF THE HEDGING MODEL

	Constant	P_t^e	$v_{r,t}$	COV_t	R^2	D-W	r_1	r_2	r_3	r_4
USA:GB	.029	.561	2.878	-.900	.927	.530	7.05	4.86	3.69	2.11
	(17.98)	(10.62)	(9.44)	(6.91)						
	(25.54)	(9.84)	(6.89)	(6.18)						
UK:GB	.035	.362	5.577	-.924	.860	.560	7.02	3.52	0.93	0.19
	(10.60)	(9.26)	(9.39)	(8.08)						
	(12.29)	(8.39)	(8.90)	(7.62)						
CAN:GB	.035	.456	3.827	-.817	.938	.551	6.79	4.34	3.51	2.54
	(19.98)	(13.25)	(14.49)	(3.89)						
	(26.59)	(12.32)	(11.03)	(2.99)						
USA:TB	.008	.655	2.541	-.826	.810	.604	6.75	4.36	4.50	3.92
	(2.43)	(7.48)	(6.70)	(5.55)						
	(2.62)	(7.98)	(6.15)	(5.01)						
UK:TB	.035	.229	1.750	.094	.633	.368	7.84	4.75	1.59	1.00
	(7.36)	(4.49)	(4.24)	(0.95)						
	(9.05)	(5.23)	(4.37)	(0.80)						
CAN:TB	-.001	.789	2.554	-.823	.794	.401	7.72	5.63	4.36	3.34
	(0.11)	(10.04)	(6.35)	(4.06)						
	(0.12)	(11.95)	(5.31)	(3.91)						

TABLE 4 OLS ESTIMATION RESULTS OF THE UNRESTRICTED HEDGING MODEL

	USA:GB	UK:GB	CAN:GB	USA:TB	UK:TB	CAN:TB
Constant	.004	.005	.007	.005	.002	.001
	(3.30)	(2.08)	(3.01)	(2.49)	(0.57)	(0.49)
	(2.87)	(2.08)	(2.32)	(2.54)	(0.56)	(0.42)
p_t^e	-.066	.013	.044	.010	-.055	.214
	(1.49)	(0.29)	(0.66)	(0.07)	(0.85)	(1.41)
	(1.27)	(0.17)	(0.76)	(0.05)	(0.82)	(1.32)
p_{t-1}^e	.195	.004	.059	.098	.006	.025
	(4.00)	(0.10)	(0.88)	(0.75)	(0.10)	(0.39)
	(3.37)	(0.06)	(1.08)	(0.52)	(0.10)	(0.25)
$v_{r,t}$	4.262	2.672	3.619	3.993	1.914	2.024
	(9.79)	(3.26)	(6.09)	(4.41)	(2.44)	(2.42)
	(6.23)	(1.98)	(6.45)	(3.47)	(2.04)	(2.30)
$v_{r,t-1}$	-4.451	-2.185	-3.027	-.3953	-1.061	-1.863
	(9.94)	(2.48)	(4.92)	(4.68)	(1.26)	(2.29)
	(6.06)	(1.47)	(5.47)	(3.69)	(1.03)	(2.17)
COV_t	-.615	-.374	.130	-.576	-.436	.230
	(5.35)	(2.45)	(0.45)	(2.51)	(3.31)	(0.66)
	(2.87)	(1.74)	(0.48)	(2.26)	(3.36)	(0.69)
COV_{t-1}	.429	.350	-.372	.586	.373	-.529
	(4.52)	(2.49)	(1.29)	(2.57)	(2.56)	(1.51)
	(2.35)	(1.54)	(1.44)	(2.73)	(2.31)	(1.45)
R_{t-1}	.875	.897	.811	.810	.896	.783
	(20.32)	(14.62)	(13.05)	(10.40)	(16.27)	(12.97)
	(18.39)	(13.10)	(10.34)	(9.58)	(13.57)	(10.89)
R^2	.991	.965	.982	.927	.917	.945
D-W	1.909	1.563	1.892	1.532	1.461	1.360
r_1	0.08	2.15	0.30	2.78	2.89	3.03
r_2	2.11	1.18	3.49	2.76	0.95	1.80
r_3	0.14	0.44	0.20	1.08	2.68	0.46
r_4	1.15	0.14	2.98	1.39	1.94	0.85

R_{t-1} denotes the lagged dependent variable.

cf. e.g. Darby (1975)). Secondly, the error terms are strongly autocorrelated, autocorrelation being of the AR(1)-type.

Before we try to find a more efficient way of estimating the Fisher equation, we estimate it in an augmented form, cf. equation (4) above, to see whether the exclusion of relevant macroeconomic variables does indeed bias the coefficient estimate of the anticipated inflation rate variable, as argued by e.g. Makin (1983) and Peek and Wilcox (1983). The results are presented in Table 2. On the basis of these results we cannot, however conclude that the additional variables would completely change the nature of the results for these three countries. Only in the case of the Treasury bill rate equation for Canada does the coefficient estimate of p_t^e exceed 1.

As far as the coefficient estimates of the additional variables are concerned, the results are rather mixed. There is no uniform sign pattern for these coefficients (except, perhaps, for that of m_t). Furthermore, the t-ratios, particularly those adjusted for heteroscedasticity (which still show an upward bias because of strong autocorrelation) do not allow us to reject the null hypothesis that the respective coefficients are equal to zero, except in a few cases.

Given this failure, it is somewhat surprising to find that the hedging model, cf. equation (3), performs rather well, particularly as far as the $v_{r,t}$ and COV_t variables are concerned. The respective coefficient estimates all have correct signs and are very precisely estimated (even though there is still a caveat because of strong autocorrelation). On the basis of the estimated coefficients one can conclude that increased variability of the nominal returns tends to raise the nominal returns while increased hedging possibilities tend to lower them.

After these preliminary results it is time to determine the proper dynamic specification. Now, when different dynamic specifications are fitted to the data, the values of the log likelihood functions indicate that the unrestricted dynamic model is typically superior to other specifications.3)

For instance, in the case of the hedging model the Cochrane-Orcutt specification can be rejected in favour of the unrestricted dynamic specification in all but one case. Thus the almost mechanical use of the former procedure in estimating interest rate equations is at variance with the data. For reasons of space we are not able to present the results of the unrestricted dynamic forms for all specifications, the only exception being the hedging model.4)

The results shown in Table 4 tell us basically the same story as those in Table 3. The only difference is that the role of the anticipated inflation rate variable diminishes drastically. Only in one case does the respective t-ratio exceed the 5 per cent level of significance. By contrast, the lagged interest rate variable appears to be an essential ingredient of the interest rate equation. Very high values of the coefficients for this variable suggest that interest rates adjust only sluggishly to the long-run equilibrium. This is certainly not a very surprising result, even though it is somewhat puzzling given the fact that we usually assume that interest rates adjust immediately to create an equilibrium in different markets.5)

4. CONCLUDING REMARKS

Our empirical results indicate that the behavior of interest rates cannot adequately be explained by using the Fisher equation, irrespective of the way the assumed changes in the real rate of interest are modelled. It seems more fruitful to exploit the implications of the substitution between different financial assets and money in the way suggested by Carmichael and Stebbing when modelling the behavior of interest rates. Another issue which should be emphasized in this context is the need for a through empirical analysis of the dynamics of interest rate behavior.

FOOTNOTES

1) To be more explicit, the demand for bonds can be expressed as: $B = W((1/RRA)(E(R)/V(R) + (COV(R,P)/V(R)(1-1/RRA))$, where B denotes the stock of bonds, W the stock of wealth, RRA the Arrow-Pratt measure for relative risk aversion, E(R) the expected return from bonds, V(R) the variance of the nominal bond return, and COV(R,P) the covariance between the nominal bond return and the rate of inflation. The sign of the hedging effect is in principle ambiguous; a plausible assumption is that RRA exceeds one; that, in turn, gives the result in the text.

2) Unfortunately, the data do not allow for a rigorous treatment of the maturity structure of interest rates and inflation expectations. The same is true with taxes.

3) The values of the log likelihood functions for different specifications turned out to be:

	(1)	(2)	(3)	(4)	Model
USA:GB	248.09	373.15	365.44	374.82	F
UK:GB	238.58	329.41	329.43	329.44	F
CAN:GB	262.15	345.64	345.99	349.15	F
USA:TB	238.56	298.50	295.95	298.93	F
UK:TB	211.45	287.21	287.13	287.21	F
CAN:TB	222.66	287.43	288.36	290.94	F
USA:GB	249.37	381.57	368.58	387.56	A
UK:GB	248.00	330.51	330.32	330.77	A
CAN:GB	282.13	346.24	346.12	354.67	A
USA:GB	243.04	308.59	303.43	316.01	A
UK:TB	219.04	291.85	294.56	295.73	A
CAN:TB	253.16	289.12	289.04	300.31	A
USA:GB	324.73	374.84	397.84	409.33	H
UK:GB	265.32	330.79	331.84	333.07	H
CAN:GB	330.81	348.00	374.94	381.14	H
USA:TB	266.53	298.61	303.33	307.86	H
UK:TB	228.57	292.93	290.89	295.90	H
CAN:TB	240.52	287.52	293.48	301.34	H

F corresponds to the pure Fisher equation (cf. Table 1), A to the augmented Fisher equation (cf. Table 2) and H to the hedging model (cf. Table 3). The log likelihood of the static specification is presented in column (1); column (2) gives the log likelihood of the model with a lagged dependent variable, column (3) gives the log likelihood of the nonlinear equation corresponding to the Cochrane-Orcutt transformation and, finally, column (4) gives the log likelihood of the unrestricted dynamic model of the type: $y_t = a_0 + a_1x_t + a_2x_{t-1} + a_3y_{t-1}$.

4) The results with the other specifications (i.e. equations (1) and (4)) were typically very unsatisfactory. The signs of the coefficient estimates varied in a completely unsystematic way and the coefficients could only be estimated very imprecisely.

5) Equation (3) was also estimated in a system form. The respective FIML estimates are reported below.

	GB	TB
Constant:USA	.053	.014
	(26.24)	(4.72)
p_t^e:USA	.061	.472
	(2.33)	(7.78)
$v_{r,t}$:USA	2.550	2.475
	(13.52)	(8.42)
COV_t:USA	-.145	-.515
	(3.66)	(5.57)
Constant:UK	.064	.035
	(21.31)	(8.25)
p_t^e:UK	.143	.231
	(5.59)	(5.58)
$v_{r,t}$:UK	3.261	1.866
	(8.26)	(5.60)
COV_t:UK	-.317	-.023
	(4.19)	(0.29)
Constant:CAN	.064	.009
	(28.85)	(2.17)
p_t^e:CAN	.080	.632
	(0.37)	(1.62)
$v_{r,t}$:CAN	2.563	2.302
	(15.86)	(8.35)
COV_t:CAN	.004	-.544
	(0.06)	(5.14)
Log L	977.89	794.98

Log L denotes the value of the log likelihood function at optimum.

In evaluating these results one should notice that the long-term interest rates of Canada and the United States are strongly correlated (r = .994) while the correlation between the short-term rates is substantially lower (r = .942). This presumably explains the very low values of the corresponding coefficients of p_t^e. The important point, however, is that the $v_{r,t}$- and COV_t-variables display striking robustness with respect to both interest rates in all three countries.

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DEFINITION OF SYMBOLS:

GB	Yield on long-term government bonds
TB	Yield on three-month treasury bills
p^e	Expected inflation rate (correponds to the predicted value of a univariate AR(4) model for the four-quarter rate of change of the CPI)
s_p	Variability of the inflation rate (constructed by computing a lagged 12-quarter moving standard deviation of p)
v_r	Variability of the interest rate (constructed by computing a lagged 12-quarter moving variance of GB and TB)
COV	Covariance of inflation and interest rates (constructed by computing a lagged 12-quarter moving covariance between p and GB, or between p and TB)
m	Proxy for "unanticipated money" (constructed by using the residuals of a univariate AR(4) model for the four-quarter growth rate of the nominal M1)
y	Proxy for aggregate demand shocks (constructed by using the residuals of a univariate AR(4) model for the four-quarter growth rate of the GDP)

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