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# THE MONETARIST MODELS OF INFLATION: THE CASE OF THE PHILIPPINES

By Joseph Lim*

This paper uses annual Philippine data (1953—1980) to test two monetarist models, namely, the Harberger equation and the Barro two-equation system. The estimation results point to specification errors in both models. This can be interpreted as partial evidence that the monetarist's concentration on aggregate demand may have led him to omit relevant supply-side effects on output growth and general price inflation.

## 1. Introduction

The theory governing many developing countries' approach to inflation has been the monetarist theory of inflation. It has become so powerful in the seventies that economies of certain countries have undergone what has been termed "monetarist experiments." This is particularly true for Chile in the post-1973 period and to a lesser extent Argentina during much of the seventies.

Simultaneous with this, the growing role of the International Monetary Fund (IMF) in bailing many Third World countries out of their external debt crises and dwindling reserves position has focused attention on the standard economic and monetary austerity package that the IMF has forced upon these countries. Evidently, the IMF has targetted inflation as one of its prime enemies and has chosen a decidedly monetarist strategy to combat it.

Unfortunately, many of these monetarist policies have yielded disappointing results, at least in the area of controlling inflation. It is therefore important that we study the monetarist theory carefully and test their validity and consistency empirically. This study tests two important monetarist models using annual Philippine data from 1953 to 1980.

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*Assistant Professor of Economics, University of the Philippines. This paper is part of the author's Ph.D. dissertation submitted to the University of Pennsylvania. The author is indebted to many people for this paper particularly to his main advisers, Profs. Edward Buffie and Jere Behrman.

## 2. The Old Monetarist Approach

The monetarist theory on price inflation stems from a belief that a continuing rise in prices is brought about by increases in aggregate demand unaccompanied by increases in real output. This increase in aggregate demand, monetarists claim, is usually caused by an unnecessary expansion of the money supply or an increase in the expectations of price inflation. This theory is best described in what is usually called the Harberger system.

### *2.1 The Harberger System*

Harberger (1963) starts his analysis with the quantity theory of money equation:

$$(1) \quad MV = PY$$

where $M$ = money supply, $V$ = velocity of money, $P$ = price level, and $Y$ = real income. The reciprocal of the velocity — which is the ratio of real income held as real balances — is assumed to depend positively on real income and negatively on the expected opportunity costs of holding money in the following fashion:

$$(2) \quad V^{-1} = Y^{a} C^{-b}$$

where $C$ is the expected cost of holding money and $a$ and $b$ are positive parameters.

Substituting (2) into (1) and logarithmically differentiating give:

$$(3) \quad \hat{P}_t = \hat{M}_t - (1 + a)\ \hat{Y}_t + b\hat{C}_t$$

where the hats denote growth rates. The equation shows clearly that a higher price inflation may be caused by an expanded rate of increase of the money supply or by a higher expected rate of increase of the cost of holding money — both unaccompanied by an offseting increase in output.

In estimating (3) econometrically, economists usually add lagged terms $(\hat{M}_{t-1})$ to accommodate delayed responses of prices to money changes. $\hat{C}_t$ — the change in the opportunity cost of holding money — is measured by the difference between this year's expected inflation rate and last year's rate. This assumes a certain stability or constancy of the interest rate of other financial assets. Harberger (1963) and Vogel (1974) (as well as some other researchers to be mentioned later) crudely measure $\hat{C}$ by the difference between the last two periods' inflation rates $(\hat{P}_{t-1} - \hat{P}_{t-2})$.

The resulting function to be estimated would then look like:

$$(4) \quad \hat{P}_t = V_0 + V_1 \hat{M}_t + V_2 \hat{M}_{t-1} + V_3 \hat{Y}_t + V_4 (\hat{P}_{t-1} - \hat{P}_{t-2})$$

Some economists even try to accommodate structuralist arguments in the equation to come up with

$$(5) \quad \hat{P}_t = V_0 + V_1 \hat{M}_t + V_2 \hat{M}_{t-1} + V_3 \hat{Y}_t + V_4 (\hat{P}_{t-1} - \hat{P}_{t-2}) + V_5 \hat{w}_t + V_6 \hat{P}_t^*$$

where $\hat{w}_t$ = wage rate growth.

$\hat{P}_t^*$ = growth rate of cost of imports whether due to changes in the international prices, exchange rate or tariff rates.

One can, however, see that this is just an *ad hoc* combination of monetarist and structuralist variables and is in no way derived from any of equations (1) through (4).

### 2.2 *Critique of the Harberger Model*

The Harberger equation has some implicit (and, in the short run, too restrictive) assumptions behind it. First, it applies mainly to a closed economy. This is partially handled by some authors when they include the exchange rate and the price of imports in the Harberger equation. This method, however, is quite *ad hoc* and does not derive from an explicitly specified model that incorporates an international sector to the Harberger system.

Secondly, the Harberger equation also implies the exogeneity of the money supply. Many economists, however, have postulated the possibility that money supply growth, as controlled by the Central Bank authorities, may itself be reacting to prices and other changes. Sargent and Wallace (1978), for example, have postulated a rational expectations justification of a Cagan type of model employing adaptive expectations to predict price inflation. They demonstrate that adaptive and rational expectations coincide if government expenditures are mostly financed by money creation and if the government keeps its real expenditures level constant or on a specific trend so that it reacts to a decline in its purchasing power (i.e. price inflation) by adding to the stock of money. Leiderman (1984), in his study using the Sims vector autoregression method[1] finds that in Mexico, a variance decomposition of forecast errors shows price inflation to have a significant feedback to money supply growth (i.e., exogenous shocks from price inflation explain a significant part of the variation in the forecast error for money supply growth. This however, doesn't occur in his other test country, Colombia.)

Finally, the Harberger equation assumes the exogeneity of income, which the old monetarists view as a measure of the classical full-employment level. The viewpoint here, therefore is a long-run relationship wherein short-run fluctuations in income — which may be caused by price fluctuations — are ignored. In the short run, however, this possible simultaneity problem must be tackled. Leiderman, again in Mexico, finds a part of the forecast error of output growth to be explained by innovations in price growth. (This again doesn't occur in Colombia.) Past studies, therefore, by Harberger (1963), Vogel (1974), Wachter (1976) and Saini (1982) which employ the ordinary least squares procedure may suffer from some simultaneity bias.

## 3. The New Monetarists

To address the simultaneity problem and bring expectations into the picture, the new monetarist approach adds a Lucas-Phelps supply equation to the Harberger model:

$$(6)\quad Y_t = a_0 + a_1 (P_t - P_t^e) + a_2 Y_{t-1} + a_3 \, time$$

where $P_t$, $Y_t$ are price and real income at time $t$ and $P_t^e$ the expected price level at time $t$. $Y_{t-1}$ and time are included by Barro (1979) and Hanson (1980) to measure a natural rate of utilization of capacity through time (a sort of "full-employment" level or natural rate of unemployment through time). Nugent and Glezakos replace these two variables with their own measure of expected income ($Y_t^e$ – the derivation of which will be described shortly).[2] Equation

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[1] Here he regresses price inflation, output growth and money supply growth to lagged values (up to two periods) of these three variables. He uses the residuals and the estimated coefficients to get the effects of exogenous shocks from each variable on the other variables.

[2] Nugent and Glezakos use equation (6) with the variables expressed in their growth rate rather than the level form as we have presented it.

(6) says that suppliers increase (decrease) their output above (below) the normal utilization of capacity when prices are higher (lower) than expected. This argument is also normally used for the labor supply function. When wages go up above the expected wages, there may be a temporary (short-run) money illusion effect, and more labor is supplied.

### 3.1 *The Nugent-Glezakos Approach*

The main question now is how to estimate the unobservable $P^e_t$. One way is to assume that people predict price inflation using past data on observed inflation through the adaptive expectations mechanism. This is what Nugent and Glezakos assume. Expected price inflation $(P^e_t)$ is supposed to be predicted by:

$$(7)\quad \hat{P}^e_t = \hat{P}^e_{t-1} + \beta\,(\hat{P}_{t-1} - \hat{P}^e_{t-1})$$

where the hats again denote the growth rate of the variables.

By repeated substitutions (using equation (7) for $\hat{P}^e_{t-1} - \hat{P}^e_{t-2}$, etc.) we can express equation (7) as:

$$(8)\quad \hat{P}^e_t = \beta \sum_{i=1}^{\infty} (1-\beta)^{i-1}\,\hat{P}_{t-i}$$

We have now expressed the expected price inflation as a function of past price inflations which are observable. In practical application of (8), we can assume a certain finite period $K$ wherein the adaptive mechanism is supposed to operate. So we can write (8) as:

$$(8')\quad \hat{P}^e_t = \beta \sum_{i=1}^{K} (1-\beta)^{i-1}\,\hat{P}_{t-i}$$

There now arises the problem of estimating $\beta$ in order to get an estimate of $P^e_t$ using equation (8'). To avoid problems usually attributed to distributed lags, Nugent and Glezakos assume that people choose $\beta$ in such a way as to minimize expected losses *(L)* in quadratic form:

$$(9)\quad L = \sum_{t=1}^{T} (\hat{P}_t - \hat{P}^e_t)^2$$

Substituting (8') into (9) and varying $\beta$ by increments of .1, starting from $\beta=0$ to $\beta=1$, one can now derive the $\beta$ that gives the lowest $L$. The data for $\hat{P}_t^e$ variable can therefore be derived using (8').

The above method was also used by Nugent and Glezakos to get an estimate of expected (or permanent) income growth rate $(\hat{Y}_t^e)$ to be used in equation (6) as well as in their estimate of the Harberger equation.

## 3.2 *The Rational Expectations Approach*

The Nugent and Glezakos method of deriving expected inflation through the adaptive mechanism would be criticized by proponents of rational expectations who claim that people are rational and therefore would not predict inflation and income simply by their past values. Instead economic agents know the relevant economic model behind the movement of economic variables. They therefore will predict these variables based on this model and their expectations of the exogenous variables.

Economists who have worked along this line are Barro (1979), Hanson (1980), Edwards (1983) and Sheehey (1984). For them the relevant economic model is equation (6) and a modified version of the Harberger equation or the quantity theory of money—most variables expressed in logarithms. The equations are:

$$(6')\quad \widetilde{Y}_t = a_0 + a_1 (\widetilde{P}_t - \widetilde{P}_t^{\,e}) + a_2 \widetilde{Y}_{t-1} + a_3\, time$$

$$(10)\quad \widetilde{P}_t = \widetilde{M}_t - b_1 \widetilde{Y}_t + b_2 \quad \text{time.}^3$$

The tilde above the variable represents its logarithm. The time variable is added to the "modified" Harberger (or quantity theory of money) equation to capture trend elements in money demand, particularly those affecting velocity such as the development and growing sophistication of financial institutions, credit facilities, etc. The rational expectations procedure derives reduced forms for the two endogenous variables $\widetilde{Y}_t$ and $\widetilde{P}_t$ by taking expected values of (6') and (10) based on information known to the economic agents. This information consists of previous period's data and other known data that would enable people to predict the exogenous variable which is $\widetilde{M}_t$. The equation that allows this prediction is called the money res-

[3] The interest rate is usually introduced here theoretically, but then is ignored later due to lack of data, or its poor performance in the estimation stage. $b_2$ in this equation can be positive or negative.

ponse function. This function will be based on how money supply or its growth rate (mainly as a result of Central Bank authorities' policies) has reacted in the past to particular key indicators.

The rational expectations procedure proceeds as follows. First, we take expected values of equations (10) and (6') giving us:

$$(11)\quad \widetilde{P}_t^e = \widetilde{M}_t^e - b_1 \widetilde{Y}_t^e + b_2\, time$$

and

$$(12)\quad \widetilde{Y}_t^e = a_0 + a_2\, \widetilde{Y}_{t-1} + a_3\ \ time.$$

Note that in equation (12), the expected price forecast error is zero so that the second term of (6') disappears.

Substituting (12) into (11) yields:

$$(13)\quad \widetilde{P}_t^e = \widetilde{M}_t^e - b_1 a_0 - b_1 a_2 \widetilde{Y}_{t-1} - (b_1 a_3 - b_2)\, time$$

Substituting (10) and (13) into (6') yields:

$$\widetilde{Y}_t = a_0 + a_1 \,[(\widetilde{M}_t - b_1 \widetilde{Y}_t + b_2\ time)\ -$$

$$(\widetilde{M}_t^e - b_1 a_0 - b_1 a_2 \widetilde{Y}_{t-1} - (b_1 a_3 - b_2)\, time] \ +$$

$$a_2 \widetilde{Y}_{t-1} + a_3\ time$$

or

$$(1 + a_1 b_1)\, \widetilde{Y}_t = a_0\,(1 + a_1 b_1) + a_1 (\widetilde{M}_t - \widetilde{M}_t^e) +$$

$$a_2\,(1 + a_1 b_1)\, \widetilde{Y}_{t-1} + (a_1 (b_1 a_3 + 2b_2) + a_3)\ time$$

or

$$(14)\quad \widetilde{Y}_t = C_0 + C_1\, (\widetilde{M}_t - \widetilde{M}_t^{\,e}) + C_2\, \widetilde{Y}_{t-1} + C_3\ time.$$

Denoting $DMR_t = \widetilde{M}_t - \widetilde{M}_t^e = DM_t - DM_t^{\,e}$

where

$$(15)\quad DM_t = \widetilde{M}_t - \widetilde{M}_{t-1}$$

and $DM_t^e = \widetilde{M}_t^{\,e} - \widetilde{M}_{t-1}$

$DM_t$ is the growth rate of money supply and $DM_t^e$ its expected value.

We can now write:

(14') $\widetilde{Y}_t = C_0 + C_1 \; DMR_t + C_2 \widetilde{Y}_{t-1} + C_3$ time.[4]

$C_3$ can be positive or negative.

The above equation states that output $(\widetilde{Y}_t)$ goes above (below) the normal rate of utilization of capacity if unanticipated money growth $(DMR_t)$ is positive (negative).

Barro further postulates that there may be lagged or delayed effects of past unanticipated monetary shocks operating through effects on productive capital (which has a long gestation period) or through delayed changes in labor inputs due to adjustment cost. He therefore adds lagged values of $DMR_t$ to derive:

$$(14'') \quad \widetilde{Y}_t = C_0 + C_1 \; DMR_t + C_{11} \; DMR_{t-1} + \ldots + C_{1K} \; DMR_{t-k}$$

$$+ C_2 \; \widetilde{Y}_{t-1} + C_3 \; time$$

3.2.1 An Alternative to the Harberger Formulation

Barro (1978), in applying this model to the U.S., uses equation (10) to come up with a reduced form estimate of prices. Substituting (14') or (14'') to (10) leads us to:

$$(16) \; \widetilde{P}_t = e_0 + \widetilde{M}_t - e_1 \; DMR_t - e_2 \widetilde{Y}_{t-1} \pm e_3 \; time$$

or

$$(16') \; \widetilde{P}_t = e_0 + \widetilde{M}_t - e_{10} DMR_t - e_{11} \; DMR_{t-1} \ldots - e_{1K} DMR_{t-k}$$

$$- e_2 \widetilde{Y}_{t-1} \pm e_3 \quad time.$$

This is a reduced form for prices that can be used as an alternative estimate to the Harberger equation.

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[4] Barro (1978, 1979) and Hanson (1980) also test this equation wherein $C_2 = 1$ so that $DY_t = C_0 + C_1 DMR_t + C_3 \; time$.

### 3.2.2 Estimating the Money Supply Response Function

The main question now is how to estimate the response function of $DM_t^e$ in order to derive $DMR_t$. Hanson (1980), arguing that there is a lack of sophistication in the information system and its dissemination in Third World countries, simply uses past monetary growth and past price inflation to predict $DM_t^e$. His results show money supply growth in moderate inflation countries — Colombia, Peru and Mexico — to follow a random walk pattern. That is, the regression (response) functions for $DM_t$ with past money growth and past price inflation as predictors do not perform well for these countries. He therefore presumes that $\widetilde{M}_t^e = \widetilde{M}_{t-1}$ so that equation (15) will narrow down to $DMR_t = DM_t$. Total money growth now becomes wholly unanticipated. And he shows that equation (14) works well for these three countries wherein $DMR_t = DM_t$. For high inflation countries like Brazil and Chile, he finds that past inflation predicts money growth well and that it also suits equation (14) well. He even generalizes for all countries to say that a one-unit unanticipated rise in money growth (or price inflation) increases output by .1.

Hanson however has been severely criticized by Edwards (1983) and Sheehey (1984) for not experimenting with more predictors for the money growth response function. Edwards adds the fiscal deficit and finds that it significantly improves all the regression results for basically the same data and countries that Hanson used. His deficit variable, however, is contemporaneous with the money supply growth variable leaving us to doubt whether people can predict a fiscal deficit first, and then the money supply growth—during the same time period.

Barro (1979), Sheehey (1984) and Porzecanski (1979), on the other hand, experiment with a lot of possible predictors that are lagged values (and so are free of Edwards' problem). Barro (1979), in his study on Mexico, Colombia and Brazil, adds in the expected growth rate of money supply in the U.S. $(D\widetilde{M}_{us})$[5] and purchasing power parity lagged one period $(PP_{t-1})$ of the country involved. Porzecanski includes lagged growth rates of the foreign exchange reserves $(DR_{t-1})$, of real GNP $(DY_{t-1})$ and the lagged rate of un-

[5] This variable is derived by the result of his 1978 paper applying this model to the U.S. economy.

employment $(U_{t-1})$. Sheehey adds in some of his own such as lagged changes in the exchange rate $(DT_{t-1})$ and the change in the rate of inflation between the last two periods $(DPP = DP_{t-1} - DP_{t-2})$ as a measure of whether past inflation has been accelerating or decelerating. (This can also be seen as an expected cost of holding money, as Harberger and his followers have done).

The expected signs to most of the above variables (as well as those of past money growth and past price inflation) are not known *a priori* for, as Porzecanski observed, it depends on whether the Central Bank has as its chief goal the maintenance of currency and price stability or some other goal(s) (such as countercyclical measures) that may undermine price and/or currency stability. Sheehey, in experimenting with all of the above variables (including, of course, past money growth and past inflation) finds that their various subsets do predict money supply growth adequately for 16 Latin American countries (including the countries studied by Hanson). He therefore concludes that Hanson's assumption of a random walk pattern about trend for the money supply growth variable is mistaken and that there *is* a difference between total money growth $(DM_t)$ and unanticipated money growth $(DMR_t)$.

### 3.2.3 The Barro Model Applied to an Open Economy

One criticism against the set of equations (6) through (15) is that, like the pure Harberger equation, the system applies to a closed economy. Barro (1978) applies this model to the U.S. and Hanson, to five Latin American countries in the pure form. However, for Third World countries which usually are more dependent on the international sector, this is a gross omission of an important factor that affects output and prices. Thus in his critique of Hanson, Edwards (1983) includes terms of trade in equation (14) and finds that it is significant. Barro (1979), himself, working on three Latin American countries, adds on to equation (14) three more variables: the lagged real GNP of the U.S. $(\widetilde{Y}_{us})$ to measure the world market for the Third World country's exports and for influences working through international capital markets, a terms of trade variable, and the absolute value of deviation from the average purchasing power parity $(|PP_t|)$ to measure the degree of distortion of domestic prices that may have affected output adversely. Sheehey also adds terms of trade and purchasing power parity (not absolute value of its deviation from an average since this did not perform well) and finds both to add significance to the regressions. We must also point out that Nugent and Glezakos added the real exchange rate in their own version of equation (6) and found it to be quite significant. The incorporation of variables to equation (14) in order to accommodate an open economy is similar to the one done for the Harberger equation. It, too, is open to the criticism of being *ad hoc* since they are tacking on variables off the air to a more or less rigorously derived reduced form. Again this seems to be an admission that some sort of accommodation must be given to other "non-monetarist" variables whose relationship to our endogenous variables may be "structural" or "cost-push" in nature.

## 4. Empirical Tests of the Monetarist Models

We will now employ annual Philippine data from 1953 to 1980 to the models we have discussed.

### 4.1 *The Harberger Equation*

Table 1 shows different versions of the Harberger Equation (with and without the cost-push variables, and with an instrument for *Y*). The first equation of section I shows the OLS estimates of the standard Harberger equation. The growth rates are measured by the difference of logarithms between the present and the preceding period. The change in opportunity cost of holding money is measured by the change in the expected rate of inflation. The latter, in turn, is calculated using the Nugent-Glezakos method described earlier.

The OLS result shows that the only significant (up to 10%) results would be that for money supply growth lagged one and two periods, with that lagged two periods having the strongest effect. Both the income and opportunity cost proxy do quite poorly in the test. Using an instrumental variable for *Y* (here, we use an estimate based on Barro's model for income to be described shortly) doesn't change the picture drastically. The magnitude and significance of the income variable are further reduced.

Adding in cost-push variables (section II of Table 1) — growth rates of wages and of the domestic cost of imports[6] – improves the regressions significantly. The former variable has a large magnitude and the latter variable has a very high significance. Also the addition of these cost-push variables decreases the magnitude and significance of the monetary growth rate of the previous (lagged-

[6] We use $t_m$ and $P^*_m$ for all imports since we do not have the data that segregate this into imported intermediate inputs and other imports.

Table 1 — Estimates of the Harberger Model

I. The Standard Harberger Equation

| | Intercept | $DM_t$ | $DM_{t-1}$ | $DM_{t-2}$ | $DY_t$ | $\hat{P}^e_t - \hat{P}^e_{t-1}$ | R-Square | DW |
|---|---|---|---|---|---|---|---|---|
| OLS | .0113<br>(.260)[a] | .1984<br>(1.061) | .3483<br>(1.765) | .5405**<br>(2.968) | −1.0921<br>(−1.102) | .3129<br>(.968) | .4838 | 1.960<br>(.002)[b] |
| IV | .0064<br>(.129) | .1297<br>(.646) | .2586<br>(1.246) | .5053*<br>(2.487) | −.5057<br>(−.420) | .3043<br>(.883) | .4286 | 2.158<br>(1.102) |

II. The Harberger Equation with Cost-Push Variables

| | Intercept | $DM_t$ | $DM_{t-1}$ | $DM_{t-2}$ | $DY_t$ | $\widehat{P}^e_t - \widehat{P}^e_t$ | $D(w)$ | $D(e(1+t_m)P^*_m)$ | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|
| OLS | −.0112<br>(−.427) | .1283<br>(1.488) | .1249<br>(1.265) | .6202**<br>(7.196) | −1.3456*<br>(−2.655) | .0061<br>(.035) | .6826**<br>(2.963) | .2251**<br>(5.612) | .7662 |
| IV | −.0019<br>(−.075) | .1290<br>(1.663) | .1044<br>(1.207) | .6608**<br>(7.548) | −1.6586*<br>(−2.742) | −.0907<br>(−.501) | .7622*<br>(3.022) | .2575**<br>(6.491) | .7389 |

a. In this and all succeeding tables, values in parenthesis indicate the t-statistic of the estimated coefficient. Coefficients with one star are significant at the 5% level and those with two stars, at the 1% level.

b. Values below the Durbin-Watson statistics give the first-order autocorrelations.

one) period. The Durbin-Watson (DW) statistic is very low for the regression here so we reestimate them by the SAS AUTOREG procedure which uses a more sophisticated variant of the Cochran-Orcutt procedure.

Adding the cost-push variable and using the AUTOREG procedure (II of Table 1) increase the magnitude and significance of the income variable and the wage variable. Using an instrument for real income doesn't change the OLS estimates significantly.

The results of the Harberger equations suggest that structuralist forces do influence prices as the standard Harberger equation improves with the *(ad hoc)* addition of structuralist variables. They also suggest that, for the Philippines, monetary variables affect prices with quite a substantial lag. It may take some time for prices to lower as an austere monetary policy will decrease aggregate demand slowly.

### 4.2 *Empirical Test of the Barro Model*

We now turn to the Barro Model described earlier. Recall that Barro includes productive capacity indirectly in the Lucas-Phelps equation by including $\widetilde{Y}_{t-1}$ and a time variable. We however use capital stock as a measure of the productive capacity of the economy. We assume complete devastation of the Philippine economy during the Second World War. Capital stock is derived by accumulating investments (priced at 1972 prices) starting from 1946 and playing around with depreciation rates from .05 to .1. The rate chosen is .05 although the results differ very little if rates ranging from .06 to .1 are used.

Equations (14'') and (16') would therefore look like

$$(17)\ \widetilde{Y}_t = C_0 + C_1 DMR_t + C_{11} DMR_{t-1} + \ldots + C_{1K} DMR_{t-K}$$
$$+ C_2 \tilde{\tilde{Y}}_t + C_3\ time$$

and

$$(18)\ \widetilde{P}_t = e_0 + \widetilde{M}_t - e_{10} DMR_t - e_{11} DMR_{t-1} + \ldots - e_{1K} DMR_{t-k}$$
$$- e_2 \tilde{\tilde{Y}}_t \pm e_3\ time$$

where $\tilde{\tilde{Y}}_t = K$, the capital stock. Again the wiggles on top of the variables denote that the variables are expressed in logarithms.

### 4.2.1 The Response Function of Money

To get $DM_t^e$, we try to formulate a money growth response function that would include most of the variables suggested by Sheehey.[7] The variables that made it significantly with t-values of at least one are those shown in Table 2: money supply growth lagged one period $(DM_{t-1})$, growth in international reserves lagged one period $(DR_{t-1})$, exchange rate changes lagged one period $(De_{t-1})$, the pace of inflation or acceleration of prices lagged one period $(DPP_{t-1})$ and purchasing power parity lagged one period $(PP_{t-1})$. It seems that the authorities increased money growth rate when prices were accelerating during the last period and when the last period's purchasing power parity was high. They decreased money growth rate when there was a devaluation during the last period, when international reserves increased during the last period and when the previous year's money supply growth was increased.

### 4.2.2 Estimation of the Barro Equations

Barro (1979) and Sheehey (1984) found that if they replace unanticipated money growth by total money growth (i.e. $DMR_t$ is

**Table 2 — Response Function for Money Supply Growth**

$$1.\quad DM_t^e = \underset{(5.565)^a}{.1625^{**}} - \underset{(-1.483)}{.3390\, DM_{t-1}} + \underset{(1.407)}{.2734\, DPP_t}$$

$$\underset{(-2.229)}{-.0796^{*} DR_{t-1}} - \underset{(-1.081)}{.0895\, De_{t-1}} + \underset{(3.443)}{.3101^{**} PP_{t-1}}$$

$$R^2 = .4075, \qquad DW = \underset{(.094)}{1.811}$$

See Footnote a of Table 1.

[7] Variables that were tested but did not make it in the equation are lagged price inflations, lagged income growth rates and lagged budget deficit.

replaced by $DM_t$) in the above equations, the result is as good as, if not better than, the results using unanticipated money growth. Thus, we also try this in our estimation procedures.

Table 3 gives us the output and price equations corresponding to (14'') and (16') above (the closed economy model). We include here a time variable (and this will be done in all succeeding equations) if its t-value gives a magnitude of one or higher. If the Durbin-Watson statistic is not given, it means that the equation uses the SAS Autoreg procedure.

The result of the first equation in Table 3 shows strong lagged influences of money growth lasting to six periods. These lagged influences are much stronger than the influence of the contemporaneous variable $DMR_t$. The second equation in Table 3 uses total money growth ($DM_t$) instead of unanticipated money growth $DMR_t$). The time variable is not included since it doesn't come in with a t-value of at least unity. The result is similar to that using $DMR_t$ except that the coefficients of capital stock and the lagged money growth variables are somewhat larger.[8]

The second part of Table 3 shows the price equation corresponding to (16'). Again the lags extend up to 4 or 5 periods (i.e. those with a t-value of at least unity) but the significance level is smaller. The contemporaneous effect $DMR_t$ now assumes a much higher significance than in the output equation. And the coefficients of the capital stock and money growth variables are much larger in magnitude than that of the output equation. This is puzzling since (16') was derived from (14'') and for the above result to occur, $b_1$ (see equation (10)) must be very large (especially in reference to the capital stock and money growth variables of the current period and one period lag — requiring a $b_1$ magnitude of at least 5) which doesn't make much sense. Note that our Harberger equation estimates of $b_1$ in Table 1 reach a high of only 1.7.

Using $DM_t$ instead of $DMR_t$ produces basically the same results except that the coefficients of capital stock and the money growth variables have higher values than if $DMR_t$'s were used.

Now we estimate the output equation using the *ad hoc* method of adding terms of trade and purchasing power parity to the equations. This is shown in Table 4. The R-Square is improved and the

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[8] Unfortunately, we do not have enough observations to do an F-test as to whether omitting the $DMR_t$'s or the $DM_t$'s would change the regression results significantly.

Table 3 — Barro's Closed Economy Model

I. Dependent Variable: $\widetilde{Y}_t$

a) Using $DMR_t$

$$\underset{(2.597)}{\widetilde{Y}_t = 4.6485^*} + \underset{(2.940)}{.5485^*\ \widetilde{\widetilde{Y}}} + \underset{(.132)}{.0091\ DMR_t} + \underset{(2.105)}{.1495\ DMR_{t-1}} + \underset{(4.432)}{.2823^{**}\ DMR_{t-2}} + \underset{(2.973)}{.1680^*DMR_{t-3}}$$

$$+ \underset{(2.367)}{.1610^*DMR_{t-4}} + \underset{(2.902)}{.1604^*DMR_{t-5}} + \underset{(2.906)}{.1679^*DMR_{t-6}} + \underset{(1.077)}{.0149\ \text{time}} \qquad R^2 = .9996$$

b) Using $DM_t$

$$\underset{(22.186)}{\widetilde{Y}_t = 3.5723^{**}} + \underset{(40.312)}{.6573^{**}\ \widetilde{\widetilde{Y}}} + \underset{(.785)}{.0388\ DM_t} + \underset{(2.860)}{.1558^*DM_{t-1}} + \underset{(4.483)}{.2666^{**}DM_{t-2}} + \underset{(3.733)}{.2330^{**}DM_{t-3}}$$

$$+ \underset{(4.244)}{.2634^{**}\ DM_{t-4}} + \underset{(3.733)}{.2265^{**}DM_{t-5}} + \underset{(2.872)}{.1585^*DM_{t-6}} \qquad R^2 = .9993$$

Table 3 (Continued)

II. Dependent Variable: $\widetilde{P}_t$

a) Using $DMR_t$

$$\widetilde{P}_t = \underset{(2.454)}{21.0627^*} - \underset{(-2.569)}{2.5977^*\,\widetilde{\widetilde{Y}}} + \underset{(4.434)}{1.0718^{**}\,\widetilde{M}_t} - \underset{(-3.368)}{1.2713^{**}\,DMR_t} - \underset{(-2.401)}{.8331^*\,DMR_{t-1}} - \underset{(-1.528)}{.6529\,DMR_{t-2}}$$

$$- \underset{(-1.152)}{.4507\,DMR_{t-3}} - \underset{(-1.000)}{.2797\,DMR_{t-4}} + \underset{(.723)}{.1746\,DMR_{t-5}} - \underset{(-1.518)}{.4645\,DMR_{t-6}} + \underset{(2.679)}{.1466^*\,\text{time}}$$

$$R^2 = .9975, \qquad DW = \underset{(-.076)}{1.938}$$

b) Using $DM_t$

$$\widetilde{P}_t = \underset{(2.472)}{33.4124^*} - \underset{(-2.533)}{3.8445^*\,\widetilde{\widetilde{Y}}} + \underset{(4.500)}{1.0433^{**}\,\widetilde{M}_t} - \underset{(-3.146)}{1.2632^*\,DM_t} - \underset{(-2.731)}{1.3427^*\,DM_{t-1}} - \underset{(-1.748)}{.9595\,DM_{t-2}}$$

$$- \underset{(-1.359)}{.6788\,DM_{t-3}} - \underset{(-1.495)}{.5922\,DM_{t-4}} - \underset{(-.361)}{.1133\,DM_{t-5}} - \underset{(-.561)}{.1527\,DM_{t-6}} + \underset{(2.612)}{.2660^*\,\text{time}}$$

$$R^2 = .9969, \qquad DW = \underset{(.045)}{1.777}$$

See Footnotes of Table 1

Dependent Variable: $Y_t$

a) Using $DMR_t$

$$\tilde{Y}_t = \underset{(3.284)}{3.8809^*} + \underset{(5.200)}{.6299^{**}}\,\tilde{\bar{Y}} + \underset{(2.339)}{.1119}\,DMR_t + \underset{(6.122)}{.3250^{**}}DMR_{t-1} + \underset{(7.253)}{.2708^{**}}\,DMR_{t-2} + \underset{(5.546)}{.2313^{**}}\,DMR_{t-3}$$

$$+ \underset{(5.722)}{.2373^{**}}\,DMR_{t-4} + \underset{(2.592)}{.0896^{*}}\,DMR_{t-5} + \underset{(.833)}{.0417}\,DMR_{t-6} + \underset{(1.393)}{.0286}\,TT_t - \underset{(-4.719)}{.1478^{**}}\,PP_t + \underset{(1.433)}{.0123}\text{ time}$$

$$R^2 = .9998, \qquad DW = \underset{(-.107)}{2.178}$$

b) Using $DM_t$

$$\tilde{Y}_t = \underset{(-.218)}{-.4201} + \underset{(5.411)}{1.0662^{**}}\,\tilde{\bar{Y}} + \underset{(3.243)}{.1757^{*}}\,DM_t + \underset{(5.874)}{.4191^{**}}\,DM_{t-1} + \underset{(7.235)}{.4201^{**}}\,DM_{t-2} + \underset{(6.166)}{.3898^{**}}\,DM_{t-3}$$

$$+ \underset{(6.490)}{.3399^{**}}DM_{t-4} + \underset{(4.818)}{.1887^{**}}\,DM_{t-5} + \underset{(2.554)}{.1084^{*}}\,DM_{t-6} + \underset{(1.940)}{.0497}\,TT - \underset{(-4.641)}{.1417^{**}}\,PP - \underset{(-1.934)}{.0292}\text{ time}$$

$$R^2 = .9997, \qquad DW = \underset{(.033)}{1.803}$$

See Footnote a of Table 1

variables, particularly purchasing power parity, do well in the )ut equation. The significant negative sign of purchasing power ty points to a contractionary effect of a higher relative domestic e for imported inputs and capital goods as predicted by the Barro lel.

Again using $DM_t$ instead of $DMR_t$ increases the magnitude of coefficients of the capital stock and the money growth variables.

We do not present the corresponding price equation since *PP* *TT* do not fare as well here, and the coefficients in the price ation are also very large as compared to the output equation ıilar to Table 3).

Suffice it to say that the addition — particularly of purchasing ver parity — to the Barro model significantly improves the model least in the output equation). Like the Harberger model, it simply nts to some omitted variable problem in the Barro formulation. :king on *PP* and *TT* does not solve the problem for their signi-ınce is not explained in the more or less rigorously derived mone-.st model.

To summarize, the Barro model yields disappointing results:

Unanticipated money changes *(DMR)* does not perform better than simple total money changes *($DM_t$)*. Thus the entire basis for rational expectations is undermined. Perhaps rational expectations may not be suitable for the Philippine economy. This is further corroborated when one looks at the money response function (Table 2). The effect of the right-hand side variables on money supply does not reveal a consistent and rational policy that guides the monetary authorities. Indeed the economic and political situation, the timing of IMF loans and the like may affect the money supply response. That economic participants can predict these easily at the right time may be a very strong assumption.

The model shows some specification errors as the coefficients for most of the variables in the price equations are much larger than those of the output equation — implying a huge response of prices to output. This fact is not borne out at all by the result of the Harberger equation.

(3) The significance of other variables *(PP* and *TT)* that are not included in the rigorous derivation of the monetarist model points to further specification errors of the model. Like the Harberger equation, it seems that monetarist models have ignored other processes that determine output and prices.

## 5. Conclusion

It therefore seems that the monetarist models suffer from specification errors. More precisely, certain important variables working in the economy appear to have been ignored (the omitted variable problem in econometrics).

There is thus a need to come up with a more general model that would include not only the monetarist aggregate demand effects but also effects put forward by competing theories — particularly the structuralist theories. This will be the topic of another paper this author will be presenting in the near future.

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