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A COMMENT ON FELDSTEIN'S FISHER-SCHULTZ LECTURE

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Abstract

Feldstein argues in his Fisher-Schultz Lecture that he has found, by accounting for inflation and taxes, large and significant rate of return effects on investment. His results are interesting because they seem to be robust to alternative specifications of the investment equation. Feldstein has clearly not exhausted all possible specifications of the investment equation, and this comment reports on results, using Feldstein's data, for one alternative specification. The results do not support Feldstein's conclusion. The data do not appear to contain enough information to decide the issue of the quantitative effect of the cost of capital on investment.

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A COMMENT ON FELDSTEIN'S FISHER-SCHULTZ LECTURE[1]

by

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The debate regarding the quantitative effect of the cost of capital on investment has been going on for a long time. Applied macro work is fraught with problems, some of which are reviewed in the Lecture, and the investment results have so far been mixed. It may be that the data do not contain enough information yet to allow one to decide this issue. Feldstein argues, however, that he has found, by accounting for inflation and taxes, large and significant rate of return effects on investment. His results are interesting because they seem to be robust to alternative specifications of the investment equation.

Feldstein has clearly not exhausted all possible specifications of the investment equation, and it is in the spirit of his Lecture to see if the rate of return variables are significant in alternative specifications. This comment reports on results, using Feldstein's data, for one alternative specification. The results do not support Feldstein's conclusion.

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[1] Feldstein (1980).

Consider the following simple model.[2] Let I_t^n denote investment, Y_t output, and K_t^n the net capital stock. Assume that the short run production function is one of fixed proportions and that firms may at times be "off" of this production function in that they may at times hold either or both "excess" capital and "excess" labor. Let $KMIN_t$ denote the minimum amount of capital needed to produce Y_t, and call $K_t^n - KMIN_t$ excess capital. Finally, let I_t^{n*} denote "desired" net investment. Assume that desired net investment is a function of the amount of excess capital on hand at the beginning of the period and of current and past output changes:

$$(1) \qquad I_t^{n*} = \alpha_0(K_{t-1}^n - KMIN_{t-1}) + \alpha_1 \Delta Y_t + \alpha_2 \Delta Y_{t-1} \ .$$

One can think of the current and past output changes as proxying for expected future changes. Assume next that there are costs of adjusting net investment and more specifically that

$$(2) \qquad \Delta I_t^n = \lambda(I_t^{n*} - I_{t-1}^n) \ , \ 0 < \lambda \leq 1 \ .$$

Combining (1) and (2) yields:

$$(3) \qquad \Delta I_t^n = \lambda\alpha_0(K_{t-1}^n - KMIN_{t-1}) + \lambda\alpha_1\Delta Y_t + \lambda\alpha_2\Delta Y_{t-1} - \lambda I_{t-1}^n \ .$$

As noted above, it is in the spirit of Feldstein's Lecture to add various rate-of-return variables to equation (3) to see if they are significant. If they are, then this would be support for his conclusion that

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[2]The theory behind this model is discussed in Fair (1974, 1976). The model seems to provide a fairly good explanation of the aggregate quarterly U. S. investment data. Feldstein's data are annual.

rate-of-return variables are significant across quite different specifications. For present purposes three variables have been tried: net return (RN), net return cyclically adjusted (RNA), and the difference between the potential and actual cost of funds (MPNR - COF). The data on these three variables are presented in Feldstein's Tables I and IV. Data on I^n/Y are presented in Table I, but data on I^n and Y are not presented separately. Data on I^n and Y were collected from the Survey of Current Business (Tables 5.3 and 1.2, respectively). A supplement to the Survey (The National Income and Product Accounts of the United States, 1929-74) was used for the data for 1972 and back; the July 1977 issue was used for the 1973 data; the July 1978 issue was used for the 1974 data; and the July 1979 issue was used for the 1975-1978 data. The ratios of I^n to Y matched Feldstein's ratios in Table I up to the number of digits presented in Table I. Feldstein also presents data on I^n/K^n in Table I, and K^n was taken to be I^n divided by I^n/K^n. Data on Y were collected back to 1951 (Table I begins with 1953) because some of the equations required data back this far.

In order to estimate equation (3), data on KMIN are needed. Three different measures were tried in the empirical work. For the first, $KMIN_t$ was taken to be $Y_t/1.471716$, where 1.471716 is the largest value of Y_t/K_t^n over the 1953-1978 period (the value in 1953).[3] This measure is based on the assumption that there has been no decline in the "potential" productivity of capital since 1953. For the second measure,

[3]The value of Y_t/K_t^n fell from 1.47 in 1953 to 1.36 in 1958, rose to 1.43 in 1964, fell to 1.28 in 1971, rose to 1.33 in 1973, fell to 1.23 in 1975, and rose to 1.32 in 1978.

$KMIN_t$ was taken to be $Y_t/1.413047$, where 1.413047 is the ratio of Y_t/K_t^n in 1963. For the third measure, $KMIN_t$ was taken to be $Y_t/(\hat{\hat{Y_t/K_t^n}})$, where $\hat{\hat{Y_t/K_t^n}}$ is one standard error greater than the predicted value of Y_t/K_t^n from a regression of Y_t/K_t^n on a constant and time for the 1953-1978 period. The third measure is based on the assumption that there has been a steady decline in the potential productivity of capital since 1953. The estimate of the coefficient of t in the regression was $-.0066$.

The results are presented in Table 1. In rows 1-3 estimates are presented for the three excess capital measures with no rate of return variables. The first and second measures give very similar results. The fit for the third measure is slightly worse than the fits for the other two. Row 4 contains estimates for the case in which no excess capital variable is included in the equation. Since the first and second measures give such similar results, no further estimates using the second measure are presented in the table.

Row 5 is the same as row 1 except that RN_{t-1} is added. The coefficient estimate for RN_{t-1} is of the wrong sign and is not significant. (By "significant" I will mean a coefficient estimate with a t-statistic greater than 2.0 in absolute value.) RN_{t-1} and the excess capital measure are highly correlated, and the introduction of RN_{t-1} to the equation has lowered the t-statistic for the excess capital variable from 2.53 to 1.43. Row 6 is the same as row 3 except the RN_{t-1} is added. The coefficient estimate for RN_{t-1} is now of the right sign, but with a t-statistic of only 0.50. Row 7 is the same as row 4 except that RN_{t-1} is added. Without the excess capital variable in the equa-

TABLE 1

Various Estimates of an Investment Equation
(t-statistics in absolute value are in parentheses)

$$\Delta I_t^n = \beta_0 + \beta_1(K_{t-1}^n - KMIN_{t-1}) + \beta_2 \Delta Y_t + \beta_3 \Delta Y_{t-1} + \beta_4 I_{t-1}^n + \beta_5 \quad (RN_{t-1} \text{ or } RNA_{t-1} \text{ or } MPNR_{t-1} - COF_{t-1})$$

Row	Measure of KMIN	Rate of Return Variable	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_4$	$\hat{\beta}_5$	$\hat{\rho}^\dagger$	R^2	SE	DW	Sample Period
1	1	--	-2.08 (1.15)	-.0368 (2.53)	.195 (7.68)	.109 (4.31)	-.174 (2.64)			.870	2.82	2.02	1954-1978
2	2	--	-2.58 (1.41)	-.0412 (2.53)	.194 (7.68)	.107 (4.17)	-.183 (2.84)			.870	2.83	2.01	"
3	3	--	-.43 (0.21)	-.0609 (2.16)	.185 (7.36)	.092 (3.09)	-.228 (3.66)			.861	2.92	1.86	"
4	-	--	-2.03 (1.00)		.169 (6.49)	.126 (4.61)	-.242 (3.59)			.828	3.17	1.71	"
5	1	RN_{t-1}	-.86 (0.27)	-.0521 (1.43)	.214 (4.39)	.155 (4.02)	-.127 (1.03)	-61.6 (0.46)		.871	2.88	2.08	"
6	3	"	-1.93 (0.54)	-.0468 (0.83)	.174 (5.01)	.093 (3.06)	-.248 (3.33)	48.5 (0.50)		.863	2.98	1.88	"
7	-	"	-4.32 (1.96)		.154 (6.10)	.103 (3.68)	-.277 (4.25)	113.8 (2.03)		.858	2.96	1.96	"
*8	3	"	-2.81 (0.72)	-.0238 (0.36)	.153 (3.28)	.100 (3.10)	-.272 (3.27)	88.7 (0.77)		.860	3.01	2.01	"
9	1	RNA_{t-1}	-2.42 (0.62)	-.0374 (0.90)	.200 (4.17)	.107 (3.46)	-.163 (1.75)	-2.24 (0.02)		.864	3.04	1.95	1955-1977
10	3	"	-3.45 (0.77)	-.0308 (0.47)	.176 (4.78)	.097 (2.96)	-.220 (3.21)	61.9 (0.66)		.859	3.09	1.77	"
11	-	"	-5.19 (2.12)		.165 (5.96)	.102 (3.36)	-.221 (3.29)	99.6 (2.07)		.857	3.02	1.76	"
12	1	$MPNR_{t-1} - COF_{t-1}$	-3.27 (1.40)	-.0229 (0.95)	.182 (4.98)	.101 (3.42)	-.180 (2.40)	48.6 (0.77)		.869	2.99	1.79	"
13	3	"	-2.72 (1.01)	-.0357 (0.84)	.172 (5.40)	.092 (2.90)	-.213 (3.17)	65.0 (1.20)		.867	3.01	1.67	"
14	-	"	-4.05 (1.86)		.160 (5.73)	.102 (3.45)	-.212 (3.19)	93.2 (2.22)		.862	2.98	1.58	"
15	1	"	-6.77 (2.10)	.0172 (0.53)	.142 (3.36)	.105 (3.93)	-.208 (2.42)	162.8 (2.10)	.26 (1.26)	.889	2.81	1.99	1956-1977
16	3	"	-5.87 (1.72)	.0049 (0.10)	.156 (4.61)	.107 (3.39)	-.191 (2.50)	126.3 (2.09)	.20 (0.94)	.887	2.83	1.99	"
17	-	"	-5.66 (2.27)		.158 (5.71)	.105 (3.98)	-.192 (2.61)	122.5 (2.77)	.20 (0.94)	.887	2.75	1.98	"

† $\hat{\rho}$ is the estimate of the first order serial correlation coefficient.

*Equation estimated by 2SLS, with first stage regressors: constant, Y_{t-1}, Y_{t-2}, Y_{t-3}, I_{t-1}^n, I_{t-2}^n, $K_{t-1}^n - KMIN_{t-1}$, RN_{t-1}, and t.

Note: Suppressing the constant term in the regressions either had a negligible effect on the results or lessened the significance of the rate of return variables.

tion, the coefficient estimate for RN_{t-1} is now significant (a t-statistic of 2.03).

Row 8 is the same as row 6 except that the equation has been estimated by two stage least squares (the endogenous variable on the right hand side is ΔY_t). With so few observations, it does not make too much sense to use the 2SLS estimator, but it is perhaps somewhat encouraging that the coefficient estimate for ΔY_t is not much affected by the use of the estimator.

Rows 9-11 are the same as rows 5-7 except that RNA_{t-1} replaces RN_{t-1} and the sample period is shortened by two years. The results for RNA_{t-1} are similar to those for RN_{t-1} . Rows 12-14 are the same as rows 5-7 except that $MPNR_{t-1} - COF_{t-1}$ replaces RN_{t-1} and the sample period is shortened two years. The results are again similar to those for RN_{t-1} , except that all three coefficient estimates for $MPNR_{t-1} - COF_{t-1}$ are now of the right sign.

The equations were also estimated under the assumption of first order serial correlation.[4] The estimates of the serial correlation coefficient were all small and had a very small effect on the other coefficient estimates except for the equations in rows 12-14, i.e., the equations using $MPNR_{t-1} - COF_{t-1}$. As can be seen in rows 15-17, which are the same as rows 12-14 except for the assumption of serial correla-

[4]Feldstein estimated his equations under this assumption. When he lists the sample period for, say, equation (3.2) as being 1954-78, it has been assumed that 1954 was used for the lagged values and thus that the true estimation period is 1955-78. Otherwise, since a lagged value of RN_{t-1} is needed (i.e., a value of RN_{t-2}) , when equation (3.2) is estimated under the assumption of first order serial correlation, data on RN for 1952 would be needed. The data for RN begin in 1953.

tion, the coefficient estimate for $MPNR_{t-1} - COF_{t-1}$ is significant in all three cases, with t-statistics of 2.10, 2.09, and 2.77.

The basic fit of the equations in Table 1 is considerably better than the basic fit of Feldstein's investment equations. This cannot be seen directly from Table 1, but it can be seen as follows. The sum of squared residuals for, say, Feldstein's equation (3.2) is .0003438. The left-hand-side variable of this equation is I_t^n/Y_t . In order to compare the basic fit of the equations in Table 1 to this number, I computed (using the equation estimated in row 3) the predicted value of ΔI_t^n for each t and added this value to I_{t-1}^n to get a predicted value of I_t^n . Call this value $\hat{I}_t^n$. I then divided $\hat{I}_t^n$ by Y_t and computed $\sum_{t=1954}^{1978} (\hat{I}_t^n/Y_t - I_t/Y_t)^2$, which is the appropriate sum of squared residuals to compare to Feldstein's. The value was .0001798, which is 52.3 percent less than .0003438. This is a considerable difference in fit for macro time series data. Although this comparison used the equation in row 3 in Table 1, the fits of all the equations in Table 1 are close, which means that all of them fit much better than do Feldstein's equations.

What should one conclude from the results in Table 1? If one were forced to decide yes or no about the significance of rate-of-return variables on investment, the conclusion would probably be no. RN_{t-1} and RNA_{t-1} are significant only when the excess capital variable is omitted from the equation, and even then the t-statistics are only 2.03 and 2.07. The results are stronger for $MPNR_{t-1} - COF_{t-1}$, although the maximum t-value obtained is only 2.77. Given the poor results for two of the three rate-of-return variables and the marginal significance of the third, it would not necessarily be unreasonable to conclude that the data do not support the hypothesis of significant rate of return effects on investment. A more reasonable conclusion to draw from the results, however, is that they are inconclusive. The data just do not appear to contain enough information to decide the issue.

I hasten to add that I do not think that the model used for the results in Table 1 is without faults. The model is quite simple, and no great care has gone into measuring excess capital. I am also skeptical about using annual data to test hypotheses regarding investment behavior, and I am uncomfortable analyzing the investment decision other than within the context of a complete model of firm behavior (i.e., a model that considers at the same time the price, wage, employment, and output decisions of a firm). But any caveats that one may have about the model are really beside the point. The point is that Feldstein's strong conclusion does not hold up for an alternative model of investment behavior, a model that is not *a priori* particularly unreasonable and that fits the data much better than do Feldstein's models.

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