WHICH INTEREST RATE SHOULD WE USE IN THE IS CURVE?

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Abstract

Do interest rates effect investment and the GDP? If so, which ones, and by how much? Research on this topic over 5 decades has produced conflicting results. Yet, this question is of critical importance to the viability of Keynesian macroeconomics. This paper attempts to explain why results have been conflicting. It also attempts to determine with some finality which rate(s), if any, are related to GDP through the standard Keynesian mechanism: the IS curve. The paper tests exhaustively (1) a variety of real and nominal rates, (2) different hypotheses about how businesses calculate "real" interest rates (3) how the number of lags used affects results, (4) whether small sample size inherent in annual time series data adversely affects results, and (5) whether lack of hetroskedasticity and autocorrelation controls in earlier studies influenced their findings. This paper concludes only the real prime or Federal funds rates, lagged two years and the nominal current mortgage rate are significantly related to variation in the GDP, and running the prime rate alone picks up most of the variation in both. The prime rate was found to be twice as important as the mortgage rate. It also finds relatively small size (40 observation) annual data sets do not lead to problems achieving statistical significance, at least in simple IS curve models. It also finds that post - 1980 White and Newey - West correction methods for hetroskedasticity make it far more likely that any of a wide variety of interest rates and lags will be found statistically significant than was the case in earlier studies, but that correcting for multicollinearity between rates again leaves only the real prime and Federal funds rate lagged two periods and perhaps the current nominal mortgage rate significant. The effect of changes in the prime rate and mortgage rates on the GDP, though systematic, appears to be small, implying the IS curve may be nearly vertical and the Fed's interest rate policy of little significance unless rate changes are draconian. We estimate that even a five percentage - point change in the real Federal funds and prime rates changes GDP only 2.4%, and employment only 1.2% maximally (using Okun's law). Other findings were that nominal interest rates deflated by adaptive expectations models of inflation using the past two year's inflation seem to best describe how businesses calculate real rates. Rational expectations models were least successful. Other rates examined include the ten year treasury rate, the Aaa and Baa corporate rates. They were seldom found statistically significant, but the mortgage rate's estimated marginal effect seems to also capture these rates' effect on the economy.

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Article Outline

1. Introduction

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1. Introduction

Whether or not interest rates influence investment and the GDP is a critically important macroeconomic issue. In the Keynesian system of mechanics, without interest rate influence the IS curve reduces to a vertical line and monetary policy becomes irrelevant. Most macroeconomics textbooks principally convey systems of mechanics that indicates they are relevant, despite the fact that over the decades there has been much debate about whether interest rates affect investment, and through investment, the GDP. Some studies have shown interest rates 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, like Eisner (1971) and Fair (1988), have found interest rates to have an effect on investment, but only a limited one. Still others found little or no relationship, such as Jorgenson, Hunter and Nadiri (1970) who examined two investment models that used interest rates and found they predicted poorly, nor did Biven (1986) when testing inventory investment.

To the extent that results by researchers differ, there would seem to be five likely reasons:

1. First, it may be that interest rates, though systematically affecting Investment and the GDP, have such a small effect on them that multicollinearity or small sample size problems encountered using time series data leave interest rates looking statistically insignificant when they are not.

2. Second, the interest rate used in studies varies considerably: some researchers use short or long term government bond rates, others use different long term corporate bond rates. Not all of them may be effective.

3. Even among studies using the same real rate, the number of periods which the rate is lagged tends to vary from study to study, as does the definition of “real”. It may be that only a few of these rates or lags are important, thereby explaining why some studies find the interest rate important, while others do not.

4. Recently developed and/or the wider availability in recent decades of methods for correcting for hetroskedasticity and autocorrelation may have significantly increased the t-statistics obtained on most variables in recent studies, increasing the chances of finding interest rates significant.

5. When testing the “real” interest rate, researchers may not define “real” the same way the business community does.

This paper tests these five hypotheses. To do so, we construct a somewhat simplified Keynesian model of the economy, which will allow us to test for the effects of interest rates while controlling for some of the other major influences on the GDP. Consumption spending is taken to be a function of after-tax income only, and investment is taken to 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, and test the IS curve. The IS curve will tell us the effects of a change in interest rates on investment, and the larger effect on GDP through the multiplier. Testing this model will give us some information on which interest rates, and which lags, (if any) seem most systematically related to the GDP. Annual U. S. data from 1960-2000 is used to test the model.

2. An IS Curve Model Showing the Impact of Interest Rates on the GDP

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 the horizontal intercept of the investment function shifts in response to the general growth in the economy; r is the real interest rate, and $(I_1 + m_{I1})$ are the marginal propensities to purchase domestic or imported investment goods in response to a change in the GDP. $(I_2 + m_{I2})$ are the marginal propensities to invest in these goods when interest rates change

(4) $M = m_0 + m_{c1}(Y-T) + m_{I1}\,\Delta Y - m_{I2}\,r$ 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 GDP is a function of the demand for domestic goods

Collecting the Y terms and adding and subtracting T on the right side, we get

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

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

$$(7) \qquad Y_t = \beta_1 + \beta_2 T_t - \beta_3 (T-G)_t + \beta_4 X_t - \beta_5 r_t + \beta_6 \Delta Y_t$$

This formulation has the advantage of showing clearly the effect of Keynesian deficits on the economy. Further, if it is also true that given (7),

$$(8) \qquad \Delta Y_t = \beta_2\,\Delta T_t - \beta_3\,\Delta(T-G)_t + \beta_4\,\Delta X_t - \beta_5\,\Delta r_t + \beta_6\,(\Delta Y_t - \Delta Y_{t-1})$$

Equation (8) is the model that will be tested. Into it, we will substitute different interest rates, interest rate lags, and definitions of "real', noting the effects on explained variance, the interest rate's coefficient and t statistic, and the effect on the stability of the estimates for the other variables.

3. METHODOLOGY

The 1960-2000 data used is taken from the Council of Economic Advisor's data appendices to the *Economic Report of the President, 2002*, Tables B2, B3, B7, B60, B73, B82 and B83.where

- Table B2 - Real Gross Domestic Product, 1959 -2001. Data on the consumption, investment, government spending and exports components of the GDP for 1960 -2000 were taken from this table

- Table B3 - Quantity and price indexes for gross domestic product, and percent changes, 1959–2001. Inflation estimates from this table, based on the implicit price deflator (ipd), were subtracted from nominal interest rates to obtain an ipd-based estimate of real interest rates.

- Table B7 - Chain-type price indexes for gross domestic product, 1959–2001. The government expenditures deflator from this table was used to deflate the government receipts data from Table B82.

- Table B60 - Consumer price indexes for major expenditure classes, 1958–2001. Inflation estimates from this table, based on the consumer price index (cpi), were subtracted from nominal interest rates to obtain a cpi-based estimate of real interest rates.

- Table B73 - Bond yields and interest rates, 1929–2001. Data on the federal funds rate, the prime interest rate, the AAA and Baa corporate bond rates and the 10 year treasury bond rate were taken from this table

- Table B82 - Federal and State and local government current receipts and expenditures, national income and product accounts (NIPA), 1959–2001. Total government receipts data from this table, minus government transfer payments data from Table B83, was used as our definition of government receipts to compare with government spending on goods and services for purposes of calculating the deficit, and for measuring disposable income.

- TABLE B–83.—Federal and State and local government current receipts and expenditures, national income and product accounts (NIPA), by major type, 1959–2001. Used as noted above in the description of uses of Table B82 data.

Equation (8) is the equation tested econometrically to determine which interest rate(s) seem most systematically related to the GDP (Y). The method used was single stage least squares. Two stage estimates of three of the right side variables (G, X and ΔY) were also tried, using the other right hand side variables as first stage regressors, but yielded identical results. As in (7), our regressions are run using first differences of the IS equation variables. First differences can help to reduce autocorrelation, non-stationarity and multicollinearity problems in time series data such as our 1960 - 2000 data. For the sample sizes in this study, t statistics of 1.8 are significant at the 8% level, t statistics of 2.0 are significant at the 5% level, and t statistics of 2.7 are significant at the 1% level. For this sample size, and the number of variables typically in the models tested, Durbin Watson statistics below approximately 1.25 suggest autocorrelation. Autocorrelation does not bias parameter (i.e., marginal effect) estimates, but often results in t statistics smaller than those that would prevail without autocorrelation (Griffiths, Hill & Judge, 1993). It often occurs because some explanatory variables are left out of the equation tested. Our model, in simplified form, does show autocorrelation, but later in this paper (Table 22) when other explanatory variables are entered, it disappears. More importantly, we find the absence of these variables did not effect our interest rate estimates significantly.

Initially, we will define the interest rate that business managers consider when deciding how much to invest to be the real interest rate (r). The real rate will be defined as the current nominal interest rate (i_t) minus the inflation rate in the last year (year t-1) for which businesses have full inflation information. Other definitions of real interest rates and nominal rates will be tested further below. Both the implicit price deflator and the cpi will be used to measure inflation. Since G represents only government purchases of goods & services, and excludes government transfers, government receipts ("taxes" or "T") are similarly adjusted downward to exclude those collected to fund transfers, not goods and services, as is the usual practice among economists.

We will measure the success of one interest rate variable compared to another by the amount of variance it explains, the theoretical correctness of its sign, and the strength of its t-statistic. We shall also evaluate results by observing the extent to which regression coefficients on other variables fluctuate when interest rate variables are added to the equation, or the particular rate used changes. Little or no fluctuation in regression coefficients for other variables suggests that the interest rate's coefficient (marginal impact estimate) is not being influenced by an ability to proxy for other variables in or out of the equation.

4. FINDINGS

4.A. Models Using Adaptive Expectations Methods To Estimate Real Interest Rates

The prime rate is the interest rate we will initially test, 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 other financial intermediaries, with only roughly a third coming from bond issues (Mishkin, 2004). The prime rate, of course, is a key bank-established lending rate that varies systematically with changes by the Federal Reserve in the federal funds rate (as we will show further below).

Theory is not clear as to whether it is current or lagged values of real interest rates (r) that influence the level of Y through their affect on investment. The first set of results in Table 1 below show the results of testing whether the current year real interest rate (r) or one of four successively more distantly lagged year values best explain changes in Y when the IS equation (10) above is tested. The definition of the real interest rate used (r) is the current nominal rate minus the average of the prior two year's cpi-measured inflation rates.

The results in Table 1 are quite clear. Only the hypothesis that there is a two year lag in time between a change in the real interest rate and its effect (by changing investment) on the GDP produces any statistically significant results. This may be theoretically plausible as well. Most expenditures incurred after a decision is made to expand productive capacity are made during a projects' construction, delivery or installation phases. This occurs after what can often be a lengthy design, competitive bidding and ordering process.

The results shown in Table 1, based on 1960-2000 data, suggest that a one percentage-point drop in the real interest rate generates a $15.89 billion dollar real (1996 dollars) increase in the GDP 2 years later.

The coefficients of the other variables in the equation change only slightly when the real interest rate variable is dropped from the equation, and the R^2 only drops from 64%% to 57%. The stability of the other coefficients suggests that our findings of the independent effects of the real interest rate are not substantially affected by multicollinearity. The R^2 results suggest that the impact of changing real interest rates, though systematic, has accounted for only 7% of the variation in year-to-year GDP changes over the years.

In short, the Table 1 findings suggest the IS curve is extremely steep. They also suggest the IS curve's location on the IS-LM graph, i.e., its horizontal intercept, rather than its slope, is theprincipal determinant of where the curve will intersect the LM curve, and therefore, what the GDP will be. Its horizontal intercept is determined by the current values of the non-interest rate factors in the IS equation, That is to say, accelerator effects, deficit effects and changes in export levels appear to shape the yearly changes of the GDP more than the yearly changes in interest rates. The average (absolute value) change in the real GDP each year during the period was

Table 1

IS Curve Coefficient Estimates Using Various Lagged Real Prime Rate (r) Values
(Real Prime Rate$_t$ = Nominal Prime Rate $_t$ - Average Inflation $_{(t-1)+(t-2)}$)
(Dependent Variable: ΔY_t)

Δr	(Deflator)	ΔT_t	$\Delta(T-G)_t$	ΔX_t	Δr	$(\Delta Y_t-\Delta Y_{t-1})$	R^2	DW
$r_t - r_{t-1}$	(cpi)	2.91(6.2)*	-2.38(-4.4)	2.48(5.9)	+ 6.23(0.8)	.50(4.4)	57%	1.21
$r_{t-1} - r_{t-2}$	(cpi)	2.95(6.0)	-2.28(-4.3)	2.48(5.7)	- 1.81(-0.2)	.47(3.2)	56%	1.18
$r_{t-2} - r_{t-3}$	(cpi)	3.05(6.7)	-2.60(-5.2)	2.59(6.5)	**-15.89(-2.6)**	.50(4.7)	64%	1.19
$r_{t-3} - r_{t-4}$	(cpi)	2.90(5.8)	-2.23(-4.2)	2.45(5.6)	- 3.53(-0.6)	.50(4.2)	58%	1.23
$r_{t-4} - r_{t-5}$	(cpi)	2.79(5.6)	-2.13(-4.1)	2.56(6.0)	+ 7.97(1.3)	.45(3.9)	61%	1.18
(no r included)		2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

$177 billion. Using the Table 1 findings as an example, we note that a change in these non-interest rate explanatory variables would be associated with the following effects;

- The accelerator variable's coefficient suggests an average-year change in the accelerator ($176 billion) effect alone might be associated with a GDP change of about $88 billion each year.
- The export variable's coefficient suggests the average yearly change in real exports ($27.5 billion) a year might be associated with a GDP change of about $71 billion a year
- the average change in the (absolute) value of the deficit of $49.84 billion, if caused by a change in government spending, might produce annual change in the GDP about $130 billion a year.
- By comparison, the average annual change (absolute value) in real interest rates, 1.56% when cpi-deflated by the last two years inflation rates, changed real GDP (two years later) only an average of $25 billion. For the average size of the real economy during the 1960 - 2000 period ($5113.9B), this suggests a 10% change in the prime rate changes GDP 3.1%. By Okun's law, this suggests a maximum possible change in unemployment of 1.55%. More refined estimates in this paper (see Table 21 and related text) will raise the estimated average change in GDP from the $25B above to $48 - 66B., and change the Okun - based estimate of the effects of a 10% change in the prime rate to 3.6% - 4.8% GDP growth and 1.8% - 2.4% unemployment decline. However, these estimates still leave the interest rate's average yearly change over the period having less effect on GDP than the average yearly changes of either the accelerator, the deficit or exports.

Testing the interest rate this way suggests that the IS curve may be nearly vertical, and shifts in the LM curve due to changes in monetary policy, unless these changes are draconian, may only have a limited, though systematic, impact on the level of the real GDP

Our IS curve only explains 64% of the variance because the model we are using is derived from simplified versions the consumption and investment functions. However, another study, (Heim, 2007a), suggests this model is more than adequate for our task. It finds that adding a wide range of additional variables to the IS equation does not change the interest rate results given in this paper (see section 6 below, where additional variables are aded).

The extent to which the nominal value of the prime interest rate (i) may affect the real GDP through the IS equation (8) was also examined for the 1960-2000 period. The results are presented in Table 2. The results were generally not statistically significant. Only the two-year lagged value of the nominal 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 the real prime interest rate and the GDP.

As theory suggests, the real interest rate, not the nominal seems to be the one most systematically associated with Keynesian changes in the GDP. Tables 3 - 5 below allow comparisons of other nominal and real rates.

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.

Table 2

IS Curve Coefficient Estimates Using Various Lagged Nominal 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	DW.
$i_t - i_{t-1}$	2.85(6.1)*	-2.14(4.0)	2.51(5.9)	- 2.34(0.3)	.47(3.9)	57%	1.16
$i_{t-1} - i_{t-2}$	2.87(6.2)	-2.20(-4.5)	2.49(5.8)	+ 0.11(0.0)	.48(3.4)	57%	1.18
$i_{t-2} - i_{t-3}$	2.87(6.3)	-2.39(-4.8)	2.54(6.2)	**-12.11(1.6)**	.54(4.7)	59%	1.05
$i_{t-3} - i_{t-4}$	2.98(6.2)	-2.28(-4.5)	2.51(6.0)	+ 9.70(1.3)	.43(3.5)	58%	1.18
$i_{t-4} - i_{t-5}$	2.75(6.2)	-2.12(-4.5)	2.77(7.0)	+20.18(3.0)	.44(4.3)	66%	1.52
(no i included)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

Of course, it might be that other interest rates are equally or more systematically related to investment and the GDP. To examine this question, a number of other real and nominal interest rates were tested, including the 10 year Treasury bond rate, the Moody's Aaa and Baa corporate interest rates, the mortgage rate and the federal funds (Fed. Funds) rate. The results are given in Tables 3 - 5. Results for the prime rate from Table 1 are included to facilitate comparison. "Real" again takes the definition of current year nominal minus the average of the prior two years inflation (using CPI to deflate in table 3, IPD in Table 4, and the nominal rate is used in Table 5). In later tables, other hypotheses as to how business people define the real rate will be tested.

The Table 3 results clearly show only the prime and Federal Funds rate being systematically related to the GDP, with t-statistics significant at the 2-3% level, though the mortgage rate appears marginally systematically related, with a t-statistic significant at the 8% level. Using the Prime rate variable alone in the regression, its coefficient (15.89) times the rate's average annual change (1.56%) suggests a possible $25B impact on the GDP in a year of average change in this interest rate's value. Rerunning the regression with the Prime rate and the Mortgage rate changes the coefficients on these interest rate variables so that an average change in both interest rates (0.83% for the Mortgage rate) has an estimated $24 B effect on the GDP. When a third interest rate, the AAA corporate bond rate (Average yearly change 0.90%) is added to the regression, the coefficients again change enough so that the total effect on the GDP is again about $24B. On the other hand, neither the Mortgage rate or the AAA rate, when used alone, produce nearly this combined effect. This suggests that the Prime rate alone serves as an adequate proxy for the combined effects of all three, but that the other two rates do not. High multicollinearity between the Prime rate and Mortgage rate (.83 simple correlation), the Prime and AAA rates (.78), and the AAA and Mortgage rates (.93) make obtaining credible estimates of separate effects of each of the three in the same regression impossible. This is an important finding, since reestimating Table 3 using Newey West hetroskedasticity corrections raises the t statistic on the AAA rate to 2.0, the Mortgage rate to 2.7 and the Prime rate to 4.4, warranting consideration as contributors to GDP change, but does not change their estimated marginal effects from those shown above in Table 3. This issue is discussed further later in the paper.

One hypothesis why bond interest rates were found insignificant in Table 3, based on the author's own construction industry experience[*], is that many capital projects are financed using bank loans to finance actual project costs as they are incurred. Only when projects are completed, often some years in the future after interest rate conditions have changed, are bond issued to pay off the banks.

Table 3

IS Curve Estimates Using Lagged Real Interest Rate Values for Various Interest Rates
Real Interest Rate (r) = Nominal Rate - Average CPI Inflation$_{(t-1)+(t-2)}$ (Except If Noted IPD)

Δr	ΔT_t	$\Delta(T-G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t-} - r_{t-1}$:							
10YTreas	2.88(6.2)	-2.32(-4.6)	2.53(6.1)	+10.46(1.1)	.47(4.2)	58%	1.22
Mortgage	2.84(6.2)	-2.37(-4.8)	2.59(6.3)	+19.08(1.6)	.50(4.6)	59%	1.21
Aaa	2.84(6.2)	-2.31(-4.7)	2.55(6.2)	+13.76(1.3)	.48(4.3)	58%	1.24
Baa	2.86(6.2)	-2.29(-4.7)	2.53(6.2)	+14.80(1.4)	.49(4.5)	58%	1.24
Prime Rate	2.91(6.2)	-2.38(-4.4)	2.48(5.9)	+ 6.23(0.8)	.50(4.4)	57%	1.21
Fed. Funds	2.90(6.2)	-2.40(-4.4)	2.51(6.0)	+ 6.11(0.8)	.50(4.4)	57%	1.21
$r_{t--1} - r_{t-2}$:							
10YTreas	2.93(5.9)	-2.26(-4.3)	2.46(5.7)	+ 2.62(0.3)	.50(4.1)	56%	1.17
Mortgage	2.98(5.9)	-2.30(-4.3)	2.46(5.7)	- 3.65(-0.3)	.48(4.0)	56%	1.17
Aaa	2.92(5.9)	-2.25(-4.3)	2.46(5.7)	+ 2.89(0.3)	.50(4.2)	56%	1.17
Baa	2.94(5.9)	-2.27(-4.3)	2.46(5.7)	+ 0.36(0.0)	.49(4.2)	56%	1.17
Prime Rate	2.95(6.0)	-2.28(-4.3)	2.48(5.7)	- 1.81(-0.2)	.47(3.2)	56%	1.18
Fed. Funds	2.95(6.0)	-2.27(-4.3)	2.47(5.7)	- 0.44(-0.1)	.49(3.2)	56%	1.17
$r_{t--2} - r_{t-3}$							
10YTreas	3.12(6.1)	-2.51(-4.6)	2.41(5.7)	-12.61(-1.3)	.48(4.2)	59%	1.22
Mortgage	3.12(6.4)	-2.53(-4.8)	2.45(5.9)	-20.33(-1.8)	.48(4.2)	60%	1.23
Aaa	3.10(6.1)	-2.48(-4.5)	2.42(5.7)	-13.26(-1.3)	.48(4.2)	58%	1.21
Baa	3.05(6.0)	-2.42(-4.4)	2.43(5.6)	-10.57(-0.9)	.49(4.2)	58%	1.21
Fed. Funds	3.07(6.7)	-2.65(-5.2)	2.59(6.5)	**-13.91(-2.5)**	.50(4.7)	63%	1.19
Prime Rate	3.05(6.7)	-2.60(-5.2)	2.59(6.5)	**-15.89(-2.6)**	.50(4.7)	64%	1.19
Fed. Funds(ipd)	*3.02(6.6)*	*-2.67(-5.2)*	*2.61(6.5)*	***-15.70(-2.6)***	*.52(4.9)*	*64%*	*1.17*
Prime Rate(ipd)	*2.98(6.5)*	*-2.57(-5.1)*	*2.60(6.5)*	***-16.31(-2.5)***	*.53(4.9)*	*64%*	*1.17*
$r_{t--3} - r_{t-4}$:							
10YTreas	2.99(6.1)	-2.33(-4.5)	2.42(5.8)	-13.57(-1.6)	.50(4.4)	60%	1.23
Mortgage	2.97(6.0)	-2.31(-4.4)	2.42(5.6)	-12.48(-1.1)	.49(4.3)	59%	1.25
Aaa	2.99(6.1)	-2.32(-4.4)	2.43(5.7)	-13.82(-1.4)	.49(4.3)	60%	1.23
Baa	2.98(6.0)	-2.30(-4.3)	2.41(5.6)	-11.95(-1.1)	.49(4.3)	59%	1.20
Prime Rate	2.90(5.8)	-2.23(-4.2)	2.45(5.6)	- 3.53(-0.6)	.50(4.2)	58%	1.23

* as Assistant Executive Director or Director of Upstate Design & Construction or Director of Internal Audit, N.Y.S. Facilities Development Corporation, Albany, N.Y. 1980-95

Table 3 (Con'd)

IS Curve Estimates Using Lagged Real Interest Rate Values for Various Interest Rates Real Interest Rate (r) = Nominal Rate - Average CPI Inflation$_{(t-1)+(t-2)}$ (Except If Noted IPD)

Fed. Funds	2.92(5.9)	-2.25(-4.2)	2.43(5.6)	- 4.36(-0.8)	.51(4.2)	58%	1.24
$r_{t-4} - r_{t-5}$:							
10YTreas	2.82(5.6)	-2.15(-4.0)	2.50(5.7)	+ 2.17(0.2)	.48(4.0)	59%	1.14
Mortgage	2.81(5.5)	-2.14(-4.0)	2.50(5.7)	+ 2.09(0.2)	.48(4.0)	59%	1.15
Aaa	2.82(5.6)	-2.14(-4.0)	2.49(5.7)	+ 0.37(0.0)	.48(4.1)	59%	1.15
Baa	2.81(5.6)	-2.14(-4.0)	2.50(5.7)	+ 3.23(0.3)	.48(4.0)	59%	1.15
Prime Rate	2.79(5.6)	-2.13(-4.1)	2.56(6.0)	+ 7.97(1.3)	.45(3.9)	61%	1.18
Fed. Funds	2.78(5.60	-2.13(-4.0)	2.57(5.9)	+ 6.15(1.1)	.46(3.9)	61%	1.15
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

Table 3 again shows that the current year GDP responds to a change in real interest rates two years earlier, but that only changes in the federal funds rate and the prime rate are significantly (2.5-2.6% level) related to changes in the GDP and that the average annual change in the federal funds rate in absolute terms (1.59%) yielded about the same change in real GDP two years later ($22 billion) as did the prime rate. This similarity of effect is not surprising; the simple correlation coefficient between the real prime rate and real federal funds rate 1959-2000 is .93.

The connection between the prime rate and the federal funds rate is strong; they essentially can be used interchangeably in regression models of investment without significant changes in the estimated regression coefficients and t-statistics of other variables, or in R^2s or Durbin – Watson (DW) statistics.

Clearly the pattern seems to be that the federal funds rate (and the discount rate, which is determined by it) drives the prime rate, which should come as no surprise since banks tend to set there prime rates to maintain a certain spread between their rate and the federal funds rate, e.g., note the following news item which appeared the day after 2/2/05 rise in the federal funds rate from 2.25 to 2.50%:

> …Many commercial banks responded by raising their prime rate, a benchmark for many consumer and business loans, to 5.5% from 5.25%…
>
> *Wall Street Journal*, *2/3/05, p.A2*

or this news item which appeared the day after the 8/8/06 decision by the Fed not to raise the federal funds rate further:

> …Ben Bernanke…led his central bank colleagues in holding a key interest rate steady at 5.25 percent....The decision to hold the federal funds rate steady means that commercial banks' prime lending rate – for certain credit cards, home equity lines of credit and other loans – stays at 8.25 percent….
>
> J. Aversa, Associated Press, 8/8/06

The systematic way in which the prime rate varies with changes in the federal funds rate is further illustrated in Graph 1 below which shows the fit of the regression equation testing the hypothesis that the prime rate is a function of the federal funds rate.

We established earlier in Table 1 that there is a systematic, though small, relationship between changes in the real prime rate and changes in the GDP. Our finding of the strong relationship between the prime and federal funds interest rates suggests the Federal Reserve's ability to affect the GDP is real and systematic, though perhaps small in terms of magnitude. This occurs because changes in the real federal rate systematically seem to result in change in the real prime rate. Fed policy, more so than the demand for money, seems to drive banks decisions when setting the Prime rate.

Table 4 also shows a tendency for a positive, but statistically insignificant relationship between current period interest rates and the GDP. This suggests the possibility that changes in long-term treasury, mortgage and corporate interest rates result from current period changes in GDP which change the demand for bonds (or change it more than the change in supply). These current period changes in the GDP may have been caused by changes in the prime and federal funds rates two years earlier. This is consistent with the finding that generally, current period interest rates tend to be procyclical (Mishkin, 2004). Further, changes in these supply and demand driven rates may pull the Federal Funds rate along in the same direction, as the Fed attempts to counter boom or bust economic conditions pushing these other rates up or down.

Graph 1

Relationship of Annual Changes the Prime Rate to the Changes In the Federal Funds Rate 1962 - 2000

Δ (Real Prime Rate)$_t$ = .853 Δ (Real Federal Funds Rate)$_t$ 2 = .95
(t=) (22.1) D.W. = 2.1

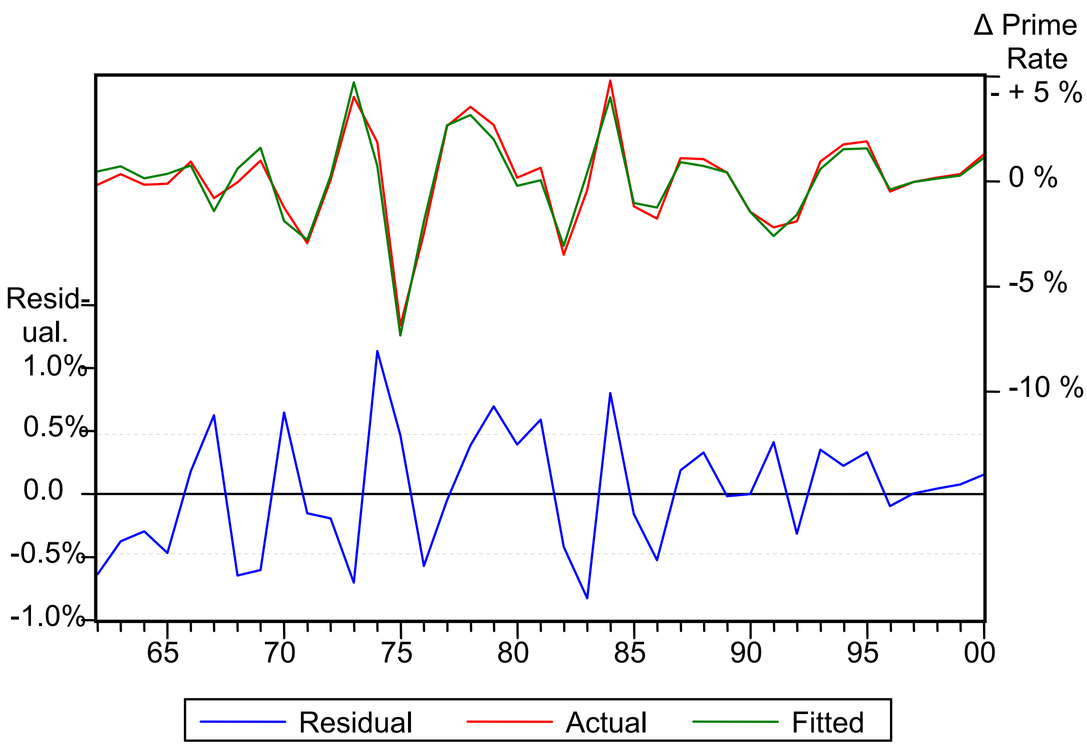

Table 4

IS Curve Coefficients Using Various Lagged Real Interest Rate (r is IPD Deflated) Values
("Real" Interest Rates = Nominal – Average Inflation Rate$_{(t-1)+(t-2)}$)
(Dependent Variable: ΔY_t)

Δr	ΔT_t	$\Delta(T-G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_t - r_{t-1}$:							
10YTreas	2.90(6.2)	-2.26(-4.4)	2.48(5.9)	+ 4.54(0.4)	.49(4.3)	56%	1.20
Mortgage	2.89(6.2)	-2.32(-4.9)	2.48(5.9)	+12.68(0.8)	.52(4.3)	57%	1.21
Aaa	2.90(6.1)	-2.26(-4.5)	2.47(5.9)	+ 7.80(0.6)	.49(4.4)	56%	1.21
Baa	2.89(6.2)	-2.25(-4.5)	2.47(5.9)	+ 7.63(0.6)	.50(4.3)	57%	1.21
Fed. Funds	2.90(6.1)	-2.28(-4.2)	2.48(5.9)	+ 2.26(0.3)	.49(4.3)	56%	1.19
$r_{t-1} - r_{t-2}$							
10YTreas	2.94(6.0)	-2.26(-4.3)	2.46(5.7)	+ 1.99(0.2)	.50(3.9)	56%	1.17
Mortgage	3.01(6.0)	-2.36(-4.4)	2.46(5.8)	- 11.67(0.7)	.45(3.6)	57	1.17
Aaa	2.93(5.9)	-2.26(-4.3)	2.46(5.7)	+ 2.08(0.2)	.50(4.0)	56%	1.17
Baa	2.96(6.0)	-2.29(-4.3)	2.46(5.7)	- 2.19(-0.2)	.49(4.0)	56%	1.17
Fed. Funds	2.95(6.0)	-2.28(-4.3)	2.48(5.7)	- 1.74(-0.2)	.47(2.9)	56%	1.17
$r_{t-2} - r_{t-3}$							
10YTreas	3.09(6.1)	-2.53(-4.5)	2.41(5.7)	- 15.13(-1.3)	.50(4.4)	59%	1.23
Mortgage	3.08(6.4)	-2.57(-4.9)	2.46(6.0)	- 28.60(-1.9)	.52(4.6)	61%	1.24
Aaa	3.07(6.1)	-2.50(-4.5)	2.42(5.7)	- 16.30(-1.2)	.50(4.4)	58%	1.21
Baa	2.99(5.9)	-2.38(-4.3)	2.44(5.6)	- 9.55(-0.7)	.51(4.3)	57%	1.21
Fed. Funds	*3.02(6.6)*	*-2.67(-5.2)*	*2.61(6.5)*	***-15.70(-2.6)***	*.52(4.9)*	*64%*	*1.17*
Prime Rate	*2.98(6.5)*	*-2.57(-5.1)*	*2.60(6.5)*	***-16.31(-2.5)***	*.53(4.9)*	*64%*	*1.17*
$r_{t-3} - r_{t-4}$							
10YTreas	2.95(6.0)	-2.28(-4.3)	2.43(5.7)	- 12.90(-1.2)	.52(4.4)	59%	1.21
Mortgage	2.92(5.8)	-2.25(-4.2)	2.44(5.6)	- 7.58(-0.5)	.50(4.1)	58%	1.21
Aaa	2.94(5.9)	-2.27(-4.3)	2.44(5.7)	- 12.02(-0.9)	.51(4.3)	59%	1.21
Baa	2.92(5.8)	-2.24(-4.2)	2.43(5.8)	- 6.24(-0.5)	.50(4.1)	58%	1.17
Fed. Funds	2.90(5.8)	-2.23(-4.2)	2.44(5.6)	- 2.86(-0.5)	.51(4.0)	58%	1.21
$r_{t-4} - r_{t-5}$							
10YTreas	2.78(5.6)	-2.14(-4.1)	2.57(6.0)	+ 13.03(1.2)	.47(4.1)	61%	1.12
Mortgage	2.67(5.4)	-2.04(-3.9)	2.66(6.1)	+ 22.38(1.5)	.46(4.0)	62%	1.11
Aaa	2.76(5.5)	-2.11(-4.0)	2.56(5.9)	+ 13.91(1.1)	.47(4.0)	60%	1.14
Baa	2.72(5.5)	-2.08(-4.0)	2.59(6.0)	+17.44(1.4)	.46(4.0)	61%	1.17
Fed. Funds	2.72(5.6)	-2.09(-4.1)	2.65(6.2)	+10.22(1.8)	.45(4.0)	63%	1.17
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

Table 5 nominal values of these interest rates, in general, show little systematic relationship to changes in the GDP. The nominal federal funds rate is found to have a negative 2 year lagged effect on GDP, like the results for the nominal value of the prime rate in Table 2. But in both cases, statistical significance levels are low. This suggests that on average, though the effects of changes in the nominal values are negative the predictability of this effect is only marginally reliable (unlike the real values of the prime and federal funds rate, as shown in Tables 1, 3 & 4).

All nominal interest rates show a curious, not easily explainable positive relationship with the GDP four years later.

Table 5

IS Curve Coefficients Using Various Lagged Nominal Interest Rate Values
(Dependent Variable: ΔY_t)

Δr	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t\text{-}\Delta Y_{t-1})$	R^2	DW
$i_{t-} - i_{t-1}$:							
10YTreas	2.86(6.1)	-2.18(-4.4)	2.50(6.0)	- 2.18(-0.2)	.48(4.3)	57%	1.16
Mortgage	2.87(6.1)	-2.19(-4.4)	2.49(5.9)	- 0.45(-0.0)	.48(4.0	57%	1.17
Aaa	2.87(6.2)	-2.19(-4.5)	2.49(5.9)	- 0.60(-0.0)	.48(4.3)	57%	1.17
Baa	2.87(6.2)	-2.20(-4.5)	2.49(5.9)	+ 0.05(0.0)	.48(4.2)	57%	1.18
Fed. Funds	2.87(6.2)	-2.18(-4.0)	2.49(6.0)	- 0.67(-0.1)	.48(4.1)	57%	1.17
$i_{t--1} - i_{t-2}$:							
10YTreas	2.94(6.4)	-2.19(-4.5)	2.45(5.9)	+13.16(0.9)	.52(4.5)	58%	1.23
Mortgage	2.87(6.3)	-2.19(-4.4)	2.49(6.0)	+ 2.20(0.1)	.49(4.3)	57%	1.19
Aaa	2.93(6.4)	-2.16(-4.5)	2.46(6.0)	+16.32(1.0)	.51(4.5)	58%	1.24
Baa	2.90(6.3)	-2.17(-4.5)	2.48(6.0)	+ 6.59(0.5)	.49(4.4)	57%	1.22
Fed. Funds	2.89(6.3)	-2.20(-4.5)	2.46(5.8)	+ 2.64(0.3)	.51(3.2)	57%	1.18
$i_{t--2} - i_{t-3}$							
10YTreas	2.86(6.0)	-2.13(-4.0)	2.54(5.9)	+ 7.77(0.5)	.47(4.0)	56%	1.24
Mortgage	2.90(6.2)	-2.18(-4.3)	2.51(5.9)	+ 8.14(0.5)	.46(3.9)	56%	1.24
Aaa	2.85(6.1)	-2.08(-4.0)	2.58(6.0)	+16.54(1.0)	.44(3.7)	57%	1.31
Baa	2.87(6.2)	-2.09(-4.2)	2.60(6.2)	+18.43(1.3)	.43(3.6)	58%	1.31
Fed. Funds	2.89(6.4)	-2.49(-5.0)	2.56(6.3)	**-13.76(-1.8)**	.54(4.8)	60%	1.04
$i_{t--3} - i_{t-4}$:							
10YTreas	2.91(6.0)	-2.22(-4.3)	2.54(5.9)	+13.09(1.0)	.45(3.7)	57%	1.29
Mortgage	2.84(6.4)	-2.12(-4.5)	2.76(6.9)	+45.48(2.9)	.37(3.3)	65%	1.46
Aaa	2.88(6.1)	-2.19(-4.4)	2.61(6.2)	+26.82(1.8)	.42(3.6)	60%	1.41
Baa	2.87(6.2)	-2.20(-4.4)	2.65(6.4)	+25.14(2.0)	.42(3.7)	61%	1.48
Fed. Funds	2.95(6.0)	-2.25(-4.3)	2.50(5.8)	+ 4.92(0.7)	.46(3.6)	57%	1.17
$i_{t--4} - i_{t-5}$:							
10YTreas	2.77(6.2)	-2.19(-4.6)	2.76(6.9)	+33.65(2.8)	.48(4.6)	65%	1.50
Mortgage	2.49(5.8)	-1.92(-4.3)	3.02(7.7)	+53.68(3.7)	.47(4.8)	70%	1.62
Aaa	2.70(6.0)	-2.09(-4.4)	2.78(7.0)	+40.57(3.0)	.48(4.6)	66%	1.55
Baa	2.71(6.0)	-2.08(-4.3)	2.74(6.8)	+32.60(2.8)	.48(4.5)	65%	1.50
Fed. Funds	2.76(6.0)	-2.15(-4.5)	2.78(6.8)	+17.13(2.7)	.45(4.2)	64%	1.43
(no i incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

In Tables 1-5 above, the best results were obtained using "real" interest rates, where real was defined as a current year nominal rate minus the average of the prior two year's inflation rates (ipd or cpi). The success of this formulation may suggest that for many investors, expectations for the future are strictly adaptive. Their best estimate of current and future inflation would be that it will continue the last two year's actual inflation.

However, this is but a hypothesis. An alternate hypothesis is that investors are (accurately) aware of actual current year inflation trends during the current year, and use only current rates to deflate nominal values to get real interest rates. Table 6 below shows the extent to which the prime rate and the Fed. Funds rate, deflated in this manner, seem related to changes in the current year's GDP, or in one of four subsequent years.

For the prime rate, the only hypothesis tested having the theoretically expected sign and also being statistically significant is again the two year lagged value. However, the results are only marginally statistically significant (significant at the 7% level for the ipd-deflated variable; 13% for the cpi deflated variable), compared to the approximately 2% significance level for the real prime rate variable deflated by two prior year average values of the cpi or ipd shown in Table 3. Hence we conclude that the average inflation rate for the past two completed years is a better single-period inflation rate to use than the current year rate. Presumably some business decision makers either misjudge the current rate, or ignore it because it cannot not be known with the same certainty as prior year's rates.

Table 6 also shows results for the federal funds rate deflated this alternate way. The earlier results for the federal funds rate using the prior two period's average inflation rate (Tables 3 & 4) were more statistically significant (t = 2.5 or 2.6), compared to Table 7 (t=1.3 and 2.0).

Using the same methods, we tested the hypothesis in Table 7 that if not the current year inflation rate, then perhaps the immediate prior year's inflation rate alone (rather than the past two year's average, tested in Tables 3 and 4) is what businesses most commonly use to form expectations of the real interest rate. All five levels of lag (0 through -4) were tested for all the different interest rates shown in Tables 3and 4). As was the case for the past two year average method used in Tables 3 and 4, none of the interest rates tested, for any level of lag was found to be significantly related to the GDP, except the prime and Fed. Funds rates. For these two rates, as was the case for the past two years average rate, only the two year lagged values were found to be statistically significant. However, the level of significance was lower (t=2.3 -2.4 compared to 2.5 - 2.6) and the estimated marginal effects of a change in the rates was $1B - 2B lower.

However, it is possible that business decision makers average in the current period inflation rate with one or more past years inflation when adaptively estimating the real interest rate. If so, we should see those interest rates more systematically related to the GDP than we have seen before. Therefore, two other alternative adaptive lag specifications were also tested. Each involved averaging two or more current and past years of inflation when deflating the nominal value of an interest rate. One of these averaged the current and past years inflation rates, the other the current and past two years inflation rates. Tables 7 and below present these results.

Table 7 uses an average of current year and immediate past year cpi inflation as the proper deflator of nominal interest rates. The results using the ipd deflator were essentially the same for all interest rates and lags as the Table 7 results, so they are not shown below. An exception is made for the prime and Fed. Funds rate findings with a two year lag. They are added to Table 7 because whether deflating by the cpi or the ipd, only the two-lag version of these rates proved statistically significant and with the correct sign.

Table 6

IS Curve Coefficients Using Various Lagged Real Prime Rate (r) Values
(Real Prime(or Fed. Funds) Rate$_t$ = Nominal Prime Rate $_t$ – Inflation $_t$)
(Dependent Variable: ΔY_t)

Δr	(r Deflator)	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
Prime Rate								
$r_t - r_{t-1}$	(cpi)	2.85(6.1)	-2.14(-4.0)	2.51(5.9)	- 2.36(-0.3)	.47(4.0)	57%	1.16
	(ipd)	2.89(6.2)	-2.22(-4.2)	2.48(5.9)	+ 1.51(0.1)	.48(4.3)	57%	1.18
$r_{t-1} - r_{t-2}$	(cpi)	2.87(6.2)	-2.20(-4.5)	2.48(5.8)	+ 0.28(0.0)	.49(3.4)	57%	1.18
	(ipd)	2.88(6.4)	-2.17(-4.5)	2.45(6.0)	+12.42(1.0)	.56(4.2)	58	1.13
$r_{t-2} - r_{t-3}$	(cpi)	2.87(6.3)	-2.39(-4.8)	2.54(6.2)	**-12.23(-1.6)**	.54(4.7)	59%	1.05
	(ipd)	3.00(6.6)	-2.48(-5.0)	2.53(6.3)	**-18.68(-1.9)**	.54(4.8)	60%	1.06
$r_{t-3} - r_{t-4}$	(cpi)	2.98(6.2)	-2.27(-4.5)	2.51(6.0)	+ 9.75(1.3)	.43(3.5)	58%	1.18
	(ipd)	2.92(5.9)	-2.24(-4.3)	2.48(5.8)	+ 5.00(0.5)	.47(3.9)	56%	1.15
$r_{t-4} - r_{t-5}$	(cpi)	2.74(6.2)	-2.12(-4.5)	2.77(7.0)	+20.34(3.0)	.45(4.3)	66%	1.52
	(ipd)	2.69(5.6)	-2.03(-4.0)	2.65(6.3)	+18.84(2.0)	.48(4.3)	61%	1.25
(no r included)		2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18
Fed.Funds Rate								
$r_t - r_{t-1}$	(cpi)	2.88(6.2)	-2.20(-4.4)	2.49(6.0)	+ 0.61(0.1)	.48(4.1)	57%	1.18
	(ipd)	2.90(6.3)	-2.28(-4.2)	2.48(6.0)	+ 3.75(0.4)	.48(4.3)	57%	1.19
$r_{t-1} - r_{t-2}$	(cpi)	2.86(6.6)	-2.24(-4.8)	2.58(6.5)	+17.38(2.0)	.60(5.0)	61%	1.12
	(ipd)	2.89(6.4)	-2.22(-4.7)	2.46(6.0)	+13.17(1.2)	.60(4.1)	60%	1.17
$r_{t-2} - r_{t-3}$	(cpi)	3.00(6.4)	-2.42(-4.7)	2.49(6.1)	-11.09(-1.3)	.51(4.6)	58%	1.11
	(ipd)	3.02(6.7)	-2.56(-5.1)	2.56(6.4)	**-17.45(-2.0)**	.53(4.8)	.61%	1.09
$r_{t-3} - r_{t-4}$	(cpi)	2.99(6.0)	-2.31(-4.4)	2.44(5.7)	- 4.12(-0.5)	.51(4.2)	56%	1.20
	(ipd)	2.96(5.9)	-2.29(-4.3)	2.45(5.6)	- 1.59(-0.2)	.50(4.1)	56%	1.18
$r_{t-4} - r_{t-5}$	(cpi)	2.71(5.2)	-2.08(-3.9)	2.65(5.9)	+11.44(1.3)	.52(4.5)	58%	1.15
	(ipd)	2.76(5.6)	-2.11(-4.1)	2.63(6.1)	+12.46(1.5)	.48(4.3)	59%	1.19
(no r included)		2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

Compared to the use of average inflation for the past two years in Table 3, the Table 7 t-statistics were not as highly statistically significant (t=2.2 - 2.4 compared to 2.5 - 2.6). However, the magnitude of the estimated marginal effects (coefficients) of a one point change in the prime or Fed. Funds rate were in all cases larger, averaging \$3B larger for the Fed. Funds and \$5B larger for the prime rate than the estimated marginal effects in Tables 3 and 4. In both cases, these changed magnitudes reflect our earlier finding that some marginally systematic impact on GDP occurred when nominal interest rates were deflated by current year actual inflation alone.

Table 7

IS Curve Estimates Using Lagged Real Interest Rate Values
(Real Interest Rate = Nominal - CPI Inflation Average$_{(t)+(t-1)}$)

Δr	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t-} - r_{t-1}$:							
10YTreas	2.89(6.4)	-2.22(-4.6)	2.56(6.2)	+12.46(1.0)	.42(3.2)	58%	1.21
Mortgage	2.87(6.4)	-2.20(-4.6)	2.57(6.2)	+12.71(1.1)	.44(3.8)	59%	1.19
Aaa	2.87(6.4)	-2.18(-4.6)	2.58(6.2)	+15.38(1.2)	.41(3.3)	59%	1.22
Baa	2.88(6.4)	-2.16)-4.5)	2.56(6.2)	+15.23(1.2)	.42(3.6)	59%	1.21
Prime Rate	2.92(6.4)	-2.36(-4.4)	2.49(6.0)	+ 8.57(0.7)	.47(4.3)	58%	1.21
Fed. Funds	2.91(6.4)	-2.40(4.5)	2.53(6.1)	+ 8.86(0.9)	.46(4.1)	58%	1.22
$r_{t--1} - r_{t-2}$:							
10YTreas	2.82(6.3)	-2.24(-4.7)	2.62(6.5)	+21.13(2.1)	.50(4.7)	61%	1.18
Mortgage	2.79(6.0)	-2.17(-4.5)	2.63(6.3)	+16.65(1.5)	.47(4.3)	59%	1.19
Aaa	2.77(6.2)	-2.19(-4.7)	2.67(6.7)	**+24.62(2.3)**	.47(4.5)	62%	1.16
Baa	2.78(6.2)	-2.17(-4.6)	2.67(6.5)	**+23.04(2.0)**	.46(4.2)	61%	1.23
Prime Rate	2.85(6.2)	-2.19(-4.5)	2.48(6.1)	+16.59(1.5)	.60(4.5)	59%	1.12
Fed. Funds	2.86(6.2)	-2.24(-4.6)	2.50(6.1)	+13.56(1.5)	.61(4.4)	59%	1.16
$r_{t--2} - r_{t-3}$							
10YTreas	2.95(5.6)	-2.27(-4.1)	2.46(5.6)	- 0.10(-0.0)	.49(4.3)	56%	1.17
Mortgage	2.96(5.8)	-2.28(-4.3)	2.46(5.7)	- 1.27(-0.1)	.49(4.3)	56%	1.16
Aaa	2.90(5.6)	-2.23(-4.1)	2.48(5.7)	+ 3.09(0.3)	.49(4.2)	56%	1.18
Baa	2.83(5.5)	-2.17(-4.0)	2.53(5.8)	+ 8.67(0.7)	.48(4.1)	57%	1.20
Prime Rate	3.15(6.8)	-2.65(-5.2)	2.54(6.4)	**-21.99(-2.3)**	.55(5.0)	62%	1.05
Fed. Funds	3.14(6.7)	-2.68(-5.1)	2.54(6.3)	**-17.32(-2.2)**	.53(4.8)	62%	1.10
Prime Rate(ipd)	*3.08(6.7)*	*-2.63(-5.2)*	*2.54(6.4)*	***-20.55(-2.3)***	*.54(5.0)*	*62%*	*1.06*
Fed. Funds(ipd)	*3.10(6.7)*	*-2.70(-5.2)*	*2.56(6.4)*	***-18.01(-2.4)***	*.53(4.9)*	*63%*	*1.11*
$r_{t--3} - r_{t-4}$:							
10YTreas	3.09(6.0)	-2.41(-4.5)	2.43(5.7)	-12.47(-1.1)	.49(4.3)	58%	1.19
Mortgage	2.96(5.7)	-2.30(-4.2)	2.46(5.6)	- 3.61(-0.3)	.49(4.2)	56%	1.19
Aaa	3.04(5.9)	-2.37(-4.4)	2.44(5.7)	- 9.71(-0.8)	.48(4.2)	57%	1.19
Baa	3.00(5.7)	-2.31(-4.2)	2.45(5.60	- 5.12(-0.4)	.49(4.2)	57%	1.17
Prime Rate	2.93(5.8)	-2.27(-4.2)	2.47(5.7)	- 1.83(-0.2)	.50(4.2)	56%	1.20
Fed. Funds	2.97(5.9)	-2.31(-4.3)	2.44(5.6)	- 5.04(-0.6)	.51(4.3)	57%	1.24
$r_{t--4} - r_{t-5}$:							
10YTreas	2.95(5.8)	-2.25(-4.2)	2.42(5.5)	- 6.23(-0.6)	.47(4.0)	58%	1.22
Mortgage	3.00(5.8)	-2.30(-4.2)	2.40(5.5)	- 8.30(-0.7)	.47(4.0)	58%	1.21
Aaa	2.99(5.9)	-2.30(-4.3)	2.41(5.6)	-10.37(-0.9)	.47(4.0)	58%	1.22
Baa	2.98(5.8)	-2.29(-4.2)	2.42(5.5)	- 7.73(-0.6)	.47(4.0)	58%	1.20
Prime Rate	2.76(5.5)	-2.10(-3.9)	2.57(5.8)	+10.71(1.1)	.48(4.2)	59%	1.22
Fed. Funds	2.81(5.5)	-2.15(-4.0)	2.54(5.7)	+ 6.16(0.8)	.48(4.2)	58%	1.19
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

*data in parenthesis next to regression coefficients are t-statistics

Table 8 shows the results from testing the hypothesis that business people deflate the nominal interest rate to get an estimate of the real rate by subtracting the average of the current and two past years inflation rates from the nominal rate. Here again, because the cpi and ipd deflated results were so similar, we have only included the cpi deflated results for all the interest rates tested. The ipd results, separately noted, are included only for the two lag versions of the prime and Fed. Funds rate for the same reasons as before. As we have come to expect, only the prime

Table 8

IS Curve Estimates Using Lagged Real Interest Rate Values
(Real Interest Rate = Nominal - Average Inflation$_{(t)+t-1)+t-2)}$)

Δr	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t-} - r_{t-1}$:							
10YTreas	2.89(6.2)	-2.28(-4.6)	2.54(6.1)	+14.36(1.1)	.44(3.7)	57%	1.23
Mortgage	2.86(6.3)	-2.29(-4.7)	2.61(6.3)	+26.79(1.6)	.46(4.2)	59%	1.21
Aaa	2.86(6.2)	-2.25(-4.6)	2.57(6.2)	+21.18(1.4)	.43(3.8)	58%	1.26
Baa	2.86(6.2)	-2.22(-4.5)	2.55(6.2)	+21.31(1.4)	.46(4.1)	58%	1.25
Prime Rate	2.92(6.2)	-2.40(-4.3)	2.47(5.9)	+ 7.27(0.7)	.49(4.4)	57%	1.21
Fed. Funds	2.91(6.2)	-2.40(-4.4)	2.51(6.0)	+ 7.58(0.8)	.49(4.3)	57%	1.22
$r_{t--1} - r_{t-2}$:							
10YTreas	2.87(5.9)	-2.24(-4.4)	2.50(5.9)	+15.43(1.2)	.53(4.5)	58%	1.17
Mortgage	2.86(5.6)	-2.20(-4.2)	2.52(5.8)	+11.64(0.7)	.50(4.3)	57%	1.17
Aaa	2.82(5.8)	-2.18(-4.3)	2.54(6.0)	+20.30(1.40	.51(4.5)	59%	1.16
Baa	2.85(5.8)	-2.18(-4.2)	2.53(5.9)	+16.39(1.10	.49(4.4)	58%	1.21
Prime Rate	2.93(5.9)	-2.25(-4.3)	2.44(5.7)	+ 5.02(0.4)	.53(3.5)	565	1.15
Fed. Funds	2.92(5.9)	-2.26(-4.3)	2.45(5.7)	+ 5.44(0.6)	.55(1.2)	57%	1.16
$r_{t--2} - r_{t-3}$							
10YTreas	3.10(5.7)	-2.45(-4.2)	2.39(5.4)	-11.00(-0.8)	.49(4.3)	57%	1.18
Mortgage	3.14(6.00	-2.48(-4.5)	2.39(5.6)	-21.37(-1.2)	.49(4.3)	58%	1.15
Aaa	3.06(6.0)	-2.40(-4.1)	2.41(5.4)	- 9.72(-0.6)	.49(4.2)	57%	1.17
Baa	2.93(5.4)	-2.26(-3.9)	2.47(5.5)	- 0.75(-0.0)	.50(4.2)	56%	1.18
Prime Rate	3.12(6.9)	-2.71(-5.4)	2.58(6.6)	**-23.40(-2.8)**	.53(5.0)	65%	1.12
Prime R(ipd)	*3.01(6.6)*	*-2.62(-5.2)*	*2.60(6.5)*	***-20.12(-2.5)***	*.55(5.0)*	*64%*	*1.11*
Fed. Funds	3.14(6.8)	-2.76(-5.3)	2.58(6.5)	**-19.41(-2.6)**	.52(4.9)	64%	1.13
Fed. F(ipd)	*3.06(6.7)*	*-2.72(-5.3)*	*2.61(6.6)*	***-18.75(-2.6)***	*.53(5.0)*	*64%*	*1.13*
$r_{t--3} - r_{t-4}$:							
10YTreas	3.11(6.3)	-2.41(-4.7)	2.40(5.8)	-22.33(-1.8)	.50(4.5)	615	1.21
Mortgage	3.06(6.0)	-2.38(-4.4)	2.39(5.6)	-19.05(-1.1)	.49(4.2)	59%	1.23
Aaa	3.11(6.2)	-2.41(-4.6)	2.40(5.7)	-23.89(-1.6)	.49(4.3)	61%	1.20
Baa	3.07(6.0)	-2.36(-4.4)	2.38(5.5)	-18.11(-1.1)	.49(1.1)	59%	1.15
Prime Rate	2.91(5.8)	-2.23(-4.2)	2.45(5.6)	- 3.99(-0.5)	.50(4.1)	58%	1.22
Fed. Funds	2.94(5.9)	-2.27(-4.2)	2.43(5.6)	- 5.69(-0.8)	.51(4.2)	58%	1.24
$r_{t--4} - r_{t-5}$:							
10YTreas	2.81(5.5)	-2.14(-4.0)	2.50(5.7)	+ 2.20(0.2)	.48(4.1)	59%	1.14
Mortgage	2.81(5.4)	-2.14(-3.9)	2.49(5.6)	+ 0.95(0.1)	.48(4.1)	59%	1.15
Aaa	2.83(5.5)	-2.15(-4.0)	2.48(5.7)	- 2.08(-0.1)	.48(4.1)	59%	1.16
Baa	2.80(5.4)	-2.12(-3.9)	2.50(5.7)	+ 3.68(0.2)	.48(4.1)	59%	1.14
Prime Rate	2.70(5.5)	-2.05(-4.0)	2.63(6.2)	+13.77(1.6)	.46(4.0)	62%	1.19
Fed. Funds	2.72(5.5)	-2.07(-4.0)	2.63(6.0)	+ 9.78(1.4)	.46(4.0)	61%	1.15
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

*data in parenthesis next to regression coefficients are t-statistics

and federal funds rates with tow lags were statistically significant, and with the same t statistics (t=2.5 - 2.6) as Table 3 and 4, with one exception, the cpi-deflated Fed. Funds rate whose t statistic at 2.8 was a little higher. However, the magnitude of the estimated marginal impact of a change in these interest rates was again higher than Table 3 and 4. The Fed. Funds rate estimates averaged about $4B higher and the prime rate estimates averaged $6B higher. Explained variance was the same for the ipd estimates, 1% higher for the cpi estimates. D.W. statistics were slightly lower. Overall, there is so little difference in the t statistics, R2 and DW statistics it is hard to clearly determine from the available results whether the average of the past two years inflation, or the average of the current and the past two years inflation best describes the inflation rate businesses use to estimate the real interest rate.

There is no significant difference to the policy conclusions reached using the Table 3 and Table 8 versions of the real interest rate. Both still suggest that an average - year size change in the values of the right hand side variables in the simple Keynesian IS curve have the following relative importance: The larger Table 8 marginal effect estimate raises the estimated effect of a change in interest rates on the GDP, but not enough to change our earlier conclusion that changing interest rates to affect the economy creates relatively minor changes compared changes in the accelerator, deficit, or exports, as noted below in Table 9.

Table 9

Summary Estimates of Relative Importance of Different Components of the IS Curve

	Change in GDP Associated With an Average year's Change In the Accelerator, Exports, the Deficit, and the Real Prime Rate	
	Using Table 1 or 3 Marginal Estimates	Using Table 8 Marginal Estimates
Deficit (Spending Change)	$130 Billion	$135 Billion
Accelerator	88	93
Exports	71	71
Real Prime Rate	25	37

Using the estimated marginal impact of real interest rate change based on current period only or prior year only inflation rates would provide results nearly identical to those above except the interest rate change would be associated with even less than a $25 billion GDP change. Using the average of current and immediate prior year inflation to deflate the nominal prime rate would also result in very similar results compared to those above, except the interest rate effect would be between the Table 3 and Table 8 estimated effects.

This again suggests that shifts in the LM curve, no matter how pronounced, due to changes in monetary policy (changes in the demand for real money balances stimulated by changing interest rates) may have a very systematic, but very small, impact on the level of the real GDP.

Table 10 summarizes our findings on different adaptive expectations - type rate hypotheses.

4.B. Models Using Rational Expectations Methods To Estimate Real Interest Rates

Perhaps near-past and present inflation rates are similar enough to present and future inflation rates that it is simply a fortuitous coincidence that they explain variance well. Perhaps in reality businesses form rational expectations about inflation, ie, use information available about likely future as well as the present and past rates to estimate real interest rates. Presumably if they do, then variation in real interest rates calculated using inflation averages including future year inflation rates (as a proxy for expected future rates) should be systematically related to the GDP.

Table 10

Summary of Results of 5 Adaptive Interest Rate Deflation Methods
For Lagged Real Interest Rates Found Most Significantly Related To GDP

	Average Inflation Rate Used:				
	Tables 3&4	Table 6	(No Table)	Table 7	Table 8
	($Av_{t-1, t-2}$)	(t Only)	(t-1 Only)	($Av_{t, t-1}$)	($Av_{t, t-1, t-2}$)
$r_{t-2} - r_{t-3}$					
Prime R.(ipd)	-16.31(-2.5)	-18.68(-1.9)	-15.03(-2.4)	-20.55(-2.3)	-20.12(-2.5)
Fed. F. (ipd)	-15.70(-2.6)	-17.45(-2.0)	-13.86(-2.3)	-18.01(-2.4)	-18.75(-2.6)
$r_{t-2} - r_{t-3}$					
Prime R.(cpi)	-15.89(-2.6)	-12.23(-1.6)	-15.39(-2.3)	-21.99(-2.3)	-23.40(-2.8)
Fed. F.(cpi)	-13.91(-2.5)	-11.09(-1.3)	-12.13(-2.3)	-17.32(-2.2)	-19.41(-2.6)

* data in parenthesis next to regression coefficients are t-statistics

Tables 11, 12 and 13 below present results for tests of three hypotheses. Each assumes that future inflation rates are reasonably discernable by investment decision makers and used alone or in conjunction with current inflation information to determine real interest rates. Except for the interest rate variable, the models are the same as those previously tested. Table 11 uses the average of current and next year inflation rates to deflate current year nominal interest rates. Table 12 uses the average of the current and next two years future inflation rates to deflate. Table 13 uses the average of the next two years future inflation rates alone to deflate nominal rates.

The results were disappointing. These rational expectations - based interest rates proved to have no statistically significant relationship to changes in GDP than adaptive models tested, and most often had positive signs, the opposite of what theory would lead us to expect. Also, explained variance was typically 3-5% lower than in comparable adaptive expectations models (where the interest rate variable added 5 -7% to explained variance. The signs on virtually all interest rates lagged 1 to 4 periods were positive instead of negative as theory would suggest, and the current year estimates, though having the right sign, generally had the lowest t statistics, usually less than one. This suggests that rational expectations real interest models that only deflate nominal interest rates using averages of current and future inflation rates, and no past rates, probably do not reflect actual business practice.

Though use of forward period actual inflation rates alone do not seem to be the way business investment decision makers deflate nominal interest rates, a possibility that has not been tested is that business managers weigh their best guesses about current year and future year inflation trends and data on past inflation trends in estimating real interest rates. Tables 14 & 15 provide two tests of this hypothesis. Weighing past information in with information on current and future inflation improves the ability of rational expectations based real interest rates to explain variation in the GDP. However these rates do not bring the explanatory power of the models (R^2=61-63%) up to the levels found using past two-periods actual inflation, or past two periods and current period actual inflation (R^2=64-66%).neither averaging one (Table 14) or two (Table 15) future periods' actual inflation in with current and two past periods actual inflation In addition, t-statistics for the interest rate variable fell from 2.5-2.8 fell with the adaptive inflation model compared to 1.9-2.4 with the average of future, current and past actual inflation levels. Every t statistic was lower, compared to the adaptive expectations version alone, and even worse compared with this model when two future periods were averaged in instead of just one.

Table 11

IS Curve Estimates Using Lagged Real Interest Rate Values
Real Interest Rate = Nominal - CPI Inflation Average$_{(t)+(t+1)}$
(Dependent Variable: ΔY_t)

Δr	ΔT_t	$\Delta(T-G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t-} - r_{t-1}$:							
10YTreas	2.85(6.1)*	-2.20(-4.5)	2.61(5.9)	- 3.52(-0.4)	.49(4.3)	54%	1.14
Mortgage	2.86(6.2)	-2.20(-4.5)	2.60(5.9)	- 2.56(-0.3)	.48(4.3)	54%	1.14
Aaa	2.86(6.2)	-2.21(-4.5)	2.60(6.0)	- 2.63(-0.3)	.49(4.3)	54%	1.14
Baa	2.86(6.2)	-2.21(-4.5)	2.60(5.9)	- 2.06(-0.2)	.48(4.3)	54%	1.14
Prime Rate	2.82(6.0)	-2.13(-4.3)	2.64(5.9)	- 4.83(-0.6)	.47(4.2)	55%	1.13
Fed. Funds	2.84(6.0)	-2.12(-4.1)	2.62(5.9)	- 3.75(-0.4)	.48(4.3)	55%	1.13
$r_{t-1} - r_{t-2}$:							
10YTreas	2.87(6.4)	-2.12(-4.5)	2.58(6.3)	+11.69(1.4)	.44(3.9)	59%	1.18
Mortgage	2.85(6.3)	-2.11(-4.3)	2.57(6.1)	+ 8.21(0.9)	.44(3.7)	58%	1.18
Aaa	2.85(6.4)	-2.09(-4.4)	2.60(6.3)	+12.28(1.4)	.42(3.6)	59%	1.17
Baa	2.86(6.3)	-2.11(-4.4)	2.57(6.2)	+ 8.76(1.1)	.43(0.1)	59%	1.20
Prime Rate	|2.88(6.3)	-2.12(-4.3)	2.50(6.1)	+ 7.95(0.9)	.50(4.5)	58%	1.13
Fed. Funds	2.88(6.4)	-2.13(-4.4)	2.51(6.2)	+12.36(1.2)	.55(4.6)	59%	1.12
$r_{t-2} - r_{t-3}$							
10YTreas	2.73(5.8)	-2.09(-4.2)	2.70(6.2)	+12.94(1.5)	.43(3.7)	59%	1.23
Mortgage	2.80(6.2)	-2.18(-4.4)	2.64(6.2)	+12.14(1.4)	.43(3.7)	58%	1.22
Aaa	2.73(5.9)	-2.12(-4.3)	2.71(6.4)	+14.63(1.7)	.42(3.7)	59%	1.24
Baa	2.75(6.0)	-2.13(-4.4)	2.71(6.4)	+14.46(1.9)	.41(3.6)	60%	1.24
Prime Rate	2.93(6.2)	-2.29(-4.5)	2.46(5.8)	- 5.28(0.6)	.52(4.1)	56%	1.14
Fed. Funds	2.97(6.3)	-2.40(-4.5)	2.45(5.9)	- 9.90(1.0)	.54(4.3)	57%	1.12
$r_{t-3} - r_{t-4}$:							
10YTreas	2.91(5.7)	-2.25(-4.3)	2.48(5.7)	+ 2.65(0.3)	.49(4.2)	56%	1.18
Mortgage	2.84(5.7)	-2.21(-4.3)	2.53(5.9)	+ 8.30(1.0)	.48(4.2)	57%	1.18
Aaa	2.87(5.7)	-2.24(-4.3)	2.50(5.8)	+ 5.30(0.6)	.49(4.2)	57%	1.19
Baa	2.85(5.7)	-2.23(-4.3)	2.52(5.9)	+ 6.52(0.8)	.49(4.2)	57%	1.22
Prime Rate	2.87(5.9)	-2.24(-4.4)	2.53(6.0)	+10.05(1.1)	.45(3.7)	58%	1.15
Fed. Funds	2.89(5.7)	-2.23(-4.2)	2.51(5.7)	+ 5.57(0.6)	.46(3.7)	57%	1.15
$r_{t-4} - r_{t-5}$:							
10YTreas	2.90(5.6)	-2.24(-4.2)	2.48(5.7)	+ 1.55(0.2)	.50(4.2)	56%	1.18
Mortgage	2.90(5.5)	-2.24(-4.1)	2.48(5.6)	+ 1.07(0.1)	.50(4.2)	56%	1.18
Aaa	2.92(5.6)	-2.25(-4.2)	2.47(5.7)	+ 0.09(0.0)	.50(4.1)	56%	1.18
Baa	2.89(5.6)	-2.23(-4.1)	2.48(5.7)	+ 1.57(0.2)	.50(4.2)	56%	1.18
Prime Rate	2.64(5.2)	-2.03(-3.9)	2.66(6.2)	+14.89(1.7)	.51(4.6)	60%	1.24
Fed. Funds	2.60(5.1)	-2.03(-3.9)	2.72(6.2)	+15.93(1.7)	.51(4.6)	60%	1.22
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

Table 12
IS Curve Estimates Using Lagged Real Interest Rate Values
Real Interest Rate = Nominal - CPI Inflation Average $_{(t)+(t+1)+(t+2)}$

Δr	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t-} - r_{t-1}$:							
10YTreas	2.67(5.6)	-2.10(-4.3)	2.68(6.1)	- 7.80(-0.9)	.49(4.4)	53%	1.12
Mortgage	2.69(5.6)	-2.12(-4.3)	2.67(6.0)	- 7.52(-0.8)	.47(4.2)	53%	1.13
Aaa	2.68(5.6)	-2.13(-4.3)	2.68(6.0)	- 7.70(-0.8)	.49(4.4)	53%	1.11
Baa	2.69(5.6)	-2.13(-4.4)	2.68(6.0)	- 6.60(-0.8)	.48(4.3)	535	1.12
Prime Rate	2.70(5.6)	-2.03(-4.0)	2.69(6.0)	-5.28(-0.7)	.47(4.1)	53%	1.12
Fed. Funds	2.72(5.7)	-2.04(-3.9)	2.65(5.9)	- 4.11(-0.6)	.48(4.2)	53%	1.12
$r_{t--1} - r_{t-2}$:							
10YTreas	2.91(6.4)	-2.12(-4.4)	2.62(6.0)	+ 8.97(1.0)	.47(4.3)	56%	1.14
Mortgage	2.88(6.3)	-2.14(-4.3)	2.62(5.9)	+ 4.54(0.5)	.47(4.1)	55%	1.15
Aaa	2.90(6.4)	-2.10(-4.3)	2.64(6.0)	+ 9.62(1.0)	.46(4.1)	56%	1.14
Baa	2.89(6.3)	-2.12(-4.3)	2.63(6.0)	+ 6.16(0.7)	.46(4.1)	55%	1.16
Prime Rate	2.89(6.2)	-2.16(-4.3)	2.58(5.8)	+ 2.34(0.3)	.49(4.1)	54%	1.14
Fed. Funds	2.89(6.3)	-2.16(-4.4)	2.57(5.8)	+ 4.72(0.5)	.52(3.9)	55%	1.13
$r_{t--2} - r_{t-3}$							
10YTreas	2.75(5.8)	-2.03(-4.0)	2.68(6.1)	+12.47(1.3)	.41(3.2)	58%	1.22
Mortgage	2.82(6.0)	-2.11(-4.2)	2.64(6.1)	+12.52(1.2)	.40(3.1)	58%	1.22
Aaa	2.74(5.9)	-2.04(-4.1)	2.70(6.2)	+15.10(1.5)	.39(3.1)	60%	1.24
Baa	2.77(6.0)	-2.06(-4.2)	2.71(6.4)	+14.81(1.7)	.38(3.1)	59%	1.23
Prime Rate	2.93(6.2)	-2.33(-4.5)	2.46(5.9)	- 6.31(-0.8)	.54(4.1)	57%	1.14
Fed. Funds	2.96(6.3)	-2.44(-4.6)	2.46(5.9)	- 9.70(-1.2)	.56(4.4)	58%	1.12
$r_{t--3} - r_{t-4}$:							
10YTreas	2.83(5.7)	-2.22(-4.3)	2.56(5.9)	+ 8.91(1.0)	.46(3.9)	.57%	1.21
Mortgage	2.74(5.7)	-2.18(-4.3)	2.67(6.3)	+17.22(1.8)	.44(3.8)	60%	1.17
Aaa	2.79(5.7)	-2.21(-4.3)	2.60(6.0)	+12.40(1.3)	.45(3.9)	58%	1.21
Baa	2.79(5.7)	-2.21(-4.4)	2.62(6.1)	+12.37(1.5)	.45(3.9)	59%	1.24
Prime Rate	2.87(6.0)	-2.25(-4.4)	2.59(6.1)	+11.24(1.5)	.42(3.4)	59%	1.15
Fed. Funds	2.87(5.8)	-2.22(-4.3)	2.57(5.9)	+ 7.98(1.0)	.43(3.4)	57%	1.16
$r_{t--4} - r_{t-5}$:							
10YTreas	2.80(5.5)	-2.19(-4.2)	2.55(5.8)	+ 8.26(0.9)	.51(4.4)	57%	1.17
Mortgage	2.76(5.3)	-2.15(-4.0)	2.57(5.8)	+ 8.84(0.9)	.52(4.4)	57%	1.18
Aaa	2.81(5.4)	-2.19(-4.1)	2.53(5.8)	+ 6.97(0.8)	.51(4.3)	57%	1.18
Baa	2.80(5.5)	-2.18(-4.1)	2.53(5.8)	+ 7.09(0.9)	.51(4.4)	57%	1.19
Prime Rate	2.65(5.4)	-2.08(-4.10	2.68(6.4)	+13.95(2.1)	.50(4.5)	61%	1.28
Fed. Funds	2.64(5.4)	-2.09(-4.1)	2.73(6.4)	+13.97(2.0)	.50(4.5)	61%	1.27
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis are t-statistics

Table 13

IS Curve Estimates Using Lagged Real Interest Rate Values
Real Interest Rate = Nominal - CPI Inflation Average$_{(t+1)+(t+2)}$
(Dependent Variable: ΔY_{t}.).

Δr	ΔT_t	$\Delta(T-G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t} - r_{t-1}$:							
10YTreas	2.65(5.5)	-2.08(-4.2)	2.72(6.1)	- 6.80(-1.0)	.47(4.2)	54%	1.13
Mortgage	2.66(5.5)	-2.09(-4.3)	2.72(6.1)	- 7.40(-1.0)	.45(3.9)	54%	1.13
Aaa	2.66(5.6)	-2.10(-4.3)	2.71(6.1)	- 6.89(-1.0)	.46(4.1)	54%	1.12
Baa	2.67(5.6)	-2.11(-4.3)	2.71(6.0)	- 6.15(-0.9)	.46(4.0)	54%	1.13
Prime Rate	2.68(5.6)	-2.02(-4.0)	2.71(6.0)	- 4.71(-0.9)	.45(3.8)	53%	1.13
Fed. Funds	2.70(5.6)	-2.02(-3.9)	2.68(6.0)	- 4.04(-0.7)	.46(4.0)	53%	1.12
$r_{t-1} - r_{t-2}$:							
10YTreas	2.89(6.2)	-2.16(-4.3)	2.59(5.9)	+ 2.12(0.3)	.48(4.3)	54%	1.15
Mortgage	2.87(6.2)	-2.21(-4.4)	2.59(5.9)	- 1.43(-0.2)	.48(4.3)	54%	1.15
Aaa	2.89(6.2)	-2.16(-4.3)	2.59(5.9)	+ 2.15(0.3)	.48(4.3)	54%	1.15
Baa	2.88(6.2)	-2.18(-4.3)	2.59(5.9)	+ 0.72(0.1)	.48(4.3)	54%	1.15
Prime Rate	2.87(6.2)	-2.21(-4.4)	2.61(5.9)	- 1.50(-0.2)	.47(4.0)	54%	1.15
Fed. Funds	2.87(6.2)	-2.20(-4.4)	2.60(5.8)	- 0.57(-0.1)	.48(3.7)	54%	1.15
$r_{t-2} - r_{t-3}$							
10YTreas	2.82(6.0)	-2.09(-4.1)	2.62(6.0)	+ 7.59(1.0)	.42(3.2)	57%	1.21
Mortgage	2.86(6.1)	-2.13(-4.2)	2.59(6.0)	+ 7.82(1.0)	.41(3.1)	57%	1.21
Aaa	2.81(6.0)	-2.09(-4.1)	2.63(6.1)	+ 9.05(1.2)	.40(3.1)	58%	1.21
Baa	2.83(6.1)	-2.09(-4.2)	2.64(6.2)	+ 9.28(1.3)	.40(3.1)	58%	1.21
Prime Rate	2.91(6.2)	-2.29(-4.4)	2.46(5.8)	- 3.53(-0.6)	.56(4.0)	56%	1.15
Fed. Funds	2.93(6.2)	-2.36(-4.5)	2.46(5.9)	- 5.53(-0.9)	.54(4.2)	57%	1.15
$r_{t-3} - r_{t-4}$:							
10YTreas	2.83(5.8)	-2.24(-4.4)	2.62(6.1)	+ 9.62(1.4)	.44(3.7)	59%	1.22
Mortgage	2.77(5.9)	-2.23(-4.5)	2.71(6.5)	+15.14(2.1)	.42(3.7)	61%	1.20
Aaa	2.81(5.8)	-2.24(-4.5)	2.64(6.2)	+11.64(1.7)	.44(3.8)	60%	1.22
Baa	2.81(5.9)	-2.24(-4.5)	2.66(6.3)	+11.25(1.8)	.44(3.8)	60%	1.25
Prime Rate	2.89(6.1)	-2.28(-4.5)	2.60(6.2)	+ 9.26(1.7)	.41(3.5)	60%	1.16
Fed. Funds	2.87(5.9)	-2.25(-4.4)	2.61(6.0)	+ 7.83(1.3)	.42(3.4)	58%	1.16
$r_{t-4} - r_{t-5}$:							
10YTreas	2.80(5.6)	-2.21(-4.2)	2.55(5.9)	+ 7.41(1.1)	.51(4.4)	58%	1.21
Mortgage	2.76(5.4)	-2.17(-4.1)	2.57(5.9)	+ 8.03(1.1)	.51(4.4)	58%	1.21
Aaa	2.81(5.6)	-2.20(-4.2)	2.53(5.9)	+ 6.70(1.0)	.50(4.4)	58%	1.21
Baa	2.80(5.6)	-2.19(-4.2)	2.54(5.9)	+ 6.51(1.1)	.50(4.4)	58%	1.21
Prime Rate	2.73(5.6)	-2.15(-4.3)	2.64(1.9)	+ 9.64(1.9)	.49(4.4)	61%	1.28
Fed. Funds	2.71(5.6)	-2.16(-4.3)	2.67(6.3)	+ 9.96(1.9)	.49(4.4)	61%	1.30
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

.* data in parenthesis next to regression coefficients are t-statistics

Table 14

IS Curve Estimates Using Lagged Real Interest Rate Values
Real Interest Rate = Nominal - CPI Inflation Average$_{(t+1)+(t)+(t-1)+(t-2)}$
Dependent Variable: ΔY_t

Δr	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t} - r_{t-1}$:							
10YTreas	2.91(6.1)*	-2.23(-4.4)	2.59(5.8)	+ 5.44(0.4)	.47(4.1)	53%	1.18
Mortgage	2.92(6.2)	-2.23(-4.4)	2.60(5.9)	+13.12(0.8)	.49(4.3)	545	1.18
Aaa	2.91(6.2)	-2.21(-4.4)	2.59(5.8)	+ 9.73(0.7)	.47(4.2)	54%	1.20
Baa	2.91(6.2)	-2.20(-4.4)	2.58(5.8)	+ 8.85(0.7)	.48(4.3)	54%	1.19
Prime Rate	2.91(6.0)	-2.24(-4.1)	2.58(5.7)	+ 1.31(0.1)	.49(4.1)	53%	1.16
Prime R.(ipd)	2.88(6.0)	-2.19(-4.0)	2.60(5.7)	- 1.23(-0.1)	.48(4.0)	53%	1.15
Fed. Funds	2.91(6.1)	-2.29(-4.1)	2.58(5.8)	+ 3.24(0.3)	.49(4.3)	53%	1.17
Fed. F.(ipd)	2.90(6.1)	-2.23(-4.0)	2.59(5.8)	+ 0.66(0.1)	.48(4.2)	53%	1.16
$r_{t-1} - r_{t-2}$:							
10YTreas	2.89(6.0)	-2.19(-4.2)	2.51(6.00	+15.53(1.2)	.50(4.4)	58%	1.18
Mortgage	2.87(5.7)	-2.17(-4.0)	2.52(5.8)	+11.24(0.6)	.48(4.1)	57%	1.17
Aaa	2.85(5.9)	-2.12(-4.1)	2.55(6.0)	+19.90(1.3)	.47(4.2)	58%	1.18
Baa	2.89(5.9)	-2.16(-4.1)	2.52(5.9)	+12.57(0.9)	.47(4.1)	57%	1.21
Prime Rate	2.94(6.0)	-2.24(-4.2)	2.44(5.7)	+ 4.70(0.4)	.52(3.7)	56%	1.15
Prime R.(ipd)	2.95(6.0)	-2.26(-4.3)	2.45(5.6)	+ 1.44(0.1)	.50(3.4)	56%	1.16
Fed. Funds	2.93(6.0)	-2.24(-4.3)	2.45(5.7)	+ 6.51(0.6)	.55(3.6)	57%	1.16
Fed. F.(ipd)	2.94(6.0)	-2.26(-4.3)	2.44(5.7)	+ 3.78(0.3)	.53(3.2)	56%	1.16
$r_{t-2} - r_{t-3}$							
10YTreas	2.90(5.3)	-2.24(-3.9)	2.48(5.3)	+ 1.13(0.1)	.49(4.1)	56%	1.18
Mortgage	2.94(5.5)	-2.27(-4.1)	2.46(5.4)	- 2.00(-0.1)	.50(4.1)	56%	1.18
Aaa	2.83(5.2)	-2.16(-3.8)	2.54(5.5)	+ 7.02(0.4)	.48(4.0)	57%	1.19
Baa	2.76(5.3)	-2.10(-3.8)	2.61(5.7)	+13.56(0.9)	.46(3.8)	57%	1.20
Prime Rate	3.08(6.5)	-2.62(-5.0)	2.50(6.2)	**-20.83(-2.2)**	.57(5.0)	62%	1.12
Prime R.(ipd)	*3.00(6.4)*	*-2.57(-5.0)*	*2.55(6.3)*	***-19.13(-2.2)***	*.56(5.0)*	*62%*	*1.09*
Fed. Funds	3.14(6.7)	-2.75(-5.2)	2.52(6.3)	**-20.48(-2.4)**	.56(5.0)	63%	1.12
Fed. F.(ipd)	*3.06(6.6)*	*-2.71(-5.2)*	*2.57(6.4)*	***-19.64(-2.4)***	*.56(5.0)*	*63%*	*1.10*
$r_{t-3} - r_{t-4}$:							
10YTreas	3.30(5.9)	-2.31(-4.3)	2.39(5.5)	-12.65(-0.9)	.50(4.3)	58%	1.18
Mortgage	2.88(5.4)	-2.20(-4.0)	2.46(5.5)	+ 1.88(0.1)	.48(4.1)	57%	1.18
Aaa	2.98(5.7)	-2.27(-4.2)	2.42(5.5)	- 8.30(-0.5)	.49(4.2)	58%	1.18
Baa	2.90(5.5)	-2.21(-4.1)	2.45(5.5)	+ 0.10(0.0)	.49(4.1)	57%	1.19
Prime Rate	2.89(5.7)	-2.21(-4.1)	2.46(5.6)	+ 1.62(0.2)	.48(3.8)	57%	1.18
Prime R.(ipd)	2.89(5.80	-2.20(-4.1)	2.46(5.7)	+ 3.44(0.4)	.47(3.7)	58%	1.17
Fed. Funds	2.92(5.8)	-2.23(-4.2)	2.43(5.5)	- 2.64(-0.3)	.50(4.0)	57%	1.21
Fed. F.(ipd)	2.90(5.8)	-2.21(-4.1)	2.45(5.6)	- 0.58(-0.1)	.49(3.8)	57%	1.19

Table 14 (Con'd)
IS Curve Estimates Using Lagged Real Interest Rate Values
Real Interest Rate = Nominal - CPI Inflation Average$_{(t+1)+(t)+(t-1)+(t-2)}$
Dependent Variable: ΔY_t

Δr	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t-4} - r_{t-5}$:							
10YTreas	2.78(5.4)	-2.12(-3.9)	2.51(5.7)	+ 4.80(0.4)	.49(4.1)	59%	1.14
Mortgage	2.76(5.1)	-2.10(-3.8)	2.52(5.6)	+ 5.35(0.3)	.49(4.1)	59%	1.14
Aaa	2.81(5.4)	-2.14(-3.9)	2.49(5.7)	+ 0.72(0.0)	.48(4.1)	59%	1.15
Baa	2.77(5.3)	-2.10(-3.9)	2.51(5.7)	+ 5.34(0.4)	.48(4.1)	59%	1.15
Prime Rate	2.62(5.4)	-2.00(-3.9)	2.68(6.3)	+17.13(1.9)	.46(4.1)	63%	1.27
Prime R.(ipd)	2.61(5.5)	-1.98(-4.0)	2.71(6.6)	+18.23(2.3)	.45(4.1)	65%	1.29
Fed. Funds	2.63(5.3)	-2.02(-3.9)	2.69(6.2)	+13.95(1.7)	.46(4.1)	63%	1.20
Fed. F.(ipd)	2.61(5.4)	-2.00(-4.0)	2.73(6.4)	+15.50(2.1)	.45(4.1)	64%	1.22
(no r incl'd.)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

Table 15

IS Curve Estimates Using Lagged Real Interest Rate Values
Real Interest Rate = Nominal - CPI Inflation Average$_{(t+2)+(t+1)+(t)+(t-1)+(t-2)}$
Dependent Variable: ΔY_t

Δr	ΔT_t	$\Delta(T\text{-}G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t} - r_{t-1}$:							
10YTreas	2.77(5.6)	-2.13(-4.1)	2.61(5.8)	- 2.48(-0.2)	.49(4.3)	51%	1.14
Mortgage	2.79(5.6)	-2.15(-4.2)	2.60(5.8)	+ 0.46(0.0)	.49(4.2)	51%	1.15
Aaa	2.78(5.6)	-2.14(-4.2)	2.61(5.8)	- 1.13(-0.1)	.49(4.3)	51%	1.15
Baa	2.78(5.6)	-2.15(-4.2)	2.61(5.8)	- 1.05(-0.1)	.49(4.3)	51%	1.15
Prime Rate	2.78(5.6)	-2.12(-3.9)	2.62(5.7)	- 1.40(-0.2)	.48(4.1)	51%	1.14
Prime R(ipd)	2.77(5.6)	-2.11(-3.9)	2.62(5.7)	- 1.84(-0.2)	.48(4.0)	51%	1.14
Fed. Funds	2.79(5.7)	-2.16(-3.9)	2.60(5.8)	+ 0.45(0.1)	.49(4.2)	51%	1.15
Fed. F.(ipd)	2.79(5.7)	-2.15(-3.9)	2.60(5.8)	+ 0.09(0.0)	.49(4.2)	51%	1.15
$r_{t-1} - r_{t-2}$:							
10YTreas	2.94(6.0)	-2.19(-4.20	2.59(5.8)	+12.35(1.0)	.51(4.4)	55%	1.14
Mortgage	2.93(5.9)	-2.22(-4.0)	2.59(5.6)	+ 4.94(0.3)	.49(4.2)	54%	1.14
Aaa	2.92(6.0)	-2.13(-4.0)	2.62(5.8)	+15.64(1.1)	.49(4.3)	55%	1.14
Baa	2.93(5.9)	-2.20(-4.1)	2.60(5.7)	+ 9.05(0.7)	.48(4.2)	55%	1.17
Prime Rate	2.95(5.9)	-2.26(-4.2)	2.56(5.6)	+ 0.90(0.1)	.50(3.5)	53%	1.14
Prime R(ipd)	2.95(5.9)	-2.27(-4.3)	2.57(5.5)	- 0.46(-0.0)	.49(3.3)	53%	1.15
Fed. Funds	2.95(5.9)	-2.25(-4.2)	2.55(5.6)	+ 2.75(0.3)	.52(3.3)	53%	1.14
Fed. F(ipd)	2.95(5.9)	-2.26(-4.3)	2.55(5.5)	+ 1.54(0.1)	.50(3.1)	53%	1.14
$r_{t-2} - r_{t-3}$							
10YTreas	2.88(5.3)	-2.21(-3.7)	2.50(5.4)	+ 2.65(0.2)	.49(3.9)	56%	1.19
Mortgage	2.91(5.6)	-2.25(-4.0)	2.48(5.4)	+ 0.69(0.3)	.49(3.7)	56%	1.18
Aaa	2.82(5.3)	-2.13(-3.7)	2.56(5.5)	+ 8.48(0.5)	.47(3.6)	57%	1.20
Baa	2.78(5.4)	-2.07(-3.7)	2.62(5.8)	+13.41(1.0)	.44(3.4)	58%	1.20
Prime Rate	3.03(6.3)	-2.57(-4.8)	2.48(6.0)	**-15.79(-1.9)**	.58(4.8)	61%	1.11
Prime R(ipd)	*2.98(6.3)*	*-2.53(-4.8)*	*2.52(6.1)*	***-15.78(-1.9)***	*.57(4.8)*	*61%*	*1.11*

Table 15 (Con'd)

IS Curve Estimates Using Lagged Real Interest Rate Values
Real Interest Rate = Nominal - CPI Inflation Average$_{(t+2)+(t+1)+(t)+(t-1)+(t-2)}$
Dependent Variable: ΔY_t

Δr	ΔT_t	$\Delta(T-G)_t$	ΔX_t	Δr	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
Fed. Funds	3.08(6.5)	-2.70(-5.0)	2.49(6.1)	**-16.85(-2.1)**	.57(5.0)	62%	1.12
Fed. F(ipd)	*3.03(6.5)*	*-2.67(-5.0)*	*2.54(6.3)*	***-17.19(-2.2)***	*.57(5.0)*	*62%*	*1.11*
$r_{t-2} - r_{t-3}$							
10YTreas	2.88(5.3)	-2.21(-3.7)	2.50(5.4)	+ 2.65(0.2)	.49(3.9)	56%	1.19
Mortgage	2.91(5.6)	-2.25(-4.0)	2.48(5.4)	+ 0.69(0.3)	.49(3.7)	56%	1.18
Aaa	2.82(5.3)	-2.13(-3.7)	2.56(5.5)	+ 8.48(0.5)	.47(3.6)	57%	1.20
Baa	2.78(5.4)	-2.07(-3.7)	2.62(5.8)	+13.41(1.0)	.44(3.4)	58%	1.20
Prime Rate	3.03(6.3)	-2.57(-4.8)	2.48(6.0)	**-15.79(-1.9)**	.58(4.8)	61%	1.11
Prime R(ipd)	*2.98(6.3)*	*-2.53(-4.8)*	*2.52(6.1)*	***-15.78(-1.9)***	*.57(4.8)*	*61%*	*1.11*
Fed. Funds	3.08(6.5)	-2.70(-5.0)	2.49(6.1)	**-16.85(-2.1)**	.57(5.0)	62%	1.12
Fed. F(ipd)	*3.03(6.5)*	*-2.67(-5.0)*	*2.54(6.3)*	***-17.19(-2.2)***	*.57(5.0)*	*62%*	*1.11*
$r_{t-3} - r_{t-4}$:							
10YTreas	2.91(5.6)	-2.22(-4.1)	2.44(5.5)	- 1.00(-0.1)	.49(4.0)	57%	1.18
Mortgage	2.71(5.2)	-2.09(-3.9)	2.62(5.8)	+19.60(1.2)	.44(3.7)	59%	1.17
Aaa	2.84(5.4)	-2.18(-4.0)	2.50(5.6)	+ 5.73(0.4)	.48(3.9)	585	1.20
Baa	2.79(5.4)	-2.15(-4.0)	2.55(5.7)	+10.43(0.8)	.46(3.9)	58%	1.24
Prime Rate	2.88(5.8)	-2.20(-4.1)	2.49(5.7)	+ 5.59(0.7)	.45(3.6)	58%	1.16
Prime R(ipd)	2.89(5.8)	-2.20(-4.2)	2.48(5.7)	+ 5.66(0.7)	.45(3.6)	60%	1.16
Fed. Funds	2.89(5.7)	-2.20(-4.1)	2.47(5.6)	+ 1.60(0.2)	.48(3.7)	57%	1.18
Fed. F(ipd)	2.89(5.7)	-2.20(-4.1)	2.47(5.6)	+ 1.81(0.2)	.47(3.7)	57%	1.18
$r_{t-4} - r_{t-5}$:							
10YTreas	2.71(5.3)	-2.10(-3.90	2.57(5.9)	+12.09(1.0)	.49(4.2)	60%	1.15
Mortgage	2.58(4.8)	-1.99(-3.7)	2.64(5.9)	+18.65(1.1)	.49(4.3)	61%	1.15
Aaa	2.71(5.2)	-2.08(-3.9)	2.55(5.8)	+10.55(0.7)	.49(4.2)	605	1.15
Baa	2.68(5.2)	-2.06(-3.8)	2.57(5.9)	+12.03(1.0)	.49(4.2)	60%	1.17
Prime Rate	2.61(5.4)	-2.01(-4.0)	2.70(6.4)	+15.84(2.1)	.46(4.2)	64%	1.29
Prime R(ipd)	2.60(5.5)	-1.99(-4.0)	2.72(6.6)	+17.23(2.4)	.45(4.2)	65%	1.31
Fed. Funds	2.60(5.30	-2.02(-4.0)	2.72(6.4)	+14.02(2.0)	.46(4.1)	64%	1.24
Fed. F(ipd)	2.60(5.40	-2.00(-4.0)	2.75(6.5)	+15.49(2.2)	.45(4.1)	65%	1.26
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

* data in parenthesis next to regression coefficients are t-statistics

4.c. Comparing Interest Rates Calculated under Adaptive and Rational Expectations Assumptions about Future Inflation

Tables 16 below provide summary comparisons of marginal effect estimates, t statistics, and R^2 for the adaptive and two most successful rational expectations models. This is an updated version of Table 10, adding the best two rational expectations model results. In essence, the table suggests that we lose explanatory power when we add current and future inflation rates to our best adaptive expectations models. This finding suggests adaptive expectations may more accurately reflect how businesses estimate future inflation than rational expectations models.

even where rational expectations models factor in past inflation as well as any available information on likely current and future year inflation trends.

Table 17 shows how the different impact on GDP of typical yearly changes 1960 - 2000 in the (absolute) values of the explanatory variables in our IS model. This is an updated version of Table 9 above. This table shows that using different interest rates in the basic IS model results in little change to the estimated impacts on the GDP of average yearly changes in the government deficit, the accelerator or exports. However, the estimated effect of typical yearly changes in interest rates on the GDP (25 to 37billion) represents a substantial change percentage change the choice of interest rate can cause considerable percentage changes in how the economy reacts. But either number represents such a small total dollar effect on GDP compared to the changes caused by the other variables that all of the models tested essentially yield the same conclusion: the real interest affects the economy systematically, but only in a very small way.

Table 16

Summary of Results of 5 Adaptive and 2 Rational Expectations Interest Rate Deflation Methods For Real Interest Rates With a 2 Period Lag

	Average Inflation Rate Used:						
	Tables 3&4	Table 6	(No Table)	Table 7	Table 8	Table 14	Table 15
	($Av_{t-1, t-2}$)	(t Only)	(t-1 Only)	($Av_{t, t-1}$)	($Av_{t, t-1, t-2}$)	($Av_{t+1,to,t-2}$)	($Av_{t+2,to,t-2}$)
(ipd)							
$r_{t--2} – r_{t-3}$							
Prime R	-16.31(-2.5)	-18.68(-1.9)	-15.03(-2.4)	-20.55(-2.3)	-20.12(-2.5)	-19.13(-2.2)	-15.78(-1.9)
Fed. F.	-15.70(-2.6)	-17.45(-2.0)	-13.86(-2.3)	-18.01(-2.4)	-18.75(-2.6)	-19.64(-2.4)	-17.19(-2.2)
(cpi)							
$r_{t--2} – r_{t-3}$							
Prime R	-15.89(-2.6)	-12.23(-1.6)	-15.39(-2.3)	-21.99(-2.3)	-23.40(-2.8)	-20.83(-2.2)	-15.79(-1.9)
Fed. F	-13.91(-2.5)	-11.09(-1.3)	-12.13(-2.3)	-17.32(-2.2)	-19.41(-2.6)	-20.48(-2.4)	-16.85(-2.1)
R^2 Prime*	64%	59, 60%	62, 64%	64%	65, 64%	62%	61%
R^2 Fed.F*	63, 64	58, 61	62	62, 63	64	64	63 62

- data in parenthesis next to regression coefficients are t-statistics. R^2 is for cpi, then ipd model. If the same, one R2 is given.

Table 17

Summary Estimates of Relative Importance of Different Components of the IS Curve

	Change in GDP Associated With an Average year's Change In the Accelerator, Exports, the Deficit, and the Real Prime Rate			
	Using Table 3 Marginal Estimates	Using Table 8 Marginal Estimates	Using Table 14 Marginal Estimates	Using Table 15 Marginal Estimates
Deficit*	$130 Billion	$135 Billion	$131 Billion	$128 Billion
Accelerator	88	93	100	102
Exports	71	71	69	69
Real Prime Rate	25	37	32	25

*Due to Government Spending Change

5. Allowing the Effects of Interest Rate Changes to Vary with Economy Size

The substitution of an interaction variable $(r_i)(Yi_{t-2})$ for just(r_i) reduces the standard error of the real interest rate regression coefficient. This seems reasonable since the amount of investment (and subsequently GDP) brought forth by a change in real interest rates of any given percent should vary with the size of the economy. Multiplying the year's interest rate by the real GDP (in trillions) increases the estimated effect of a change in real rates in later parts of the 1960-2000 period examined, when the economy was much larger than in 1960. This adjustment made for a slightly tighter fit of the interest rate variable to the data, as shown in Table 18 below. where we test using one of the two most successful adaptive expectations models (past two year average inflation) for estimating real interest rates. To measure the varying size of the economy, we use the GDP size two years earlier than the time period used for the interest rate variable. Unsurprisingly, we again find that only two year lagged version of the interest rate variable is significant. This formulation of the interest rate adds from -1 to +2 points to explained variance, and one to two tenths of a point to t-statistics, as shown in Table 20. We also ran this same test using the other most successful adaptive hypothesis - that the average of current and past two years inflation rates was what was used by businesses to deflate nominal interest rates. here again, only the results for the two period lagged income-adjusted interest rate were found significant. These results for (only) that lag period are shown in Table 19 and summarized in Table 20. As before, this formulation left the prime and Fed. Funds rates slightly more significantly related to GDP than the non-income modified version, with slightly higher R^2 for two of the four key regressions, and slightly lower Durbin Watson statistics for all four.

Table 18

IS Curve Interest Rate Tests Using Interest Rates Variables Modified by GDP Size (r_iY_{i-2})
Real Interest Rate = Nominal - CPI Inflation Average$_{(t-1)+(t-2)}$
(Dependent Variable: ΔY_t)

Δr_iY_{i-2}	ΔT_t	$\Delta(T-G)_t$	ΔX_t	$\Delta(r_tY_{t-2})$	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_t Y_{t-2} - r_{t-1}Y_{t-3}$:							
10YTreas	2.85(6.1)	-2.29(-4.6)	2.51(6.0)	+ 2.33(1.2)	.47(4.2)	58%	1.24
Mortgage	2.74(6.0)	-2.30(-4.8)	2.53(6.3)	+ 5.15(2.0)	.51(4.7)	60%	1.23
Aaa	2.80(6.1)	-2.26(-4.6)	2.51(6.1)	+ 3.29(1.5)	.47(4.3)	59%	1.26
Baa	2.78(6.1)	-2.24(-4.6)	2.49(6.1)	+ 3.57(1.6)	.49(4.5)	59%	1.27
Prime Rate	2.91(6.3)	-2.44(-4.5)	2.42(5.8)	+ 1.94(1.1)	.51(4.5)	57%	1.22
Prime R (ipd)	2.90(6.1)	-2.28(-4.2)	2.45(5.6)	+ 0.48(0.3)	.49(4.2)	565	1.19
Fed. Funds	2.90(6.2)	-2.45(-4.5)	2.48(6.0)	+ 1.77(1.1)	.50(4.5)	57%	1.22
Fed. F (ipd)	2.90(6.2)	-2.30(-4.2)	2.46(5.8)	+ 0.59(0.3)	.49(4.3)	56%	1.20
$r_{t-1} Y_{t-3} - r_{t-2}Y_{t-4}$:							
10YTreas	2.93(5.9)	-2.26(-4.30	2.45(5.7)	+ 0.49(0.2)	.50(4.1)	56%	1.17
Mortgage	2.99(5.9)	-2.31(-4.3)	2.47(5.8)	- 0.92(-0.3)	.48(4.0)	56%	1.16
Aaa	2.92(5.9)	-2.25(-4.3)	2.45(5.7)	+ 0.65(0.3)	.50(4.2)	56%	1.17
Baa	2.94(5.9)	-2.27(-4.3)	2.46(5.7)	+ 0.11(0.0)	.49(4.2)	56%	1.17
Prime Rate	2.95(6.0)	-2.28(-4.3)	2.48(5.6)	- 0.28(-0.2)	.48(3.3)	56%	1.18
Prime R(ipd)	2.95(6.0)	-2.29(-4.4)	2.49(5.6)	- 0.54(-0.3)	.46(3.1)	56%	1.19
Fed. Funds	2.95(6.0)	-2.27(-4.3)	2.47(5.7)	- 0.17(-0.1)	.48(3.2)	56%	1.17
Fed. F(ipd)	2.95(6.0)	-2.27(-4.4)	2.48(5.7)	- 0.44(-0.2)	.47(2.9)	56%	1.18
$r_{t-2} Y_{t-4} - r_{t-3}Y_{t-5}$:							
10YTreas	3.10(6.0)	-2.47(-4.40	2.43(5.7)	- 2.21(-1.1)	.48(4.2)	58%	1.22
Mortgage	3.16(6.3)	-2.56(-4.7)	2.50(6.0)	- 4.41(-1.7)	.48(4.2)	60%	1.22
Aaa	3.09(6.0)	-2.46(-4.4)	2.45(5.7)	- 2.35(-1.0)	.48(4.2)	57%	1.21
Baa	3.03(5.8)	-2.39(-4.2)	2.46(5.7)	- 1.60(-0.7)	.49(4.2)	57%	1.21

Table 18 (Con'd)

IS Curve Interest Rate Tests Using Interest Rates Variables Modified by GDP Size (r_iY_{i-2})
Real Interest Rate = Nominal - CPI Inflation Average$_{(t-1)+(t-2)}$
(Dependent Variable: ΔY_t)

Δr_iY_{i-2}	ΔT_t	$\Delta(T-G)_t$	ΔX_t	$\Delta(r_tY_{t-2})$	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
Prime Rate	3.09(6.8)	-2.63(-5.30	2.67(6.7)	**- 3.65(-2.7)**	.50(4.7)	64%	1.17
Prime R(ipd)	*3.01(6.6)*	*-2.58(-5.1)*	*2.67(6.6)*	***- 3.43(-2.5)***	*.52(4.9)*	*63%*	*1.16*
Fed. Funds	3.11(6.9)	-2.68(-5.4)	2.64(6.7)	**- 3.45(-2.8)**	.49(4.7)	65%	1.16
Fed. F (ipd)	*3.05(6.8)*	*-2.67(-5.4)*	*2.66(6.7)*	***- 3.65(-2.8)***	*.52(4.9)*	*65%*	*1.14*
$r_{t-3}Y_{t-5} - r_{t-4}Y_{t-6}$:							
10YTreas	3.00(6.1)	-2.34(-4.5)	2.46(5.9)	- 2.87(-1.5)	.49(4.3)	60%	1.21
Mortgage	2.98(5.9)	-2.31(-4.3)	2.45(5.7)	- 2.03(-0.8)	.49(4.2)	58%	1.23
Aaa	3.00(6.1)	-2.33(-4.4)	2.46(5.8)	- 2.91(-1.4)	.48(4.2)	60%	1.22
Baa	3.00(6.0)	-2.32(-4.3)	2.44(5.7)	- 2.36(-1.0)	.49(4.2)	59%	1.18
Prime Rate	2.91(5.8)	-2.23(-4.2)	2.46(5.7)	- 0.65(-0.5)	.50(4.2)	58%	1.22
Prime R(ipd)	2.90(5.8)	-2.21(-4.1)	2.45(5.6)	- 0.06(-0.0)	.49(3.9)	57%	1.19
Fed. Funds	2.92(5.9)	-2.26(-4.2)	2.44(5.7)	- 0.97(-0.8)	.50(4.2)	58%	1.24
Fed. F(ipd)	2.90(5.8)	-2.23(-4.2)	2.45(5.6)	- 0.58(-0.4)	.50(4.0)	58%	1.21
$r_{t-4}Y_{t-6} - r_{t-5}Y_{t-7}$:							
10YTreas	2.81(5.6)	-2.14(-4.0)	2.49(5.7)	+ 0.76(0.4)	.47(4.0)	59%	1.14
Mortgage	2.78(5.5)	-2.11(-3.1)	2.51(5.8)	+ 1.59(0.6)	.47(4.0)	59%	1.13
Aaa	2.81(5.6)	-2.14(-4.0)	2.49(5.7)	+ 0.43(0.2)	.48(4.0)	59%	1.15
Baa	2.79(5.5)	-2.12(-4.0)	2.49(5.7)	+ 1.15(0.5)	.47(4.0)	59%	1.14
Prime Rate	2.74(5.6)	-2.08(-4.0)	2.57(6.1)	+ 2.11(1.6)	.45(3.9)	62%	1.19
Prime R(ipd)	2.66(5.6)	-2.01(-4.0)	2.65(6.5)	+ 3.04(2.3)	.44(4.0)	65%	1.23
Fed. Funds	2.76(5.6)	-2.10(-4.0)	2.59(6.0)	+ 1.64(1.3)	.45(3.9)	61%	1.16
Fed. F(ipd)	2.68(5.6)	-2.04(-4.0)	2.68(6.4)	+ 2.64(2.1)	.44(4.0)	64%	1.18
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)	.48(4.4)	57%	1.18

.
*data in parenthesis next to regression coefficients are t-statistics

Table 19

IS Curve Interest Rate Tests Using Interest Rates Variables Modified by GDP Size ($r_{t-2}Y_{t-4}$)
Real Interest Rate = Nominal - CPI Inflation Average$_{(t)+(-1)+(t-2)}$
(Dependent Variable: ΔY_t)

$\Delta r_{t-2}Y_{i-4}$	ΔT_t	$\Delta(T-G)_t$	ΔX_t	$\Delta(r_{t-2}Y_{t-4})$	$(\Delta Y_t - \Delta Y_{t-1})$	R^2	DW
$r_{t-2}Y_{t-4} - r_{t-3}Y_{t-5}$:							
Prime Rate	3.16(6.9)	-2.72(-5.4)	2.67(6.8)	**- 4.98(-2.8)**	.52(5.0)	65%	1.10
Prime R(ipd)	*3.04(6.6)*	*-2.62(-5.2)*	*2.67(6.6)*	***- 4.12(-2.5)***	*.54(5.0)*	*63%*	*1.10*
Fed. Funds	3.18(7.1)	-2.78(-5.6)	2.64(6.8)	**- 4.66(-3.0)**	.51(4.9)	66%	1.08
Fed. F (ipd)	*3.09(6.9)*	*-2.73(-5.4)*	*2.66(6.8)*	***- 4.34(-2.8)***	*.53(5.0)*	*65%*	*1.09*

.
*data in parenthesis next to regression coefficients are t-statistics

Table 21 shows how using the income adjusted interest rate variable markedly changes the predicted change in the GDP resulting from the 1.56% average yearly change in the prime rate during the 1960-2000 period. The example is based on the coefficients for the cpi-deflated prime interest rate shown in Tables 3, 18 and 19.

Notice that without using the income modifier, the estimated effect of a 1% interest rate change is the same ($ 15.89 Billion) - the average size of the effect, over the 1960-2000 period, regardless

Table 20

Coefficient and t-Statistic Comparison of r_{-2} and $r\text{-}2_tY_{-4}$ Variables in the Standard IS Model

	r_t (Table 3)	r_tY_{t-2} (Table 18)	r_tY_{t-2} (Table 19).
Fed. Funds Rate			
cpi – Deflated	-13.91(-2.5)*	-3.45(-2.8)	-4.66(-3.0)
ipd – Deflated	-15.70(-2.6)	-3.65(-2.8)	-4.34(-2.8)
R^2 (cpi, ipd)	63, 64%	65, 65%	66, 65%
Prime Rate			
cpi – Deflated	-15.89(-2.6)	-3.65(-2.7)	-4.98(-2.8)
ipd – Deflated	-16.31(-2.5)	-3.43(-2.5)	-4.12(-2.5)
R^2 (cpi, ipd)	64,64%	64, 63%	65, 63%

*data in parenthesis next to regression coefficients are t-statistics

Table 21

Using An Economy Size Modifier When Predicting Interest Rate Effects on GDP (Y)

Predicted Δ in Y	Estimate of Marginal Effect of Δr (or rY_{-2})	Δ in Real Prime Rate	Real GDP_{-2} Size Modifier Used
	Effect of 1% ΔPrime Rate on Large (1998 Size) Economy		
$ 25 Billion	-15.89	-1.56%	(No Size Modifier)
$ 48 Billion	- 3.65	-1.56%	$8.508 Trillion (1998Y)
$ 66 Billion	- 4.98	-1.56%	" "
	Effect of 1% ΔPrime Rate on Small (1960 Size) Economy		
$ 25 Billion	-15.89	-1.56%	(No Size Modifier)
$ 14 Billion	- 3.65	-1.56%	$2.377 Trillion (1960Y)
$ 18 Billion	- 4.98	-1.56%	" " "

of whether it takes place in a small or a large economy. Using the GDP size -modified interest rate variable ($r_{t-2}Y_{t-4}$), our estimated effect of a one percent change in the prime rate is about 2 - 2.5 times as large in the economy of the late 90's as the non-size modified estimate of $25 billion. For the smaller 1960 economy, the economy size modified effect is only about fifty to seventy percent the size of the $15.89 B non-income modified effect. However, even the most powerful income - modified effect leaves average annual interest rate changes still less impactful on the economy than either the average annual changes of the accelerator, the deficit or exports.

The reduced standard errors (larger t statistics) on the size-modified interest rate parameter estimate suggests economy size can be a perhaps marginally useful factor to include in model specification when estimating interest rate effects. We use the term "perhaps marginally" because though t statistics improved, there was no improvement in explained variance in two of the four cases above, and only one percent more variance explained in the other two.

The income modified interest rate data in Table 21 suggest that a one percent change in the prime interest rate in the year 2000, using the 3.65 marginal effect estimate, would be associated with a change in 2002 real GDP of $33.67 Billion, a 5% change in the prime rate with a $168.36 Billion change in the 2002 real GDP. The (third quarter) 2002 real GDP estimate was $9.486 Trillion. Hence, the somewhat sizeable rightward shift in the LM curve required to bring about a large 5% change in the real prime rate would, ceteris paribus, likely be associated with change in the GDP of only about 1.8%. The results above suggest even a draconian drop of 10% in the real prime rate would only yield a 3.6% change in the GDP. Note that Okun's Law

$$\Delta \text{ Real GDP} = 3.5\% - 2\ (\Delta \text{ Unemployment Rate})$$

(Mankiw, 2007)

suggests a drop in the unemployment rate of about nine-tenths of one percent might result from a reasonably large 5% change in the real prime rate which resulted in adding another 1.8% to GDP growth in a particular year. A more draconian 10% change in the real prime rate might add 3.6% to GDP, reducing unemployment 1.8%. This suggests the IS curve is extremely steep, and that though the Fed does control the interest rates that matter, even large changes in these rates may only generate small changes in the level of employment and the GDP. Using the 4.98 marginal effect estimate raises the estimated effect of a 10% change in the prime rate on GDP to 4.8%, and the effect on employment to 2.4%.

6. Adding Additional Explanatory Variables to the Simple Keynesian Model

As a check on the results of our simple IS curve model above, additional variables which might reasonably also be considered determinants of consumption and investment were entered into the IS equation, and the equation was retested to see if our interest rate results remained the same. Several variables which may affect consumption were added, some with lagged values. These variables were added to account for the effects of wealth (Dow Jones Composite Index lagged two periods), the price of foreign goods (the average exchange rate for the current and past three years), and the current year prime interest rate (a measure of cost of consumer credit). Variables measuring current year depreciation, prior year capacity utilization, a variable to proxy for Tobin's q (Dow Jones Composite Index lagged two periods), profits lagged two periods and the same four year average exchange rate variable were added to the investment equation. All of these variables had been found significantly related to consumption or investment in other studies See for example (Heim, 2007 a, b). All these additional variables are thought by some to also be determinants of the GDP, through their affect on "C" and "I". They were added to our simple Keynesian IS curve previously used, and the curve was reestimated using the various interest rates and lags tested earlier with the simpler model.

These additional variables raise R^2 for our IS curve equation (using the two period lagged cpi-deflated prime rate or Fed. Funds rate) from the previous 63-64% range to 85%. In addition, we find the estimated marginal effects for the prime and Fed. Funds interest rates and their statistical significance to be very similar to those obtained with the simple model, as shown in Table 22 below. This helps assure us that the marginal impact estimate for the interest rate variable in the simpler model is not overstated due to an ability to proxy for "left out" variables. The DW statistic rises significantly from the 1.1 - 1.3 range found with the simple model to 2.1 - 2.2 with the addition of other explanatory variables, eliminating the autocorrelation problem (and also indicating it was not skewing our earlier estimates). This was not expected since low DW statistics, such as we with the simpler, are often merely a sign that the model is missing some other explanatory variables.

However, unlike earlier analyses, the one period lag prime and Fed. Funds rates were also found statistically significant when tested in the expanded model. However, this appears to be an artifact of the data, namely excessive collinearity between the newly added capacity utilization variable and the interest rate variable. The one period lagged capacity utilization variable is fairly highly correlated (.62) with the one period lagged prime and Fed. Funds rates, and appears to be influencing its value. Retesting the expanded model without the capacity utilization variable, or including it with either one less or one more lag, and the one period lagged prime and Fed. Funds rates become statistically insignificant, as in the simple IS model previously tested. Hence, we are inclined to disregard the expanded models' finding of statistical significance for the single period lagged values as multicollinearity - caused, i.e., spurious.

No other interest rate tested with the this completely specified model, either the mortgage rate, the 10 year treasury rate, the Aaa or the Baa rates, were found statistically significant at any lag level. This repeats the findings of our simpler IS model use above. Results for these variables are also shown in Table 22.

Table 22

Real Interest Rate Coefficient and t-Statistics Using An IS Curve With Additional Explanatory Variables

Lags	Fed.Funds	Prime	Mortgage	Aaa	Baa	Treas10 .
0	3.63(0.8)*	0.84(0.2)	3.80(0.9)	1.05(0.4)	- 0.11(-0.3)	- 0.27(-0.1)
	23.54(1.1)**	0.25(0.0)**	17.85(0.9)**	9.61(0.6)**	1.25(0.1)**	1.95(0.1)
-1	- 2.91(-2.2)[a]	- 3.30(-2.4)[a]	- 3.14(-1.3)	-1.70(-0.9)	- 2.02(-1.1)	- 1.18(-0.7)
	-16.53(-2.5)**,[a]	-18.55(-2.8)**,[a]	-17.32(-1.6)**	- 9.88(1.0)**	-10.94(-1.2)**	- 7.61(-0.9)
-2	- 3.00(-2.5)	- 3.33(-2.3)	- 3.45(-1.5)	- 2.29(-1.1)	- 1.90(-0.9)	- 2.29((-1.3)
	-12.51(-2.4)**	-15.76(-2.5)**	-16.16(-1.7)**	-12.39(-1.4)**	-11.43(-1.2)**	-12.74(-1.5)
-3	0.23(0.2)	0.20(0.2)	0.19(0.1)	0.59(0.3)	1.22(0.6)	- 0.11(0.1)
	0.91(0.2)**	0.50(0.1)**	- 3.01(-0.3)**	0.14(0.2)**	2.60(0.3)**	- 1.31(-0.2)
-4	1.25(1.1)	1.47(1.2)	- 0.54(-0.2)	- 1.09(-0.5)	- 1.00(-0.4)	- 0.75(-0.4)
	4.70(1.0)**	5.34(1.0)**	- 0.95(-0.1)**	- 4.76(-0.5)**	- 4.61(-0.5)**	- 3.19(-0.4)

*data in parenthesis next to regression coefficients are t-statistics
** Interest rate variable not income-modified. [a] Appears to be statistically significant only because of a multicollinearity problem. See text above.

7. Post 1980 Testing with Hetroskedasticity Corrections

Reviewing the empirical literature, their appears to be a greater tendency for pre - 1980 than post - 1980s studies to find no significant relationship between interest rates and investment or the GDP. Since the 1980s, it seems to have been more common for studies to find some, albeit often small, relationship. This may have been because often in the pre-1980 period, testing was done without corrections for hetroskedasticity problems, and perhaps to a lesser extent, autocorrelation problems. This of course, can cause significance levels of regression coefficients was be understated, leading some variables which were significantly related to others to appear insignificant.. This could lead some pre -1980 studies to the conclusion that some interest rate variables were not statistically significant, when in fact they were. However, with the advent of, and easy access to, more modern statistical packages which include hetroskedasticity correction methods, particularly White's method (White 1980) for non - autocorrelated data sets and Newey -West's method (Newey, West 1987) for data sets with autocorrelation, variables tested, including interest rates, began to show higher levels of statistical significance in studies than before. To some extent, this was probably also true of autocorrelation corrections. The question is, would our earlier results, and the results of earlier studies, have changed much if we had used these corrections with our earlier models?

Table 23 below revises the t-statistic findings from the more complete IS model in Table 22 above to reflect application of the White (W) and Newey-West (N) hetroskedasticity correction methods. T-statistics for autocorrelation corrections with and without hetroskedasticity corrections are also added. With these corrections, regression coefficients, R^2 and D.W. statistics should and do remain unchanged, but generally t-statistics increase. With higher t-statistics on most interest rates than before, we still find that it is mainly the two period lagged real interest rates that are systematically related to GDP. However, now, it is not only the two period lagged prime and Fed. Funds rates that that appear statistically significant, but also the two period lagged mortgage and Aaa corporate bond rates as well! This also appears, like the one period lag findings of statistical significance above, to be the result of the high degree of intercorrelation between these interest rates and the prime rate, which allows them to (imperfectly) proxy for the prime and Fed. Funds rates, as we show in Tables 23.A and 23.B below. However, when entered as a separate variable in a regression that already contains the two year lagged prime rate, the t-statistics on

Table 23

Interest Rate Coefficient and t-Statistics Using An IS Curve With Additional Explanatory Variables and White (W) and Newey-West(N) Hetroskedasticity Corrections

Lags**	Fed.Funds	Prime	Mortgage	Aaa	Baa	Treas.10 .
Nom.$_{0}$	-17.40(-1.4)(-1.5)	-22.48**(-2.5)(-2.4)**	-33.70**(-2.2)(-2.2)**	-27.05(-1.8)**(-2.1)**	-23.27**(-2.1)**(-1.8)	-22.91(-1.8)(-1.5)
N-IM$_{0}$	23.54(1.4)(1.6)	0.25(0.0)(0.0)	17.85(1.5)(1.5)	9.61(0.8)(0.8)	1.25(0.1)(0.1)	1.95(0.2)(0.1)
IM$_{0}$	3.63(1.1)(1.0)	0.84(0.2)(0.2)	3.80(1.3)(1.7)	1.05(0.4)(0.4)	- 0.11(-0.0)(-0.4)	-).28(-0.1)(-0.1)
Nom.$_{-1}$	-18.11**(-2.2)(-2.2)**[a]	-20.40**(-2.3)(-2.5)** [a]	-10.31(-0.6)(-0.6)	- 3.36(-0.3)(-0.2)	- 5.43(-0.5)(-0.6)	-- 1.11(-0.1)(-0.1)
N-IM$_{-1}$	-16.40**(-2.7)(-3.1)**[a]	-18.40**(-2.7) (-3.2)**[a]	-17.32**(-2.0)(-2.0)**[a]	- 9.88(1.2)(1.3)	-10.94(-1.3)(-1.4)	- 7.60(-1.0)(1.0)
IM$_{-1}$	- 2.91**(-2.0)(-2.6)**[a]	- 3.30**(-2.2) (-2.7)**[a]	- 3.14(-1.3) (-1.6)	- 1.70(-1.0)(-1.6)	- 2.02(-1.2)(-1.3)	- 1.17(-0.7)(-0.8)
Nom.$_{-2}$	-15.80(-1.7) **(2.0)**	-12.76(-1.5) (-1.4)	- 0.95(-0.1) (-0.1)	5.38(0.5)(0.3)	8.05(0.8)(0.9)	- 2.32(-0.2)(-0.4)
N-IM$_{-2}$	-12.51**(-2.5) (-3.3)**	-15.76**(-2.8) (-3.5)**	-16.16**(-2.1) (-2.1)**	-12.39(-**2.0 (-2.4)**	-11.43(-1.6)**(-2.2)**	-12.74**(-2.1)(-2.5)**
IM$_{-2}$	- 3.00**(-2.4) (-4.0)**	- 3.33**(-2.1) (-3.4)**	- 3.45(-1.6) (-1.9)	- 2.29(-1.5 **(-2.0)**	- 1.90(-1.2)(-1.8)	- 2.29(-1.6)(-2.1)
Nom.$_{-3}$	7.25(1.4) (1.1)	7.18(1.3) (1.1)	28.30(1.7) (1.7)	30.82**(2.2 (2.2)**	24.28**(2.2)(2.1)**	17.50(1.6)(1.6)
N-IM$_{-3}$	0.91(0.2) (0.2)	0.50(0.1) (0.1)	- 3.01(-0.4) (-0.4)	0.14(0.0 (0.0)	2.60(0.4)(0.4)	- 1.31(-0.2)(-0.3)
IM$_{-3}$	0.23(0.2) (0.3)	0.20(0.2) (0.2)	0.19(0.1) (0.1)	0.59(0.4 (0.5)	1.22(0.8)(0.8)	0.11(0.1)(0.1)
Nom.$_{-4}$	11.76(2.2) (2.0)	15.21(2.4) (2.2)	34.19(1.7) (2.0)	13.06(0.9)(0.8)	11.57(0.9)(0.7)	9.96(0.9)(0.9)
N-IM$_{-4}$	4.70(1.2) (1.2)	5.34(1.3) (1.3)	- 0.95(-0.1) (-0.1)	- 4.76(-0.5)(-0.5)	- 4.61(-0.4)(-0.5)	- 3.19(-0.4)(-0.4)
I-M$_{-4}$	1.25(1.3) (1.4)	1.47(1.5) (1.2)	- 0.54(-0.3) (-0.3)	- 1.09(-0.5)(-0.5)	- 1.00(-0.4)(-0.4)	- 0.75(-0.4)(-0.4)

* data in parenthesis next to regression coefficients are t-statistics
** Nom$_i$, I-M$_i$ and N-IM$_i$ = Nominal rate, Income -modified and Non-Income Modified Rates, lagged (i) periods [a] Statistical significance appears spurious due to multicollinearity (See text).

the two year lagged Mortgage, Aaa, Baa and Treasury rates fall to insignificance (t = 0.8, 1.3, 1.7, 1.0 respectively) and the sign on all of them changes negative to positive. In addition, the magnitude of the regression coefficient changes markedly. By comparison, the sign on the two year lagged prime rate in the same equation stays the same (negative), it remains statistically significant, and the coefficient stays much closer to its value in Table 23, where it was the only two year lagged real rate in the equation.

Further evidence of the ability of ability of the two year lagged mortgage, Aaa, Baa and treasury rates to proxy for the prime rate can be seen by examining the relatively high simple correlation coefficients for these rates and the prime rate, shown in Table 23A below.

Another measure of the extent to which, when entered separately, one real interest rate variable may be proxying for another is a failure for them, when both entered in the regression, to explain significantly more variance than either alone. Table 23B shows R^2 for each two year lagged when entered alone, and when two or more are both included separately

Table 23A

Simple Correlation Coefficients for Table 23 Interest Rates

Real PR	1.00	0.25	0.32	0.74	0.18
Nom. Mort.	0.25	1.00	0.84	0.74	0.85
Nom. Aaa	0.32	0.84	1.00	0.70	0.97
Nom. PR	0.74	0.74	0.70	1.00	0.63
Nom. Baa	0.18	0.85	0.97	0.63	1.00

Table 23B

Regressions With Only One Real Interest Rate, Compared With Those Containing the Prime Rate and Another Rate (Using Newey-West Hetroskedasticity Corrections)

Two Period Lagged Real Interest Rate(s)	R^2	T-statistic(s)
No 2-Lag Rate Included	.81	N.A.
Prime(PR) Only	.85	-3.5
Mortgage(Mort) Only	.83	-2.1
Aaa Only	.83	-2.4
Baa Only	.82	-2.2
10 Yr. Treasury Only	.83	-2.5
Both PR, Mort.	.85	-2.5, +0.8
Both PR, Aaa	.85	-2.7, +1.3
Both PR, Baa	.86	-3.2, +1.7
Both PR, 10 Yr. Treas.	.85	-2.5, +1.0

In Table 24 below, we tested current period nominal rates using the simpler IS model. .In this simple model, none were found statistically significant, even with hetroskedasticity and auto correlation corrections. This is not the case for the expanded model in Table 23, where several current period nominal rates were found statistically significant.

In Table 23, he current period nominal values of the Prime, Aaa, Baa and Mortgage rates were sometimes found to be statistically significant and with the right sign, for at least one of the hetroskedasticity correction methods, and have the correct (negative) sign, even though their real rates were not found statistically significant. So, the question arises: why would the current year nominal rates for these interest rates (in some tests) seem to affect current real GDP, but some not? The answer appears to lie with the addition of the real current year prime interest rate (PR_0)in the expanded model (because it has been found to be systematically related to consumer spending in some studies). This real rate is moderately correlated with the current period nominal interest rates found significantly related to the GDP. However, when this real rate was dropped from the equation, none of the nominal rates (with and without hetroskedasticity corrections)

Table 24

Current Period Nominal Interest Rate Coefficient and t-Statistics Using the Simple Keynesian Model with White (W) and Newey-West(N) and No (NC) Hetroskedasticity Corrections

Lags	Fed.Funds Coef. (NC) (W) (N) (AR1)(AR1N)	Prime Coef.(NC) (W) (N) (AR1) (AR1N)	Mortgage Coef. (NC) (W) (N) (AR1)(AR1N)
(0)	- 0.67 (-0.1) (-0.1)(-0.1) (+2.0)(+2.2)	- 2.34 (-0.3) (-0.3)(-0.5) (+1.3)(+1.3)	- 0.41 (-0.0)(-0.0)(-0.0)(+0.7)(+0.7)
	Aaa Coef.(NC) (W) (N) (AR1)(AR1N)	**Baa** Coef.(NC) (W) (N) (AR1) (AR1N)	**10 Yr.Treasury** Coef.(NC) (W) (N) (AR1)(AR1N)
(0)	- 0.60 (-0.0) (-0.1)(-0.1) (+0.4)(+0.4)	- 0.05 (-0.0) (-0.0)(-0.0) (+0.3) (+0.3)	- 2.18 (-0.2)(-0.2)(-0.3)(+0.4)(+0.5)

* data in parenthesis next to regression coefficients are t-statistics
**For hetroskedasticity problems: NC=No correction; W= White correction; N=Newey-West correction; For autocorrelation problems, AR1 = 1st order correction; AR1N = 1st order correction and Newey-West hetroskedasticity correction

retained their statistical significance except the current year mortgage rate, which was significant in all three hetroskedasticity tests, and the current period nominal prime rate, which was barely significant in one of the three tests (Newey - West).

Since the earlier results with the simple model so convincingly showing that it is the real, not nominal prime rate that matters, we examined the possibility that the mortgage rate effect was real (a case can certainly be made that current mortgage rates, not those of two years ago, affect current housing demand and therefore the current GDP and that the current year nominal prime, Aaa, Baa and treasury rates were merely a proxying for the mortgage rate and/or the two year lagged prime rate when one or both were missing from the equation tested in Table 23.

This was tested, first, by rerunning the regression with the expanded variable set with <u>both</u> the two year lagged real prime rate (found significant in every test) and the current year nominal mortgage rate. Doing so, we found the nominal mortgage rate's magnitude to be fairly similar to that found in Table 23 (-25.44 vs. -33.70) and statistical significance (t=2.1) to be almost identical to that in Table 23 (t=2.2), where it was used as an *alternative* to the two year lagged real prime rate. Also, R^2 increased from .849 to .865 when both were used together. We conclude that the current year nominal mortgage rate has an effect of GDP independent of the two year lagged real prime rate. In Table 26 below, we will show that the effect, while systematic, is not great, averaging about half the prime rate effect.

We then tested the Aaa, Baa and Treasury current period nominal rates in this model. All were found statistically insignificant when entered with the two period lagged real prime rate, but not greatly so (t=1.9). Other tests suggested that these rates are so intercorrelated that using one or the other of these current year nominal rates (the mortgage, Aaa, Baa, and 10 year Treasury) in the above model, or the average of all of them, or entering all of them separately in the above model and adding up their individual regression coefficients, yielded about the same estimates of the total impact on the GDP (all relatively minor compared to a real GDP in 2000 of $9,224 billion). The range of findings for the effect on GDP of the average yearly change in these current year nominal rates plus the two year lagged real prime rate were as follows, using the standard (expanded) model above:

1. Using only one of the current year nominal rates: $34 - 39 billion
2. Using 2 - 4 of them as separate variables: $37 - 42 billion
3. Using 2 - 4 of them averaged together: $36 - 38 billion

These results also suggest the corporate rates and the treasury rate might have some, independent effect, but one captured in, and hard to separate out of, the estimated effect of the mortgage rate on the GDP. Using any one of these nominal rates alone appears to do a reasonable job of estimating the effects on the economy of a given percentage change in all the separate bond - related rates, but using the mortgage rate seems to do it best.

However, we cannot say this for one of the current year nominal rates: the prime rate. Adding this instead of the mortgage rate to an expanded model containing the two year lagged real prime rate causes its regression coefficient to fall to about half it's Table 23 level, where it was used alone, its t-statistic falls from -2.4 to -1.6, and R^2 only increased 6/10 of a percent. This suggests the finding in Table 23 that current year current year nominal prime rate was statistically significant occurred only because it could serve as an imperfect proxy for the current year nominal mortgage rate and/or the two year lagged real prime rate, not because the current year *nominal* prime rate in any way systematically affects the GDP.

In this two - rate version of the expanded model, the point estimate of the effect on the real GDP of a change in interest rates is then given by the following regression coefficients:

Δ GDP	-12.27 Δ (Real Prime Rate)$_{-2}$	- 25.44 Δ (Nominal Mortgage Rate)$_0$
(t=)	(-3.2)	(-2.1)

where we realize that the mortgage rate's marginal effect estimate may also be picking up the effect of other bond - related rates(Aaa, Baa and treasury) that move with it.

Earlier in the paper we noted the average change (in absolute value) in the real prime rate 1960-2000 was 1.56 percent. The average change in the nominal mortgage rate during the same period was .56 percent. Hence, an average year's change in these rates (both changing in the same direction) would be 12.27(1.56) + 25.44(.56) = $ 33.4 billion. Recalculating Table 21 using these two interest rates' combined effect, and comparing with economy size modified results gives

Table 25

Using An Economy Size Modifier When Predicting Interest Rate Effects on GDP (Y)

Predicted Δ in Y	Estimate of Marginal Effect of ΔPR (PRY_{-2})	Δ in Real Prime Rate	Estimate of Marginal Effect of ΔMort(Mort Y_{-2})	Δ in Nom. Mort Rate	Real GDP_{-2} Size Modifier Used
Effect of Av. Annual ΔPrime Rate, Mortgage Rate on Large (1998 Size) Economy					
$ 33 Billion	-12.27	-1.56%	-25.44	-0.56%	(No Size Modifier)
$ 56 Billion	- 2.92	-1.56%	- 3.64	-0.56%	$8.508 Trillion (1998Y)
$ 66 Billion	- 3.43	-1.56%	- 4.24	-0.56%	" " "
Effect of Av. Annual ΔPrime Rate, Mortgage Rate on Small (1960 Size) Economy					
$ 33 Billion	-12.27	-1.56%	-25.44	-0.56%	(No Size Modifier)
$ 11 Billion	- 2.92	-1.56%	- 3.64	-0.56%	$2.377 Trillion (1960Y)
$ 18 Billion	- 3.43	-1.56%	- 4.24	-0.56%	" " "

Using the past two years average inflation to deflate the nominal prime rate (with and with out economy size modifier), the estimated impact for both on the GDP is $8 billion higher than in Table 21, where only the effect of the real prime rate was calculated There is no change in the Table 21 estimated income modified effect ($66 billion for a 1998-sized economy) of a change using the average of the current and past two years inflation as a deflator to arrive at the real prime interest rate. So, by adding the current year nominal mortgage rate as a proxy for the effect of all bond related rates on the economy, we may improve our estimated effect of a change in interest rates over what we get just using the two year lagged prime rate alone, but not by much.

What does remain clear is that interest rate effects, even with the mortgage rate's effect added, are still small compared to the effects of an average year's change in either the accelerator effect or changes in the government deficit. Even the average yearly change in our exports seems related to a larger effect.

We end our reanalysis of the expanded IS model using hetroskedasticity and autocorrelation controls, with the conclusion that controlling for some multicollinearity issues, the reanalysis confirms the simple IS model findings that the two year lagged real prime rate is the most important interest rate related to business investment However, we also note that this model suggests that in addition to the two year lagged prime rate, the current year nominal mortgage interest rate also systematically affects the GDP through its affect on residential housing, and to some extent, business investment through its ability to proxy for other bond - related interest rate effects (Aaa, Baa and 10 year treasury). This result did not show in the simpler model used earlier in this paper, as shown in Table 24 below. Including the average annual rate change in the mortgage rate over the 1060-2000 period added maximally about $8 billion (0-16% of the economy - size adjusted estimates, 32% to the unadjusted estimates) of how much a change in interest rates affects the economy. If we compare the regression coefficients in Table 21 with those in Table 25 above, we see that part of the reason the mortgage rate added so little is that the real prime rate itself is intercorrelated enough with it to pickup part of the mortgage rate effect, when the mortgage rate is not included in the same test. Adding the mortgage rate reduces the estimated marginal effect of the real prime rate by 20 - 30 percent. Still, about two thirds of the total effect on the economy comes through the prime rate; only one third through the mortgage and mortgage - related bond rates. These two rates then, the two year lagged prime rate and the current year nominal mortgage rate seem the appropriate rates to include in the IS curve to describe the effect of interest rates on investment.

For completeness, Table 26 below recalculates the real interest rates in the simple Keynesian IS model given in Table 3, which had no hetroskedasticity or autocorrelation controls, using these controls.

Table 26

IS Curve Estimates Using Lagged Real Interest Rate Values for Various Interest Rates
Real Interest Rate (r) = Nominal Rate - Average CPI Inflation$_{(t-1)+(t-2)}$ (Except If Noted IPD)

					t-Statistics With Hetroskedasticity, .Autocorrelation Corrections** .					
Δr	ΔT_t	$\Delta(T-G)_t$	ΔX_t	Δr	(NC)	(W)(N)	(AR1)(AR1N)	$\Delta Y_t - \Delta Y_{t-1}$	R^2	DW
$r_{t-} - r_{t-1}$:										
10YTreas	2.88(6.2)*	-2.32(-4.6)	2.53(6.1)	+10.46	(1.1)	(1.1)(1.8)	**(2.0)**(1.9)	.47(4.2)	58%	1.22
Mortgage	2.84(6.2)	-2.37(-4.8)	2.59(6.3)	+19.08	(1.6)	(1.5) **(2.3)**	**(3.1)(3.9)**	.50(4.6)	59%	1.21
Aaa	2.84(6.2)	-2.31(-4.7)	2.55(6.2)	+13.76	(1.3)	(1.4)**(2.4)**	**(2.0)(2.1)**	.48(4.3)	58%	1.24
Baa	2.86(6.2)	-2.29(-4.7)	2.53(6.2)	+14.80	(1.4)	(1.6)**(2.8)**	**(2.2)(2.1)**	.49(4.5)	58%	1.24
Prime Rate	2.91(6.2)	-2.38(-4.4)	2.48(5.9)	+ 6.23	(0.8)	(0.7)(1.2)	**(3.1)(4.0)**	.50(4.4)	57%	1.21
Fed. Funds	2.90(6.2)	-2.40(-4.4)	2.51(6.0)	+ 6.11	(0.8)	(0.8) (1.3)	**(3.3)(4.3)**	.50(4.4)	57%	1.21
$r_{t-1} - r_{t-2}$:										
10YTreas	2.93(5.9)	-2.26(-4.3)	2.46(5.7)	+ 2.62	(0.3)	(0.3)(0.3)	**(2.0)(3.9)**	.50(4.1)	56%	1.17
Mortgage	2.98(5.9)	-2.30(-4.3)	2.46(5.7)	- 3.65	(-0.3)	(-0.3)(-0.4)	(1.5)**(2.6)**	.48(4.0)	56%	1.17
Aaa	2.92(5.9)	-2.25(-4.3)	2.46(5.7)	+ 2.89	(0.3)	(0.3)(0.3)	(1.8)**(2.9)**	.50(4.2)	56%	1.17
Baa	2.94(5.9)	-2.27(-4.3)	2.46(5.7)	+ 0.36	(0.0)	(0.0)(0.0)	(0.9)(1.2)	.49(4.2)	56%	1.17
Prime Rate	2.95(6.0)	-2.28(-4.3)	2.48(5.7)	- 1.81	(-0.2)	(-0.2)(-0.3)	(2.0)**(2.2)**	.47(3.2)	56%	1.18
Fed. Funds	2.95(6.0)	-2.27(-4.3)	2.47(5.7)	- 0.44	(-0.1)	(-0.1)(-0.1)	(2.1)**(2.1)**	.49(3.2)	56%	1.17
$r_{t-2} - r_{t-3}$										
10YTreas	3.12(6.1)	-2.51(-4.6)	2.41(5.7)	-12.61	(-1.3)	(-1.6)**(-2.1)**	(-0.8)(-0.9)	.48(4.2)	59%	1.22
Mortgage	3.12(6.4)	-2.53(-4.8)	2.45(5.9)	-20.33	(-1.8)	(-1.9)**(-2.7)**	(-1.2)(-1.2)	.48(4.2)	60%	1.23

Table 26 (Con'd.)

IS Curve Estimates Using Lagged Real Interest Rate Values for Various Interest Rates
Real Interest Rate (r) = Nominal Rate - Average CPI Inflation$_{(t-1)+(t-2)}$ (Except If Noted IPD)

Aaa	3.10(6.1)	-2.48(-4.5)	2.42(5.7)	-13.26 (-1.3)	(-1.4)**(-2.0)**	(-0.6)(-0.6)	.48(4.2)	58% 1.21
Baa	3.05(6.0)	-2.42(-4.4)	2.43(5.6)	-10.57 (-0.9)	(-1.2)(-1.5)	(-0.3)(-0.3)	.49(4.2)	58% 1.21
Fed. Funds	3.07(6.7)	-2.65(-5.2)	2.59(6.5)	**-13.91 (-2.5)**	**(-3.1)(-4.8)**	**(-2.8)(-3.5)**	.50(4.7)	63% 1.19
Prime Rate	3.05(6.7)	-2.60(-5.2)	2.59(6.5)	**-15.89 (-2.6)**	**(-3.3)(-4.4)**	**(-3.3)(-3.6)**	.50(4.7)	64% 1.19
Fed. Funds(ipd)	*3.02(6.6)*	*-2.67(-5.2)*	*2.61(6.5)*	***-15.70 (-2.6)***	***(-3.3)(-4.8)***	***(-4.1)(-4.1)***	*.52(4.9)*	*64% 1.17*
Prime Rate(ipd)	*2.98(6.5)*	*-2.57(-5.1)*	*2.60(6.5)*	***-16.31 (-2.5)***	***(-3.2)(-4.2)***	***(-4.5)(-4.4)***	*.53(4.9)*	*64% 1.17*
$r_{t-3} - r_{t-4}$:								
10YTreas	2.99(6.1)	-2.33(-4.5)	2.42(5.8)	-13.57 (-1.6)	**(-3.0)(-2.9)**	(-1.9)**(-3.3)**	.50(4.4)	60% 1.23
Mortgage	2.97(6.0)	-2.31(-4.4)	2.42(5.6)	-12.48 (-1.1)	**(-2.3)(-3.0)**	**(-2.8)(-2.8)**	.49(4.3)	59% 1.25
Aaa	2.99(6.1)	-2.32(-4.4)	2.43(5.7)	-13.82 (-1.4)	**(-3.0)(-3.0)**	(-1.8)**(-2.8)**	.49(4.3)	60% 1.23
Baa	2.98(6.0)	-2.30(-4.3)	2.41(5.6)	-11.95 (-1.1)	**(-2.4)**(-1.9)	(-1.9)**(-2.8)**	.49(4.3)	59% 1.20
Prime Rate	2.90(5.8)	-2.23(-4.2)	2.45(5.6)	- 3.53 (-0.6)	(-0.6)(-0.7)	(-1.4)**(-2.2)**	.50(4.2)	58% 1.23
Fed. Funds	2.92(5.9)	-2.25(-4.2)	2.43(5.6)	- 4.36 (-0.8)	(-1.1)(-1.3)	(-1.7)**(-2.6)**	.51(4.2)	58% 1.24
$r_{t-4} - r_{t-5}$:								
10YTreas	2.82(5.6)	-2.15(-4.0)	2.50(5.7)	+ 2.17 (0.2)	(0.3)(0.3)	(-0.7)(-0.8)	.48(4.0)	59% 1.14
Mortgage	2.81(5.5)	-2.14(-4.0)	2.50(5.7)	+ 2.09 (0.2)	(0.2)(0.3)	(-0.5)(-0.6)	.48(4.0)	59% 1.15
Aaa	2.82(5.6)	-2.14(-4.0)	2.49(5.7)	+ 0.37 (0.0)	(0.0)(0.1)	(-0.9)(-1.1)	.48(4.1)	59% 1.15
Baa	2.81(5.6)	-2.14(-4.0)	2.50(5.7)	+ 3.23 (0.3)	(0.3)(0.4)	(-0.5)(-0.5)	.48(4.0)	59% 1.15
Prime Rate	2.79(5.6)	-2.13(-4.1)	2.56(6.0)	+ 7.97 (1.3)	(1.1)(1.8)	(0.4)(0.5)	.45(3.9)	61% 1.18
Fed. Funds	2.78(5.60	-2.13(-4.0)	2.57(5.9)	+ 6.15 (1.1)	(0.9)(1.5)	(0.5) (0.5)	.46(3.9)	61% 1.15
(no r incl'd)	2.88(6.4)	-2.20(-4.6)	2.49(6.1)	(NA)			.48(4.4)	57% 1.18

*data in parenthesis next to regression coefficients are t-statistics
**For hetroskedasticity problems: NC=No correction; W= White correction; For autocorrelation problems, AR1 = 1st order correction; AR!N = 1st order correction and Newey-West hetroskedasticity correction applied.

Table 26 mainly shows the same results with hetroskedasticity and autocorrelation corrections as shown earlier in Table 3. The exceptions are that the three year lagged 10 year treasury, the mortgage, Aaa and Baa rates now also appear statistically significant. However, when the two year lagged Prime or Fed. Funds rate (which are even more statistically significant in Table 26 above) is added to the equation, they retain approximately their Table 26 coefficients and t-statistics, and the three period lagged rate becomes statistically insignificant. Hence, we conclude that the significance of the three period lagged rates above is due to their ability to weakly proxy for the two period rates, not because they independently affect the real GDP.

The two period lagged mortgage, treasury and Aaa rates also show statistical significance in at least one of the Table 26 tests. They also become statistically insignificant when the two period lagged prime and Fed. Funds rates are added to the equation, but the prime or Fed. Funds rate remain significant. Here again, we conclude that these rates are merely showing significance in Table 26 above because they can imperfectly proxy for the (absent) prime or Fed. Funds rate, not because the hetroskedasticity and autocorrelation corrections they have an independent effect.

Conclusions -

The evidence above indicates that the prime interest rate and the federal funds rate are the interest rates most systematically related to changes in the GDP through IS curve mechanics (changes in investment). Also, since changes in the prime rate appear to be effectively controlled by the Federal Reserve's changes in the federal funds rate, the findings confirm the importance of the Fed's role in monetary policy. These two rates, rather than long term treasury, corporate, or mortgage interest rates, are probably most important because they are bank rates, and banks or bank-like financial intermediaries provide over half of all the outside funds used by businesses.

The study also finds that current period mortgage interest rates also enjoy an additional systematic and independent effect on GDP, about half the size of the two year lagged real prime rate effect. It appears to also effectively pickup any additional, smaller effects on the economy of variation in the corporate (Aaa or Baa) or government bond (10 year treasury) rates with which the mortgage rate is highly correlated

Our finding that bond rates may not be as systematically related to investment as the prime rate may be because so much more investment is done using bank or bank - like loans, and because of the nature of much of capital project financing: short term bank loans are typically taken to finance actual development, and are paid off after project completion. Hence, there can be something of a disconnect between interest rates affecting the decision to invest, and later rates prevailing when bonding must occur.

Further, the results indicate that changes in the prime and federal funds rates affect the GDP after a two year lag. This seems reasonable. When reductions in interest rates lead to decisions to make large investments, the architectural and engineering project design processes that follow, and subsequent contractor/vendor selection and construction/fabrication time periods can often be lengthy. This can cause the actual production of investment goods to occur one or more periods after the investment decision is made.

Our findings also indicate that business managers appear to estimate real interest rates by use of adaptive expectations methods involving the use of either the current and past two years' inflation rates, or only the past two years' rates to deflate current nominal rates. There was little evidence to suggest rational expectations models that included estimates of future inflation trends were used to deflate current nominal interest rates.

Finally, our findings suggest that the apparent tendency for studies in recent decades, compared to studies before 1980, to be more likely to find a systematic relationship between interest rates and the macro economy, may result from the wider use after 1980 of hetroskedasticity controls, which often seem to raise the statistical significance of otherwise insignificant variables. Nonetheless, when correcting for the tendency of many interest rate variables to proxy for either the two year lagged real prime rate we find that the hetroskedasticity/ autocorrelation controlled studies yield the same results as the earlier studies as regards the prime rate.

These findings have several implications for Keynesian IS - LM mechanics:

1. Steepness of the IS Curve - A Measure of Monetary Policy Effectiveness

The income modified interest rate data in Table 21 suggest that a one percent change in the prime interest rate in the year 2000, using the 3.65 marginal effect estimate, would be associated with a change in 2002 real GDP of $33.67 Billion, a 5% change in the prime rate with a $168.36 Billion change in the 2002 real GDP. The (third quarter) 2002 real GDP estimate was $9.486 Trillion. Hence, the somewhat sizeable rightward shift in the LM curve required to bring about a large 5%-point change in the real prime rate would, ceteris paribus, likely be associated with change in the GDP of only about 1.8%. The results above suggest even a draconian drop of 10% in the real prime rate would only yield a 3.6% change in the GDP. Note that Okun's Law

$$\Delta \text{ Real GDP} = 3.5\% - 2\,(\Delta \text{ Unemployment Rate})$$

(Mankiw, 2007)

suggests a drop in the unemployment rate of about nine-tenths of one percent might result from a reasonably large 5% change in the real prime rate which resulted in adding another 1.8% to GDP growth in a particular year. A more draconian 10% change in the real prime rate might add 3.6% to GDP, reducing unemployment 1.8%. This suggests the IS curve is extremely steep, and that though the Fed does control the interest rates that matter, even large changes in these rates may only generate small changes in the level of employment and the GDP. Using the 4.98 marginal effect estimate in Table 21 raises the estimated effect of a 10% change in the prime rate on GDP to 4.8%, and the effect on employment to 2.4%.

The data in Table 25, where changes in the GDP are calculated from both prime rate and mortgage rate effects yield slightly larger estimates. During the 1060-2000 period, a one point change in the prime rate was associated with a 0 .337 point change in the mortgage rate in the same period. Using the 2.92 prime rate marginal effect and the 3.64 mortgage rate marginal effect, this suggests a $38 billion change in the GDP would be associated with a one percent change in the prime rate. A 5 and 10% change would be associated with GDP changes of $191 billion and $382 billion respectively. A 5 or 10% change would raise the GDP 2 or 4% respectively, and reducing unemployment 1 or 2%respectively.

Using The larger 3.43 and 4.24 marginal effect figures from Table 25, a 5 or 10% change in the prime rate would raise the GDP 2.35 and 4.7% billion respectively, and reduce the unemployment rate 1.2 or 2.4% respectively (the same as Table 21).

<u>2. Shifts in the IS Curve May Account for Much More Change in GDP than Movement Along It.</u>

Using the simpler IS model, the results also suggest that the changes in the accelerator, the government deficit (associated with a change in government spending) and exports, each of which shifts the horizontal intercept of the IS curve, rather than cause movement along it, would be associated with larger changes in the GDP than a change in interest rates. These variables seem to explain a substantially larger portion of the variance in GDP over the 1960 - 2000 period than changes in interest rates.

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