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Interests Rates and Inflation: Uncertainty Cushions, Threshold and "Patman" Effects

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1. Introduction

It was the opinion of the late Congressman Wright Patman that it is senseless "to fight inflation by raising interest rates. Throwing gasoline on a fire to put out the flames would be just logical".[1] Marco models of the 1950's or 1960's were unable to evaluate this populist view, since they detailed only the aggregate demand side of the model. More recently, since the OPEC oil price shocks, aggregate supply has come into sharper focus, revealing many ways in which high interest rates may have adverse effects on aggregate supply.[2]

That these supply side effects have repurcussions for the theoretical properties of otherwise conventionally specified macro models, is increasingly being realised. It is now known, for example, that they may make stability less likely (see Mitchell (1984)), that they may adversely shift the trade-off between output and price stability (see Driskill and Sheffrin (1985)), and that they may cause fiscal policy to have perverse effects on the output gap during a monetary disinflation process (see Myatt and Scarth (1986)).

In the light of these developments it is conceivable that high interest rates may have inflationary impacts which persist through time. If aggregate supply reductions exceed the aggregate demand reductions consequent upon interest rate increases, the price level could be bid up, creating inflationary pressure and a transition to a higher price level. What is not clear however, since it depends on the model and its stability condition, is whether this could generate further rounds of inflation unless and/or until the government took offsetting measures. The possibility of instabi-

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[1]Cited by Driskill and Sheffrin (1985).

[2]If working capital advances are required (as in Taylor (1981)) or if real balances enter the production function (as in Levhari and Patinkin (1968)), these adverse effects are associated with a rise in nominal interest rates. On the other hand, if goods are held as inventories (see Myatt (1985) or if adjustment costs are labour using (see Scarth (1984)) these adverse effects are associated with a rise in real interest rates. The only possible benign effect of high real interest rates comes from intertemporal substitution on the part of labour suppliers (see Lucas and Rapping (1970)).

lity was first taken seriously by Cagan (1956) who was concerned only with the flight from money effect, and who used somewhat rudimentary statistical methods in an empirical investigation of the issue. We now have more reasons to take this possibility seriously and more sophisticated statistical techniques at our disposal.

This paper investigates the time series relationship between inflation and both real and nominal interest rates using monthly U.S. data, from January 1953 to June 1985. We apply the time series methodology, and in particular, the Wald variant of a Granger type causality test[3] to investigate whether there is any empirical evidence of either real or nominal interest rates causing inflation, and if so, whether high interest rates reduce inflation (as the traditional view supposes) or worsen it (as the "Patman effect" postulates).

We also investigate whether there is empirical evidence of inflation having a causal impact on interest rates (both real and nominal), and the direction of this influence. We suggest that the period can be usefully divided into three sub-periods of about equal length. In the first period (1953-65) both the mean and variance of the inflation rate are low. The second 1966-77) differs from the first in that the mean inflation rate is significant. The third sub-period (1978-85) differs from the second in that the variance of the inflation rate increases dramatically. The existence of such sub-periods could be of great value in testing hypotheses related to the signal extraction problem and the propogation of business cycles. In the present context we use the sub-periods to look for evidence of "threshold effects" in the public's perception of inflation, and for evidence of the incorporation of "uncertainty cushions" in both the real and nominal interest rate as the variance of inflation increases.

The next section considers the causal relationship between inflation and both real and nominal interest rates and tests for evidence of a "Patman" effect. Section 3 considers the nature of the dependence of interest rates on inflation and tests of evidence of "threshold effects" and "uncertainty cushions". Section 4 presents concluding remarks.

2. The Causal Relationship Between Interest Rates and Inflation: Is There a "Patman Effect"?

The Data

We used monthly U.S. data from January 1953 to June 1985. The nominal interest rate was measured by the annual rate on six month commercial

[3]This is the variant of the causality test recommended by Geweke (1981) and Geweke Meese and Dent (1983).

[4]We would like to thank Herb Taylor of the Federal Reserve Bank of Philadelphia for making available to us the most recent Livingstone survey data.

TABLE 1

GRANGER CAUSALITY BETWEEN REAL EX ANTE INTEREST RATES AND INFLATION

PERIOD: January 1953 - June 1985

Dependent Variable	Independent Variable	No. of lags of Independent Variable	F	F* 5%	F* 1%
Inflation Rate	Real Rate of Interest	24	0.97	1.52	1.79
		18	1.08	1.63	1.95
		12	0.43	1.75	2.18
		6	0.15	2.10	2.80
Real Rate of Interest	Inflation Rate	24	2.32	1.52	1.79
		18	2.88	1.63	1.95
		12	3.55	1.75	2.18
		6	5.06	2.10	2.80

TABLE 2

GRANGER CAUSALITY BETWEEN NOMINAL INTEREST RATES AND INFLATION

PERIOD: January 1953 - June 1985

Dependent Variable	Independent Variable	No. of lags of Independent Variable	F	F* 5%	F* 1%
Inflation Rate	Nominal Rate of Interest	24	1.10	1.52	1.79
		18	1.18	1.63	1.95
		12	0.40	1.75	2.18
		6	0.11	2.10	2.80
Nominal Rate of Interest	Inflation Rate	24	2.29	1.52	1.79
		18	2.95	1.63	1.95
		12	3.56	1.75	2.18
		6	5.05	2.10	2.80

paper. The real ex ante interest rate was calculated by subtracting the six month inflation forecast obtained from Livingstone data, from the nominal interest rate prevailing when the forecast was made.[4] The actual inflation rate was calculated using the CPI over the same six month period, and converted to an annual rate by simply doubling it. From the point of view of the causality test it is important to note that both the expected and actual inflation rates were "forward looking." That is, the actual rate of inflation recorded for January 1953 is the actual rate of inflation between January 1953 and June 1953, the period of time relevant for 6 month commercial paper issued in January 1953.

The Causality Test

To implement the Granger test both series are whitened by first differencing and regressing on a second order polynomial in time and eleven monthly dummies.[5] The residuals from these equations were then used as data in equation (1) below:

$$Y_t = \sum_{i=1}^{m} A_1(i)\, Y_{t-i} + \sum_{j=1}^{n} A_2(j)\, X_{t-j} + a_t \qquad (1)$$

where first an interest rate is set as X and the inflation rate as Y, and then the interest rate as Y and the inflation rate as X.

Equation (1) was estimated using 24 lagged values of the dependent variable[6], while four different lag lengths were used for the independent variable: 6, 12, 18 and 24. Table 1 reports the F statistic for the null hypothesis that

$$\sum_{j=1}^{n} A_2(j) = 0$$

using the real interest rate as the interest measure. Table 2 shows the results of the causality test when the nominal interest rate is substituted.

Considering first the top half of Tables 1 and 2, we find no evidence of either real or nominal interest rates having a causal impact on inflation. We subjected this result to considerable sensitivity testing. Different measures of the interest rate were used, (the three month treasury bill rate and the rate on long term bonds), and the same result was obtained. Finally, different sub-periods were investigated. The post

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[5]The second order polynomial is necessary to capture trend growth of an exponential nature, when using unlogged data (as we are).

[6]The choice of lag length is somewhat arbitrary, but it is better ot use too many lagged dependent variables than too few.

TABLE 3

GRANGER CAUSALITY BETWEEN REAL EX ANTE INTEREST RATES AND INFLATION

PERIOD: January 1978 - June 1985

Dependent Variable	Independent Variable	No. of lags of Independent Variable	F	F* 5%	F* 1%
Inflation Rate	Real Rate of Interest	24	0.83	1.52	1.79
		18	0.79	1.63	1.95
		12	0.51	1.75	2.18
		6	0.28	2.10	2.80
Real Rate of Interest	Inflation Rate	24	1.85	1.52	1.79
		18	2.24	1.63	1.95
		12	3.05	1.75	2.18
		6	3.50	2.10	2.80

TABLE 4

GRANGER CAUSALITY BETWEEN NOMINAL INTEREST RATES AND INFLATION

PERIOD: January 1978 - June 1985

Dependent Variable	Independent Variable	No. of lags of Independent Variable	F	F* 5%	F* 1%
Inflation Rate	Nominal Interest Rate	24	0.89	1.52	1.79
		18	0.93	1.63	1.95
		12	0.48	1.75	2.18
		6	0.30	2.10	2.80
Nominal Interest Rate	Inflation Rate	24	1.86	1.52	1.79
		18	2.28	1.63	1.95
		12	3.02	1.75	2.18
		6	3.39	2.10	2.80

1965 period was of interest because pre-1965 interest ceilings were in place. Also of interest was the post 1978 period, since Seelig (1974) suggests that interest rates would have to exceed about 9% in order for them to be important determinants of prices. In the post 1978 period nominal interest rates exceeded the 9% mark 68% of the time, and exceeded the 8% mark 96% of the time. [These results are reported in Tables 3 and 4]. However, in no instance was there any evidence of a "Patman effect" at the 5% level of significance. It is therefore with some confidence that we reject the "Patman hypothesis."

Considering the bottom half of Tables 1 and 2, we find evidence for every lag length, at the 1% level of significance, that inflation causes both real and nominal interest rates. (This continues to hold in the post 1978 sub-period). The causal dependence of the real interest rate shows that single equation tests of the Fisher relation are not legitimate. For example, many researchers have tested whether the co-efficient in front of a measure of expected inflation differs significantly from unity, with nominal interest rates as the dependent variable. (See Kane, Rosenthal, and Ljung (1983) for references). However our evidence shows that the real rate of interest is effectively, not just theoretically, an endogenous variable and may not be assumed constant.[7]

3. The Effect of Inflation on Interest Rates: "Threshold Effects" and "Uncertainty Cushions"

Since a uni-directional causal relationship between inflation and interest rates was identified, a simple OLS regression of interest rates on past inflation rates would yield consistent estimates. However, since it is the significance of the relationship that is at issue a correction for the presence of serial correlation must also be made. Consequently, equation 2 was fitted using the AUTOREG procedure in SAS. First order serial correlation was found and removed.

$$r_t = \sum_{s=1}^{k} h(s)\, P_{t-s} + \sum_{u=0}^{t} d(u)\, e(k-u) \qquad (2)$$

P denotes the rate of inflation; r either the nominal or real rate of interest and e represents a random error term. Four different values of k were tried (k = 24, 18, 12, 6) and the sum of the h(s) co-efficients was calculated. Judging from the insignificance of adding additional lagged variables, and the robustness of the sum of h(s) co-efficients, k = 18 was chosen as the lag length.

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[7]This result is not due to irrationalities in the Livingstone inflation forecasts. When the ex ante real interest rate is generated assuming rational expectations (following Mishkin (1984)), inflation continues to have a causal impact at the 1% level of significance.

TABLE 5

THE THREE SUB-PERIODS

	Period 1 1953-65	Period 2 1966-77	Period 3 1978-85
1. Mean Inflation Rate	1.4	5.6	7.3
2. Variance of Inflation	1.6	6.5	17.5
3. Mean Expected Inflation as a proportion of actual	0.36	0.69	0.96
4. Mean Nominal Interest	3.1	6.4	10.7
5. Mean Ex Ante Real Interest	2.6	2.5	3.7

Equation (2) was fitted for three sub-periods: the pre 1965 period in which interest rate ceilings were still in place; the post 1978 period after the Federal Reserve's conversion to monetarism; and the intervening 1966-77 period. Further justification for the sub-division is given in the first two rows of Table 5 which provides support for the view that the inflation process was significantly different in each sub-period. Both the mean and variance of inflation jumps four-fold between periods 1 and 2. On the other hand period 3 has almost the same mean inflation rate as period 2, but a variance that has increased almost threefold.

Table 5 also provides some interesting evidence on the question of whether there are threshold effects in the public's expectations of inflation. Consider the mean expected inflation rate as a proportion of the actual mean inflation rate, given in row 3. It certainly appears as if such threshold effects occur and that they may be related not only to increases in the mean inflation rate but also in the variance. In the first sub-period mean expected inflation was only 0.36 of the actual, perhaps because 1.4% inflation is not noticeable. It is, after all, possible that quality increases can make such an inflation rate nothing more than a statistical figment of the imagination. In the second sub-period expectations are nearly twice as accurate in response to the fourfold increase in inflation. But it takes a threefold increase in the variability of inflation to awaken people to the point where mean expected inflation is 96% of the actual mean rate.[8]

The results of estimating equation (2) over the three sub-periods are contained in Tables 6 and 7.

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[8]Of course there are other explanations consistent with the data. It may be that expectations are extremely backward looking. That is, it takes 20 years of mean inflation of 6% for people to catch on.

TABLE 6

EFFECT OF INFLATION ON NOMINAL INTEREST RATES

	1953-65	1966-77	1978-85
Intercept	2.80	3.13	5.04
Sum of Inflation Co-efficients	0.2769	0.5664	0.8398
R^2	.3857	.5393	0.4594

TABLE 7

EFFECT OF INFLATION ON REAL INTEREST RATES

	1953-65	1966-77	1978-85
Intercept	2.44	2.54	3.75
Sum of Inflation Co-efficients	-0.0966	-0.0426	-0.0725
R^2	.3568	.4621	.4114

Consider the effect of inflation on real and nominal interest rates in period 1, 1953-65. A one point increase in inflation tended to raise nominal interest rates by 0.28%, to lower ex ante real interest rates by about 0.10%, and hence to create a spread of about 0.38% between real and nominal rates. This is about as it should be in that the mean expected inflation rate as a proportion of the actual mean inflation rate was 0.36 (from Table 5). Similarly, in period 2 a one point increase in inflation creates a spread of 0.61% between real and nominal interest rates because on average over the period expected inflation increased only 0.69% for every point increase in actual inflation. For the third period our estimated co-efficients imply a spread of .91% for every point increase in the inflation rate, which corresponds fairly reasonably with the ratio of the mean expected inflation rate and the actual mean inflation rate (0.96). Of course, if inflation had had no effect on inflationary expectations, neither the nominal nor the ex ante real interest rate would have been affected.

The effect of expected inflation on ex ante real interest rates can be deduced from Table 7. Our results imply that a one point increase in expected inflation would reduce ex ante real interest rates by 0.26 (= -0.096/0.36) in period one, by 0.07 (= -0.042/0.6) in period two, and by 0.076 (= -0.073/0.96) in period three. In other words there does seem to be a consistently negative relationship between expected inflation and ex ante

real interest rates over the period.[9]

Also of interest is the change in the intercept of the real interest equation in period 3. This represents a 50% increase and mirrors the 50% increase in the mean ex ante real interest rate recorded in Table 5. Since this rather dramatic increase coincides with the equally rather dramatic increase in the variability of inflation in period 3, there would seem to be a "prima facie" case to be made that the former occured as a result of the latter.[10] In other words, the 50% increase in real ex ante interest rates in period 3 reflects a cushion to protect against the higher uncertainty of the inflation rate.

To subject this hypothesis to more rigorous statistical testing two moving variance measures were constructed: the variance of inflation over the previous two years; and the variance over the previous five years.[11] These were then incorporated into the regressions of interest rates on inflation over the entire period. No significant change occured to the sum of the inflation co-efficients. Tables 8A and 8B report the co-efficient and significance of the moving variance variable when it was added to equation (2). Though in only one instance was this measure of uncertainty significant at less than 5%, in every instance it has the correct sign, and moreover, the size of the co-efficient is of the correct order of magnitude to explain the increase in mean real interest rates observed post 1978. For example a co-efficient of 0.12 for the twenty-four month moving variance

TABLE 8A

CO-EFFICIENT AND SIGNIFICANCE OF TWENTY FOUR

MONTH MOVING VARIANCE

Dependent Variable	Period	Co-efficient	Significance Level
Real Interest Rate	1955-85	0.12	10%
Nominal Interest	1955-85	0.13	8%

[9]Symons (1983) reports similar findings for the U.K.

[10]The fact that the increase in the variability of inflation as we move from period 1 to period 2 did not produce an increase in real ex ante interest rates could be due to a combination of threshold effects and uncertainty cushions. Perhaps the uncertainty must pass a threshold before it becomes reflected in higher interest rates.

[11]A moving variance is exactly analogous to a moving average. Clearly we lose 24 observations with the two year moving variance and 60 observations with the five year moving variance.

TABLE 8B

CO-EFFICIENT AND SIGNIFICANCE OF SIXTY MONTH MOVING VARIANCE

Dependent Variable	Period	Co-efficient	Significance Level
Real Interest Rate	1958-85	0.07	12%
Nominal Interest Rate	1958-85	0.20	1%

"explains" the 1.2% increase in real interest rates which occured between periods 2 and 3 when the variance of inflation increased by ten points.

Further evidence that interest rates are causally affected by the variance of inflation was obtained using the Granger causality test. As before, all series were whitened by first differencing and regressing on eleven monthly dummies and a second order polynomial in time. Table 9 contains the results. We find significant evidence that the variance of inflation has a causal influence on both real and nominal interest rates. With 24 lags of the independent variable this evidence exists at the 1% level of significance using a 5 year moving variance, and at the 5% level using a two year moving variance.

TABLE 9

GRANGER CAUSALITY BETWEEN INTEREST RATES AND THE VARIANCE OF INFLATION

Dependent Variable	Independent Variable	No. of lags of Independent Variable	F	5%	1%
Real Rate of Interest	24 month moving Variance	24	1.57	1.52	1.79
		18	1.65	1.63	1.95
		12	1.52	1.75	2.18
Nominal Rate of Interest	24 month moving Variance	24	1.54	1.52	1.79
		18	1.47	1.63	1.95
		12	1.07	1.75	2.18
Real Rate of Interest	60 month moving Variance	24	1.80	1.52	1.79
		18	1.66	1.63	1.95
		12	1.58	1.75	2.18
Nominal Rate of Interest	60 month moving Variance	24	1.94	1.52	1.79
		18	1.84	1.63	1.95
		12	1.77	1.75	2.18

4. Concluding Remarks

Recent theoretical results have suggested that increases in interest rates may cause inflationary price increases and make stability less likely. Despite these results we find no evidence of either real or nominal interest rates having a causal impact on inflation, even in the 1978-85 sub-period which saw nominal interest rates go into double digits. There is no evidence of a Patman effect in the recent era of the U.S. economy.

There is evidence, however, of inflation having a strong causal influence on both nominal and real rates of interest. The latter result shows that much work which has been done testing the Fisher relation has erroneously assumed a constant exogenous real rate of interest. In fact inflation has a small but consistently negative impact on real rates of interest throughout the period.

We also find that the period can usefully be divided into three sub-points of approximately equal length. The first period 1953-65 is one of price stability; the second 1966-77 is characterized by a relatively easily predicted inflation; the final period is characterized by an uncertain and highly unpredictable inflation. Using these periods and Livingstone survey data on expected inflation, we find evidence highly suggestive of the existence of threshold effects in the public's perception of inflation. These threshold effects seem to be related not only to the level of inflation but also to its variability.

Finally, we have shown that the increased variability of inflation can explain the entire observed increase in real ex ante interest rates in the post 1978 period, and that the variance of inflation has a statistically significant causal impact on both real and nominal interest rates over the entire period.

This latter result is of interest to those engaged in analysing the adverse effects of high government deficits. Increases in real interest rates coincide not only with these record high deficits, but also with record high variability in inflation rates. High real interest rates may therefore reflect the incorporation of uncertainty cushions, rather than increased demand for loanable funds due to the deficit.[12]

Our results suggest the best recipe for low real interest rates: - high but easily predicted inflation. They also suggest that a monetary disinflation process would tend to raise real interest rates by both reducing inflation and increasing its unpredictability. The adverse supply side effects of these higher real interest rates must be set against the beneficial supply side effects of lower nominal interest rates.[13]

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[12]It would be of interest to design a test to distinguish between the two hypotheses. This points the direction for future research.

[13]Both nominal and real interest rates may have supply side effects. See footnote 2 above.

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