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The Variability of Inflation in Brazil: 1974-1982*

John H. Welch**

This paper shows that variability of unanticipated inflation depended positively on the level of the inflation rate in Brazil for the period 1974 to 1982. The model assumes that individuals use all information available in formulating forecasts about future inflation rates. The variance around this forecast is defined as the unanticipated variability of inflation. I estimate the model using monthly data and generate estimates of the one-step-ahead forecasts of the level and variance of monthly inflation rates. This method represents an improvement on previous research on Brazilian inflation variability in that the mean of inflation is modeled explicitly and the variance is estimated around this mean, as opposed to calculating variability around a moving average or simple time trend.

I. Introduction

Does inflation uncertainty increase with the inflation rate? Milton Friedman (1977) maintains that it does, and that this is the predominant danger of inflation. This note tries to determine empirically whether inflation "uncertainty" increases with the inflation rate in Brazil. I use the variance of inflation around its conditional mean as a proxy for inflation "uncertainty." My main objective is to find the conditioning elements of the variance of Brazil's inflation.

Recent work by Engle (1983) shows that a positive relationship between the inflation rate and the variance of inflation suggested by Friedman (1977) does not exist in the United States. Inflation rates in the U.S.,

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** Assistant Professor, Department of Economics, Oakland University.

deals with ignorance and not with a game of chance where all possible outcomes are known and assigned probability measures of occurrence. Weintraub (1975) delineates the difference between risk and uncertainty when discussing Keynes' treatment of the relationship between uncertainty and probability theory in the following passage:

> In modern parlance, it was Keynes' viewpoint that a major leap of faith is involved in treating situations characterized by uncertainty as situations involving only risk. Any choice now among future alternatives is thus fundamentally uncertain, since the future is logically unknowable. No sampling from the future is feasible to ascertain probabilities for future alternatives, so there is no way uncertainty problems can be reduced to problems of risk.[4]

Hence, inflation variability can best be used to model inflation risk and not uncertainty. In spite of this problem, it will be assumed that individuals act as if they assign a subjective probability distribution to possible future values of inflation. More specifically, when expectations are formed about the future value of a random variable, one must form expectations about the full probability distribution of the variable in question. Ideally, one would like to model expectations on the entire probability distribution of inflation. This, however, is beyond the scope of this note. Instead, the paper will focus on a two parameter (location-scale) conditional distribution function for the inflation rate.

Following Engle (1983), the random variable inflation will have a nonstochastic unconditional mean and variance at each point in time. Economic agents, however, are concerned with the conditional distribution of inflation given all past information and its conditional moments may be defined as being dependent on this information set. Let $\tilde{p}_t$ be the inflation rate at time t, Φ_{t-1} the information set including all information through time $t-1$, π_t be the conditional mean of $\tilde{p}_t$, and v_t be the conditional variance of $\tilde{p}_t$ around π_t. Formally, we are interested in estimating π_t and v_t where:

(1) $$E(\tilde{p}_t \mid \Phi_{t-1}) = \pi_t$$

(2) $$E\,((\tilde{p}_t - \pi_t)^2 \mid \Phi_{t-1}) = v_t$$

This model is an improvement on methods which assume either a constant variance over time (such as, for example, Lucas (1973)) or those which estimate v_t around a moving average of the inflation rate (such as, for example, Klein (1977), Pindyck (1984) and, for the Brazilian case in

4 See Weintraub (1975, p. 532), Shackle (1967) and Kregel (1976).

equation (3) (which assumes homoscedastic ϵ_t), e_t^2, on the predicted values of inflation. The test statistic TR^2, where the R^2 is from this auxiliary regression, is distributed as a $X^2(1)$ under the null hypothesis of homoscedastic ϵ_t. If this null hypothesis is rejected, inflation variance depends upon the level of inflation.

The ARCH model of Engle (1982) assumes that the variance of inflation at time t is a function of past variances.

$$(6) \quad v_t = \alpha_0 + \alpha(B)\epsilon^2_{t-1}$$

Where $\alpha(B) = \alpha_1 + \alpha_2 B + \alpha_3 B^2 + \cdots + \alpha_q B^{q-1}$. Under the null hypothesis that $\alpha_1 = \alpha_2 = \cdots = \alpha_q = 0$, the test statistic TR^2 formed by taking the R^2 from the regression (including intercept) of the squared residuals, e^2_t, on the lagged values of the squared residuals $e^2_{t-1}, e^2_{t-2}, \cdots, e^2_{t-q}$ is distributed as a $X^2_{(q)}$.[7]

IV. The Results

After some experimentation with different monetary aggregates, the OLS estimate of equation (3) using seasonally adjusted monthly data[8] from 1974 to 1982 is:[9]

7 Both these tests are discussed in Engel, R.F. (1983). The first test, however, is a modified version of the one Engle uses.

8 The data appear in Martone (1983). Mudanças Estruturais no Mercado Monetário e Suas Implicaçoes, Working Paper No. 24, University of Sao Paulo, seasonally adjusted by ratio to moving trend methods. The data was seasonally adjusted by using the U.S. Bureau of the Census X-11 program. Seasonality was not constant for all variables.

9 Equations using the monetary base, M_1, M_2, M_3, and total credit to the private sector were estimated and causality tests were used to determine which monetary aggregate was the most appropriate. The $F_{(12, 68)}$ statistics for the test of whether the above variables aggregate cause inflation appear below.

	$\tilde{p}$
Monetary Base	1.894***
M_1	1.908**
M_2	0.675
M_3	1.042
Bank Credit to Private Sector	1.171

Only the monetary base and M_1 significantly cause inflation. I chose to work only with M_1 as its significance level was lowest for simplicity. It should be noted that the heteroscedastic structure of inflation around its conditional mean was exactly the same for both aggregates, and hence, using the monetary base in addition to M_1 adds nothing to the analysis. The causality results presented above agree with Martone's (1983) results on the demand for money. They also agree in general with causality tests reported in Cardoso (1977), Contador (1978), Carneiro Netto and Fraga Neto (1984), and Bastos Marques (1983).

The joint inclusion of predicted inflaiton and lagged values of the squared residuals did not reject the null hypothesis that all parameters were equal to zero. This is explained by the very high collinearity of the squared residuals and the predicted value of inflation. In order to keep the analysis as simple as possible, the remainder of this paper assumes that the level of inflation is the main determinant of its variance. This assumption seems reasonable as lagged values of the squared residuals failed to cause inflation variance using standard causality tests while the predicted values did significantly cause inflation variance.

Finally, a simple correction for the heteroscedasticity found above proved extremely satisfactory. I divided the dependent and independent variables in (3) by the predicted values from equation (7). This procedure was iterated until conergence was achieved within four iterations. The final inflation equation is as follows.

$$(8) \quad \tilde{p}_t = \underset{(4.441^*)}{0.495\tilde{p}_{t-1}} \underset{(-1.718^{***})}{-0.224\tilde{p}_{t-4}} \underset{(-1.930^{***})}{-0.101\tilde{p}_{t-12}} + \underset{(2.981^*)}{0.100\tilde{m}_{1t-3}}$$

$$+ \underset{(1.705^{***})}{0.060\tilde{m}_{1t-5}} + \underset{(2.509^{**})}{0.090\tilde{m}_{1t-6}} + \underset{(3.247^*)}{0.125\tilde{m}_{1t-7}} + \underset{(2.465^{**})}{0.102\tilde{m}_{1t-8}}$$

$$+ \underset{(3.244^*)}{0.139\tilde{m}_{1t-10}} + \underset{(2.400^{**})}{0.95\tilde{m}_{1t-12}} + \underset{(3.259^*)}{0.0100D_{1979}}$$

$$F_{(27,68)} = 110.414^* \qquad R^2 = 0.9777$$

The large improvement in the performance of the equation reinforces the assertion that inflation variability increases with inflation. After some experimentation with different functional forms, I regressed the squared residuals from (8) on the squared predicted values of inflation from (8) to generate an estimate of inflation variance equation. An unrestricted equation produced an insignificant negative intercept. The following equation constrains the intercept to be zero to ensure non-negative variances.

$$(9) \quad v_t = \underset{(4.386^*)}{0.0274\tilde{p}_t^2} \qquad F_{(1,\,94)} = 45.289^*$$

$$R^2 = 0.3251 \quad TR^2 = 31.21^*$$

Clear, $dv_t/d\tilde{p}_t > 0$ for positive inflation rates, and, hence, inflation variance varies directly with the level of inflation. It should be noted that there were no negative inflation rates over this period. Estimates of the noted that equation (9) is stable along the lines of Weiss (1985).

Finally, an application of the technique used in this paper to the variability of relative prices seems in order. The dependence of the variability of relative prices around a conditional mean of relative prices on the general rate of inflation has yet to be established.[14]

14 As mentioned above, Kadota and Moura da Silva (1982) establish that a relationship between the variance of relative prices around a moving average of relative prices and inflation exists.

Appendix 1 (continued)

		Error	Expected Inflation	Expected Variance
1978	J	–0.00429	0.0281	0.000022
	F	0.00365	0.0242	0.000016
	M	–0.00235	0.0263	0.000019
	A	0.00303	0.0280	0.000022
	M	0.00453	0.0285	0.000022
	J	0.00283	0.0352	0.000034
	J	0.00214	0.0242	0.000016
	A	–0.00085	0.0292	0.000023
	S	–0.00517	0.0310	0.000026
	O	0.00006	0.0297	0.000024
	N	0.00238	0.0291	0.000023
	D	–0.00229	0.0241	0.000016
1979	J	–0.01108	0.0452	0.000056
	F	–0.00354	0.0343	0.000032
	M	0.00363	0.0432	0.000051
	A	–0.00511	0.0417	0.000048
	M	–0.01120	0.0364	0.000036
	J	0.00353	0.0332	0.000030
	J	0.00099	0.0423	0.000049
	A	0.00735	0.0478	0.000063
	S	0.01628	0.0573	0.000090
	O	–0.00263	0.0575	0.000091
	N	0.00845	0.0454	0.000056
	D	0.02440	0.0561	0.000086
1980	J	–0.00547	0.0638	0.000112
	F	–0.02138	0.0559	0.000086
	M	0.00142	0.0516	0.000073
	A	–0.00020	0.0580	0.000092
	M	–0.00206	0.0663	0.000120
	J	–0.01783	0.0776	0.000165
	J	0.01039	0.0714	0.000140
	A	–0.00496	0.0690	0.000131
	S	–0.00488	0.0589	0.000095
	O	0.01131	0.0647	0.000115
	N	0.00080	0.0705	0.000136
	D	0.00325	0.0630	0.000109

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