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WHICH INTEREST RATE SEEMS MOST RELATED TO BUSINESS INVESTMENT? A FEW PRELIMINARY FINDINGS FROM AN ONGOING STUDY

John J. Heim*

Abstract: This paper examines (econometrically) which interest rates seem most systematically related to investment and the GDP and how long the lag time is before changes in these interest rates affect the GDP. We conclude that the Prime interest rate has the most important and systematic influence on these variables and that it affects investment and the GDP after a two year lag due to the lengthy periods required to design, bid and build new factories, commercial facilities and some machinery. Other rates examined, but not found related to investment - triggered GDP growth, include the Aaa and Baa corporate bond rates, the Mortgage interest rate and the 10 year Treasury bond rate. Our results also suggest the magnitude of the effect of interest rate changes on the economy is relatively modest, and that therefore the Federal Reserve's ability to influence the economy by changing rates may also be somewhat constrained. JEL E00,E12, E22,E44.

Over the years, there has been much debate about the affect, if any, of interest rates on investment, and subsequently through the multiplier, in a larger way on the GDP itself. Some studies have shown it to be an important determinant. Bernanke (1983), for example, notes that during the 1979-82 period, real interest rates were high and widely blamed for low investment, and that his own work confirmed this. Others such as Biven (1986) found no relationship when testing inventory investment. Nor did Jorgenson, Hunter and Nadiri (1970) who examined two investment models that used interest rates and found they predicted poorly. Others, like Eisner (1971) and Fair (1988), have found interest rates to have an effect on investment, but only a limited one.

To the extent that results by seasoned researchers differ, there would seem to be two likely reasons (and perhaps others): First, it may be that interest rates, though systematic in their effect, have such a small effect, that multicollinearity or small sample size problems can leave the variable looking insignificant when it really isn't. Second, one notices that the particular interest rate used in studies varies: some use short term government rates, others long term government or corporate bond rates, and even among studies using the same rate, the extent to which they lag the value used usually is not the same.

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It may be that some rates are, and others are not, related to investment and that even for those rates that are related, test results will show no relationship if the wrong lag is used. This in fact, is the hypothesis of this paper. To test this hypothesis, we will construct a simple Keynesian model of the economy. In it we will have consumption as a function of after-tax income only. Investment will be a function of an interest rate and an accelerator variable only. We will use these two equations to construct the IS curve they infer. The IS curve will tell us not only the effects of a change in interest rates on investment, but through the multiplier, the larger effect on the GDP as a whole. We will then test this IS model to see which interest rates, with which lags, best explains the variance in GDP 1960-2000, *ceteris paribus*.

A Model Showing the Impact of Interest Rates on the GDP, Via Investment

For business community readers unfamiliar with common textbook economic notation, the following definitions are presented: The GDP (Y) is comprised of consumer goods (C), investment goods (I), government goods and services (G) and net exports (X-M):

(1) $Y = C + I + G + (X-M)$

In a simple Keynesian model of the economy

(2) $C = c_0 + (c_1 + m_{c1})(Y-T)$ where Y-T is total income generated producing the GDP minus total taxes; $c_1 + m_{c1}$ are the marginal propensities to consume domestic and imported goods

(3) $I = I_0 + (I_1 + m_{I1})\,\Delta Y - (I_2 + m_{I2})\, r$

where ΔY is the accelerator, indicating I grows in response to the general growth in the economy, r is the real interest rate, $I_1 + m_{I1}$ are the marginal propensities to purchase domestically produced or imported investment goods in response to a change in the GDP, and $I_2 + m_{I2}$ are the marginal propensities to invest in these goods when interest rates change

(4) $M = m_0 + m_{c1}(Y-T) + m_{I1}\,\Delta Y + m_{I1}\, r$ i.e., the demand for imported consumer or investment goods is driven by the same variables as is domestic demand.

Substituting (2), (3) and (4) into equation (1) gives

(5) $Y = (c_0 + I_0 - m_0) + c_1(Y-T) + I_1\,\Delta Y - I_2\, r + G + X$ i.e., the domestic GDP is a function of the demand for domestic goods

Collecting the Y terms, we get

(6) $$Y = \frac{(c_0 + I_0 - m_0) - c_1 T + I_1\,\Delta Y - I_2\, r + G + X}{(1-c_1)}$$

adding and subtracting T to the right side gives

$$(7)\ Y = \frac{(c_0 + I_0 - m_0) + (1 - c_1)\,T - (T - G) - I_2\, r + X + I_1\, \Delta Y}{(1-c_1)}$$

or, where the subscript t denotes the current period, we can rewrite (7) as

$$(8) \qquad Y_t = \beta_1 + \beta_2 T_t - \beta_3 (T\text{-}G)_t + \beta_4 X_t - \beta_5 r_t + \beta_6 \Delta Y_t$$

This formulation has the advantage of showing clearly the effect of Keynesian deficits on the economy. Further, if it is also true that that, given (8),

$$(9) \qquad Y_{t-1} = \beta_1 + \beta_2 T_{t-1} - \beta_3 (T\text{-}G)_{t-1} + \beta_4 X_{t-1} - \beta_5 r_{t-1} + \beta_6 \Delta Y_{t-1}$$

then it must follow that

$$(10) \qquad \Delta Y_t = \beta_2\, \Delta T_t - \beta_3\, \Delta(T\text{-}G)_t + \beta_4\, \Delta X_t - \beta_5\, \Delta r_t + \beta_6\, (\Delta Y_t - \Delta Y_{t-1})$$

METHODOLOGY

The 1960-2000 data we will use is all taken from the Council of Economic Advisor's data appendices to the *Economic Report of the President, 2002*, Tables B2, B3, B7, B60, and B82.

Equation (10) is the equation we shall test to determine which interest rate, through its effect on I, affects Y the most, and the most systematically. As in (10), our regressions are run using first differences of the IS equation variables. First differences are commonly used to reduce non-stationary and multicollinearity issues in our time series data.

We define the interest rate that businessmen consider in period t when deciding how much to invest to be the "real" interest rate (r), which we define as the current nominal interest rate (i_t) minus the inflation rate in (t-1), the last year for which they have full inflation data. The implicit price deflator is used to measure inflation. Since G represents only government purchases of goods & services, and excludes government transfers, Taxes (T) are similarly adjusted downward to exclude those collected to fund transfers, not goods and services, as is the usual practice among economists.

FINDINGS

The Prime rate is the interest rate initially used, since preliminary exploration indicated greater sensitivity of the GDP to this interest rate than to various bond rates. This makes a certain degree of sense given that over half of all external financing obtained by non-financial corporations is from banks or bank-like entities, with only roughly a third coming from bond issues (Mishkin, 2004). The Prime rate, of course, is a key bank-established lending rate.

Theory is not clear as to whether it is current or lagged values of real interest rates (r) that influence the level of the GDP through their affect on investment. Table 1 below show the results of testing whether the current or one of four successively more distantly lagged period values of r best explains changes in Y when equation (10) above is tested. The results in Table 1 regarding the lag in time between a change in the real interest rate and its effect (through increased investment and the subsequent multiplier) on the GDP are quite clear: Only the hypothesis that the lag is 2 years produces any statistically significant results. This is a reasonable lag to expect. After a decision is made to expand productive capacity, most expenditures are made during a projects' construction or installation phase, subsequent to an often multi-year design and bidding process. Machinery of any substantial size and sophistication is also often must be ordered long before desired delivery dates.

Notice that the coefficients on the other variable only change slightly when the real interest rate variable is dropped from the equation. This suggests that our findings of the independent effects of the real interest rate are not substantially affected by multicollinearity. We also find that dropping he interest rate variable results in a drop in the R^2 from 63 to 56%. Hence, interest rate effects are substantial enough to explain 7% of the variance in GDP over the 1960-2000 period. Though greater than Fair's 1988 estimate of 3%, it is still relatively small.

The data for the last 40 years suggest that a one percentage-point drop in the real interest rate generates a only a $15.39 billion dollar real (in 1996 dollars) increase in the GDP 2 years later. This also suggests that over the past 40 years the impact of changing real interest rates, though systematic, may not have accounted for much of the total variation in GDP.

In short, the results, using this simple Keynesian model, suggest the IS curve is extremely steep, and its location leftward or rightward on the IS-LM graph, i.e., its horizontal intercept determined by other factors , rather than its slope is the principal determinant of where the curve will intersect the LM curve. This means that accelerator effects, deficit effects and changes in export levels probably shape the level of the GDP more than the level of interest rates. For example, the average (absolute value) change in the real GDP each year during the period was $177 billion, suggesting that the accelerator effect alone changed GDP an average of about $90 billion each year; the average change in real exports was about $27.5 billion a year, changing GDP about $71 billion a year, and the average change in the (absolute) value of the deficit of $49.84 billion produced annual change in the GDP about $109 billion a year. By comparison, the average annual change in real interest rates (about 1.45% when ipd-deflated) changed real GDP (two years later) only $22 billion

This of course also suggests that to the extent Federal Reserve policy can affect the Prime rate, monetary policy to this end will only have a small impact on the level of the GDP. .

Table 1
IS Curve Estimates Using Various Lagged Real Prime Rate (r) Values
(Real Prime $Rate_t$ = Nominal Prime $Rate_t$ - $Inflation_{t-1}$)
(Dependent Variable: ΔY_t)

Δr	(Defl)	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2
$r_t - r_{t-1}$	(ipd)	2.89(6.3)	-2.29(-4.3)	2.47(6.0)	+ 3.69(0.4)	.49(4.4)	57%
$r_{t-1} - r_{t-2}$	(ipd)	2.87(6.2)	-2.19(-4.5)	2.48(5.9)	+ 0.95(0.1)	.49(3.8)	57%
$r_{t-2} - r_{t-3}$	(ipd)	3.02(6.8)	-2.56(-5.2)	2.56(6.5)	**-15.39(-2.3)**	.52(4.9)	62%
$r_{t-3} - r_{t-4}$	(ipd)	2.95(6.0)	-2.27(4.3)	2.46(5.7)	- 0.63(-0.1)	.49(4.1)	56%
$r_{t-4} - r_{t-5}$	(ipd)	2.84(5.8)	-2.21(-4.3)	2.58(6.0)	+ 9.06(1.3)	.46(4.0)	59%
(no r included)		2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%

* data in parenthesis are t-statistics: 2.0 = 5%, significance level; 2.7 = 1% level
Implicit price deflator used to measure inflation when calculating r

We also tested one nominal interest rate (i), the prime interest rate, to see if nominal rates may also affect the real GDP through the IS equation (10). The results are presented in Table 2 below. Except for one case in which the result seemed spurious, the results were not statistically significant. Only the two-year lagged value of the nominal Prime interest rate seemed at all systematically related to GDP, and even there, the low t-statistic (only significant at the 13% level) suggests the relationship between changes in the nominal prime interest rate and the GDP is much less systematic and predictable than the relationship between changes in the real prime interest rate and the GDP.

We findings suggest that, as economic theory also suggests, it is the real interest rate, not the nominal which most systematically leads to a change in investment and as a result, GDP.

Puzzling in Table 2 is the perverse sign and the strength of the t-statistic on the 4-year lag. Its simple correlation with the dependent variable is very low (+.12) compared to the much stronger negative coefficient for the 2-year lag (-.42). There is a moderate negative correlation (-.27) between the two and four year lags, which may also have influenced the apparent strength and sign of the 4-year lag's relationship with the GDP. We conclude the finding is spurious.

Table 2
IS Curve Estimates Using Various Nominal Lagged Prime Rate (i) Values
(Dependent Variable: ΔY_t)

Δi	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δi	$(\Delta Y_t - \Delta Y_{t-1})$	R^2
$i_t - i_{t-1}$	2.85(6.1)	-2.14(4.0)	2.51(5.9)	- 2.34(0.3)	.47(3.9)	57%
$i_{t-1} - i_{t-2}$	2.87(6.2)	-2.20(-4.5)	2.49(5.8)	+ 0.11(0.0)	.48(3.4)	57%
$i_{t-2} - i_{t-3}$	2.87(6.3)	-2.39(-4.8)	2.54(6.2)	**-12.11(1.6)**	.54(4.7)	59%
$i_{t-3} - i_{t-4}$	2.98(6.2)	-2.28(-4.5)	2.51(6.0)	+ 9.70(1.3)	.43(3.5)	58%
$i_{t-4} - i_{t-5}$	2.75(6.2)	-2.12(-4.5)	2.77(7.0)	+20.18(3.0)	.44(4.3)	66%
(no i included)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%

* data in parenthesis are t-statistics: 2.0, = 5%, significance levels; 2.7 = 1% level

Of course, the question arises as to whether the prime interest rate or some other rate most systematically influences GDP via investment effects. We tested a number of other real interest rates, including the 10 year treasury bond rate, the Moody's Aaa and Baa corporate bond rates, and the mortgage rate. The results are given in Tables 3. "Real" again takes the definition of current year nominal minus prior year's inflation (using the implicit price deflator).

The results shown in Table 3, also includes the Prime rate findings from Table 1 for reference. They fail to show, for any level of lag, a systematic negative relationship between the Aaa, Baa, Mortgage or 10 year Treasury rate and the GDP. However, as previously noted when examining Table 1, the results are consistent with the theory that the current year GDP is systematically related to a change in the real Prime interest rates two years earlier.

We conclude by noting again that this finding suggests the Federal Reserve's ability to systematically affect the GDP through changes in interest rates may be real, though perhaps only marginal in terms of magnitude, and perhaps only to the extent it is able to change the prime rate through its monetary policy actions.

Table 3
IS Curve Estimates Using Various Lagged Real Interest Rate (r is IPD Deflated) Values
("Real" Interest Rates = Nominal – Prior Year Inflation Rate)
(Dependent Variable: ΔY_t)

Δr	ΔT_t	$\Delta(T-G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2
$r_t - r_{t-1}$:						
10YTreas	2.89(6.4)	-2.28(-4.6)	2.50(6.1)	+ 8.94(0.8)	.47(4.2)	58%
Mortgage	2.88(6.4)	-2.32(-4.7)	2.52(6.2)	+15.86(1.2)	.49(4.5)	59%
Aaa	2.87(6.4)	-2.28(-4.7)	2.51(6.1)	+12.53(1.0)	.47(4.3)	58%
Baa	2.88(6.40	-2.27(-4.7)	2.49(6.1)	+13.32(1.1)	.48(4.4)	59%
Prime Rate	2.89(6.3)	-2.29(-4.3)	2.47(6.0)	+ 3.69(04)	.49(4.4)	57%
$r_{t-1} - r_{t-2}$						
10YTreas	2.85(6.2)	-2.18(-4.5)	2.48(6.0)	+ 8.96(0.8)	.52(4.4)	58%
Mortgage	2.85(6.1)	-2.18(-4.4)	2.49(6.0)	+ 3.28(0.2)	.49(4.2)	57%
Aaa	2.82(6.2)	-2.15(-4.4)	2.49(6.1)	+10.42(0.9)	.51(4.5)	58%
Baa	2.84(6.2)	-2.16(-4.4)	2.49(6.0)	+17.45(0.6)	.50(4.4)	58%
Prime Rate	2.87(6.2)	-2.19(-4.5)	2.48(5.9)	+ 0.95(0.1)	.49(4.4)	57%
$r_{t-2} - r_{t-3}$						
10YTreas	3.05(6.2)	-2.42(-4.5)	2.41(5.7)	-10.36(-0.9)	.49(4.4)	57%
Mortgage	3.05(6.4)	-2.43(-4.7)	2.43(5.9)	-16.56(-1.3)	.49(4.4)	58%
Aaa	3.02(6.1)	-2.38(-4.4)	2.43(5.7)	- 9.72(-0.8)	.49(4.3)	57%
Baa	2.95(5.9)	-2.29(-4.2)	2.45(5.7)	- 4.71(-0.4)	.49(4.3)	56%
Prime Rate	3.02(6.8)	-2.56(-5.2)	2.56(6.5)	**- 15.39(-2.3)**	.52(4.9)	62%
$r_{t-3} - r_{t-4}$						
10YTreas	3.01(6.2)	-2.38(-4.5)	2.45(5.8)	-11.50(-1.1)	.51(4.4)	58%
Mortgage	2.97(6.0)	-2.31(-4.3)	2.46(5.7)	- 4.33(-0.3)	.50(4.3)	56%
Aaa	3.00(6.1)	-2.35(-4.5)	2.46(5.8)	- 9.45(0.8)	.50(4.4)	57%
Baa	2.97(6.0)	-2.31(-4.3)	2.45(5.7)	- 4.90(-0.4)	.50(4.3)	56%
Prime Rate	2.95(6.0)	-2.27(-4.3)	2.46(5.7)	- 0.63(-0.1)	.49(4.1)	56%
$r_{t-4} - r_{t-5}$						
10YTreas	2.91(5.8)	-2.25(-4.3)	2.48(5.7)	+ 2.40(0.2)	.49(4.2)	56%
Mortgage	2.90(5.7)	-2.24(-4.2)	2.49(5.6)	+ 2.58(0.2)	.49(4.2)	56%
Aaa	2.92(5.8)	-2.25(-4.3)	2.48(5.7)	+ .25(0.0)	.50(4.2)	56
Baa	2.89(5.7)	-2.24(-4.2)	2.49(5.7)	+ 4.39(0.3)	.49(4.1)	56%
Prime Rate	2.84(5.8)	-2.21(-4.3)	2.58(6.0)	+ 9.06(1.3)	.46(4.0)	59%
(no r included)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%

* data in parenthesis are t-statistics : 2.0, = 5%, significance levels; 2.7 = 1% level
Prime Rate data from Table 1 are included for easy comparison with other rates.

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