Eastern Economic Journal, Volume XVII, No 4, October-December 1991

Output Effects of Unanticipated Money Growth in Asia

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INTRODUCTION

Two propositions emanating from the rational expectations models of Lucas (1973, 1975), and Sargent and Wallace (1975), have received much empirical attention. Proposition 1 (the policy ineffectiveness proposition)asserts that systematic monetary policy will not have real effects in the short-run. The second proposition contends that the effects of unanticipated policy changes decline the more unpredictable, or variable, policy changes become.

Following Barro (1977, 1978), and Lucas (1973) respectively, propositions 1 and 2 have been tested extensively on U.S. data and data drawn primarily from other developed countries.[1] Empirical support for these propositions especially for developing countries, remains controversial, and the need for additional empirical work has been widely recognized.

This lack of consensus about the effects of unanticipated monetary policy and its variability on output growth can be taken to mean that: (a) for some countries, particularly the U.S. and other developed countries, taken individually and in particular groupings, propositions 1 and 2 hold. However, for developing countries they do not, and/or (b) different methods used to test these propositions lead to different conclusions.

This paper is motivated primarily by these issues and represents a attempt to resolving them. It, therefore, tests proposition 2 and a variant of proposition 1 (i.e. unanticipated policy has real effects in the short-run) for a select group of developing countries in Asia with similar institutional and socioeconomic settings, among other shared characteristics.

The methodology employed is similar to the one used earlier by Kormendi and Meguire (1984) which found empirical evidence in favor of the above-mentioned and related propositions for a diverse group of 47 countries. However, it builds on their method by employing Akaike's final prediction error (FPE) in selecting lag lengths on the predictor variables in contrast to ad-hoc procedures employed so far in the rational expectations literature.

The paper is organized as follows. Section 2 outlines the methods used to empirically test the two propositions in this study. Also discussed are the common characteristics among the countries selected for the purpose. Section 3 is devoted to the estimation of money and real output growth equations for each country and the testing of propositions 1 and 2 using the FPE criterion for lag length selection. Section 4 compares the results obtained in section 2 with the ones that are obtained by employing the Kormendi and Meguire procedure. Section 5 concludes this paper by summarising the main findings.

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We wish to thank, without implicating, the editor and two anonymous referees of the *Eastern Economic Journal* for many helpful comments and suggestions.

DESCRIPTION OF THE MODEL

Kormendi and Meguire's (KAM from now) tests of the two propositions are conducted in the well-known framework of the rational expectations-natural rate model of the business cycle as formulated by Barro (1977, 1978, 1981). First, for each country, a time series of the unanticipated component of money supply changes is obtained by estimating variants of the following equation:

$$DM_t = d_0 + \Sigma\, d_i DM_{t-i} + \theta T + \varepsilon_t \quad (1)$$

where: d_o, d_i, and θ are the regression coefficients, DM_t is the first difference of log nominal money supply at time t, T is a time trend, and et is the white noise residual. et is also the estimate of unanticipated money growth at time t. (Henceforth ε_t is referred to as RM_t which is consistent with the notation employed in the literature in general and by Kormendi and Meguire in particular.)

The observed money growth series (DM_t) in equation (1), is viewed as a sample realization from an autoregressive moving average process and is estimated as an ARMA model for each country by KAM. In estimating equation (1) the lag length on DM is generally truncated to two periods or less.

Second, a real output growth model is estimated, which is specified as follows:

$$DY_t = \alpha + \beta(L)\, RM_t + \gamma(L)\, DY_{t-1} + \delta T + V_t \quad (2)$$

where: DY is the change in natural log of real output in period t; RM_t is the unanticipated money supply growth in period t; T is a trend term; and V_t is a white noise residual in period t. DY t is assumed to depend upon a distributed lag of RM_t (the residual from equation (1) above), and its own past values.The OLS projection coefficients $\beta(L)$ and γ (L) are defined as $\sum_{i=0}^{N_1} \beta_i L_i$ and $\sum_{i=1}^{N_2} \gamma_i L_i$ respectively, where L is the lag operator and N_1 and N_2 are assumed to be finite. In estimating equation (2) KAM set the lag length on RM to four and allowed the lags on DY to vary upto a maximum of two.

In addition to the arbitrary selection of lag lengths, this study also uses Akaike's (1970) final prediction error (FPE) to select the optimal lag lengths in both the money growth and real output equations. Thornton and Batton (1985) have recommended the use of FPE on the basis of its good performance in determining optimal lag lengths in an exhaustive study based on a standard, classical hypothesis testing norm.

While there is no general agreement on criteria for optimal lag length selection, we feel that employing the FPE criteria is at least as good and perhaps better than arbitrarily selecting lag lengths.[2] Moreover, Mishkin (1982) has observed that the choice of lag length may have an important bearing on the perceived differences in the results concerning the rational expectations hypothesis. By comparing the results obtained by employing both procedures, should enable us to determine whether this is indeed the case.

The final step consists of testing the hypothesis that 'there is a negative relation between the peak effects of unanticipated money supply changes (χ) and the variance of unanticipated money supply changes (σ^2_{RM}) across countries. χ is obtained from summing all positive values of β_i till a maximum is obtained for i=0,1,..,Nl. To test this hypothesis, however, care needs to be exercised in the selection of countries. Rational expectation models are based on the assumption of market economies where the socioeconomic and political institutions are presumed to be stable so that there is no uncertainty (in the Knightian sense) about these institutions.

Specifically, it assumes that there are no uncertainties such as: whether next year the present semi-democratic administration will be replaced by martial law; whether private enterprises will be nationalized, whether the government will legislate wage increases not in line with productivity increases; whether banks will be nationalized; whether the country will be at war with its neighbor and so on. Therefore, the countries should be selected in such a manner that the pattern of development is similar, variability of institutional uncertainties across them are minimal, and product and factor markets function more or less equivalently. On the other hand, output growth, inflation, and stabilization policy experiences, should have been different.

This method of selecting countries would be the closest to a 'controlled experiment'. Such has been the approach used in our study. Keeping the above-mentioned criteria in mind, we have chosen the following 13 countries in Asia: Burma, India, Indonesia, Korea, Malaysia, Nepal, Pakistan, Philipines, Singapore, Sri Lanka, Taiwan, Thailand, and Turkey. While this is a relatively small sample, the payoff we hope, will be in the credibility of results obtained.

All these countries are mixed developing economies where the government has taken an active role in the development process by the systematic allocation of total investment in the various sectors over the medium term (five year plans) . They have had fixed or actively managed exchange rates vis-a-vis the U.S. dollar over the period studied. Most of these countries can be characterized as employing relatively labor-intensive techniques of production and are roughly at similar stages of economic development. In the sixties these countries had fairly stable price levels. In the ensuing two decades they had differing but generally higher inflation rates, due to external shocks such as sharp increases in oil prices (all are oil importers), higher prices for non-competitive imports vital for their growth and development, lower demand from the industrial countries for their exports, and different stabilization policies adopted to cope with these internal and external developments.[3]

ESTIMATION AND TESTS

The Money Growth Equation

The problem of nonstationarity in economic time-series data is addressed by using the first difference of the natural log of all variables. It is assumed that forecasts of nominal money growth can be approximated by variants of equation (1).

Equation (1) was estimated for each country as an ARMA model where the lags on the autoregressive part were determined by the FPE criterion. The maximum lag length was set at four. While the ARMA method for forecasting is not a full rational expectations approach, from a statistical perspective, it is appealing because it gives a parsimonious representation of the stochastic process governing money growth.

For Burma, Pakistan, Philipines, Taiwan, and Thailand it was not possible to get a satisfactory model to explain nominal money growth. To check on the time series properties of nominal money growth in these countries the first through sixth order auto-correlation coefficients (γ_i) were computed. In addition the Q statistic was used to test the null that the first to sixth order auto correlation coefficients are zero.(The Q statistic follows a chi-square distribution with k degrees of freedom, where k denotes the maximum lag specified for the autocorrelation function for the residual series.) This test confirmed that the series were indistinguishable from white-noise. Based on these results, actual nominal money growth was considered to be equivalent to unanticipated nominal money growth.

The estimated equations for the other eight countries had a number of satisfactory features. First, a substantial part of nominal money growth was explained. Second, the residuals were indistinguishable from white noise as evidenced by the key diagnostics of γ_i and Q(6). Third, the models were found to be structurally stable.[4] Two tests were employed to check on the structural stability of the estimated models. The Chow tests for structural stability were performed by splitting the estimation period in half. The null hypothesis of structural stability was not rejected at the 10% or higher levels of significance. As a further check on these stability results, the Farley-Hinich test which investigates whether there is a continuous drift in the equation was also applied (see Farley, Hinich and McGuire (1975) for details). This test also failed to reject the null hypothesis of structural stability at the 10% or higher levels of significance.[5]

The Real Output Equation

The residuals from the estimated money growth equations were taken to be estimates of the unanticipated portion of nominal money growth (RM). These were then used to estimate variants of equation (2) for the thirteen countries. To determine the lag lengths for the one-sided lag polynomials $\beta(L)$ and $\gamma(L)$ an extensive search of the lag space was conducted. The maximum lags on both polynomials were set at four. The estimated equation with the lowest FPE was then selected as the real output equation.

Parameter estimates for variants of equation 2 are reported in Table 1. An intercept term was estimated but is not reported. As key diagnostics, the residuals of these equations and their auto-correlations were analysed. As an overall check Durbin's m test for serial correlation of the residuals upto order 6 was conducted. This is essentially an F test and is applicable in the presence of lagged dependent variables. The corresponding F statistics are reported in the last column as m(6).

Also reported in Table 1 are the time periods used for the estimation for each country, t-statistics, adjusted R^2, and the F statistic. Except for Sri Lanka, all estimated equations are statistically significant and their residuals display white-noise properties at the 5% or higher levels of significance as implied by their respective F and m(6) statistics.

Our estimation procedure is markedly different than Kormendi and Meguire's in that they constrained the lag length on $\beta(L)$ to be 4 and the maximum lag length on γ (L) was set at 2. Using the minimum FPE criterion and having searched the entire lag space up to order 4 for both $\beta(L)$ and (L), the results indicate that in only one country (India) did β (L) have an order of 4. Four countries (Burma, Korea, Malaysia, and Turkey) had lag lengths of order 3, and Pakistan had 2 lags on $\beta(L)$. On the other hand, for five countries (Indonesia, Phillipines, Singapore, Sri Lanka, and Thailand) there was only a contemporaneous relationship between DM and RM.[6]

In terms of the statistical significance of βi,' for countries with only contemporaneous RM entering the relationship (Indonesia, Phillipines, Singapore, Sri Lanka, ana Taiwan), the t-test for a single coefficient is sufficient. The β coefficient for these countries (except for Sri Lanka) is positive and statistically significant at the 5% level in a one-tail test.

For the other eight countries, an F test on the set of βi's was employed. Besides Turkey, the other seven countries rejected at the 10% level the null hypothesis that all coefficients on RM^{t-i} are equal to zero. Therefore for 11 out of 13 countries in our study, the proposition that unanticipated nominal money growth has statistically significant effects on real output, is not rejected. This concludes our test of a variant of proposition 1.

We now test proposition 2, i.e. whether there is an inverse relationship between real output effects of monetary shocks (χ) and the variance of unanticipated monetary shocks (σ^2_{RM}). Table 2 presents the peak effects of unanticipated money growth (χ), and the variance of unantipated money growth (σ^2_{RM}) Figure 1 shows RM the plot of x against σ^2_{RM}. As is clear from the scatter diagram there does not appear to be any systematic relationship between the two. The simple correlation coefficients between χ and σ^2_{RM} and between log of χ and σ^2_{RM} were 0.082 and 0.012 respectively. The associated standard errors were 0.28 and 0.30 respectively. Nonparametric tests were also employed for evaluating the σ^2_{RM} relationship. The Spearman's rank correlation coefficient had a value of .04 with an associated t-value of 0.14. This confirmed our visual impression of no systematic association between χ and 0'2 for the 13 countries.

On closer inspection of Figure 1, it is apparent that there are some extreme combinations of χ and σ^2_{RM} which may be biasing the relationship. This applies to Burma, Taiwan, and Malaysia. On the other hand, combinations of χ and σ^2_{RM} for India, Indonesia, Korea, Nepal, Pakistan, Phillipines, Singapore and Thailand, appear to fall on a downward sloping line indicating an inverse relationship between χ and σ^2_{RM} The simple correlation between χ and σ^2_{RM} for these 8 countries is -0.649 with an associated t-value of about 2. If only Burma, Taiwan, and Malaysia are excluded then the corresponding simple correlation between χ and σ^2_{RM} decreases (in absolute terms) to -0.275 with a value of -0.9.[7]

TABLE 1

Estimated Real Output Growth Models - Minimum FPE

Country	RM					DY					
(Period)	0	-1	-2	-3	-4	-1	-2	-3	R^2	F	m(6)
Burma	-.06	-.03	.30	-.17		.29	-.10	.23	.62	3.31	2.00
(1964-86)	(-1.0)	(-.39)	(4.40)	(-2.19)		(1.51)	(-.67)	(1.53)			
India	-.08	.23	.06	-.19	.09	-.23			.48	3.18	2.13
(1966-87)	(-.73)	(2.1)	(.45)	(-1.74)	(1.02)	(-1.95)					
I ndonesia	.13					.48			.29	3.07	2.91
(1962-88)	(2.11)					(2.34)					
Korea	.05	.10	-.05	-.25		.17		.37	2.67	1.83	
(1968-88)	(1.37)	(1.78)	(-1.35)	(-2.12)		(.67)					
Malaysia	.14	.38	-.01	.19		-.36	-.41		.36	4.62	3.77
(1965-88)	(1.49)	(3.36)	(-0.9)	(2.02)		(-1.40)	(-1.07)				
Nepal		-.23	.26			-.20	-.44		.37	3.08	1.44
(1966-88)	(-1.51)	(1.81)				(-1.12)	(-2.51)				
Pakistan	.23	-.12	.24			.28			.37	2.95	4.32
(1963-88)	(2.58)	(-1.26)	(2.67)			(1.46)					
Philippine	.08					.64			.46	9.24	2.03
(1962-88)	(1.91)					(3.04)					
Singapore	.30					.63			.54	9.95	3.09
(1966-88)	(2.39)					(3.80)					
Sri Lanka	-.02					-.16			.03	.03	10.71
(1965-88)	(-.16)					(-.76)					
Taiwan		.19				.36	-.35		.46	5.71	4.91
(1964-88)	(3.69)					(2.09)	(-1.87)				
Thailand	.13					.31	.19	.23	.35	2.58	3.88
(1964-88)	(2.07)					(1.56)	(.90)	(1.06)			
Turkey	-.17	-.41	.12	-.42		.04	-4.0		.56	3.56	1.67
(1965-88)	(-1.11)	(-2.93)	(.76)	(-2.65)		(.14)	(-1.48)				

In concluding our investigation of the relationship between x and o '2 we can confirm that across 8 countries there appears to be an inverse relationship between the peak effects on real output of monetary shocks and the variance of such shocks.

FIGURE 1

FPE METHOD

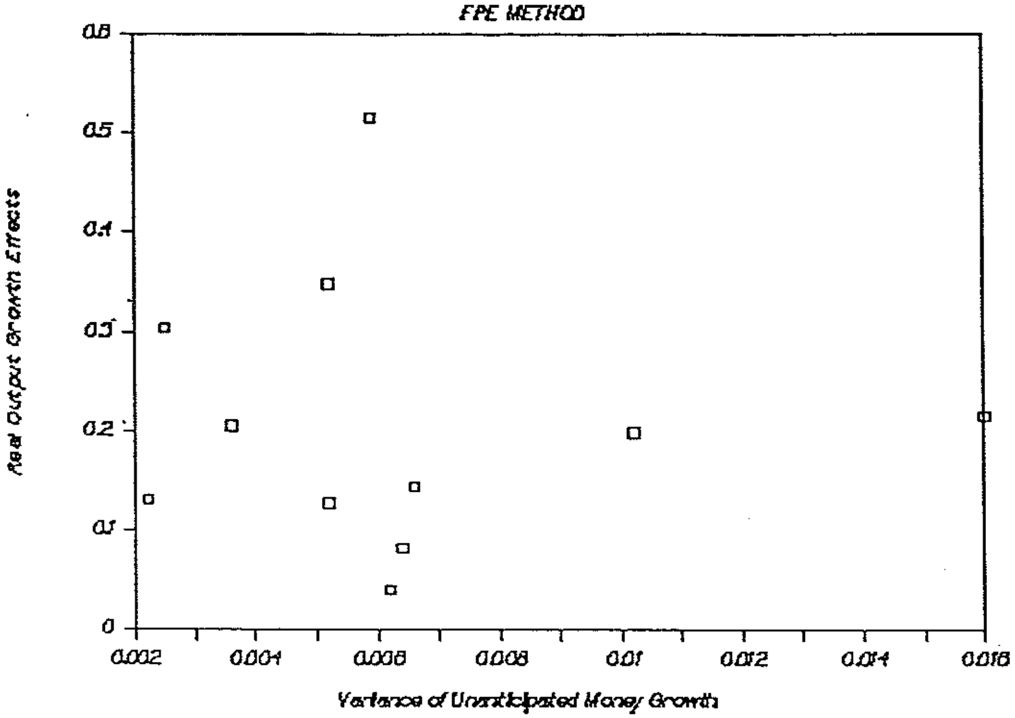

FIGURE 2

AD-HOC METHOD

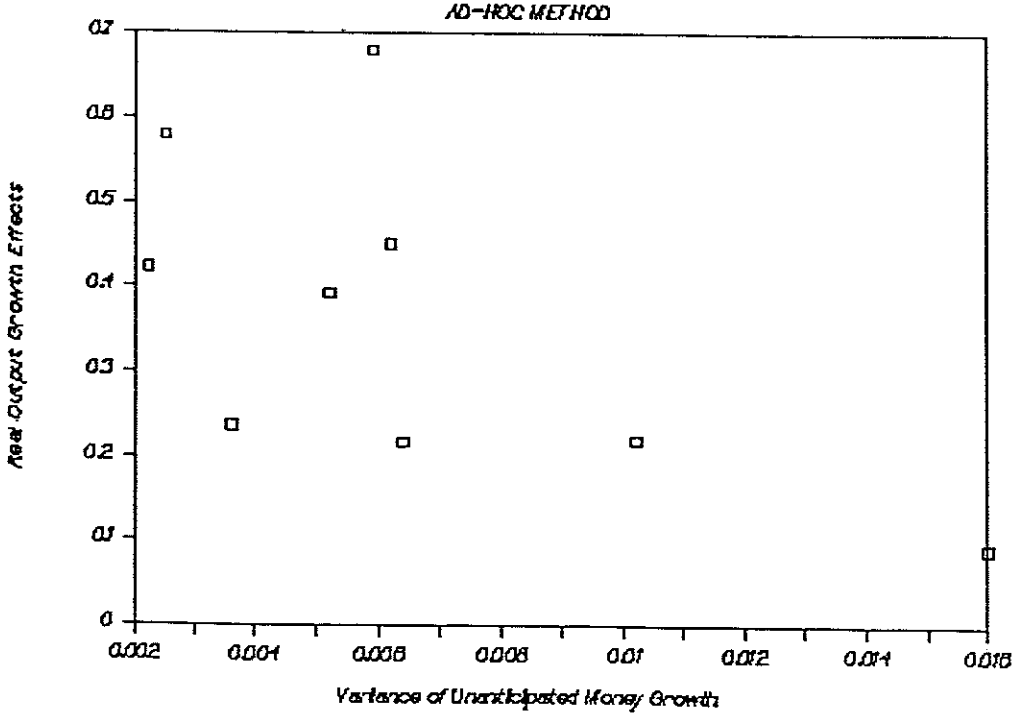

TABLE 2

PEAK EFFECTS ON REAL OUTPUT OF MONETARY SHOCKS AND VARIANCE OF MONETARY SHOCKS

	PRE METHOD		AD-HOC METHOD	
COUNTY	χ	σ^2_{RM}	χ	σ^2_{RM}
Burma	0.215	0.0160	0.092	0.0160
India	0.205	0.0036	0.237	0.0036
Indonesia	0.131	0.0022	0.423	0.0022
Korea	0.145	0.0066	0.090	0.0056
Malaysia	0.516	0.0059	0.679	0.0059
Nepal	0.040	0.0062	0.452	0.0060
Pakistan	0.349	0.0052	0.393	0.0052
Phillipines	0.083	0.0064	0.217	0.0064
Singapore	0.304	0.0025	0.579	0.0023
Sri Lanka	-0.020	0.0040	-0.009	0.0028
Taiwan	0.199	0.0102	0.220	0.0102
Thailand	0.128	0.0052	0.239	0.0052
Turkey	-0.170	0.0052	-0.251	0.0052

The real output effects were statistically insignificant.

COMPARISON WITH EARLIER METHODS

This section compares our findings with those which would be obtained by replicating KAM's procedure of ad-hoc lag length selection in both the money growth and real output growth equations. In terms of the money growth equation both studies estimate equation (1) as ARMA models except that KAM set the maximum lag length on DM to 2 in contrast to us setting it at 4 and then using the minimum FPE criterion to establish the optimal lag length. However, both procedures employ the same diagnostic tests on the residuals to ascertain that they are indistinguishable from white noise.

Evidently for the five countries for which this study was unable to obtain a satisfactory model for money growth, similar findings would be obtained under the KAM procedure. For the other eight countries the KAM procedure would generate more or less the same estimated models for India, Indonesia, Malaysia, and Turkey. This is because the lag lengths on DM are 2 or less. However, for four countries i. e. Korea, Nepal, Singapore, and Sri Lanka, the ad-hoc selection of lag lengths would imply a different estimated model of money growth since the FPE criterion selects lags on DM of 3 and 4. Therefore the money growth models for these four countries were re-estimated by employing KAM's procedure of using lags on DM of 2 or less. The series of residuals obtained from these re-estimated equations along with the series of residuals computed previously for the other nine countries constitute KAM's estimates of RM. These were then employed as explanatory variables in estimating the real output equation.

Table 3 reports the parameter estimates of the real output growth equation for the thirteen countries using the ad-hoc lag length procedure. Two key statistics reported in this table should suffice in interpretting the results. In terms of overall significance of the fitted equations, F-statistics, (F_1 in Table 3), indicate that except for Sri Lanka all the other country models are statistically significant at the 10 % or higher levels of significance.

TABLE 3

Estimated Real Output Growth Models-Ad Hoc Lags

	RM					DY			R^2	F_1	F_2	m(6)
	0	-1	-2	-3	-4	-1	-2	Trend				
Burma	-.076	-.035	.203	-.053	-.074			.002	.40	3.36	3.51	1.50
(1964-86)	(-1.26)	(-.56)	(3.27)	(-.87)	(-1.21)			(1.60)			(.03)	
India	-.058	.279	.016	-.173	.18				.28	2.63	2.67	2.32
(1966-87)	(-.56)	(2.65)	(0.15)	(-1.59)	(1.60)						(.06)	
Indonesia	.178	.163	.082	.054	.036		-.590		.70	7.17	8.51	2.75
(1966-88)	(3.31)	(2.89)	(1.22)	(1.42)	(1.03)		(-2.53)		(.00)			
Korea	.018	.072	-.068	-.264	-.0002			-.003	.36	1.48	1.32	1.80
(1969-88)	(.13)	(.51)	(-.46)	(-1.95)	(-.002)			(-1.51)			(.32)	
Malaysia	.245	.263	.171	-.016	.263		-.263		.21	1.47	2.04	2.77
(1966-88)	(1.68)	(1.75)	(1.02)	(-.09)	(1.68)		(-1.04)				(.10)	
Nepal	-.791	.321	.060	.862	-.192		-.441		.34	2.68	2.27	1.67
(1969-88)	(-2.49)	(1.14)	(.21)	(2.63)	(-.78)		(-2.59)				(.10)	
Pakistan	.231	-.091	.253	.040	.090	.191			.23	2.11	2.44	5.02
(1965-88)	(2.35)	(-.82)	(2.54)	(.37)	(1.04)	(.80)					(.08)	
Philippine	.034	.004	.179	.179	.190	.404	-.456	-.004	.57	3.20	2.40	2.03
(1966-88)	(.44)	(.05)	(2.42)	(.35)	(2.44)	(1.59)	(-1.95)	(-3.16)			(.09)	
Singapore	.265	.265	.049	-.201	-.164			-.002	.50	3.46	2.81	1.07
(1970-88)	(1.58)	(2.01)	(.35)	(-1.03)	(-.75)			(-1.07)			(.08)	
Sri Lanka	-.052	-.076	.030	.089	-.109	-.320		-.001	.03	.96	.43	6.66
(1969-88)	(-.39)	(-.59)	(.24)	(0.71)	(-0.81)	(-1.08)		(-.56)			(.82)	
Taiwan	.220	-.050	-.544	.080	-.091	.389	-.558		.53	3.60	4.50	4.91
(1968-88)	(4.14)	(-0.66)	(-.76)	(1.14)	(-1.46)	(1.58)	(-2.24)				(.02)	
Thailand	.108	.089	.042	-.019	.018			-.002	.33	1.32	1.13	3.8
(1968-88)	(1.84)	(1.42)	(.76)	(-.31)	(.31)			(-2.92)			(.38)	
Turkey	-.078	-.282	.109	-.169	-.017			-.003	.27	2.04	1.03	2.63
(1966-88)	(-.52)	(-1.93)	(.78)	(-.98)	(-.10)			(-1.92)			(.44)	

The other key statistics is F_2 which is the F-statistic for the null hypothesis that the set of β_i lacks explanatory power. Also reported in parentheses are the marginal significance levels. These indicate that nine of the countries reject at the 10 % or higher levels of significance the null hypothesis that unanticipated money growth has no effects on real output. For Korea, Sri Lanka, Thailand, and Turkey the KAM method fails to find statistically significant output effects of unanticipated money growth. Therefore, in terms of proposition 1 both the FPE method and and the KAM method have the same findings for eleven countries. They differ on Korea and Thailand.

To test proposition 2 with the KAM method the peak effects of unanticipated monetary growth (χ) and the variance of RM(σ^2_{RM}) were computed and are reported in Table 2 (alongwith values of these variables under the FPE method). Figure 2 shows the plot of x against σ^2_{RM}. As is clear from a visual inspection of the scatter diagram, there appears to be an inverse relationship between the two. For the nine robust countries, the simple correlation between χ and σ^2_{RM} and between log of χ and σ^2_{RM} wereRM RM-0.624 annd -0.779 respectively. The associated standard errors were 0.33 in both cases. The Spearman's rank correlation coefficient has a value of -0.77 with an associated t-value of -2.2.

On comparing the findings for proposition 2 using the two different methods we see that while proposition 2 appears to hold for a group eight of countries under the FPE method, it holds for a group of nine countries under the KAM method. The common group of 6 countries with favorable results under both methods are, India, Indonesia, Nepal, Pakistan, Phillipines, Singapore.

CONCLUSIONS

Two of the propositions implied by rational expectations models that have been tested extensively have had to do with policy ineffectiveness, and the inverse relationship between output effects of policy surprises and the variability of such policy surprises. This study has attempted to shed light on whether the differing results reported in the literature are due to different methods employed or the particular groupings of countries selected.

Two methods of lag length selection on the explanatory variables are employed to test two propositions for a common set of thirteen countries from Asia, specially selected for the purpose based on them having certain characteristics in common and with varied stabilization experiences. One method uses the FPE criteria to determine optimal lag lengths on the explanatory variables in both the monetary growth equation and the real output equation. The other method uses ad-hoc criteria used by most studies in determining lag lengths, as exemplified by Kormendi and Meguire (1984) in their tests of the two propositions for 47 countries.

Using the FPE method, our results indicate that for 11 out of the 13 countries taken individually there is empirical support for the proposition that unanticipated monetary growth has statistically significant effects on real output. This proposition finds support in 9 countries under the ad-hoc lag selection method. For eight countries, taken as a group, there is empirical support for the proposition that real output effects of unanticipated money growth are inversely related to the variability of unanticipated money growth under the FPE method. Nine countries fall in this inverse pattern under the ad-hoc lag length selection method.

Based on these results it appears that tests of proposition 1 are sensitive to the lag lengths used whereas tests of proposition 2 are sensitive to the particular grouping of countries. The latter finding is evidenced by the fact that proposition 2 holds f or only 63% & 70% of the countries using the FPE and ad-hoc methods respectively in contrast to 90% of the countries in the Kormendi and Meguire study.

NOTES

1 Tests of proposition 1 have been performed on: U.S. data [Barro (1977), (1978); Leiderman 1980; Mishkin (1982); Boschen (1985); McGee and Stasiak (1985); Rush (1986); Manchester (1989)], U.K. data [Attfield, Demery, and Duck (1981); S ounder (1988)], Canadian data [Wogin (1980); Darrat (1985b); Ambler (1989)), data drawn from Canada, Germany, U.K. and U.S. [Thoma (1989)), and Italian data [Darrat (1985a)].

The seminal test of proposition 2 by Lucas (1973) was followed by Froyen and Waud (1980) who conducted more detailed tests for 10 industrialized countries. Hanson (1980) tested the proposition for 5 Latin American countries. Other prominent studies of proposition 2 include: Alberro (1981), Kormendi and Meguire (1984), Sheehey (1984), Hoffman and Schlagenhauf (1982), and Canarella and Pollard (1989).

2 An exhaustive study by Thornton and Batten (1985) suggests using the minimum FPE criterion for choosing lag lengths based on a standard, classical hypothesis testing norm. The FPE criterion selects the optimal lag length as that minimizing $FPE(K) = [(n + k + 1)/(n-k-1)] \times SSR(k)/n$ where n is the sample size, k is the lag length being tested, SSR(K) is the sum of squared residuals of the regression with k as the lag length.

3 The annual data on various variables used in this study came mainly from the 1988 and 1989 yearbooks of *International Financial Statistics* published by the International Monetary Fund, Washington D.C. The data set is available from the authors upon request.

4 Estimates of the money growth models, as well as the complete diagnostic checking, are available from the authors upon request.

5 A referee has correctly pointed out that "by running the ARIMA forecasting for the whole period we assume that the probability density structure of the estimated coefficients remains the same for the whole period. This is most anamolous in view of Lucas' view that the estimated structure of an econometric model is not invariant to policy changes". Therefore, in addition to the Chow test, we have used the more rigorous Farley-Hinich test.

6 the results from employing the FPE criterion, in comparison to Kormendi and Meguire's procedure, our more in line with Milton Friedman's oft-repeated claim that monetary shocks have their effects on real output over "long and variable lags" of 6 - 18 months.

7 Since the distributional properties of χ and σ, are not fully established, tests based on the t-statistic may not be applicable. It is reported simply to give an indication of the strength of the relationship.

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