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A MONETARY SUBMODEL OF THE PHILIPPINE ECONOMY, 1950-1969

by

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# A Monetary Submodel of the Philippine Economy, 1950-1969 <sup>1/</sup>

José Encarnación, Jr.

## 1. Introduction

A previous paper [4] presenting a simple aggregative model of the Philippine economy involved the stock of money as an exogenous variable. As was stated in that paper, the exogeneity of the money stock was not supposed to mean that this variable is completely at the control of the monetary authorities, but simply that this variable was not explained in that model. The present paper supplements the "basic model" of the previous paper with a submodel of the monetary sector so that money supply becomes endogenous.

In the basic model, the money stock variable  $Z$  was defined as the average of end-of-month figures from October of the previous year to September of the current year. We chose this definition because in the price equation of the basic model, which specified the GNP implicit price index as a linear function of real GNP and the stock of money, this definition gave better statistical properties for the price equation than alternative definitions. Money stock  $Z_m$ , defined as the average of end-of-month figures over the calendar year, did not show

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results as good. (Our choice of  $Z$  in the basic model thus amounts to assuming a 3-month lag in the effect of the stock of money on the general price level.)  $Z_m$  is an endogenous variable in the monetary submodel of this paper, and we will use the specification of  $Z_m$  also for  $Z$  in order to effect a link with the basic model.

## 2. The submodel

Like the basic model, this submodel is based on annual observations for the period 1950-1969. Although end-of-month figures are available for currency in circulation and stock of money, only end-of-year figures (equal to beginning-of-the-following-year values) are available for the other variables included. This is due to the fact that in the early 60's the Central Bank changed its reporting of end-of-month figures from an "other banks" to "commercial banking system" coverage. The latter excludes savings banks but includes rural banks which accept demand deposits.

Endogenous variables (all monetary variables are in million pesos, except where otherwise stated)

$Z_c$  : currency in circulation, average of end-of-month figures over the year

$Z_m$  : stock of money, equal to  $Z_c$  plus private demand deposits

$Z_b$  : monetary base, equal to  $Z_c$  plus  $Z_a$

$Z_a$  : available reserves of the commercial banking system, average of beginning and end of year figures

$L_{bp}^a$  : private domestic credits of the commercial banking system, average of beginning and end of year figures

$L_{cb}^a$  : Central Bank loans and advances to the commercial banking system, average of beginning and end of year figures

$F_r$  : international reserve, end of year

We will also use  $L_{cb}$  for end-of-year figures corresponding to  $L_{cb}^a$ , so that

$$(1) L_{cb} = 2L_{cb}^a - L_{cb}^{t-1}$$

#### Exogenous variables

$B_g$  : internal debt outstanding of the government, end of year

$R_r$  : ratio of required reserves to total deposits in the commercial banking system, average of beginning and end of year figures, in percentage units

$R_d$  : Central bank rediscount rate, average over the year, in percentage units

$R_b$  : weighted average of interest rates charged by banks, <sup>2/</sup> in percentage units

$A_f$  : a variable that is implicitly defined in the following identity -

$$(2) F_r = F_{r-1} - (M^* - X^*) + A_f$$

where  $M^*$  and  $X^*$  are current imports and exports, respectively, from the basic model. In other words,  $A_f$  includes all variables except the trade deficit that affect the international reserves.

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<sup>2/</sup> For 1950-59, this refers to "other banks," which include rural and savings banks in addition to commercial banks; for 1960-69, the data pertain to commercial banks only. No serious error seems to be introduced by using this mixed series, however.

The following structural equations were estimated by ordinary least squares. (Two-stage least squares estimates gave regression coefficients that are not very different; see Appendix B.) Numbers in parentheses are t-values.

$$\begin{aligned} (3) \quad Z_b &= 288.215 + .3855 L_{cb-1} + .3842 B_{-1} + .3651 F_{-1} \\ &\quad (2.81) \quad (11.38) \quad (3.02) \\ \bar{R}^2 &= .987, \quad s = 73.58, \quad D.W. = 1.545 \end{aligned}$$

$$\begin{aligned} (4) \quad Z_m &= 1004.06 + 1.4278 Z_b - 70.077 R_r \\ &\quad (64.44) \quad (-8.42) \\ \bar{R}^2 &= .995, \quad s = 63.08, \quad D.W. = 1.570 \end{aligned}$$

$$\begin{aligned} (4') \quad Z &= 1037.82 + 1.3750 Z_b - 70.445 R_r \\ &\quad (53.29) \quad (-7.27) \\ \bar{R}^2 &= .993, \quad s = 73.46, \quad D.W. = 1.565 \end{aligned}$$

$$\begin{aligned} (5) \quad Z_c &= 122.03 + .4137 Z_m \\ &\quad (70.06) \\ \bar{R}^2 &= .996, \quad s = 24.17, \quad D.W. = 1.565 \end{aligned}$$

$$\begin{aligned} (6) \quad L_{bp}^a &= 333.90 + 5.6784 Z_a + 16.439 R_b \\ &\quad (6.04) \quad (2.41) \\ \bar{R}^2 &= .980, \quad s = 16.439, \quad D.W. = 1.117 \end{aligned}$$

$$\begin{aligned} (7) \quad L_{cb}^a &= -800.233 + 34.9157 R_r + .2022 L_{bp}^a \\ &\quad (-3.16) \quad (22.22) \\ \bar{R}^2 &= .972, \quad s = 16.439, \quad D.W. = 1.373 \end{aligned}$$

Finally we have the identity

$$(8) \quad Z_a = Z_b - Z_c$$

Eq. (3) gives the monetary base as a linear function of Central Bank loans to the commercial banking system, government debt and the international reserve at the beginning of the year. (Government debt) plays a prominent role because this has been (financed largely through the banking system.) One might expect a priori that the regression coefficients would be close to unity, but the estimated coefficients are very close to one another and less than 0.4, indicating that (the greater part of changes in the explanatory variables do not affect the monetary base.) The reason seems to be institutional in character. (The international reserve is defined to be the sum of the commercial banks' net foreign exchange holdings and the Central Bank's gross foreign exchange holdings plus gold. Thus Central Bank borrowings from abroad, while increasing the international reserve, would not by itself affect the monetary base. Also, not all bank borrowings from the Central Bank are counted towards bank reserves <sup>3/</sup> with the Central Bank. Finally, of course, when the government borrows directly from the Central Bank, this does not by itself add to the monetary base. As an empirically observed relationship, eq. (3) may still prove useful for medium-term projections.

Given the monetary base, money supply is determined in eq. (4) as a function also of the reserve requirement ratio  $R_T$ . Ceteris paribus,

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<sup>3/</sup> We use this term as synonymous with "available reserves," which consist of the commercial banking system's holdings of "eligible" government securities, foreign balances and securities in addition to vault cash and demand deposits at the Central Bank. The nature and composition of what qualify as reserves have been changed by the Central Bank from time to time for policy purposes.

<a higher  $R_r$  must lead to lower money supply.> This relationship may be misleading, however, if it is concluded that other tools of monetary policy available to the Central Bank have had little additional effect on the money supply. In fact the Central Bank has used these other tools (margin requirements against letters of credit, minimum capital ratios and portfolio ceilings on the holdings of commercial banks, rediscount rates, etc.) in conjunction with reserve requirements. Thus the regression coefficient of the variable  $R_r$  should be interpreted as reflecting not only the effect of the reserve requirement ratio but also the effect of these other tools which have moved in the same direction.> According to (4), <an increase in the monetary base by ₦1 million leads to a ₦1.43 increase in the supply of money.> This "marginal monetary multiplier" of 1.43, if it may be called that, seems somewhat low relative to monetary multipliers estimated for the United States (about 2.5). The two concepts are not quite comparable, however.

Eq. (4') links the monetary submodel to the basic model. It has the same form as (4) but is logically somewhat awkward because the explanatory variables are defined over a period of time that leads the explained variable by 3 months. However, <using (3) to substitute for  $Z_b$  in (4') we see that for prediction purposes, only  $R_r$  needs to be foreknown.>

<Eq. (5) indicates that the ratio of currency to the stock of money has been decreasing with an increase in the money supply, which is highly correlated with real income per capita. As this rises, less currency is held relative to the total amount of money.>

With  $Z_b$  and  $Z_c$  already determined, the identity (8) gives bank reserves  $Z_a$ , which is an explanatory variable for bank loans to the private sector in eq. (6). This can be considered a supply function depending on bank reserves, the reserve requirement ratio and the interest rate. According to (6), a P1 million increase in reserves leads the banks to increase their loans by P5.7 million. An increase in the reserve requirement ratio reduces bank lending, which of course may be expected. The role of the interest rate is equally clear.

Finally, bank borrowings from the Central Bank are explained by eq. (7) in terms of the rediscount rate, the reserve requirement ratio and bank loans to the private sector. It appears from this equation, which may be considered a demand function, that the demand for Central Bank loans has been largely determined by bank lending to the private sector, and that credit expansion has been indirectly financed mainly by the Central Bank. For while banks are increasing their loans by P1 million, at the same time they are borrowing P0.2 million from the Central Bank. An increase in the reserve requirement ratio also increases bank borrowings, apparently in order to satisfy the higher reserve requirements and also other conditions imposed by the Central Bank when requirement ratios are changed. The effect of the rediscount rate is of course negative.

Eqs. (1) - (8) form a consistent system of 8 equations that determine the 8 variables  $L_{cb}$ ,  $F_r$ ,  $Z_b$ ,  $Z_m$ ,  $Z_c$ ,  $L_{bp}^a$ ,  $L_{cb}^a$  and  $Z_a$ , given



the predetermined variables and  $M^* = X^*$  from the basic model. Only predetermined variables are involved in the determination of the variable  $Z$  which is required in the basic model, so that for a given year, solution of the basic model does not presuppose a complete solution of the monetary submodel. In the following year,  $Z$  is partly determined by the results of the basic model through eq. (2). It seems likely that the true relationships are such that the lags involved are rather shorter, but lack of the necessary quarterly data prevents a test of this conjecture. An alternative specification of simultaneity will be considered in Appendix A.

### 3. Reduced-form equations and "predictions" for 1970

Because of the simple recursiveness of the monetary submodel, it is easy to get the reduced-form equations. Reduced-form coefficients are given in Table 1.

It is interesting to compare the submodel's "predictions" for 1970 with the actual data, particularly since the February 1970 de facto devaluation of the peso made 1970 a very atypical year. We have the following data for 1970:  $L_{cb-1} = 1444.2$ ,  $B_{g-1} = 5838.4$ ,  $F_{r-1} = 644.2$ ,  $R_r = 17.54$ ,  $R_b = 11.05$ ,  $R_d = 4.75$ . Using these figures in Table 1, we get estimated values for the endogenous variables in Table 2, which also gives actual data for 1969 and 1970 for reference.

Table 1. Reduced-form coefficients

	$L_{cb-1}$	$B_{g-1}$	$F_{r-1}$	$R_r$	$R_b$	$P_d$	Const.
$Z_b$	.3855	.3842	.3651				288.22
$Z$	.5301	.5283	.5020	-70.445			1434.12
$Z_m$	.5505	.5486	.5212	-70.077			1415.57
$Z_c$	.2277	.2269	.2156	-28.988			707.59
$L_{tp}^a$	.8962	.8931	.8487	-81.625	416.439		-2047.50
$L_{cb}^a$	.1812	.1806	.1716	41.543	84.196	-34.916	-1214.20

★ Table 2. Estimates for 1970

<u>Variable</u>	<u>1969 value</u>	<u>1970 value</u>	<u>1970 estimates</u>	<u>percentage error</u>
$Z_b$	2944.0	3541.4	3323.3	(6.2)
$Z_m$	4075.5	4618.0	4519.8	(2.1)
$Z$	3873.8	4563.4	4371.8	(4.2)
$Z_c$	1776.0	2074.2	1991.7	(4.0)
$L_{bp}^a$	7100.7	7854.9	8177.9	4.1
$L_{cb}^a$	1394.8	1294.8	1705.4	31.7

The model's estimates for 1970 seem reasonably accurate (except in the case of Central Bank loans to the commercial banking system which is overestimated by 32%), considering the unusually large increase in the money supply that year resulting from export proceeds. The extremely poor estimate for Central Bank loans, however, shows up a defect in the model, viz. the lack of a supply equation for such loans which in conjunction with the demand equation (7) would determine  $L_{cb}^a$ . Clearly the Central Bank does not merely and passively grant loans to banks upon the latter's demand. The drop in  $L_{cb}^a$  between 1969 and 1970 suggests that the Central Bank attempted to counteract inflationary pressures by, among other measures, reducing bank borrowings. For projection purposes therefore, it may be preferable to delete eq. (7) in the model and consider  $L_{cb}^a$  (or alternatively,  $L_{cb}$ ) as exogenous.

#### 4. Concluding remark

The model presented in this paper is based only on data published in the Central Bank's Annual Reports and its Statistical Bulletin. It would be desirable in future work to use unpublished data and see whether a quarterly model might be feasible. A start has already been made in this direction by Peterson [8]. (For other quantitative work on Philippine monetary variables, see [9] [10] [5].) Brunner and Meltzer's "linear hypothesis" [1] [2] has influenced the specification of money supply in this paper, but there are many dissimilarities of course. Finally, the present attempt to formulate a model explaining money supply was suggested by recent literature which shows increasing attention being paid to money supply hypotheses. (For very useful surveys see [6] [7].) Demand equations appear relatively straightforward, and four possibilities are reported in Appendix C.

# Appendix A. Alternative specifications

Our specification of money supply in the text gives this as a linear function of the monetary base (or "high-powered money") and the average reserve requirement ratio. Inclusion of the ratio of currency in circulation to private demand deposits (call this  $D_{dp}$ ) as an additional explanatory variable would be better from a theoretical viewpoint, as this ratio is a determinant of the money supply. This can be rationalized from the following considerations.

The identities

$$(A1) \quad Z_b = Z_c + Z_a$$

$$(A2) \quad Z_m = Z_c + D_{dp}$$

give

$$(A3) \quad \frac{Z_b}{Z_m} = \frac{Z_c}{Z_m} + \frac{Z_a}{Z_m}$$

$$(A4) \quad 1 - \frac{Z_c}{Z_m} = \frac{D_{dp}}{Z_m}$$

and

$$(A5) \quad \left( \frac{Z_a}{Z_m} \right) = \left( \frac{D_{dp}}{Z_m} \right) \cdot \frac{Z_a}{D_{dp}} = \left( 1 - \frac{Z_c}{Z_m} \right) \cdot \frac{Z_a}{D_{dp}}$$

Thus from (A3) and (A5),

$$(A6) \quad \frac{Z_b}{Z_m} = \frac{Z_c}{Z_m} + \frac{Z_a}{D_{dp}} - \left[ \frac{Z_c}{Z_m} \cdot \frac{Z_a}{D_{dp}} \right]$$

or

$$(A7) \quad Z_m = \frac{1}{\frac{Z_c}{Z_m} + \frac{Z_a}{D_{dp}} - \frac{Z_c}{Z_m} \cdot \frac{Z_a}{D_{dp}}} \cdot Z_b$$

Accordingly, Cagan [3] calls  $Z_b$ ,  $Z_c/Z_m$  and  $Z_a/D_{dp}$  the three determinants of the money supply.

Being an identity, (A7) provides no explanation of the money supply unless behavioral equations are specified for its three determinants. Let us consider the empirical hypothesis that [money supply is a linear function of the monetary base, the reserve requirement, and the ratio of currency in circulation to private demand deposits (which is at the control of the private sector).] [The higher is this ratio, the smaller is the so-called monetary multiplier (i.e., the coefficient of  $Z_b$  in (A7)). Also, the higher is the average reserve requirement ratio - the ratio of required reserves to total deposits (including time and savings deposits) - the greater we expect is the ratio  $Z_a/D_{dp}$  and therefore the lower is the monetary multiplier.]

We have the following regression:

$$(A8) \quad Z_m = 1322.16 + \frac{1.3740}{(44.38)} Z_b - \frac{66.3343}{(-8.68)} R_T - \frac{2.2805}{(-2.26)} (100 Z_c/D_{dp})$$

$$\bar{R}^2 = .996, \quad s = 56.579, \quad D.W. = 1.806$$

Comparing this with eq. (4), (A8) appears slightly better. One could therefore have an alternative model with (A8) in place of (4), and an

equation to explain  $Z_c/D_{dp}$  in place of eq. (5) in the system of the text. (Otherwise, if (5) is retained, inconvenient nonlinearities would result.)

For example one might use

$$(A9) \quad 100 Z_c/D_{dp} = 162.90 - .01697 Z_m$$

(-5.42)

$$\bar{R}^2 = .599, \quad s = 12.80, \quad D.W. = 0.978$$

But this is much weaker and seems unnecessarily roundabout..

Another model is possible with

$$(A10) \quad Z_b = 342.157 + .3926 L_{cb}^a + .3484 B_g^a + .2827 F_r^a$$

(2.25) (8.12) (1.82)

$$\bar{R}^2 = .986, \quad s = 74.989, \quad D.W. = 1.015$$

where  $B_g^a$  and  $F_r^a$  are averages of beginning and end of year values of the corresponding variables  $B_g$  and  $F_r$  in place of eq. (3). By the usual statistical criteria, (A10) is relatively weaker. What seems attractive from a theoretical viewpoint about such a model, however, is that there would be simultaneous feedbacks between the basic model and the monetary submodel, so that the combined models would constitute a single simultaneous equation system. But computational difficulties are increased and for projection purposes, the model of the text seems superior.

Yet another possibility is to make the interest rate  $R_b$  endogenous, which is clearly to be preferred, and introduce a demand function for bank loans:

$$(A11) \quad L_{bp}^a = 1156.04 - 224.541 R_b + .3169 Y^* - 1.2873 (100 W/P)$$

(-1.56) (11.62) (-2.18)

$$\bar{R}^2 = .992, \quad s = 184.96, \quad D.W. = 0.708$$

where  $Y^*$  is current GNP,  $W$  is the annual money wage rate (in pesos) and  $P$  is the implicit GNP price deflator (1955 = 100). [Here, the higher is the real wage, the less profitable is investment and consequently the lower is the demand for bank loans (which have financed much investment)]. The coefficient of  $R_g$  has the correct sign but has a rather low  $t$ -value, however.

Finally, it is possible to have an alternative model that replaces eq. (4) with the following two equations, where  $Z_m' = Z_m + D_{tp}$  and  $D_{tp}$  is private time (including savings) deposits, and  $R_g$  is the interest rate on government securities.

$$(A12) \quad Z_m = 827.117 + \frac{.4417}{(43.96)} Z_m' - \frac{60.9802}{(-3.46)} R_g$$

$$\bar{R}^2 = .996, \quad s = 55.013, \quad D.W. = 1.486$$

$$(A13) \quad Z_m' = 535.900 + \frac{3.4604}{(82.90)} Z_b - \frac{139.2917}{(-8.89)} R_g$$

$$\bar{R}^2 = .997, \quad s = 118.845, \quad D.W. = 1.738$$

These would indicate that given the supply of money in the broad sense (à la Friedman), the private sector's decision as to the amount of money it will hold depends on its cost as reflected by  $R_g$ , taken to be exogenous. In other words, (A12) is a portfolio-choice equation. For projection purposes, however, a model that uses (A12) and (A13) in place of (4) may not be very useful, considering that the interest rate on government securities seems to have been kept excessively low during much of the observation period.



# Appendix B. Two-stage least squares estimates

The first stage in deriving these estimates regressed the endogenous variables on  $L_{cb-1}$ ,  $B_{g-1}$ ,  $F_{r-1}$ ,  $R_r$ ,  $R_b$  and  $R_d$ . The 2SLS estimate of the  $Z_b$  equation is of course the same as the OLS estimate in the text.

$$(B1) \quad Z_m = 1004.89 + \frac{1.4271 Z_b}{(33.13)} - \frac{70.069 R_r}{(-4.35)}$$

$$\bar{R}^2 = .983, \quad s = 121.98, \quad D.W. = 1.836$$

$$(B2) \quad Z = 1037.58 + \frac{1.3752 Z_b}{(32.43)} - \frac{70.447 R_r}{(-4.44)}$$

$$\bar{R}^2 = .982, \quad s = 120.09, \quad D.W. = 1.411$$

$$(B3) \quad Z_c = 120.08 + \frac{.4146 Z_m}{(38.44)}$$

$$\bar{R}^2 = .987, \quad s = 43.86, \quad D.W. = 1.096$$

$$(B4) \quad L_{bp}^a = 959.57 + \frac{6.0435 Z_a}{(5.11)} - \frac{268.31 R_r}{(-3.17)} + \frac{352.116 R_b}{(1.64)}$$

$$\bar{R}^2 = .975, \quad s = 336.85, \quad D.W. = 0.903$$

$$(B5) \quad L_{cb}^a = -793.116 - \frac{38.0824 R_d}{(-4.55)} + \frac{57.5182 R_r}{(8.11)} + \frac{.2066 L_{bp}^a}{(29.62)}$$

$$\bar{R}^2 = .984, \quad s = 51.11, \quad D.W. = 2.23$$

### Appendix C. Money demand equations

The following equations were estimated by OLS. Symbols used are defined in the text or in Appendix A.

$$(C1) \quad Z_m = -338.41 + \frac{.10065 Y^*}{(11.06)} + \frac{10.1434 P}{(3.17)} - \frac{62.9312 R_g}{(-3.34)}$$

$$\bar{R}^2 = .996, \quad s = 57.66, \quad D.W. = 2.112$$

$$(C2) \quad Z_m = -303.59 + \frac{.09969 Y^*}{(8.69)} + \frac{7.45227 P}{(1.91)}$$

$$\bar{R}^2 = .994, \quad s = 72.71, \quad D.W. = 1.198$$

$$(C3) \quad Z_m/P = 4.0060 + \frac{.00119 Y}{(25.08)} - \frac{.28042 R_g}{(-2.01)}$$

$$\bar{R}^2 = .984, \quad s = 0.5403, \quad D.W. = 1.372$$

$$(C4) \quad Z_m/P = 3.4256 + \frac{.00112 Y}{(31.72)}$$

$$\bar{R}^2 = .981, \quad s = 0.5845, \quad D.W. = 1.132$$

[ Inclusion of the interest rate on government securities, as an indicator of the cost of holding money, gives a better fit whether or not the dependent variable is deflated by the price level. ]

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