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MODELLING INFLATION IN THE PHILIPPINES: THE P-STAR MODEL APPROACH

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The P-Star approach of modelling inflation has been widely tested for the United States and other developed countries. However, the robustness of the P-Star model for developing countries has received less attention among the researchers. The purpose of this study is to test the applicability of the P-Star approach with respect to a developing country—the Philippines. Using a sample period of 1981:1 to 1994:4, our results suggest that the monetary data for the Philippines support the P-Star model approach. Our results indicate that broad money M2 provides an anchor for the Philippines inflation during the period under study.

1. Introduction

More recently, Hallman *et al.* (1989) have proposed the use of a simple model, the so-called P-Star (P*) approach, in modelling inflation. Using the P-Star model, Hallman *et. al.* (1989) found out that "P* ties together the level of money and prices" very well, and it was able to track inflation movements successfully even during financial deregulation and innovations in the United States. Since the work of Hallman *et al.*, the P-Star approach has been widely tested for the United States and other western countries. Our question is: Is P-Star model applicable to the developing countries under the same financial environment?

The purpose of the present paper is to investigate whether monetary data of a developing country—the Philippines—support the P-Star approach of modelling inflation. The Philippine economy has recovered from the severe economic and financial crises in the 1980s. Since 1983, the Philippines has embarked on financial reforms, prominent among which is the complete liberalization of interest rates on loans and deposits. Further, the determina-

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tion of peso was freely determined by market forces beginning October 19 Generally during the 1980s, the rapid transformation of the Philippin nancial system has resulted in greater depth and sophistication of the ba ing system. However, a more market-oriented structure together with regulation and financial innovation have complicated the task of monet management. The structural changes in the financial system resulted volatile movements in the velocity of M1, which consequently led to the bre down in the relationship between M1 and key macroeconomic variab (Tseng and Corker, 1991). As a result, the broader definition of monet aggregates, M2 and M3, have assumed greater significance in terms of playing a more stable and predictable relationship with the underlying e nomic activity (Adhikary, 1989).

The plan of the paper is as follows: section 2 presents the derivatio the P-Star model used in the analysis; section 3 discusses the calculation o using three monetary aggregates M1, M2, and M3, and presents the empiri results; and the last section contains our conclusions.

2. The HPS-P-Star (P*) Model

The P* approach is based on the equation of exchange

(1) $$PQ = MV$$

where the product of the price level (P) and real GNP (Q) equals the stoc money (M), multiplied by its velocity (V). Taking logarithms (lower-case tation) for equation (1) gives

(2) $$p + q = m + v.$$

From equation (2), the price level can be expressed as

(3) $$p = m + v - q.$$

According to Hallman *et al.* (1991), the equilibrium price level (p written as follows

(4) $$p^* = m + v^* - q^*$$

where v* is the equilibrium level of velocity and q* is the real potential output. Equation (4) says that the equilibrium price level, p*, is defined as money stock per unit of real potential output and the long-run equilibrium level of the velocity of money. Subtracting equation (4) from (3), we have the following HPS P-Star model derived by Hallman *et al.* (1989, 1991),

$$p - p^* = (v - v^*) + (q^* - q) \quad (5)$$

where the gap between the actual and equilibrium prices, p – p*, is determined by a velocity gap, v – v*, and an output gap, q* – q. The P-Star model indicates inflationary pressure if there is a monetary overhang, that is, when current velocity is below its long-run equilibrium level and/or when current output is above its potential level.

Hallman et al. (1991) hypothesize that in the long-run, the discrepancy between actual and equilibrium prices, p – p*, becomes zero as p adjusts to p*. Assuming the long-run relationship between p and p*, the short-run dynamic model of inflation, π, is therefore given by the following model

$$\Delta\pi_t = a + \alpha\left(p_{t-1} - p^*_{t-1}\right) + \sum_{i=1}^{k} \beta_i \Delta\pi_{t-i} + \varepsilon_t \quad (6)$$

where α is the speed of adjustment of actual prices to p* and should be negative.

Hallman et al. (1991) also proposed estimating an alternative inflation model based on its components. Substituting equation (5) into (6), we have the unrestricted inflation model of the following form

$$\Delta\pi_t = a + \gamma_1\left(v_{t-1} - v^*_{t-1}\right) + \gamma_2\left(q^*_{t-1} - q_{t-1}\right) + \sum_{i=1}^{k} \beta_i \Delta\pi_{t-i} + \varepsilon_t \,. \quad (7)$$

They constrain the velocity gap, $v_{t-1} - v^*_{t-1}$, and the output gap, $q^*_{t-1} - q_{t-1}$, in equation (7) to have equal weights, that is, $\gamma_1 = \gamma_2$. Equation (7) presents two competing views of how the rate of inflation adjusts from a disequilibrium position. The Phillips curve view or the output gap model of inflation is the special case of equation (7) in which $\gamma_1 = 0$. In this case, the inflation rate adjusts to the output gap. On the other hand, the monetarist model of inflation is when $\gamma_2 = 0$, in which the inflation rate adjusts to monetary disequilibrium.

3. Empirical Results for the Philippines

A central issue in the empirical testing of the HPS-P-Star modell approach is how to measure potential output (q*) and equilibrium velocity (since these two series are unobservable. In this study, we use the Hodri Prescott filter to determine potential output and equilibrium velocity. T Hodrick-Prescott (HP) filter is a common procedure to estimate trends, p ticularly in the business cycle literature. In implementing the P-Star proach in their study, Hoeller and Poret (1991), and Kool and Tatom (19 applied the HP-filter to compute the potential output and equilibrium vel ity. Hoeller and Poret (1991), and Razzak and Dennis (1996) have point out that the HP-filter is easy to implement (compared to more complica Kalman filter) and the trends it produces usually appear 'plausible'.

According to Hodrick and Prescott (1980), the filter is designed to p duce a non-linear trend based on the variability of the series by minimiz the following[1]

(8) $$\sum_{t=1}^{T} \left(y_t - \tau_t\right)^2 + \lambda \sum_{t=2}^{T-1} \left[\left(\tau_{t+1} - \tau_t\right) - \left(\tau_t - \tau_{t-1}\right)\right]^2$$

where y is the time series, τ is the trend component series (τ_t, t = 1,...,T), λ is a fixed parameter. The first term is the sum of the squared deviati between the contemporaneous trend values and the original series. The ond term is a multiple λ of the sum of the squares of the trend compone second differences. Hodrick and Prescott claimed that λ can be interpre as a measure of the relative differences of the trend component. If $\lambda = 0$, growth component series coincides with the original series and the cycl component is zero. If λ goes to infinity, the trend component approach linear deterministic time trend. Hodrick and Prescott proposed a value of 1600 for quarterly time series data as reasonable, and their recommenda has been widely followed in the literature applying the HP-filter.[2]

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[1] See also Kydland and Prescott (1990).

[2] The HP-filter has been criticized on several grounds, among which are: (a computation of the trend component is sensitive to the choice of λ; (b) the filter can alte properties of the series; (c) the filter can lead to spurious cyclical behavior; and (d) the can generate business cycle dynamics even if none are present in the original series. for example, King and Rebelo (1993), Jaeger (1994), and Cogley and Nason (1995). C these strictures, we emphasize that our use of the filter is purely for exploratory purp

In this study, we use quarterly time series data for the period 1981:1 to 1994:4 and for our purposes, we use the consumer price index as measure of price level for the Philippines. Since there is no *a priori* evidence as to which measure of money should be used—narrow or broad money—we examine all three monetary aggregates—M1, M2 and M3—in the construction of P-Star. Empirical studies have shown that different monetary aggregates used to construct P-Star have different implications for the performance of the P-Star approach. For example, in the United States, Hallman *et al.* (1991) have indicated that M2 can be a good anchor for the price level, but Tatom (1990) on the other hand, suggests that money and the price level are linked when M1 is used to construct P-Star. For France, Bordes *et al.* (1993) used the monetary aggregates M1, M2 and M3 to calculate P-Star, and found that a long-run relationship between money and the price level was established using M1 and M2. On the contrary, Todter and Reimers (1994) found that between the three monetary aggregates (M1, M2 and M3), "the best results were obtained when M3 is used to estimate the equilibrium price."

For output, we have used total exports as a proxy for nominal income for the Philippines, since it is well known that the data on gross national product for majority of Asian countries are only available in annual form. The rationale of using exports as proxy for income in majority of the Asian developing countries has been supported by numerous empirical studies (see, for example, Tyler, 1981; Ram, 1987; and Odedokun, 1991). These studies have empirically detected positive and significant effects of export expansion on economic growth.[3] Data on the consumer price index, total exports, and monetary aggregates and their components were compiled from various issues of *SEACEN Financial Statistics-Money and Banking* published by the SEACEN Centre, and *International Financial Statistics* which is published by the International Monetary Fund.

Table 1 reports the results from estimating equations (6) and (7) for the Philippines. The results for the price gap equations for money M1, M2 and M3 are presented in columns 2, 3 and 4 respectively. The results in Table 1 suggest that the inflation equation can be explained satisfactorily using the price gap and lagged one quarter period inflation in first-differenced as the determinants for the Philippines. The price gap has a correct negative sign and was

[3] Furthermore, the use of exports will minimize any spurious results that will arise when using income that had been generated using some interpolation technique. Nevertheless, one has to be cautious when interpreting the results.

Table 1: Regression Results: HPS-P-Star Model for the Philippines

Independent variables	Restricted Model			Unrestricted Model		
	M1	M2	M3	M1	M2	M3
Constant	-0.0000	-0.0003	-0.0004	0.0000	-0.0002	-0.0002
	(0.0200)	(0.1032)	(0.1347)	(0.0244)	(0.0776)	(0.0865)
$p_{t-1} - p^*_{t-1}$	-0.1342	-0.1775	-0.1674			
	(4.2841)**	(4.5422)**	(4.4803)**			
$v_{t-1} - v^*_{t-1}$				-0.1488	-0.1892	-0.1776
				(3.6566)**	(4.1858)**	(4.1501)**
$q^*_{t-1} - q_{t-1}$				-0.1781	-0.2429	-0.2341
				(4.3147)**	(4.9470)**	(4.8994)**
$\Delta\pi_{t-1}$	-0.5892	-0.5835	-0.5888	-0.7133	-0.7058	-0.7110
	(5.6742)**	(5.7245)**	(5.7447)**	(5.3396)**	(5.5650)**	(5.5701)**
$\Delta\pi_{t-2}$				-0.2098	-0.1983	-0.1979
				(1.4745)	(1.4859)	(1.4786)
R-squared	0.472	0.489	0.485	0.501	0.533	0.531
SER	0.024	0.023	0.023	0.024	0.023	0.023
D.W.	2.073	2.226	2.211	1.722	1.741	1.716
LM(4)	4.486	5.209	4.948	5.166	5.682	6.629
	[0.344]	[0.266]	[0.293]	[0.271]	[0.224]	[0.156]
F-test	-	-	-	0.663	2.752	3.069
				[0.419]	[0.104]	[0.086]

Notes: SER and D.W. denote standard error of regression and Durbin-Watson statistic respectively. LM(4) is the Breusch and Godfrey's Langrange Multiplier test for residual serial correlation of the fourth-order process. The LM Chi-square statistic for serial correlation with four lags, with four degree of freedom at the 5 percent level is 9.48.
Numbers in parentheses (.) and [.] are respectively, *t*-statistics and *p*-values.

significantly different from zero for both monetary aggregates used in computing p*. The speed of adjustment suggests that actual inflation adjusts to p* quite slowly: about 13 percent (for M1), 18 percent (for M2), and 17 percent (for M3) of the deviations are eliminated after more than three quarters.

In columns 5, 6 and 7 of Table 1, we present the results of equations with the separate components of the price gap as determinants for inflation equation. We observe that the coefficients of the velocity gap and output gap were significantly different from zero for all three monetary aggregates used. The coefficients of the velocity gaps and output gaps show correct negative signs. Further, in all cases, the constraint of equality of the two gap coefficients cannot be rejected at the five percent level. Hoeller and Poret (1991, p. 16) have pointed out that these results imply that "no forecasts of actual velocity and output are needed in order to forecast inflation; knowledge of trend velocity, potential output and future money-stock development is sufficient."

Interestingly, the above results seem to support the HPS-P-Star approach in modelling the inflation equation for the Philippines. However, this conclusion should be taken cautiously. The validity of the HPS-P-Star approach has been questioned on fundamental grounds. For instance, Tatom (1992), and Kool and Tatom (1994) have pointed out that the non-stationarity of the price gap is sufficient to invalidate the HPS-P-Star model approach. Non-stationarity of p – p* implies rejection of the hypothesis that p tends to equal p* in the long-run.

We have conducted the non-stationarity tests on the price gap, p – p*, using the standard augmented Dickey-Fuller (ADF) test (Said and Dickey, 1984).[4] Our results indicate that the null hypothesis of a unit root cannot be rejected for narrow money M1, but the null hypothesis of unit roots can be rejected for both broad money M2 and M3. The above results imply that the results of the HPS-P-Star models estimated for Simple-sum M1 are "spurious" in the sense of Granger and Newbold (1974). The ADF tests clearly indicate that the price gap version for Simple-sum M1 is non-stationary, however, these

[4] The t_{ADF} for M1, M2, and M3 are –3.05, –4.19, and –3.95, respectively. The relevant tests are derived from the OLS estimation of the following augmented Dickey-Fuller (ADF) regression:

$$\Delta y_t = a + bt + \beta y_{t-1} + \sum_{i=i}^{n} d_i y_{t-i} + v_t$$

price gaps variables are significantly different from zero in theHPS-P-Sta models estimated earlier. This is clearly the case of "spurious regression" o which Granger and Newbold (1974) have earlier warned, whereby the inclu sion of a non-stationary variable in an ordinary least squares regression ca yield t-statistics that indicate "significant" statistical relationships where non actually exist (see Tatom, 1992). Nevertheless, in summary, our results sug gest that monetary data of the Philippines support the HPS-P-Star approach modelling inflation.

4. Conclusions

The purpose of the present study is to investigate the applicability of th P-Star approach of modelling inflation in a developing country like the Philip pines. The P-Star model was proposed earlier by Hallman *et al.* (1989) and ha been widely tested for the United States and other developed countries. Usin a sample period of 1981:1 to 1994:4, our results suggest that both broad mone M2 and M3 provide an anchor for the inflation during the period under stud and thus the growth of M2 and M3 can be useful in forecasting movements i inflation in the Philippines. The choice made by the Central Bank of Philip pines to emphasize broad money M2 and M3 are supported by this study.

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where Δ is the difference operator, t is a linear time trend and v is the disturbance term. T hypothesis that a series contains a unit root is tested by H_0: $\beta = 0$ while the hypothesis that t series is non-stationary with a stochastic trend rather than a deterministic time trend is test by $H_0 : b = -\beta$. Rejection of the latter hypothesis suggests the existence of a determinis trend. τ_τ is the t-statistic for testing the significance of β when a time trend is included in t above equation. In determining the lag length n, we started with one lagged regressor, a proceeded by adding an extra lagged term to the regression until the t-statistic on the la lagged term is greater than 1.6 (approximately the 10 percent critical bound) and the err is white noise. If the error is not white noise, the process is repeated by adding anoth lagged term until the t-statistic on the last lagged coefficient is greater than 1.6 and che the error for white noise. LM(4) is the Breusch and Godfrey's Lagrange Multiplier test residual serial correlation of the fourth-order process. The calculated statistics are the computed in MacKinnon (1991). The critical value at 5 percent for T = 50 is –3.49 for τ_τ. T LM Chi-square statistic for serial correlation with four lags, with four degree of freedom the 5 percent level is 9.48. The lag length, n, for M1, M2, and M3 are 12 (with LM(4) = 5.1 13 (with LM(4) = 4.32), and 13 (with LM(4) = 6.205), respectively.

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