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DETERMINANTS AND FORECASTING OF MONEY STOCK IN PAKISTAN

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ABSTRACT

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MONEY STOCK IN PAKISTAN

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Until recently it was traditional to treat the money stock as a policy variable exogenously determined by the central bank of a country. In the last twenty years, however, the notion that the money stock is jointly determined by the central bank, the commercial banks, and the nonbank public has gained general acceptance among economists. Thus regarded as an endogenous variable, the problem of choosing that model of money stock determination which provides the best predictions of its values in the immediate future assumes importance. It was the purpose of this dissertation, then, to formulate alternative models of the Pakistani money stock process and determine which of them yields the best short-run predictions.

After a brief survey of the literature on models of money supply, money demand and money stock process, we constructed a model of money stock process in Pakistan

which incorporates the major institutional feature of the economy. We hypothesized that the money stock in Pakistan is different from the conventional base-multiplier relationship in that the money stock is obtained as the product not of stock of base money and an appropriate multiplier, but as a product of a broader total of bank holdings of liquid assets and an appropriate multiplier.

The models examined ranged from naive models to single equation models. Each model was estimated over four sample periods, all beginning in 1961 but differing in that their end point was systematically moved in four quarter steps from 1967:4 to 1970:4. Quarterly forecasts of money stock for each of the years 1968-1971 were then made, based on the estimates obtained for each sample period, by dynamically simulating each estimated equation for the next four quarters. A comparison of the predictive performance based on the root mean square error (RMSE) statistics was made.

The predictive performance of the economic models was also compared with that of the naive models. The evidence seems to suggest that the structural models provide reasonably good forecasts one, two and three quarters ahead. Furthermore, there is little to choose between the Brunner linear money supply hypothesis and our liquidity model for the first three quarters forecasts. For the fourth quarter forecast, an autoregressive money stock model and Gibson's model had the lowest RMSE statistics. Given the empirical results, we also concluded that money multiplier predictability can not be taken as a sufficient condition for the accurate forecasts of the money stock in Pakistan.

To my son, Usman

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CHAPTER I

INTRODUCTION

Government stabilization policies attempt to promote the economic well-being of a nation by creating an environment conducive to sustain socioeconomic growth. Implementation of such policies involves both fiscal and monetary actions. Monetary actions refer to actions taken by a country's central bank which affect its money supply, credit and interest rates. The role of monetary policy has become increasingly important in recent years, as economists and policy makers realize its contributions in achieving desired levels of gross national product, employment and prices. There is a widespread belief that changes in money influence the economy. Knowledge of the basic factors underlying these changes in the money stock is, therefore, of considerable importance to economists and policy makers who view money as a strategic variable.

In recent years, increased attention has been devoted to forecasts of GNP and its components, while little attention has been paid to models that can be used to forecast the money stock. Perhaps this is because it is traditional to treat the money stock as a policy variable exogenously controlled by the central bank. In the last twenty years, however, the notion that the money stock is jointly determined by the central bank, the commercial banks, and the nonbank public has gained general acceptance among economists. Thus regarded as an endogenous variable, the problem of choosing that model of money stock determination which provides the best predictions of its values in the immediate future assumes importance. It is the purpose of this dissertation, then, to formulate alternative models of the Pakistani money stock process and determine which of them yields the best short-run predictions.

The dissertation will be organized in the following manner. Chapter II outlines the basic features of the money market in Pakistan. It explains the functioning of the State Bank of Pakistan (SBP), the commercial banks and the institutional arrangements of Pakistan's monetary system. The concept of the monetary base is derived from the T-accounts of the SBP, the commercial banks and the nonbank public. It is found that major changes in base money are caused by changes in the State Bank of Pakistan's holdings of government securities and changes in the level of commercial banks borrowing from the State Bank.

Chapter III contains a brief survey of the literature on models of money supply, money demand and the money stock process related to the United States economy. The latter are more familiarly known as money multiplier models. In the discussion, we explain which of these models we have estimated and used to predict the Pakistani money stock, and which could not be so used.

Even though the models of Chapter III offer a basic analytic framework which is intended to have general applicability, the construction of a money stock hypothesis for Pakistan will necessarily have to incorporate the major institutional features of the economy. This is the purpose of Chapter IV. We first evaluate the existing studies on the money supply process in Pakistan. We then hypothesize that the money stock in Pakistan is different from the conventional base-multiplier relationship in that the money stock is obtained as the product not of stock of base money and an appropriate multiplier, but as a product of a broader total of bank holdings of liquid assets and an appropriate multiplier. We take two alternative approaches to the empirical implementation of this model. The first simply makes the money stock a linear function of the liquid assets total and the parameters of the multiplier. But since the liquid asset total is probably not independent of the multiplier parameters, this approach is not strictly correct. Therefore, we derive an alternative model in which the liquid asset total is eliminated and percentage changes in the money stock are given by the sum of the percentage changes in the multiplier parameters each weighted by an appropriate elasticity.

In Chapter V, we present the estimated parameters of some naive models of the money stock. Each model is estimated over four sample periods, all beginning in 1961 but differing in that their end point was systematically moved in four quarter steps from 1967:4 to 1970:4. Quarterly forecasts of money stock for each of the years 1968-1971 are then made, based on the estimates obtained for each sample period, by dynamically simulating each estimated equation for the next four quarters. A comparison of the predictive performance based on the root mean square error (RMSE) statistics is made.

In Chapter VI we apply the same analysis to the models of Chapters III and IV that we applied to the naive models in Chapter V. Each model is estimated over four separate sample periods, quarterly forecasts for the first year after each sample period are made, and root mean square error statistics for the various models are compared. They are also compared with those naive models of Chapter V having the best predictive performance. We find that Brunner's linear money supply hypothesis gives the best prediction for one quarter ahead followed by the liquidity model. The liquidity model outperforms the prediction of money stock for second and third quarter forecast. Gibson's model gives the best prediction four quarters ahead.

CHAPTER II

FINANCIAL SECTOR IN PAKISTAN

The purpose of this chapter is to describe the main features of the money market in Pakistan. The economy of Pakistan is predominantly agricultural in nature. The industrial sector has been growing steadily but the pace of development has been relatively slow. Population in June 1971 was estimated to be 116.6 million with per capita income of Rs. 430 or 43 U.S. dollars. The sectoral breakdown of GNP in June 1971 was as follows: agriculture 42.1%, manufacturing 16.7%, wholesale retail trade 15.1%, services and construction 12.4% and the rest 13.8%. A majority of the population (roughly 70%) lives in rural villages where banking facilities do not exist, and hence currency is much more widely used than bank deposits. In a sense, there exists a dual money market in rural and urban sectors of the economy.

Prior to the 1947 partition of the sub-continent into Pakistan and India, the commercial banking sector was relatively developed compared with other colonial countries. The official view is that currency was relatively more important in Pakistan than in India because it had a larger monetized sector but one where commercial banks were less developed. The paucity of data makes a test of this view impossible. Table 2.1 gives the ratios of currency to demand deposits, k_1, currency to money stock, k_2, and time deposits to demand deposit, t, for the period 1961-71. Over this period, there has been a considerable decline in currency ratio k_1, suggesting a shift from currency to demand deposits and a movement from demand to time deposits. Given the trend of k_1, one would expect k_2 to decrease over time, but this decline in currency to money stock ratio has been very moderate except for 1971.

TABLE 2.1.--Currency and Time Deposits Ratios.

Year-Quarter	k_1	k_2	t
61.4	1.83	.64	.63
62.4	1.63	.62	.75
63.4	1.45	.69	.76
64.4	1.31	.57	.79
65.4	1.37	.58	.91
66.4	1.30	.57	1.05
67.4	1.17	.55	1.18
68.4	1.13	.53	1.19
69.4	1.08	.52	1.07
70.4	1.09	.59	1.06
71.4	.94	.48	.94

The basic institutions of the financial sector in Pakistan are the central bank, State Bank of Pakistan (SBP), and the commercial banks. There are other private institutions such as cooperative banks and some government credit institutions such as the Agricultural Development Bank of Pakistan and the Industrial Development Bank of Pakistan which do not accept deposit liabilities, and hence their role is not directly pertinent to the supply of money. These institutions were created to "fill the gap where private interests were not ready to participate";[1] and so they do provide credit for activities which could not obtain financing through commercial banks.

The models of money stock tested in this dissertation incorporate only the SBP and the commercial banks. It excludes the cooperative banks, the Postal Saving System, and the government-sponsored corporations either because of data problems or because their liabilities are not generally acceptable demand deposits. The remaining portion of this chapter presents a brief review of the development of the financial institutions. In Sections A and B, we will discuss the SBP and the commercial banks, while Section C presents the composition

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[1] Government of Pakistan, Selected Papers on Pakistan Economy, Karachi, 1955, p. 5.

of money stock from the balance sheet of these institutions--a useful procedure in the study of money stock.

A. State Bank of Pakistan (SBP)

The SBP received the usual powers of a central bank: the right to conduct open market operations in government securities and authority to control borrowing by the commercial banks via quantitative restrictions, variations in the discount rate, and through variations in the required reserve ratios. Open market operations have been limited almost entirely to transactions with the commercial banks because very little of the debt of the central government is held by others.[2] The main conclusion is that in the kind of public debt in which it deals, the banking system including SBP is nearly the only dealer. Whatever securities the SBP decides to sell must be entirely purchased by the commercial banks.

The SBP Act of 1956 introduced several changes in the functioning of the Bank. The latter was required not only to ensure price stability, but also to foster the growth of a monetary and credit system in the

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[2]In June 1971, as reported by the International Monetary Fund in International Finance Statistics [May 1976, p. 297], out of a total of Rs. 26881 million government debt, 7492 million were held by SBP, 2247 by commercial banks, 340 by other financial institutions, 3085 by international institutions, 11093 by foreign governments and 2624 by others. This amount by others is less than 10% of total government debt.

national interest and help in fuller utilization of the country's productive resources. The SBP is required to maintain price stability by controlling the rate of credit expansion and yet to ensure an adequate flow of credit to the economy. The consideration of sources of finance for development expenditure has become an important feature in the discussion of monetary policy. In this context, fiscal policy determines the total debt which must be divided between the central bank and commercial banking sector. In these circumstances, the SBP tries to calculate the safe limits of deficit financing. The SBP's own analysis of monetary problems is mainly concerned with the sources of expansion of bank credit and their effect on total money supply and the price level.

Economists have long recognized the fact that central banks cannot use the traditional tools of monetary policy in developing economies where there exists a limited underdeveloped security market. Therefore the State Bank has been given a wide range of selective controls over credit. These controls have been used regularly, though not always effectively. The Bank has the power to mandate that commercial banks grant loans for particular projects, to set compensating balance requirements on these loans, and to set the interest rates to be charged on them. The aim of these selective controls is to provide some degree of flexibility to regulate the flow of credit to different sectors of the economy. Moral suasion is another means through which the Bank has tried to influence the lending policies of the commercial banks. Due to direct controls on commercial banks, the SBP can easily accomplish its desired policy under a branch banking system.

Although the SBP is empowered with all the usual tools of monetary policy, it does not significantly rely on these traditional monetary instruments to control either money supply or bank credit. The discount rate was fixed at 4% until 1964 when it was raised to 5%. The efficiency of the discount rate is judged by its effect on credit creation. The Bank felt that since government deficits accounted for a large portion of the increases in money supply, any marginal actions on the part of the SBP might have been detrimental to the overall economic growth of the country. Hence it relied primarily on moral suasion paid for at the cost of providing discount privileges to the commercial banks. In June 1971, about 24% of total outstanding credit of commercial banks was financed by borrowing from the SBP, as against about 12% in June 1958. The raising of the bank rate in 1964 did not have any significant effect on the volume of commercial bank borrowing. Although borrowing limits allowed by the SBP were scaled down in the early sixties, the Bank has pursued a flexible policy with frequent adjustments in credit control measures to suit the changing conditions of the economy.

The year of 1971 was a period of turmoil and disturbances in East Pakistan, followed by a war with India and in December 1971 came the separation of East Pakistan, now known as Bangladesh. After separation, a number of monetary reforms were implemented by the State Bank.[3] The multiple exchange rate system prevailing in the 1960's, which had been used as part of the "Export Bonus Scheme," was abandoned. The discount rate was raised from 5% to 6%; the SBP permitted the banks to pay interest on demand deposits. Simultaneously with the increase in the discount rate, it raised the ceiling on interest rates on bank advances from 9% to 10%.

Another traditional tool of monetary policy is the requirement of legal reserves against commercial banks' deposit liabilities. In practice, required reserve ratios have been seldom varied. They were 5% on demand deposits and 2% for time deposits from the early 50's till 1963. They reminaed at 5% for both

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[3]State Bank of Pakistan, Report on Currency and Finance, Karachi, 1971-72, p. 41.

time and demand deposits from July 1963 to April 1965, then rose to 7.5% from May 1965 to August 1965. The rate was brought down to 6.25% in August 1965 and finally back to 5% on both types of deposits in January 1968.[4] S. Meenai, an expert on monetary problems, closely associated with the SBP, is of the view that "over the years, the conviction has grown that the power to vary reserve requirements is really an instrument of monetary management rather than a mere safeguard for the depositors."[5]

A most important aspect of the commercial banking system is the liquidity requirement for all banking companies. This requires all member banks to maintain in cash, reserves, gold or unencumbered approved securities at least 20% of their total demand and time liabilities. This last category requires some comments. Approved securities are those which the SBP is willing to accept as collateral for its advances. These include all government securities and almost all nongovernment investments of the commercial banks. To qualify for inclusion in the bank's liquidity these securities must also be "unencumbered," which means not being used as

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[4] SBP, Banking Statistics of Pakistan, Karachi, 1971-72, p. 11.

[5] S. A. Meenai, Money and Banking in Pakistan, Karachi, 1966, p. 156.

collateral for SBP borrowing. This liquidity ratio was raised to 25% in 1966 and further raised to 30% in May 1972 in order to contain credit expansion within reasonable limits. As a result of this change in 1972, the commercial banks' excess liquidity which had developed in the late 60's due to growing deposits was curtailed. We will discuss the implications for money stock prediction of this liquidity requirement in depth in Chapter IV.

B. Commercial Banks

Commercial banks in Pakistan operate somewhat along the lines of the British branch banking system. They are divided into scheduled banks and nonscheduled banks.[6] The number of actively operating nonscheduled banks is very small. There were 212 branches of 32 scheduled banks on July 1, 1952; these had increased to 580 on July 1, 1961. The number stood at 3418 on July 1, 1971. In spite of phenomenal increases in the number of branches of commercial banks, banking facilities still continue to be confined to larger cities. Tables 2.2 and 2.3 give the summary statistics for the first quarter of 1961 and 1971 for all scheduled commercial banks.[7]

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[6]A bank with a paid up share capital and reserves of Rs. 500,000 is declared as scheduled bank, if it also satisfies other minor conditions.

[7]Capital accounts in both balance sheets are ignored.

TABLE 2.2.--Assets and Liabilities of Commercial Banks on March 31, 1961 (millions of Rs.).

Assets			Liabilities	
(i)	Cash and Reserves	298.9	Demand Deposits	1931.9
(ii)	Government Debt	1334.4	Time Deposits	1148.8
(iii)	Credit to Private Sector	2065.9	SBP Borrowing	354.1
			Net Liabilities	263.6
	Total	3698.2	Total	3698.2

TABLE 2.3.--Balance Sheet of Commercial Banks on March 31, 1971 (millions of Rs.).

Assets			Liabilities	
(i)	Cash and Reserves	1228.7	Demand Deposits	6254.0
(ii)	Government Debt	2689.0	Time Deposits	6565.0
(iii)	Credit to Private Sector	11335.3	SBP Borrowing	2434.0
	Total	15253.0	Total	15253.0

Since 1961, the structure of the commercial banks' deposits and liabilities has been changing very rapidly. Although both demand and time deposits went up significantly, the rate of growth of time deposits was much higher than that of demand deposits. It is difficult to explain the unprecedented increase in time deposits that has occurred since 1960. To some extent, the increase may reflect the rapid increase in real income. The increase in time deposits has been much too great to be accounted for by increased private savings. One possible explanation may lie in the margin requirement that is required for many imported commodities before a letter of credit is granted. Since 1960, imports have been growing very rapidly, and margin requirements have been used increasingly to control the level of imports. A rising trend in the rates of interest on different kinds of time deposits may also have some contribution.

Commercial bank borrowing from the SBP is another important source of funds, which needs some discussion. Table 2.4 describes the credit to the private sector, borrowing of commercial banks from the SBP and total deposits of commercial banks for selected years. First of all, advances (credit to private sector) have been rising much faster than deposits so that commercial banks have had to borrow from the SBP more frequently and in ever-increasing amounts. Secondly, the quantity of commercial banks borrowing is determined, not only by the SBP, but by the demands of these banks and their holdings of government securities. Whenever a new government loan is to be offered, the SBP suggests a quota to each bank, probably an emergency measure at first, but later an established routine. This quota system ensures that the banks have large holdings of government securities collateral; thus their wishes are the main determinants of the volume of borrowing. Borrowing from the SBP is no longer strictly seasonal as was the case in the 1950's.

TABLE 2.4.--Commercial Banks' Credit and Borrowings (millions of Rs.).

Year	Borrowing From SBP	Total Deposits	Credit to Private Sectors
1960	6.1	2923	1445
1962	403.2	3378	2593
1964	783.0	5761	4342
1966	1078.5	8149	6317
1968	1698.0	10890	9412
1970	1402.6	13238	10655
1971	2972.0	13878	11579

Other sources of funds like interbank borrowing (call money market) or foreign loans constitute only a small fraction of the commercial banks' total liabilities. No matter what constraint to expansion operates, the SBP can induce a contraction of bank borrowing if it wishes to do so by raising the discount rate or through selective controls and moral suasion. In practice, the SBP has rarely used discount rate as a policy tool. The very fact that discount rate was changed only twice in 25 years shows the reluctance on the part of the Bank to use conventional tools in a developing economy.

As far as the assets of the commercial banks are concerned, three major components are: holdings of government securities, cash and reserves, and credit to the private sector. Cash and reserves are determined by the requirements of the State Bank. Holdings of government securities are also exogeneously determined by the SBP. Table 2.5 shows the relative position of total investment in government securities, total loans and advances (including bills purchased and discounted) and total deposit liabilities. Commercial banks have a preference for short-term lending. However, large borrowers do get their advances renewed. The banks mainly serve the needs of import-export business, local commerce and some large-scale manufacturing. In June

1971, these sectors accounted for roughly 76.6% of total commercial loans.

TABLE 2.5.--Investment of Commercial Banks (millions of Rs.).

Year	(1) Total Investment	(2) Total Loans and Advances	(3) Total Deposit Liabilities	(1) as % of (3)	(2) as % of (3)
1960	1231.2	1617.4	3029.9	40.6%	53.4%
1962	1319.9	2861.5	3872.4	34.1%	73.9%
1964	1528.1	4791.3	5966.0	25.6%	80.3%
1966	2221.6	6591.0	8434.4	26.4%	78.1%
1968	2782.0	9284.4	11185.3	24.9%	83.0%
1970	3485.0	10715.0	13834.9	25.2%	77.4%
1971	3774.8	11620.9	14111.9	26.7%	82.3%

A closer look at Table 2.5 reveals that before 1961, investment in government securities was as important a use of ccmmercial banks' resources as loans and advances. In recent years, however, loans to the private sector have become the most important form of asset held in banks' portfolios. It is also evident that the structure of assets and liabilities of these banks is undergoing significant change. Because of these structural changes, the SBP may be in a better position to influence commercial bank lending position without major changes in reserves or liquidity requirement.

1. Interest Rate

Very little is known and discussed about the interest rate structure in Pakistan. The usual argument that even in developed economies savings are interest inelastic so that a monetary policy which relies on increasing interest rates as a means of enhancing savings and growth will not be successful has become a good excuse for developing countries. Often forgotten in this context is the point that an increase in interest rates can also have a beneficial impact on growth to the extent that higher interest rates contribute toward the establishment of a capital market. When financial assets have relatively low yields, wealthholders in Pakistan hold a large proportion of their portfolio in the form of real goods. Interest rates also affect the amount of capital flight from the country. Pakistani wealthholders prefer to hold part of their wealth in the form of foreign assets.

Very little has been done to promote development of a financial market. An appropriate monetary policy requires the government to permit the level of interest rates to fluctuate. But the SBP virtually never changes the discount rate and holds the yield on government securities at an artificially low level. Some major banking reforms were introduced in May 1972, when the

"Export Bonus Scheme" was abolished, the (true) effective exchange rate was established at 1$ = Rs. 11.00, and the discount rate was changed. The SBP also raised its ceiling on the interest rate on bank advances from 8% to 10% in the case of larger banks. The rise in the interest rate structure was intended to encourage savings, reduce consumption expenditure and bring about a greater selectivity in investment and spending. The commercial banks were permitted to pay interest on current deposits. The SBF also specified minimum rates payable on saving deposits, leaving the banks free to offer higher rates if they so desired--an interesting contrast to Regulation Q of the U.S. Federal Reserve System, which gives the Federal Reserve Board power to set <u>maximum</u> rates payable on saving deposits.

C. Money Supply in Pakistan

Here we begin with the assumption that the money supply is not exogenously determined in Pakistan. We start with the aggregate balance sheet of each group of economic agents making up the economy. The monetary authority in Pakistan is represented by the Treasury and the SBP. Table 2.6 describes the general nature of the balance sheets of the SBP, the commercial banks and nonbank public, respectively. From these we must construct a table for the concept of the monetary base in terms of its sources and uses since no such breakdown is explicitly provided in the SBP's publications. Table 2.7 presents the components of the monetary base as of June 30, 1971, for Pakistan.

TABLE 2.6.--Balance Sheet of the Banking System.

Assets	Liabilities
State Bank of Pakistan	
SBP holding of Foreign Reserve (FR)	Currency Outstanding (C^P)
Govt. Bonds held by SBP (GS_1)	Commercial Banks' Reserves (R)
Commercial Banks' Borrowing (A^{SBP})	Other Liabilities of SBP (O_L)
Other Assets (O_A)	
Commercial Banks	
Banks' Reserves (R)	Demand Deposits (DD)
Claims on Govt. (GS_2)	Time Deposits (TD)
Foreign Assets (FA)	Borrowings from SBP (A^{SBP})
Loans to Private Sector (L)	Foreign Liabilities (FL)
Other Assets (O_A)	Other Liabilities (O_L)

Unlike most financially developed economies where bank reserves constitute a major use of the base, currency in Pakistan dominates the uses side of the base. The sources of base may be classified into net domestic credit, net foreign assets and other liabilities of the SBP. The uses of the base are currency in circulation and commercial bank reserves with the SBP. The monetary base will be changed by government fiscal operations as well as by changes in the SBP's holding of foreign reserves. We will assume that the stock of foreign reserves is exogenous, based on the assumption that this part is not directly controllable by the monetary authority. Its behavior depends on the ultimate determinants of the balance of payments position. Due to wide fluctuations in exports and their demand price, the control over the value of exports is limited.

TABLE 2.7.--Monetary Base in Pakistan (millions of Rs.).

Sources of Base		Uses of Base	
SBP holdings of gold, dollar and sterling	845.5	Currency held by public	8735.0
SBP advances to commercial banks	2872.0	Reserves	652.4
SBP holdings of govt. securities	7992.0	Vault cash held by commercial banks	657.7
less Treasury deposits	1444.1		
less Treasury cash holding	320.3		
Source Base	10045.1	Uses of Base	10045.1
Net Source Base	7173.1	Uses of Net Source Base	7173.1

The relationship of the budget deficit to the base is crucial in Pakistan. Past experience suggests that the SBP has played more the role of a fiscal agent of the government than that of a monetary management officer. No specific limits have been laid down in regard to government borrowing from the banking system. The general feeling is that the money supply has been increasing at a rate greater than that consistent with price stability. We will hypothesize that major changes in the monetary base in Pakistan come through deficit financing. An increase in the SBP's holdings of government securities will imply an equivalent amount of reserve credit causing an increase in the source base. Thus, if the government chooses independently the level of its expenditure for development purposes, it appears that the size of the base will not be an independent policy variable of the SBP, and the SBP's discretionary control over the money supply is quite limited. Other items like government deposits are neither important magnitudes nor are they policy determined variables in controlling the monetary base as is the case in the U.S. economy. In summary, major changes in the stock of base money in Pakistan are caused by changes in the level of the country's foreign reserves, changes in the SBP's holdings of government securities and changes in the level of commercial bank borrowing from the State Bank.

CHAPTER III

MODELS OF MONEY STOCK

In the past several years, the process of money stock determination has drawn increasing interest. A number of models describe the money stock as an endogenous variable, determined jointly by the actions of the public, commercial banks and monetary authorities. This chapter is a brief survey of the literature on models of money supply, money demand and the money stock process. The latter models which combine elements of supply and demand in a single equation are also known as money multiplier models.

A. Money Supply Models

Since the central bank and the commercial banks are the main suppliers of money, it is only their behavior that is of interest in models of money supply as opposed to models of the determination of money stock which combine supply and demand elements. Although Brunner and Meltzer call their various theories "money supply hypotheses" these theories, since they contain also elements of demand for money, should be more appropriately referred to as "money stock hypotheses." For this reason a discussion of their work will be deferred to the section on money multiplier models.

Models which have tended to view the money stock from the suppliers' side are few. Meigs [1962] presented determinants of money supply with respect to the role of free reserves (excess minus borrowed reserves). The main hypothesis is that commercial banks seek to maintain a desired ratio of free reserves to total deposits which is a decreasing function of market interest rates and an increasing function of the discount rate and the percentage change in unborrowed reserves. Banks adjust their actual ratio to the desired free reserves ratio by varying their earning assets or borrowings from the Federal Reserve. Hendershott and DeLeeuw [1970] developed an equation which had demand deposits being a function of the discount rate, Treasury bill rate, lagged free reserves, changes in unborrowed reserves, changes in commercial loans and borrowed reserves.

Modigliani, Rasche and Cooper (MRC) [1970] examine the problem of money stock in terms of interaction of the central bank, the commercial banking sector and the public demand. They start with a balance sheet approach to exhibit the investment portfolio decision of an individual bank and then proceed to describe a relationship between bank investments and demand deposits that can be inferred from the balance sheet identity for the whole banking system. This relation between investment and demand deposits seems to relate money supply explicitly to central bank policy by way of unborrowed reserves, RU. Their final empirical formulation of the money supply hypothesis is given in terms of a free reserve equation. This analysis of money supply is mainly influenced by the behavior of the Federal Reserve setting certain policy variables and of commercial banks in managing their portfolios in response to stochastic fluctuations in their reserves.

Teigen [1964, 1976] estimated a "money supply equation" in which the dependent variable was the ratio of M, actual money stock, to M*, that part of the maximum money stock attainable at any given time which is based on reserves supplied at the initiative of the monetary authorities, RU. In Teigen's formulation the money stock, M, is given by

$$M = \frac{k}{1 - c - h} (RU - R^e) + \frac{k}{1 - c - h} RB$$

$$= \frac{k}{1 - c - h} RU - \frac{k}{1 - c - h} FR \qquad (1)$$

where k is the required reserve ratio on member bank demand deposits, c is the public's desired ratio of currency to total money stock, h is the public's desired ratio of nonmember bank deposits to total money stock, RB is borrowed reserves, R^e is excess reserves, and FR is free reserves. The magnitude M* is given by

$$M^* = \frac{k}{1 - c - h} RU. \qquad (2)$$

Teigen's basic hypothesis, then, is that the ratio of M to M* depends on an interest rate differential:

$$\frac{M}{M^*} = X \ (r - r_d)$$

where r is the 4-6 month commercial paper rate, a proxy for the rate of interest available to banks on loans, and r_d is a measure of banks' lending costs approximated by the discount rate. Unfortunately, throughout our sample period the volume of unborrowed reserves, RU, in Pakistan was negative. Substituting a negative value of RU into equation (2) implies that that part of the maximum attainable money stock which is based on RU is negative. Hence we have chosen not to utilize Teigen's model in obtaining short-run forecasts of the Pakistani money stock.

Gibson [1972] showed that a function with the ratio of M to M* as the dependent variable is actually a free reserve function relating free reserves to total reserves, in which, furthermore, the parameters k, c, and h drop out. The latter point is actually a virtue since if one asserts that he is presenting a money supply function, the parameters c and h which reflect elements of demand for money should not appear. And Gibson implicitly acknowledges this when he proposes his own empirical money supply function:

$$M^S = \alpha_0 + \alpha_1 R + \alpha_2 r + \alpha_3 r_d \qquad (3)$$

where R is total reserves. The parameters c and h do not appear explicitly in this equation. Gibson's model is one we will estimate and use to obtain short-run predictions of the Pakistani money stock.

B. Money Demand Models

There has been a substantial amount of research on the demand for money, and the theoretical literature exhibits a greater diversity of approach than found in the empirical estimation. We do not intend to give a survey of the whole literature, since it is well documented elsewhere (Laidler [1977], Boorman and Havrilesky [1971], Goldfeld [1973], Barro and Fischer [1976], and Feige and Pearce [1977]). We will briefly discuss the points at issue in the theoretical and empirical work on the demand for money. At the risk of some oversimplification, we can pin down the issues involved as follows.

1. Choice of Dependent Variables

Economists over the last twenty years have investigated the question of proper dependent variables. Is it demand for nominal, real or real per capita money balances? The choice of the dependent variable will depend on the economic specifications concerning the role of prices, population and income. A demand for real money balances would imply absence of money illusion. Theories of portfolio choice may imply that the demand function is homogeneous in wealth. On the empirical level, Friedman [1959] assumed that demand for money function was homogeneous of degree one in population. Latane [1960] assumed a function which was homogeneous of degree one in prices and real income. Goldfeld [1973] tested these constraints with respect to prices and population and generally found evidence for the support of real money balances only.

2. Choice of Explanatory Variables

Most demand for money functions include an interest rate and a scale variable. The question of whether the short or long rate is appropriate, and whether wealth, permanent income or nominal income is relevant in the study of money demand stems from the historical development of the literature. The transaction theory of demand, most notably linked in the first half of the twentieth century with Fisher and Pigou was expressed in an equation of exchange, which emphasized the role of money as a medium of exchange held for transaction purposes. Baumol [1952] and Tobin [1956] further demonstrated that the transaction demand for money was also interest elastic. In their view, the transaction demand for money is a problem of inventory theory, and desired average cash balances vary proportionally with income and expenditure flows. There are costs in holding cash and these costs could be reduced to zero by not holding money at all. From this analysis the scale effects are emphasized.

In the inventory approach to money demand, the demand is interest elastic because costs are incurred in shifting from money into other assets and vice versa. In "portfolio analysis" usually associated with Keynes [1936], Hicks [1935, 1967] and Tobin [1965] money is demanded as an asset competing with other assets. According to this approach, the proportion of wealth held in different assets is determined by the expected relative yields and expected variability in the yield of these assets.

The "quantity approach" to demand for money as exemplified by Friedman [1956, 1959], in which money is demanded for its services as a durable good, attempts to treat the theory of money as a subject within capital theory. With Friedman, the demand for money is a problem to be studied in the framework of portfolio composition. He distinguishes between ultimate wealth-holders, for whom money is one of the forms in which wealth can be held, and business firms for which money is a means of production. In the portfolio analysis, the demand for money depends, among other things, on total nonhuman wealth. Patinkin [1969] asserts that Friedman's theory is simply a version of Keynesian liquidity preference. Meanwhile Friedman [1970] has admitted that his approach to money demand builds upon cash-balance approach and Keynesian portfolio analysis.

With this development of the literature on demand for money as outlined in the preceding paragraphs, the questions whether the short or long rate is appropriate, and whether nominal income, wealth or permanent income is the appropriate scale variable depends on which theory is correct. The level of income has played an important role in the empirical tests of transactions-based theories of the demand for money. Frequently use of a wealth variable has been preferred in portfolio analysis. Friedman treats the demand for money as similar to the demand for any durable goods and argues that the relevant variable is permanent income generated by his work on consumption function. Turning to the problem of measuring the opportunity cost variable, the availability of data and institutional framework limits the choice to one or two series.

A fair amount of effort has been expended on investigations of the relationship between the demand for money and the rate of interest. Despite the rather voluminous literature, there is considerable variety of opinions as to which interest rate is the relevant determinant of the demand for money. Some researchers have argued that long rate is a better indicator of the opportunity cost of holding money. Others have suggested the use of short rates. Most researchers simply use whatever set of interest rates is consistent with the rationale offered for the demand for money. The general consensus for the U.S. economy using M_1 shows that the elasticity of demand for money with respect to short rate appears to have varied between -.17 to -.20, and, with respect to the long rate around -.5. Another issue extensively examined in the literature is whether income, wealth or permanent income is the appropriate scale variable in the demand for money function. The evidence seems to be fairly strong in favor of a wealth variable.

There are other issues involved in the empirical estimation like the choice of data base, disaggregation of money demand by ownership category [Miller and Orr, 1966], disaggregation of total money demand in terms of currency and demand deposit [Goldfeld, 1973; MRC, 1970] and structural shift in the data. The question of functional form to be used is also important. Some investigators employ a linear form, while others use a log-linear demand function. If theory is not a guide to the appropriate choice of the functional form, data may determine the functional form. Quite often, log linear form is used. In general, much depends on the choice of the dependent variable. The results of our estimates of money demand equations will be reported in Chapter VI.

3. Simultaneous Equations Models

The single equation models discussed so far will yield unbiased estimates if the explanatory variables can be considered exogenous. If the money stock process, involving demand and supply elements, simultaneously determines the money stock and interest rates, then we have the identification problem and our income and interest rate elasticity estimates will be biased. The studies of Brunner and Meltzer [1964, 1968], Teigen [1964, 1976] and Gibson [1972, 1976] took particular account of this problem by simultaneously fitting supply and demand functions for money for the U.S. economy.

Brunner and Meltzer [1964] specified both "money supply" and money demand equations in their empirical work. Their linear and nonlinear "money supply" functions will be discussed in the next section. Their money demand function depends on both the short-term interest rate, r_s, and long-term bond yield, r_l, and on real wealth, net national product price deflator and ratio of current income to Friedman's permanent income. Further extending their work [1968] on the money supply to discuss the interaction of money supply, bank credit and interest rates, they outlined a theory of monetary process to explain differences in the cyclical behavior of money and bank credit for the U.S. economy using data for 1919-41 and 1952-58. They estimated money supply and demand equation where estimates of the demand equation were obtained using the interest rate, r^*_l, estimated from the bank credit market equation.

Teigen [1964] constructed a simultaneous equation model where money stock, short-term interest rate and income were jointly determined. The three equations were a demand function, a ratio of observed money stock, M, to the exogenous segment of the total money supply M* and an income equation. His money supply function has been discussed in section A. His money demand and income equations are of the form:

$$M^d = \alpha_{10} + \alpha_{11} r_s Y + \alpha_{12} M_{t-1} + \sum_{i=4}^{6} \alpha_{1i} S_i + e_1 \qquad (4)$$

$$Y = \alpha_{30} + \alpha_{31} E + \alpha_{32} NW + \alpha_{33} Y_{t-1} + \sum_{i=4}^{6} \alpha_{3i} S_i Y_{t-1} + e_3 \qquad (5)$$

where Y is GNP, r_s is short-term interest rate, E is total exogenous expenditure, NW refers to net worth and the S_i are seasonal dummies.

Gibson [1972] criticized Teigen's model and his money supply function as discussed earlier. He re-estimated the model with his money supply function equation (3) and a log linear money demand function equation:

$$\ell n M^d = \alpha_{10} + \alpha_{11} \ell n r_s + \alpha_{12} \ell n Y + \alpha_{13} \ell n M_{t-1} + \sum_{i=4}^{6} \alpha 1i S_i + e_1 \qquad (6)$$

For Pakistan data on all scale variables conceivably appropriate in a demand for money function are available only on annual basis, while the data needed to estimate money supply functions are available on a quarterly basis. It would have been possible to estimate simultaneous equation models using annual data but the resulting small numbers of degrees of freedom suggested that the costs of such an undertaking would exceed the benefits, and we chose not to engage in it.

C. Money Multiplier Models

The understanding of the money stock process has become quite important in recent years. One can focus on supply or demand elements as discussed in Sections A and B, respectively. One way to combine these elements in a single equation framework is through money multiplier models. In this framework, the money stock is the product of an aggregate of base money or high-powered money and a multiplier:

$$M = mB \tag{7}$$

where m is the money multiplier and B is the monetary base. The multiplier is a function of certain ratios which reflect the behavior of the public, the banking system and the monetary authority. The monetary base, at least in the U.S. context, may be viewed as an asset supplied by the Federal Reserve and the Treasury to the economic units that make up the economy.

The study of money stock process began with the early work of C. Phillips [1921], which gave the standard textbook analysis until fifteen years ago. The relationship between the amount of reserves held by the banks, R, and the amount of bank money supplied to the public, DD, was presented as

$$DD = \frac{1}{r}R \tag{8}$$

where r is the legal reserve ratio, and $\frac{1}{r}$ is called the bank money multiplier. This simple analysis ignored the influence of central bank policy, behavioral actions of the banks and the public as they influence the money stock process. The approach of Friedman-Schwartz [1963] hereafter, FS, and Cagan [1965][1] was a step towards filling this gap.

The FS approach is based on two simple definitions. The money stock, M, is equal to total currency holdings, C^P, and total demand deposits, D.

$$M = C^P + D \tag{9}$$

High powered money, H, defined as the total of all money that can be used as currency or reserves is given by:

$$H = C^P + R \tag{10}$$

where R is total reserves. Their basic result is obtained by equations (9) and (10) after simple algebraic manipulation:

$$M = H \cdot \frac{(D/R)(1 + D/C^P)}{(D/R + D/C^P)} \tag{11}$$

Equation (11) is a tautology, being derived from the definition of M and H. The determinants of H are not spelled out specifically in their work.

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[1]Cagan's tautology for money stock is slightly different from FS [1963] as presented in Appendix B in Friedman-Schwartz, A Monetary History of the United States, 1867-1960, p. 791.

This framework was pursued further and subsequent writers replaced H with B, which specified the relationship between money stock and monetary base by the money multiplier as given in equation (7). According to Frost [1977], the different concepts of base developed in the literature can generally be described by the following relationships.

$$\text{Source Base} = C^P + R = B \qquad (12)$$

$$\text{Monetary Base} = \text{Source Base} + L \qquad (13)$$

$$\text{Net Source Base} = B - A = B^a \qquad (14)$$

$$\text{Net Monetary Base} = B + L - A \qquad (15)$$

where C^P is currency in the hands of public, R is total reserves, L is liberated reserves due to changes in reserve requirements, and A is borrowing of member banks from the Federal Reserve System. The relative usefulness of these decompositions depends on the purpose of the user. Monetary Base is the common terminology of the St. Louis Federal Reserve and most widely used concept.[2]

The appropriate functional representation of the multiplier will vary with the concept of base being used. For the net source base, the appropriate multiplier in the U.S. context is

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[2]However, a study by Burger, Kalish and Babb [1971] at the St. Louis Federal Reserve used the Net Source Base rather than the Monetary Base.

$$m = (1 + k)/[(r - b)(1 + t + d) + k] \tag{16}$$

where k is the ratio of currency to demand deposits held by the public, r the ratio of total reserves to total deposits, b the ratio of borrowed reserves to total deposits, t the ratio of time deposits to demand deposits and d the ratio of treasury deposits to demand deposits. The expression (16) can be explicitly derived. We begin with the definitions of net source base B^a, total reserve R, and borrowing of member banks from the Federal Reserve, A.

$$B^a = R - A + C^P \tag{17}$$

$$R = r(D + T + D^t) \tag{18}$$

$$A = b(D + T + D^t) \tag{19}$$

where D^t is treasury deposits at commercial banks, T is time deposits, D is demand deposits, r is average required reserve ratio and b is borrowing ratio. Substituting (18) and (19) in (17) results as

$$B^a = (r - b)(D + T + D^t) + C^P \tag{20}$$

Divide (20) by demand deposits, D

$$\frac{B^a}{D} = (r - b)\left(\frac{D}{D} + \frac{T}{D} + \frac{D^t}{D}\right) + \frac{C^P}{D}$$

$$= (r - b)(1 + t + d) + k$$

$$D = \frac{1}{(r - b)(1 + t + d) + k} \cdot B^a \qquad (21)$$

where k is currency ratio, t is time deposit ratio and d is treasury deposit ratio. From the definition of money stock M_1, we have

$$M_1 = D + C^P$$

$$(1 + k) = (D + C^P)/D$$

$$\therefore \frac{1}{(1 + k)} \cdot M_1 = D$$

substituting this expression for D in (21) yields:

$$M_1 = \left[\frac{1 + k}{(r - b)(1 + t + d) + k}\right] B^a \qquad (22)$$

The expression in the brackets is the money multiplier given in equation (16).

Brunner [1961] developed a linear money supply hypothesis, in which money is explained by the monetary base, the currency ratio, k, time deposit ratio, t, and reserve ratio, r. He used three different base concepts: source base B, monetary base (B + L), and net source base ($B^a + L^3$), where L^3 is liberated reserves and B^a is monetary base minus excess reserves. Equations for estimating the money stock for different bases are:

$$M_1 = a_{10} + a_{11}B - a_{12}k - a_{13}t - a_{14}r + e_1 \qquad (23)$$

$$M_1 = a_{20} + a_{21}(B + L^3) - a_{22}k - a_{23}t + e_2 \tag{24}$$

$$M_1 = a_{30} + a_{31}(B^a + L^3) - a_{32}k - a_{33}t + e_3 \tag{25}$$

We will estimate this model with minor changes and results are presented in Chapter VI.

Brunner and Meltzer's [1964] nonlinear money supply hypothesis expressed in terms of multiplier and net source base yields the following expression.

$$M_1 = \left[\frac{1 + k}{(r + e - b)(1 + t) + k}\right] \cdot B^a \tag{26}$$

Logarithmic differentiation of this expression leads to the formula:

$$\frac{dM_1}{M_1} = \left[\frac{dB^a}{B^a} + \varepsilon^{1i} \cdot \frac{dr^d}{r^d} + \varepsilon^{2i} \cdot \frac{dr^t}{r^t} + \varepsilon^{3i} \cdot \frac{dk}{k}\right]$$

$$+ \varepsilon^{4i} \cdot \frac{de}{e} + \varepsilon^{5i} \cdot \frac{db}{b} + \varepsilon^{6i} \cdot \frac{dt}{t} \,. \tag{27}$$

This expression describes the relative change of money stock in terms of relative changes in the adjusted base B^a, requirement ratios r^d and r^t, the currency ratio k, time deposit ratio t, and the banks' excess reserve and borrowing ratios e and b. The coefficients ε^{ji}, are the elasticities of the appropriate multiplier m^i with respect to the parameter associated with ε^{ji}. A similar model will be developed for Pakistan's economy in Chapter IV.

Equations explaining the different ratios entering into the money multiplier expressions have not been estimated. These ratios depend on various interest rates and some measure of economic activity variable like nominal income or permanent income. Instead, most writers have used the linear combination of the logarithms of a monetary aggregate and the ratios each weighted by its appropriate elasticities. Hosek [1970] considered a model where these ratios were considered to be endogenous and determined by different interest rates and permanent income. The author did not use these endogenous values to forecast money multiplier or money stock.

Burger and Kalish [1970, 1972] rule out the possibility of using the various ratios to forecast money stock, since this would involve forecasting expectations and interest rates. Burger provided a framework in which money stock control can be analyzed through the multiplier-base relationship. Since the multiplier is not constant, the Federal Reserve should estimate the multiplier to determine the value of the net source base required to achieve a desired growth of money stock. Forecasts of the money stock using his model will be presented in Chapter V.

The multiplier approach to the money stock process assumes independence between the money multiplier and the base. However, there could be feedbacks from changes in base to the multiplier through interest rates,[3] and if these multipliers are highly sensitive to interest rate changes, then it may be difficult to implement monetary control through a reserve aggregate. Rasche [1972] has surveyed the empirical evidence on this matter and concludes that this interest elasticity appears to be extremely low.

[3]Open market operations affect both monetary base and interest rates; changes in interest rates, in turn, influence the portfolio decisions of the commercial banks and the public, thus changing the values of some of the ratios which comprise the multiplier.

CHAPTER IV

MONEY MULTIPLIER MODEL FOR PAKISTAN

In Chapter III we briefly surveyed the money stock models relating to the U.S. economy. The purpose of this chapter is to evaluate the existing studies on the money supply process in Pakistan, and to develop a money multiplier model. This is intended to further knoweldge of the process by which the supply of money is determined in a developing economy. Unlike developed economies, where contemporary theoretical and empirical work on money stock has grown substantially since Harry Johnson [1962, p. 357] wrote, "that the theory of money supply is virtually an unexplored area of monetary research," an extensive search by this writer has turned up very few studies of the money supply in Pakistan.

A. Snyder's Model

W. Snyder [1963, 1964, 1970] developed a model to explain quarterly changes in the money stock in Pakistan between 1953 and 1961. Given the T-accounts of the SBP and commercial banks, he had seven endogenous variables: borrowing by the commercial banks from the

SBP, B, currency held by the public N, currency held in vault cash by commercial banks VC, required reserves of the commercial banks with SBP, RR, excess reserves of commercial banks ER, bank credit to private sector L, and demand deposits held by the public DD.

The model included four behavioral functions to explain DD, VC, L, B and a statutory regulation determined the amount of required reserves RR. Excess reserves, ER, and currency in the hands of the public, N, are determined by the above five functions and by the two identities:

$$X + B \equiv N + VC + RR + ER \qquad \text{(S.1)}$$

$$DD + B \equiv VC + RR + ER + L + Y \qquad \text{(S.2)}$$

where X is other net assets of the SBP and Y is net assets of the commercial banks and are both exogenously given.

Substitution of DD, VC, L, B, RR and given Y is (S.2) will residually determine the excess reserves of the commercial banks as:

$$ER_t = DD_t + B_t - VC_t - RR_t - L_t - Y_t \qquad \text{(Snyder's 6a)}$$

The substitution of VC, RR, ER, B and given X in (S.1) residually determined the currency in circulation as:[1]

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[1]Equations (6a) and (7) refer to Snyder [1964].

$$N_t = X_t + B_t - VC_t - RR_t - ER_t \qquad \text{(Snyder's 7)}$$

With this specification of the model, money supply usually defined, M_1, is determined simultaneously and is not specified in a "reduced form" equation.

Several aspects of the model need comments. The inclusion of vault cash as an endogenous variable is surprising, since it could have been considered as an exogeneous variable given by some fraction of the total liabilities of the commercial banks or been determined as a residual. Writing a behavioral equation to explain the stock of vault cash demonstrates a curious misplaced emphasis. It would seem much more important in a money supply model to relate the stock of currency and of excess reserves to the behavior of the public and of the banks, respectively, than to worry about explaining the stock of vault cash. In Snyder's model, as we have seen, the former two stocks are determined residually. This procedure ignores the role in the money stock process of the public's relative preference for currency and demand deposits and of the banks' micro-behavior in optimizing their reserve holdings.

His equation for changes in volume of bank credit suggests that use of seasonal dummies, imports and exports can be used to explain adequately bank credit to the private sector. This may have been true in earlier years, but, as we have seen, the seasonal pattern in bank loans has become less pronounced. His hypothesis that borrowing of the commercial banks from the SBP depends on the current level of free reserves and the past level of borrowing did not anticipate the now standard approach of relating this borrowing to the difference between returns on banks' advances and their cost of borrowing funds. The relationship between borrowing and free reserves without reference to yield and cost does not provide any information to the understanding of banks' behavior. There could be good reasons to relate money supply to free reserves and interest rates, but borrowings of commercial banks may not necessarily depend on free reserves.

Snyder's model worked reasonably well to explain variations in the money supply during the sample period. But as he commented, "the hope is usually present that the estimated relationship should be useful to understand i.e. predict future changes, given a new set of exogenous conditions" (Snyder [1970, p. 54]). A reappraisal of the model in 1970 found that the predictive power of the model to forecast ahead of the sample period for 1962 through 1968 was very poor. The basic reason suggested by Snyder was that the model and data used to estimate the parameters were more typical of a stationary economy and the equations fitted to the original period were largely inappropriate during the rapid development in Pakistan since 1961.

His comparison of the original model's predictive performance in the second period 1962-68 with a simple "money multiplier" model where changes in money supply were expressed in terms of his variable X and seasonal dummies was also very low. Even his multiplier formulation ignored the role of time deposits, excess reserves and borrowing. In brief, the omission of income and interest rate variables leaves little room for public and commercial banks' behavior in the determination of the money supply process. His own reappraisal of the model suggests that it would be fruitless for us to reestimate it with three more years worth of quarterly data.

B. Bhuiyan's Equation

Bhuiyan [1971], in a large framework, undertook to explain aggregate money supply in behavioral terms. Manipulating the accounts on the balance sheets of the Treasury and SBP, he obtained the following expressions.

$$RR = GS + B + FR - GD - RR^{0} - ER - C^{P} - O_{T} - O_{B} \qquad (B.1)$$

$$RR = rDD \qquad (B.2)$$

$$MS = C^{P} + DD \qquad (B.3)$$

where RR is required reserves on private DD, FR is foreign reserves of the SBP, B is borrowing of commercial banks from SBP, GS is government securities held by SBP, GD is total government debt, r is required reserve ratio, RR^0 is required reserves on other deposits and ER is excess reserves.

Substitution of (B.1) into (B.2) for RR and then substitution of DD in (B.3) yields the following:

$$MS = \frac{GS+B+FR-GD-RR^0-ER}{r} - \frac{(1-r)C^P - (O_B+O_T) - VC}{r} \qquad (B.4)$$

He also added vault cash VC with a negative sign in (B.4). The author did not estimate equation (B.4) claiming that such a formulation assumes the supply of currency in circulation as exogenous. Rather, he estimated the following equation:

$$M^S = \underset{(5518.5)}{11628.9} + \underset{(2.53)}{13.49}\ GDF + \underset{(.44)}{1.17}B + \underset{(4.68)}{15.54}FR$$

$$\bar{R}^2 = .96 \qquad D.W. = 1.11 \qquad SE = 454.4$$

where GDF is government deficits, B and FR are as defined above.

Bhuiyan's conception of the money supply process assigns no explicit role to the behavior of the commercial banks and the nonbank public, nor to the interaction of such behavior with that of the monetary authority. These phenomena are explicitly recognized in money multiplier models, and it will be desirable for us to develop such a model based on the institutional features of the Pakistani money supply process.

C. Porter's Model

As mentioned in Chapter II all commercial banks in Pakistan are constrained to maintain liquid assets equal to at least 25% of their deposits. Liquidity is defined in Pakistan as SBP balances, cash in vault and those government securities which have not been used as collateral for borrowings, i.e. unencumbered securities. The sum of the first two items, State Bank balances and vault cash, is called total reserves.

In the early 1960's, this required liquidity was far below the ratio in fact maintained by most banks and hence made it less useful as a predictive device. However, in the late 1960's this constraint has become quite effective. In fact Porter [1965] has constructed a model of the Pakistani financial sector in which there are four possible constraints on expansion of bank deposit liabilities. One of these is the liquidity constraint and Porter shows that it or the loan demand constraint always sets the effective limit to deposit expansion. He starts with the general structure of assets and liabilities of the banking system as given in Table 4.1.[2]

TABLE 4.1.--Balance Sheet of Banking System.

SBP		Commercial Banks	
Assets	Liabilities	Assets	Liabilities
All assets other than commercial banks' borrowing (A) Commercial banks' borrowing (B)	Commercial banks' reserves (TR) Currency issued (C)	Total reserves (TR) Govt. securities (GS) Loans to private sector (LPS)	Deposits (D) Borrowing from SBP (B)

The system is constrained by two balance sheet identities (P.1) and (P.2).

$$A + B = TR + C \tag{P.1}$$

$$TR + GS + LPS = D + B \tag{P.2}$$

The public desires to hold a fraction k of the money supply, M, as currency.

$$C = kM \tag{P.3}$$

$$D = (1 - k)M \tag{P.4}$$

The commercial banks must hold reserves at least sufficient to satisfy the reserve requirement:

[2]Porter ignores capital accounts in both balance sheets.

$$TR \geq rD \tag{P.5}$$

where r is the average required reserve ratio. The banks must also meet the liquidity requirement:

$$TR + GS - B \geq \ell D \tag{P.6}$$

where ℓ is the required liquidity ratio and is assumed to be greater than r. The commercial banks cannot lend more than the creditworthy public wishes to borrow from them.

$$LPS \leq LPS_o \tag{P.7}$$

where LPS_o is the maximum loan demand. Finally, borrowings from the SBP must be less than the amount of government securities collateral held by the banks.

$$B \leq GS \tag{P.8}$$

The system of equations (P.1) to (P.4) and inequalities (P.5) to (P.8) is a fair representation of the essential features of Pakistan's banking system with many details omitted. Substitution of (P.1) through (P.4) into (P.5) to (P.8) with some algebraic manipulations will yield:

$$M \leq \frac{A + B}{k + r(1 - k)} \quad \text{(Reserve requirement constraint)} \tag{P.9}$$

$$M \leq \frac{A + GS}{k + \ell(1 - k)} \quad \text{(Liquidity constraint)} \tag{P.10}$$

$$M \leq A + GS_0 + LPS_0 \qquad \text{(Loan demand constraint)} \qquad (P.11)$$

$$B \leq GS \qquad \text{(Collateral availability constraint)} \qquad (P.12)$$

In view of (P.12), when banks have reached the limit of their borrowing from the State Bank, the right hand side of (P.9) is given by:

$$\frac{A + GS}{k + r(1 - k)}$$

and M would be equal to this value. But as long as the value of r is less than that of ℓ, the liquidity constraint (P.10) would be violated. Thus either the latter, or the loan demand constraint (P.11) is always the first constraint to be reached and therefore sets the effective limit to bank deposit expansion. If we are willing to assume that at a low enough rate of interest there are always willing creditworthy borrowers, then the liquidity constraint is always the binding constraint. For this reason a money multiplier model involving the required total of liquid assets rather than the monetary base is more appropriate for studying the money supply process in Pakistan.[3]

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[3]I am indebted to Mark Ladenson for giving me this idea and for working out many of the derivations, associated with this model, that are presented in the course of this and subsequent chapters.

D. Liquidity Model

The basic equation of the liquidity model is given as:

$$M = m_L L \tag{L.1}$$

where L is the stock of eligible liquid assets (cash, deposits at the SBP, and commercial bank holdings of unencumbered government securities), and m_L is the appropriate multiplier. We derive an expression for m_L as follows: Let

ℓ = Required liquidity ratio.

e' = Desired excess liquid assets to deposits ratio.

D = Total deposits of the commercial banks (sum of private demand and time deposits).

k = C^P/DD.

t = TD/DD.

$$\therefore \quad L = \ell(DD + TD) + e'(DD + TD) = (\ell + e')(DD + TD)$$

$$= (\ell + e')(DD + TD) \tag{L.2}$$

We define money supply as currency plus demand deposits,

$$M = C^P + DD. \tag{L.3}$$

Dividing (L.3) on both sides by (L.2):

$$m_L = \frac{M}{L} = \frac{C^P + DD}{\ell(DD + TD) + e'(DD + TD)} \tag{L.4}$$

Divide the numerator and denominator of the right hand side of (L.4) by private demand deposits:

$$m_L = \frac{M}{L} = \frac{C^P/DD + DD/DD}{\ell(DD/DD + TD/DD) + e'(DD/DD + TD/DD)}$$

$$= \frac{(k + 1)}{\ell(1 + t) + e'(1 + t)} \tag{L.5}$$

$$M = [\frac{(1 + k)}{(\ell + e')(1 + t)}] \cdot L \tag{L.6}$$

where L is liquidity and the expression in brackets is the associated multiplier. Equation (L.6) can be linearly approximated as:

$$M = \alpha_0 + \alpha_1 L + \alpha_2 k + \alpha_3 e' + \alpha_4 t + \alpha_5 \ell + \varepsilon \tag{L.7}$$

We were not able to estimate equation (L.7). The SBP did not begin publishing a data series on L until the third quarter of 1967. We attempted to construct our own series on L by summing the published values of its components but there were discrepancies between our constructed series and the published series over the period in which we could compare them. We therefore decided to work with the model

$$M = m'_L L' \tag{L.1'}$$

where L' is our constructed series.[4] Let L' = L + L"

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[4]The series for L' was constructed from published data, which includes commercial banks' holdings of cash in tills (col. 13), balances held with the SBP (col. 14), holdings of central government securities (col. 18), holdings of provincial government securities (col. 19) of Table 20, Report of Currency and Finance, SBP, 1971, pp. 146-147.

where L" represents the discrepancy between L' and the unobserved variable L, and

$$L'' = e''(DD + TD).$$

Using the same procedure as before we derive:

$$m_{L'} = \frac{M}{L'} = \frac{C + DD}{L + L''}$$

$$= \frac{C + DD}{(\ell + e')(DD + TD) + e''(DD + TD)} \tag{L.4'}$$

$$M = \frac{1 + k}{(\ell + e' + e'')(1 + t)} \cdot L'. \tag{L.6'}$$

We linearize this equation:

$$M = \alpha_0 + \alpha_1 L' + \alpha_2 k + \alpha_3 (e' + e'') + \alpha_4 t + \alpha_5 \ell + \varepsilon. \tag{L.7'}$$

We calculated the values of (e' + e")[5] and the ratios k, t, and ℓ on a quarterly basis and used them to estimate the parameters of equation (L.7').

Our linear approximation in the form of equation (L.7') is not without problems. The coefficients, α_1, in equation (L.7') are <u>partial</u> derivatives. For example, the coefficient, α_2, tells us the effect on the money stock of a given change in k, all other variables, in particular L', held constant. But L' will be

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[5] $$(e' + e'') = \frac{L' - \ell(DD + TD)}{(DD + TD)}$$

constant when k rises only if the SBP obligingly puts more currency into circulation as if it were manna from heaven. A more reasonable assumption is that when k rises, the banks must oblige the public by reducing L'. But then equation (L.7') is not even a reasonable linear approximation to the money multiplier process (L.6').

As an alternative to equation (L.6'), therefore, we obtain equation (L.8) by logarithmic differentiation of equation (L.6'):

$$\frac{dM}{M} = \sum_j E_j^{m_{L'}} \cdot \frac{dj}{j} + \frac{dL'}{L'} \qquad j = k,\ \ell,\ (e'+e''),\ t \tag{L.8}$$

where the $E_j^{m_{L'}}$ are elasticities of the multiplier with respect to the four parameters,

$$E_j^{m_{L'}} \equiv \frac{\partial m_{L'}}{\partial j} \cdot \frac{j}{m_{L'}},$$

and

$$E_k^{m_{L'}} = \frac{k}{1 + k} \tag{L.9}$$

$$E_\ell^{m_{L'}} = -\frac{\ell}{(\ell + e' + e'')} \tag{L.10}$$

$$E_{(e'+e'')}^{m_{L'}} = -\frac{(e' + e'')}{(\ell + e' + e'')} \tag{L.11}$$

$$E_t^{m_{L'}} = -\frac{t}{(1 + t)} \tag{L.12}$$

The percentage change in the money stock equals the sum of percentage changes in the parameters of the multiplier j, each percentage change multiplied by the elasticity of the multiplier with respect to that parameter, plus the percentage change in the stock of liquid assets, dL'/L'. Since our basic reason for proposing equation (L.8) as an alternative to equation (L.7') is that L' (and hence changes in it) cannot be assumed independent of the parameters, j, we must express dL'/L' as a function of these parameters. We begin by noting that from previous definitions

$$L' = (\ell + e' + e'')(DD + TD)$$

$$DD = \frac{1}{k}C$$

$$TD = tDD.$$

Substituting the latter two relations into the first and collecting terms gives

$$L' = (\ell + e' + 3'')(\frac{1 + t}{k})\ C$$

For ease of exposition define

$$\ell' = (\ell + e' + e'')(1 + t) \qquad (L.13)$$

so that

$$L' = \frac{\ell'}{k}C \qquad (L.14)$$

Taking the total differential of (L.14) we get:

$$dL' = \frac{\ell'}{k}dC + Cd\frac{\ell'}{k} .$$

As discussed above we assume that when (for example) k rises, the banks provide the additional currency by reducing their liquid assets. For the sake of concreteness we now more specifically assume that for each additional rupee in the hands of the public, the banks' holdings of liquid assets decline by a rupee:

$$dC = -dL'.$$

Thus

$$dL' = Cd\frac{\ell'}{k} - \frac{\ell'}{k}dL'.$$

$$= C[\frac{1}{k + \ell'}d\ell' - \frac{\ell'}{k(k + \ell')}dk]. \qquad (L.15)$$

Making use of (L.14) and dividing by L' we get

$$\frac{dL'}{L'} = [\frac{1}{k + \ell'}d\ell' - \frac{\ell'}{k(k + \ell')}dk]\frac{k}{\ell'}$$

and substituting (L.13) for $d\ell'$ gives

$$\frac{dL'}{L'} = [\frac{1}{k + \ell'} d((\ell + e' + e'')(1 + t)) - \frac{\ell'}{k(k + \ell')}dk]\frac{k}{\ell'} \qquad (L.16)$$

Manipulating equation (L.16) appropriately[6] we obtain

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[6] See Appendix to this chapter, pp. 63-64.

$$\frac{dL'}{L'} = \sum_j E_j^{L'} \frac{dj}{j} \qquad j = k, \ell, (e'+e''), t. \qquad \text{(L.17)}$$

where the $E_j^{L'}$ are elasticities of L' with respect to the four parameters,

$$E_j^{L'} = \frac{\partial L'}{\partial j} \cdot \frac{j}{L'}$$

and[7]

$$E_k^{L'} = -\frac{k}{k + \ell'} \qquad \text{(L.18)}$$

$$E_\ell^{L'} = \frac{\ell k}{(k + \ell')(\ell + e' + e'')} \qquad \text{(L.19)}$$

$$E_{(e'+e'')}^{L'} = \frac{(e' + e'')k}{(k + \ell')(\ell + e' + e'')} \qquad \text{(L.20)}$$

$$E_t^{L'} = \frac{tk}{(k + \ell')(1 + t)} \qquad \text{(L.21)}$$

Substituting equation (L.17) into equation (L.8) we find

$$\frac{dM}{M} = \sum_j \varepsilon^j \frac{dj}{j} \qquad j = k, \ell, (e'+e''), t \qquad \text{(L.22)}$$

where $\varepsilon^j = E_j^{mL'} + E_j^{L'}$. The percentage change in the money stock is now given by the sum of percentage changes in the multiplier parameters each weighted by the appropriate elasticity. In each case the appropriate elasticity is the sum of the multiplier elasticity and the

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[7]See Appendix to this chapter for the expressions for the elasticities.

liquidity elasticity. Forecasts of the money stock based on equations (L.7') and (L.22) will be discussed in Chapter VI.

Appendix to Chapter IV

In this appendix we show how the elasticities (L.18)-(L.21) were derived, and use them to show that the right hand sides of equations (L.16) and (L.17) are equivalent. We begin by substituting equation (L.13) into equation (L.15)

$$dL' = C[\frac{1}{k + \ell'} d[\ell + e' + e")(1 + t)] - \frac{\ell'}{k(k + \ell')} dk]$$

$$= C[\frac{1}{k+\ell'} [(\ell+e'+e")d(1+t) + (1+t)d(\ell+e'+e")] - \frac{\ell'}{k(k+\ell')} dk]$$

Making use of the definition (L.14) we obtain the elasticities

$$\frac{dL'}{dk} \cdot \frac{k}{L'} = \frac{k}{k + \ell'} \tag{L.18}$$

$$\frac{dL'}{d\ell} \cdot \frac{\ell}{L'} = \frac{\ell k}{(\ell + e' + e")(k + \ell')} \tag{L.19}$$

$$\frac{dL'}{d(e'+e")} \cdot \frac{(e'+e")}{L'} = \frac{(e'+e")k}{(\ell+e'+e")(k+\ell')} \tag{L.20}$$

$$\frac{dL'}{dt} \cdot \frac{t}{L} = \frac{tk}{(1 + t)(k + \ell')} \tag{L.21}$$

Now carrying out the indicated differentiation in equation (L.16) we get

$$\frac{dL'}{L'} = [\frac{1}{k+\ell'}[\ell+e'+e")d(1+t)+(1+t)d(\ell+e'+e")] - \frac{\ell'}{k(k+\ell')} dk]\frac{k}{\ell'}$$

$$= [\frac{k}{\ell'(k+\ell')} [\ell+e'+e")d(1+t)+(1+t)d(\ell+e'+e")] - \frac{\ell'k}{\ell'k(k+\ell')}dk] \tag{A1}$$

Substituting the elasticities (L.18)-(L.21) into equation (L.17) we get

$$\frac{dL'}{L'} = \frac{\ell k}{(\ell+e'+e'')(k+\ell')} \cdot \frac{d\ell}{\ell} + \frac{(e'+e'')k}{(\ell+e'+e'')(k+\ell')} \cdot \frac{d(e'+e'')}{(e'+e''}$$

$$+ \frac{tk}{(1+t(k+\ell')} \cdot \frac{dt}{t} - \frac{k}{k+\ell'} \cdot \frac{dk}{k} \;.$$

Canceling ℓ, (e'+e"), and t, where appropriate, multiplying numerator and denominator of the first two terms by (1+t), multiplying numerator and denominator of the third term by (ℓ+e'+e"), and multiplying numerator and denominator of the last term by ℓ' we get:

$$\frac{dL'}{L'} = \frac{(1+t)k}{\ell'\ (k+\ell')}d\ell + \frac{(1+t)k}{\ell'\ (k+\ell')}\, d(e'+e'') + \frac{(\ell+e'+e'')k}{\ell'(k+\ell')}dt$$

$$- \frac{\ell' k}{\ell'\ (k+\ell')} \quad \frac{dk}{k} \;. \tag{A2}$$

Comparing the right hand side of (A2) with the right hand side of (A1) and noting that dt = d(1+t), we see that the right hand sides of (L.16) and (L.17) are equal.

CHAPTER V

NAIVE MONEY STOCK MODELS

A. Introduction

In this chapter, we present some naive models of the money stock. Although these models lack economic content, they may be capable of generating reasonably accurate forecasts. Various mechanistic models capable of forecasting money stock will be described,[1] and then their predictive performance will be examined. Comparing the forecasts of an econometric model to a naive method of forecasting supplies us a technique for assessing the economic information contained in an econometric model. The naive method of forecasting of money stock depends exclusively on statistical properties of economic time series, such as trend, past levels or changes.

Two popular naive forecasting methods are the "no change" and "same change" models. In the no-change method, the naive forecast is that future values of each economic time series will equal their own present values. In the same-change model, the naive forecast is that the

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[1]Discussion of these models is based on Pfaff [1973, Chapter IV].

value of each variable will continue to change in the same direction by the same amount. It can be shown that the no-change and same-change models are special cases of the autoregressive model. The autoregressive model is

$$M_{t+1} = \alpha_0 M_t + \alpha_1 M_{t-1} + \alpha_2 M_{t-2} + \dots + \alpha_n M_{t-n}$$

The no-change model sets $\alpha_0 = 1$ and all other α's = 0. The same change model asserts

$$M_{t+1} - M_t = M_t - M_{t-1} \qquad \text{or}$$

$$M_{t+1} = 2M_t - M_{t-1}$$

so it is a special case of the autoregressive model with $\alpha_0 = 2$, $\alpha_1 = -1$, and all other α's = 0. Both these methods will be used to forecast the money multiplier. We will also estimate and use for forecasting the parameters of the general autoregressive model. We will use it to predict the values of the money stock and the money multiplier.

The results of the models with the best predictive performance will be compared to other single equation money stock models. In this chapter, section B describes the content and format of the models and estimation procedure used, section C presents the empirical results, while section D gives the predictive performance of these models.

B. Models

At the outset we mention that all our empirical work throughout this dissertation is based on data on the money stock reported by the State Bank of Pakistan and that these are reported only on a not-seasonally adjusted basis. Thus the problem faced by the students of the U.S. money stock of whether to use the seasonally adjusted or nonseasonally adjusted series is one we did not have to deal with. In this chapter, five different models will be examined. The first is an autoregressive money stock model using quarterly data with a seasonal dummy. The next three models are money multiplier models: a no-change naive model, a constant percentage change model, and an autoregressive money multiplier. Two different concepts of base will be used with all multiplier models: the net source base and source base. The subscript j represents a forecast for quarter j beyond time period t. Future values of money stock quantities are predicted values, but the values of base are actual values.

The last model is a semi-mechanistic model of money stock based on Burger [1972]. He has provided a framework in which money stock control can be achieved through the multiplier-base relationship. The essence of the approach is designed within the framework of the Brunner-Meltzer nonlinear money supply hypothesis. The net source base is taken as the control variable. The money multiplier m becomes the link between net source base and money stock. Since the multiplier is not constant, the Fed must estimate the multiplier to determine the value of the base required to achieve a desired growth of money stock. The method to forecast the money multiplier requires a minimum of information. The multiplier is forecast using a monthly model of the form:

$$m_t = \alpha_0 + \alpha_1 \frac{1}{3} (\sum_{i=1}^{3} m_{t-1}) + \alpha_2 [TB_{t-1} - TB_{t-2}]/TB_{t-2}$$

$$+ \sum_{i=1}^{11} \beta_i D_i + \rho U_{t-1}$$

where m_{t-1} is the three-month moving average of past values of the multiplier, TB is the Treasury bill rate and D_i are seasonal dummy variables.

The coefficients of the regression used to forecast each month's multiplier were estimated by OLS using the previous 36 months observations. Each forecast depended only on the preceding three years data. The multiplier was then used to forecast the money stock as shown in autoregressive money multiplier model N4B[a] [p. 81]. The use of the Treasury bill rate may exclude this model from the class of mechanistic models, yet the spirit of multiplier forecast is analogous to our N4 [p. 81] model which may justify its appropriateness here.

1. Autoregressive Money Stock Model[2]

$$M_{t+j} = \sum_{i=1}^{P} \alpha_1 M_{t-i+j} + S_5 + e_{t+j} \qquad (5.1)$$

where $S_5 = 1$ for the first rhree quarters and takes on a value of zero for the fourth.[3] The autoregressive process is of order P.

2. Money Multiplier No-Change Model

$$M_{t+j} = m_t (B_{t+j}) \qquad (5.2)$$

where $m_t = M_t/B_t$.

3. Money Multiplier Same Percent Change Model

$$M_{t+j} = (1 + \alpha_t)^j \; m_t (B_{t+j}) \qquad (5.3)$$

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[2]The autoregressive equation does have a constant term.

[3]This type of dummy was used to take account of the seasonal effect on money stock, where the banking system tries to accommodate the monetary needs of the economy arising from the flow of agricultural crops in the market during the fourth quarter.

where $\alpha_t = (m_t - m_{t-1})/m_{t-1}$. Substituting the value of α_t in (5.3), we can write

$$M_{t+j} = (m_t/m_{t-1})^j \; m_t(B_{t+j}) \tag{5.3'}$$

4. Autoregressive Money Multiplier Model

$$m_{t+j} = \sum_{i=1}^{P} \hat{\alpha}_i m_{t-i+j} + e_{t+j} \tag{5.4}$$

5. Burger Multiplier Model

$$m_t = \alpha_0 + \alpha_1 \frac{1}{3}\left(\sum_{i=1}^{3} m_{t-1}\right) + \alpha_2[TB_{t-1} - TB_{t-2}]/TB_{t-2}$$

$$+ \sum_{i=1}^{11} \beta_i D_i + \rho U_{t-1} \tag{5.5}$$

Estimation Procedure

For comparison purposes the following notation will be used. Each model is identified by the letter N to indicate that it is a mechanistic model, followed by a number corresponding to the listing above the models. The letters B^a and B stand for net source base and source base, respectively. For example, $N2B^a$ indicates that we are discussing the money multiplier model with no-change and using net source base.

Throughout this project, our total sample period consists of 44 observations, 1961:1-1971:4. For forecasting purposes, the period used was 1968 to 1971.

The problem of evaluating forecast can be handled in a variety of ways. But we have followed Goldfeld's [1973] procedure to ascertain the quality of short-term ex-post forecasts and to test for short-term instability in the relationships. This involves estimating the models over different sample periods, each starting in 1961:1 but differing in their terminal points, which run from 1967:4 to 1970:4 in steps of four quarters. Forecasts were then made based on the estimates obtained for each sample period by dynamically simulating each estimated equation for the next four quarters.[4] For example, forecasts of the money stock for the four quarters of 1968 are based on data for the period 1961-1967 while forecasts for 1971 are based on data for the period 1961-1970. The question of short-run structural stability is dealt with in Goldfeld's technique by asking how good the immediate four quarter forecasts are. An additional informal method which is not a very rigorous test is a casual inspection of the individual coefficient estimates to see if they shift around somewhat over different sample periods.

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[4]Even for the lagged values of money stock used in the equation, the actual period of estimation begins in 1961:1, since lagged values of money stock were taken from 1959:3 to 1960:4.

C. Results

1. Autoregressive Money Stock Model: N1

The parameters of the autoregressive model based on equation (5.1) were initially estimated for the sample period 1961-1967 and then the sample was increased by four quarters in each subsequent estimation. The results obtained with ordinary least squares (OLS), using the Cochrane-Orcutt technique to adjust for serial correlation, are given in Table 5.1. N stands for the number of observations, C is the constant term of the regression equation and S_5 is the seasonal dummy.

In the selection of these regressions, we estimated a series of autoregressive equations with lags of 2, 4 and 6 variables. The regressions with the lowest standard error are given in Table 5.1, although the equations involving two or four lagged variables did not have significantly different standard errors than those presented here. The equations were also estimated by OLS, without taking account of serial correlation and the results coefficients were generally the same except for the D-W statistics.

The results of Table 5.1 suggest that changes in money stock are well explained by a one quarter lag. As we go back, we do not gain much information. Nevertheless in the two largest samples the coefficient of the

TABLE 5.1.--Quarterly Autoregressive Model of Money Stock: N1.

N	M_{t-1}	M_{t-2}	M_{t-3}	M_{t-4}	M_{t-5}	M_{t-6}	C	S_5	R^2	D.W.	SER	ρ
28	1.40	.03	-.74	.10	.11	.09	814.7	-962.4	.98	1.99	.031	-.44
	(8.76)*	(.11)	(-2.58)*	(.33)	(.23)	(.36)	(3.0)*	(-3.7)*				
32	1.42	-.23	-.52	.45	-.39	.28	608.3	-725.2	.98	2.06	.029	-.36
	(9.61)	(-.97)	(-2.45)*	(2.02)*	(-1.08)	(1.39)	(2.7)*	(-3.32)*				
36	1.39	-.24	-.43	.52	-.56	.34	500.0	-662.4	.99	1.98	.027	-.31
	(10.50)*	(-1.25)	(-2.35)*	(1.78)	(1.89)	(2.45)*	(-3.17)*					
40	1.35	-.30	-.29	.63	.85	.49	315.2	-514.4	.99	1.91	.027	-.25
	(10.02)*	(-1.67)	(3.54)*	(-2.92)*	(2.79)*	(1.55)	(-2.50)*					

Note: The t values are expressed in parentheses. An asterisk indicates statistical significance at 95% confidence interval.

money stock lagged six quarters is significant. Turning to the question of the predictive ability of these equations, there are a number of prediction evaluation statistics available.[5] Commonly used statistics include the root mean square error (RMSE), mean absolute error (MAE) and percentage error in forecasting (ERPC). Table 5.2 presents the four quarter forecast for each year starting from 1968 and the relevant statistics. $\hat{M}$ is the forecast of money stock in million rupees. Out of 16 observations, the model underestimates for seven quarters; and with the exception of 1971 it underestimates for each fourth quarter. This is quite consistent with the fact that fourth quarter has a seasonal element in the economy, and the SBP and commercial banking system try to accommodate any such needs through monetary expansion and liberal borrowing of the commercial banks. Over the whole forecasted period, the ERPC is within reasonable limits and less than 3%. As explained in Chapter II, 1971 was not a normal year in any sense due to Civil War and separation of the country. To expect any reasonable forecast for this year from any sophisticated or mechanistic model would be very demanding.

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[5]For a summary, see Pfaff [1973, Chapter 2].

TABLE 5.2.--Annual Predictive Performance of N1 Model.

YEAR-Q	$\hat{M}$	M	ERPC	RMSE	MAE
1968:1	9743.9	9998.3	-2.54		
2	10184.3	10402.0	-2.09		
3	10134.3	11069.8	0.64		
4	11131.7	11286.1	-1.36	187.1	172.7
1969:1	11400.6	11287.7	1.00		
2	11811.0	11615.5	1.68		
3	11447.8	11284.4	1.44		
4	12302.5	12611.3	-2.83	227.1	207.6
1970:1	12706.0	12398.9	2.48		
2	13168.0	12753.4	3.25		
3	12841.1	12584.2	2.04		
4	13939.3	14413.6	-3.29	373.3	363.3
1971:1	14409.7	14060.8	2.48		
2	15023.4	15741.0	-4.55		
3	14774.2	16061.5	-8.01		
4	16250.2	15611.3	4.09	821.9	748.2

2. Money Multiplier
No-Change Model: N2

A naive way of forecasting money stock is through the multiplier, whose behavior is considered to be stable. One way to look at the problem is to hold the value of the multiplier unchanged for a four quarter forecast, and then by multiplying that value by the actual values of the monetary base to forecast the money stock. This was done making use of equation (5.2) and two concepts of the base. The values of the money stock forecasted by using the source base are reported in Table 5.3 along with the appropriate prediction statistics. The signs of the prediction errors are very highly positively correlated, much more than in the N1 model. The error percentage in forecasting on the whole is also greater, as are the RMSE statistics. The comparatively poor performance can be attributed to certain inherent characteristics and assumptions of this model.

The forecasting of money stock with a no-change money multiplier model was also examined using the net source base. The results are displayed in Table 5.4. If RMSE and percentage error in forecasting are our primary evaluation criterion, then this model even does worse than N2B and N1 models. The simulation performance of this simple money multiplier model is poor. We recall that the simulation does not involve any

TABLE 5.3.--Annual Predictive Performance of No-Change Multiplier Model: N2B.

YEAR-Q	$\hat{M}$	ERPC	RMSE	MAE
1968:1	9829.4	-1.68		
2	9704.7	-6.68		
3	9785.5	-2.82		
4	10686.9	-5.30	475.43	437.42
1969:1	11795.9	4.50		
2	11802.9	1.61		
3	11592.8	2.73		
4	12330.8	2.61	352.79	168.42
1970:1	13072.8	3.82		
2	12813.4	0.47		
3	12713.3	1.02		
4	14496.6	0.05	250.86	186.5
1971:1	14728.9	4.75		
2	16240.2	3.17		
3	14502.3	-9.70		
4	14660.5	-6.09	1003.81	950.6

TABLE 5.4.--Annual Predictive Performance of N2B[a] Model.

YEAR-Q	$\hat{M}$	ERPC	RMSE	MAE
1968:1	9725.9	-2.72		
2	9926.0	-4.57		
3	10079.6	0.09		
4	10539.6	-6.61	463.17	371.77
1969:1	11544.6	2.27		
2	13085.3	12.65		
3	13274.2	17.62		
4	13185.8	4.14	1270.9	1060.4
1970:1	14338.2	15.64		
2	13987.8	9.67		
3	13668.7	8.77		
4	14626.3	1.47	1279.6	1122.2
1971:1	14058.2	-0.01		
2	15065.4	-4.29		
3	14696.9	-8.50		
4	16329.7	4.60	811.5	690.3

regression estimation. For the 1968 forecast, we are just multiplying the 1967:4 multiplier by the actual values of the base of 1968. The simulated series of $\hat{M}$ in Tables 5.3 and 5.4 do seem to reproduce the general long-run behavior of the actual money stock series, but seasonal fluctuations in the actual series usually occurring in the fourth quarter of each year are generally not reproduced.

3. Money Multiplier Same-Percentage Change Model: N3

To evaluate forecasts of the money stock with a same-change model, the naive forecast of the multiplier is based on the assumption that the multiplier will continue to change in the same direction by the same proportional amount. Equation (5.3') was used to forecast the money stock and results are reported in Table 5.5 for the source base. The prediction of money stock in 1969, 1970, and 1971 using the net source base had root mean square errors (reported in Table 5.7) so much higher than those obtained when the source base was used that we have not included a table like 5.5 to report these predictions.

TABLE 5.5.--Annual Predictive Performance of N3B Model.

YEAR-Q	$\hat{M}$	ERPC	RMSE	MAE
1968:1	9695.8	-3.02		
2	10048.4	-3.39		
3	11431.9	-13.52		
4	9093.7	-19.42	1311.3	1052.6
1969:1	12098.9	7.18		
2	10810.4	-6.93		
3	12615.3	11.76		
4	11745.4	7.23	988.4	965.0
1970:1	13870.0	11.86		
2	11522.1	-8.32		
3	13636.3	-6.18		
4	14207.4	-1.43	992.3	879.2
1971:1	14797.3	5.24		
2	14790.9	-6.03		
3	14124.4	-5.83		
4	17993.2	15.26	1413.9	1251.4

4. Quarterly Autoregressive Model of Money Multiplier: N4

The model is estimated like the N1 autoregressive model of the money stock. The forecasts for money multipliers were made and then multiplied by actual values of the base prevailing in the period for which the money stock is forecast. The estimation of money multiplier is based on equation (5.4). Two to six quarter lagged variables were used in the regression equations for money multipliers associated with both concepts of base. The results for money multiplier forecasts using source base were not encouraging and hence not pursued further.

Regression equations involving different numbers of lagged variables were estimated. Among all these equations, the first quarter lag variable had a significant coefficient. The standard errors of regression equations as the lagged terms increased did not change. On this basis it was decided to forecast the multiplier using up to three quarter lags. This choice was made arbitrarily, but without loss of any information. The results for the multiplier forecast, forecast of money stock and evaluation statistics (RMSE, MAE and ERPC) are given in Table 5.6. A typical equation estimated with 28 observations for money multiplier is given on page 83.

TABLE 5.6.--Annual Predictive Performance of N4B[a] Model.

YEAR-Q	$\hat{m}$	$\hat{M}$	ERPC	RMSE	MAE
1968:1	2.32	9887.8	1.10		
2	2.36	10265.3	1.30		
3	2.41	10644.9	5.70		
4	2.33	10761.3	4.60	399.0	336.72
1969:1	2.44	11527.5	2.12		
2	2.43	13012.4	12.02		
3	2.24	12168.1	7.80		
4	2.12	11439.5	9.64	1034.75	935.57
1970:1	2.49	14215.6	14.60		
2	1.84	10968.9	14.00		
3	2.30	13418.0	6.62		
4	2.14	13339.7	7.45	1444.17	1377.10
1971:1	2.28	13861.9	1.41		
2	2.32	15115.7	3.97		
3	2.40	15254.4	5.02		
4	2.50	17655.5	6.68	1192.81	668.85

$$m_t = \underset{(1.66)}{.29} + \underset{(4.23)}{.86m_{t-1}} + \underset{(.72)}{.18m_{t-2}} - \underset{(-.18)}{.036m_{t-3}}$$

$R^2 = .81$ DW = 1.98 SER = .055

5. Burger Multiplier Model: N5B

Since monthly data on the appropriate variables do not exist for Pakistan, we replaced Burger's three month moving average of the multiplier with a three-quarter moving average. As the interest rate, we used the interbank call money rate, r_c. For the entire forecast period, sixteen different regression equations were used to obtain each quarterly forecast of the money multiplier, $\hat{m}$, associated with the source base. The forecast of the money stock is obtained like the N4 model. The results for the multiplier forecast, forecast of money stock and relevant statistics are given in Table 5.7.

The model's predictive performance is reasonable among the money multiplier models. The fourth quarter forecasts are generally poor, in spite of the use of seasonal dummies in regression equations. The relative performance of this model is discussed in the next section.

TABLE 5.7.--Annual Predictive Performance of N5B Model.

YEAR-Q	$\hat{m}$	(1) $\hat{M}$	(2) ERPC	(3) RMSE
1968:1	1.595	9770.0	2.33	
2	1.645	9950.9	-4.33	
3	1.648	10050.7	- .02	
4	1.670	11121.9	-1.45	157.95
1969:1	1.681	111701.3	3.66	
2	1.728	12035.5	3.61	
3	1.667	11422.2	1.22	
4	1.666	12077.0	-4.61	420.66
1970:1	1.625	12208.0	-1.53	
2	1.685	12407.6	-2.71	
3	1.701	12429.8	-1.22	
4	1.599	13325.2	5.89	426.87
1971:1	1.695	14431.7	2.63	
2	1.737	16307.8	3.60	
3	1.682	13133.9	-18.2	
4	1.77	15007.9	-3.86	1532.44

D. Evaluating Predictive Performance

There are different ways to evaluate the predictive performance of a model. One criterion of a good forecasting model is its structural stability. Cooper [1972] devised a statistical test for structural change. This test uses the sum of squared residuals over the forecast period divided by mean square error over the fitted period. This statistic has a chi square, χ^2, distribution. If large values of the statistic are obtained, we reject the hypothesis that no structural shift has occurred. Any such test is not feasible for our no-change money multiplier and same percent change models, since no estimation of regression equations was involved in these models.

Goldfeld's procedure to evaluate the predictive performance was to calculate the RMSE of each sample's prediction for the four quarters as given in each table of section C. However, this procedure is not useful for our purposes of comparing different models. A more reasonable procedure for our purposes would be to calculate the RMSE of each model's first quarter forecasts, second quarter forecasts, third quarter forecasts, and fourth quarter forecasts over the entire forecast period 1968-71, and then ask the question which model is superior in making predictions one quarter ahead, two quarters ahead and so on. We have assembled each quarter's predictive performance of mechanistic money stock models in terms of RMSE in Table 5.8.

TABLE 5.8.--Predictive Performance of Naive Money Stock Models (RMSE of predictions for each quarter over the entire forecast period).

Model	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
N1	271.0	439.4	662.2	432.2
N2B	482.7	432.8	809.9	585.9
N2B[a]	987.5	1044.9	2439.3	590.3
N3B	929.5	837.2	1129.3	1677.9
N4B[a]	923.3	1178.5	783.9	1001.5
N5B	315.0	425.9	1467.5	566.0
N5B[a]	1786.7	2893.1	1480.8	960.1

If the RMSE performance of each quarter of these various models is examined, it is found that the autoregressive model, N1, had the lowest RMSE for forecasts all quarters ahead but two where the Burger model has the lowest error. The Burger model (N5B) and no-change money multiplier model using source base (N2B) have the next lowest RMSE. All other models have very large prediction errors and their predictive performance is generally very poor. The superior performance of the autoregressive money stock model is not surprising since it involves the lagged values as explanatory variables. Among the naive money multiplier models, the comparative performance of the Burger model with the exception of forecasts three quarters ahead is superior to the others. Table 5.9 exhibits the summary of error percentage of (ERPC) quarterly forecast of these models.

TABLE 5.9.--Percent Error in Forecasts of Different Naive Models.

YEAR:Q	N1	N2B	N2B[a]	N3B	N4B[a]	N5B	N5B[a]
1968:1	-2.54	-1.68	-2.72	-3.02	1.10	2.33	7.05
2	-2.09	-6.67	-4.57	-3.39	1.30	-4.33	4.32
3	0.64	-2.82	0.09	-13.52	5.7	-0.02	1.60
4	-1.36	-5.30	-6.61	-19.42	4.6	-1.45	0.18
1969:1	1.00	4.50	2.27	7.18	2.12	3.66	12.90
2	1.68	1.61	12.65	-6.93	12.02	3.61	29.50
3	1.44	2.73	17.62	11.76	7.80	1.22	10.50
4	-2.83	2.61	4.14	7.23	9.64	-4.61	6.90
1970:1	2.48	3.82	15.64	11.86	14.60	1.53	0.90
2	3.25	0.47	9.67	-8.32	14.00	-2.71	12.80
3	2.04	1.02	8.77	-6.18	6.62	-1.22	7.88
4	-3.29	0.05	1.47	-1.43	7.45	5.89	1.52
1971:1	2.48	4.75	-0.01	5.24	1.41	2.63	12.73
2	-4.55	3.17	-4.29	-6.03	3.97	3.60	27.57
3	-8.01	-9.70	-8.50	-5.83	5.02	-18.2	15.70
4	4.09	-6.09	4.60	15.26	6.68	-3.86	10.83

CHAPTER VI

FORECASTING WITH SINGLE EQUATION MODELS OF MONEY STOCK

In this chapter a number of single equation models that can be used to determine and forecast the money stock will be examined. In the discussion of these models, we will follow the sequence as laid down in Chapter V. We will present the estimated coefficients of different money supply, money demand and money stock process models in sections A, B and C respectively along with their forecast statistics. Section D will examine the evaluation of predictive performance of these models.

A. Money Supply Models

While we have discussed a number of money supply models in Chapter III, we observed that, in view of Pakistani institutional features and data constraints, Gibson's model is the only one we can estimate and use for forecasting. Gibson estimated a money supply equation of the form:

$$M^S = \alpha_{10} + \alpha_{11}R + \alpha_{12}r + \alpha_{13}r_d + \alpha_{14}S_5 + e \qquad (1a)$$

where R is member banks' total reserves, adjusted for reserve requirement change,[1] r is the commercial paper rate, S_5 is seasonal dummy and r_d is the discount rate. For comparison purposes with Teigen's formulations, he also estimated the money supply function with the difference in the two interest rates.

$$M^S = \alpha_{20} + \alpha_{21}R + \alpha_{22}(r - r_d) + \alpha_{23}S_5 + e \qquad (1b)$$

We have estimated both versions of equation (1) without taking account of RAM, since reserve requirements have been kept constant through most of the period under study. We have employed a quarterly average rate on the return to commercial banks from making loans to represent r, and the bank rate to represent the cost of borrowing, r_d. The initial period of estimation was 1961:1 to 1967:4. The sample size was repeatedly increased by four quarters, following Goldfeld's procedure explained in Chapter V.

The estimated OLS coefficients of equation (1a), both without correction for serial correlation and using the Cochrane-Orcutt technique to adjust for serial correlation, are given in Table 6.1(a). Equations with

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[1]The "reserve adjustment magnitude," RAM, and associated revision of the monetary base in U.S. context has stimulated a lot of controversy. For a discussion, see Burger and Rasche [1977].

TABLE 6.1(a).--Estimated Coefficients of the Gibson Model.

Equation Number	N	C	R	r	r_d	S_5	R^2/SE	D.W.	ρ
(1)	28	-2977.4 (-1.43)	3.73 (2.32)*	1009.6 (2.72)*	721.8 (1.93)*	-242.0 (-1.08)	.92/498.1	.78	--
(2)	32	-3402.1 (-1.82)*	3.66 (2.40)*	1118.0 (3.48)*	685.8 (1.92)*	-285.9 (-1.41)	.94/479.7	.96	--
(3)	36	-4484.3 (-2.30)*	3.44 (2.12)*	1468.2 (4.72)*	466.5 (1.25)	-261.6 (-1.28)	.94/514.6	.84	--
(4)	40	-4958.1 (-2.62)*	3.17 (1.98)*	1661.4 (6.27)*	336.3 (.95)	-314.2 (-1.63)	.96/512.5	.90	--
(1')		5775.0 (.25)	1.48 (1.46)	394.9 (.73)	115.4 (.29)	-337.6 (-3.07)*	.96/354.8	1.90	.94
(2')		-4287.6 (-2.01)*	1.94 (1.53)	1415.7 (3.72)*	638.4 (1.53)	-356.0 (-2.57)*	.95/406.8	1.76	.62
(3')		-5396.0 (-2.62)*	1.95 (1.51)	1665.8 (4.83)*	547.4 (1.28)	-351.4 (-2.63)*	.96/420.0	1.82	.63
(4')		-6144.5 (-3.25)*	1.94 (1.45)	1833.0 (6.44)*	485.9 (1.18)	-403.2 (-3.05)*	.97/431.7	1.78	.57

primes represent the coefficients estimated using the Cochrane-Orcutt (CO) technique. The t statistics are given in parentheses. An asterisk * on the t values denotes significance at the .05 level.

In all regression equations, the estimated coefficients of the explanatory variables had the right signs as theory would suggest, except for that of the bank rate r_d, which is positive. The individual coefficients of r, r_d and S_5 in the equations estimated without correction for serial correlation display remarkable instability as the sample size increases in steps of four quarterly observations. The coefficients of seasonal dummies had the right sign but were not significant, suggesting that the fourth quarter is not different from the others. We know this is not true[2] and the low Durbin-Watson statistics suggest that our t-ratios are suspect. When the equations were estimated using the Cochrane-Orcutt technique, the D-W statistics are substantially higher, between 1.78 and 1.90, the total reserve variable is no longer significant, and the seasonal dummy assumes significance. Evidently the seasonal effect is so strong that it swamps the independent effect of changes in total reserves when the

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[2]We have specified before in Chapter V, footnote 3 (p. 69) that fourth quarter has a seasonal effect on money stock.

equations are estimated to take account of serial correlation of residuals. The wrong sign of the r_d coefficient is not surprising. While Gibson and Pfaff [1973] obtained the wrong sign on r_d using U.S. data, there is an even stronger reason that obtaining a plausible estimate in our case would have been most unlikely. The bank rate, r_d, showed virtually no variation, having been changed only once during the sample period.

We also estimated the regression with the constrained interest rate variable by taking the difference of r and r_d. The results of estimation uncorrected for serial correlation are reported in Table 6.1(b). The results of estimation using the CO technique are not reported for the constrained interest rate variable because they did not make much economic sense. The results of Table 6.1(b) suggest that all variables had the right sign. The coefficients of the reserve variable are significant at the 1% level. The interest rate differential coefficient is low and insignificant for equations (1) and (2), but as the sample size increases this coefficient increases in its magnitude and becomes significant. While the estimated coefficients of total reserves show some variation over time, this variation is profound in the case of the interest rate differential variable. The Durbin-Watson statistics are low, but mostly falling close to the indeterminate zone.

TABLE 6.1(b).--Estimated Coefficients of Gibson's Money Supply Equation.

Equation Number	C	R	$(r-r_d)$	S_5	R^2/SER	D.W.
(1)	4130.6	8.97	151.0	-139.8	.88/605.9	1.20
	(6.66)*	(11.80)*	(.44)	(-.51)		
(2)	3785.0	9.25	323.8	-152.8	.90/592.4	1.38
	(6.99)*	(12.64)*	(1.04)	(-.62)		
(3)	3129.7	9.44	687.3	-129.9	.92/623.9	1.24
	(6.29)*	(12.55)*	(2.33)*	(-.53)		
(4)	2836.73	9.33	894.3	-185.5	.94/618.9	1.27
	(7.24)*	(12.59)*	(3.88)*	(-.81)		
(5)	1704.6	8.16	1669.6	- 95.3	.92/861.5	.93
	(3.61)*	(8.19)*	(6.41)*	(-.31)		

Comparison of the regression results based on equations (1a) and (1b) seems to indicate that specification of the money supply function in terms of the interest rate differential (1b) gives a better fit relative to unconstrained interest rates (1a) as we increase the sample size. However, for our purposes what is important is the ability of the equation to forecast. The unconditional[3] forecast of money stock for 1968-1971

[3]In an unconditional forecast, values for all the explanatory variables in the forecasting equation are known with certainty. Any ex-post forecast is, of course, an unconditional forecast.

was made using the procedure described in Chapter V. Table 6.2 gives these statistics. Column 1 gives the forecast of money stock based on equation (1a) with correction for serial correlation and unconstrained interest rate variables; column 3 based on (1b), using OLS without correction for serial correlation and constrained interest rates; and column 5 with constrained interest rate and using the CO technique. Columns 2, 4 and 6 are the percent errors in forecast of these models respectively. In this single equation regression model, we observe that the use of forecasting as a means of evaluating a model's reliability is quite distinct from the classical t, R^2, and other statistics. A single equation model can have significant statistics and still forecast very badly period after period which seems to be the case here. This might result from a structural change in the economy during the forecast period not explained by the model. We will discuss this issue of testing for structural shift along with the matter of the predictive performance of all our models in section D of this chapter.

A glance at Table 6.2 suggests that none of the forecasts of money stock obtained from the three regressions is satisfactory. The poor performance of Gibson's money supply equation in our context may be explained in terms of the fact that it leaves out all elements

TABLE 6.2.--Forecast of Money Stock Based on Gibson's Model.

YEAR-Q	(1) $\hat{M}$	(2) ERPC	(3) $\hat{M}$	(4) ERPC	(5) $\hat{M}$	(6) ERPC
1968:1	9756.2	-2.42	9544.8	-4.53	10282.1	2.83
2	9751.6	-6.50	9741.5	-6.34	10314.8	-.83
3	9834.3	-2.33	9794.2	-2.73	10330.0	2.58
4	10281.4	-5.90	10373.7	-8.08	10736.4	-4.87
1969:1	10441.0	-7.50	10510.9	-6.88	12363.8	9.53
2	10429.6	-10.20	10456.2	-9.98	12355.9	6.37
3	10720.9	-4.99	10559.9	-6.42	12362.5	9.55
4	11596.4	-8.41	11260.8	-11.06	12779.7	.93
1970:1	11870.1	-4.26	11803.2	-4.80	13645.6	10.05
2	12313.6	-3.44	12471.7	-2.20	13741.5	7.74
3	12622.7	0.30	12491.1	-0.73	13740.6	9.18
4	13380.7	-7.16	13111.0	-9.03	14186.7	-1.57
1971:1	13204.0	-6.09	12563.6	-10.64	15524.7	10.41
2	13097.8	-16.80	12053.7	-23.42	15441.1	-1.88
3	13420.9	-16.44	12814.6	-20.21	15565.3	-3.08
4	14524.5	-6.16	14782.7	-5.31	16285.0	4.31

involved in the demand for money; elements which may be introduced either by using a money multiplier approach or a simultaneous equations approach.

B. Money Demand Models

A survey of the literature on the demand for money reveals that, in general, the desired level of real money balances is expressed as a function of two variables, an economic activity variable and a vector of interest rates. The theory relates the demand for money to the decision-making unit in the economy, be this the individual, the household or the firm. In this section, our aim is to explore the factors that affect the demand for money in Pakistan. Following the general practice of the art, we used money stock as a proxy for the demand for money, assuming that the money market is always in equilibrium and the variables which appear in the demand function do not belong to the supply function.

1. Model and Estimation Procedure

The general features of our money demand function are quite standard. We posit that desired money balances are a function of interest rates and a constraint, x.

$$M = M(r, x) \tag{2}$$

where x is either GNP or some measure of wealth and r is a vector of interest rates. In most econometric studies, the practice of deflating nominal money demand by either the price level or population or both is undertaken in order to isolate the effect of changes in demand for money balances resulting from changes in price level or population as compared with changes in income. To test the hypothesis that the demand for money function is homogenous in prices, desired real balances should be invariant with respect to changes in that variable.

Our estimates of the money demand functions are based on mid-year observations of each year over the period 1958-1971 and thus include 14 annual observations. These estimates utilize many fewer observations than did the single equation money supply estimates, due to unavailability of quarterly data on GNP for Pakistan. Used as the economic activity variable in the absence of data on wealth were actual GNP and a measure of permanent GNP. Several studies on money demand have calculated the permanent income series by relating it to the consumption series as was done by Friedman [1959]. In the absence of reliable estimates of consumption expenditure, we defined permanent income as the following weighted average of current and past incomes.

$$Y_{P_t} = .4Y_t + .3Y_{t-1} + .2Y_{t-2} + .1Y_{t-3}$$

Support for this procedure is provided by Rausser and Laumas [1976], who argue that it is by no means necessary that the measure of permanent income relevant in determining consumption expenditure should be the one that is relevant in determining demand for cash balances.

Two other aspects of the model which require specification are the list of possible components of the interest rate vector r, and the process by which actual money balances approach their long-run equilibrium values. In an economy like Pakistan where rates of interest are controlled by the authorities and thus not accurate in reflecting market conditions, the use of the bond rate as a measure of the opportunity cost of holding money was not considered appropriate after preliminary analysis. The only relevant measures of the opportunity cost of holding money are either the call bank rate r_c, or the rate on savings and time deposits r_{st}. In a quarterly money demand model, one would expect to find reasons for using the partial adjustment hypothesis.[4] In our framework, we assume complete adjustment occurs in the money market within one year.

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[4]Studies by Chow [1966], Modigliani, Rasche and Cooper [1970], using annual data, and by Goldfeld [1973], using quarterly data, include lagged money as an independent variable.

2. Nominal Money Demand Function

All equations are estimated using log-linear form. The estimated coefficients based on equation (2) using OLS are displayed in Table 6.3. The empirical definitions of the variables are as follows: M is the domestically held money stock (the sum of currency and demand deposits in the hands of the public), r_c is the interbank call money rate at Karachi, r_{st} is the annual average of rate on saving and time deposits, $\dot{P}$ is a measure of inflation rate, Y is nominal GNP, Y_p is permanent income, and WD is war dummy for 1965 and 1971.

Several aspects of the results warrant comment. All the parameters in the equations have the expected signs. The coefficients of GNP or Y_p are significantly different from zero at the 5% level and are also significantly different from one. The coefficients of r_c or r_{st} have the correct negative sign and come close to being significant in the specifications using current income. We also note that the statistical fit of the equations is exceedingly close. The standard errors of the regression correspond roughly to a 5 to 8 percentage-point error in the annual growth rate in the money stock. The introduction of war-dummy WD in equation (2) improves the r_c coefficient. The coefficient of the inflation rate, $\dot{P}$, in equation (3) has the right sign but is close

TABLE 6.3.--Estimated Coefficients of Nominal Money Demand Model.

Equation Number	C	Y	Y_P	r_c	r_{st}	WD	$\dot{P}$	R^2/SE	D.W.	ρ
(1)	-4.45 (-3.50)*	1.27 (9.88)*		-.16 (-1.70)				.97/.06	1.35	--
(2)	-4.48 (3.74)*	1.28 (10.43)*		-.19 (-2.05)*		.087 (1.97)		.98/.05	1.96	.027
(3)	-4.58 (-3.31)*	1.29 (9.41)*		-.20 (-1.85)		.078 (1.70)	-.22 (-.62)	.98/.05	1.90	.22
(4)	-10.34 (-1.60)	1.82 (2.84)*		-.022 (-.13)	-.062 (-.23)			.88/.14	.70	--
(5)	-12.92 (-3.13)*		2.07 (5.16)*	-.025 (-.30)				.95/.08	1.06	.55
(6)	-14.25 (-4.19)		2.21 (6.61)*		-.23 (-.47)			.95/.08	1.11	--
(7)	-14.40 (-3.76)		2.23 (5.89)*	-.011 (-.11)	-.22 (-1.34)			.97/.08	1.11	--

Notes: The t values are expressed in parentheses; SE is standard error of the regression; and ρ is the estimated serial correlation coefficient. A star indicates that coefficients are statistically significant at 95% confidence interval. All of the variables except for $\dot{P}$ and WD are in natural logarithmic form, as described in the text.

to zero. The nominal income elasticity for Pakistan is one of the most robust statistics of this section: regardless of the specification of the demand function, all the estimates of this parameter lie between 1.27 and 2.06. Of greater interest are the real income elasticities discussed in the next section. The use of permanent income in equations (5) to (7) further increases the income elasticity but reduces the significance of interest rate coefficients. Since the D.W. statistics remained low in equation (5) even when the Cochran-Orcutt technique was applied, it seems that current income is preferable to our measure of permanent income and we reject equation (5) in favor of equation (1).

3. The Real Money Demand Function

A money demand function with the quantity variables divided by the implicit price deflator[5] was also estimated. The estimated coefficients and their t ratios are given in Table 6.4. All equations are in log-linear form. All of the coefficients have the theoretically correct signs. The real GNP coefficients are statistically significant at the 95% confidence level. The D.W. statistics of equations not corrected

[5]The implicit GNP price deflator available for Pakistan is with base 1960 = 100. The range for our sample period was between 95.6 and 143.5.

TABLE 6.4.--Estimated Coefficients of the Real Money Demand Model.

Equation Number	C	y	r_c	r_{st}	WD	R^2/SE	D.W.	ρ
(1)	-4.66	1.53	-.18			.94/.056	1.34	--
	(-4.10)*	(7.34)*	(-2.06)*					
(2)	-4.65	1.52	-.18			.94/.057	1.40	.29
	(-3.53)*	(6.37)*	(-1.71)					
(3)	-4.33	1.26	-.17		.08	.98/.052	1.96	--
	(-3.89)*	(11.14)*	(-2.11)*		(2.05)			
(4)	-7.47	2.01	-.21	-.33		.95/.050	1.69	.002
	(3.06)*	(4.38)*	(-2.05)*	(-.35)				

Note: See note to Table 6.3; y is GNP divided by implicit price deflator.

for serial correlation are slightly lower in the range of 1.31 to 1.40. When permanent income was used as the scale variable, we obtained a negative income elasticity. We have chosen not to report these results.

The specification of both nominal and real money demand functions provides some common grounds for analysis. Note the income elasticity of money demand for either formulation ranges between 1.26 and 1.52 when a single interest rate, r_c, was employed. More important is the fact that all these income elasticities are significantly different from 1, which may not be consistent with one of the basic propositions of monetary theory that changes in the price level have no long-run effect on the demand for real balances. One can cite Friedman:

> Much empirical evidence indicates that the income elasticity is not very different from unity. The empirical evidence seems to me to indicate that the elasticity is generally larger than unity, perhaps in the neighborhood of 1.5 to 2.0 for economies in a period of rapid economic development, and of 1.0 to 1.5 for other circumstances. Other scholars would perhaps set it lower.[6]

Turning to the interest rate elasticity, we find that the response of demand for aggregate money balances to changes in the call money rate is much lower and in the neighborhood of -.20 in all equations. In general, the interest rate elasticity is significantly different

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[6]Friedman [1971, p. 34].

from zero. Our estimates of the interest rates coefficients and their t values are gratifying in a regime of poor substitution between money and bonds, and controlled interest rates not reflecting the true opportunity cost of holding money.

4. Further Empirical Results

As noted in Chapter III, a matter of some controversy is the proper form of the dependent variable. Should nominal balances be deflated by population and/or prices? We investigated this question with Pakistani data. The best fit is reported here.

$$\ln \frac{M}{N \cdot P} = \underset{(1.73)}{2.40} + \underset{(.31)}{.12} \ln(Y/N \cdot P) - \underset{(-.94)}{.13} \ln r_c \qquad (3)$$

$$R^2 = .80 \qquad D.W. = 1.84 \qquad SER = .07 \qquad \rho = .94$$

To test the hypothesis that the demand for money function is homogeneous of degree zero in prices, and ignoring the problem of income distribution, our best fitted equation is given below.

$$\ln m = \underset{(-2.86)}{-8.62} + \underset{(4.80)}{2.08} \ln y - \underset{(-2.47)}{.27} \ln r_c - \underset{(-1.48)}{.41} \ln r_{st} + \underset{(.59)}{.25} \ln P \qquad (4)$$

$$R^2 = .96 \qquad D.W. = 1.98 \qquad SER = .055$$

In (4) the coefficient of lnP is insignificantly different from zero and hence we can accept the proposition that demand for money balances is invariant with respect to prices. However, when the equation was estimated using the Cochrane-Orcutt technique we obtained

$$\ln m = -13.61 + 2.48\ln y - .39\ln r_c - .90\ln r_{st} + .96\ln P \qquad (5)$$
$$(-6.0) \quad (9.2) \quad (-5.4) \quad (-4.2) \quad (2.7)$$
$$R^2 = .96 \quad D.W. = 2.39 \quad SER = .049 \quad \rho = -.82$$

Since serial correlation is not a problem in (4), we consider the earlier result more plausible.

In a recent book, McKinnon [1973] presents a theory of finance in the process of economic development. A key relationship in his model is "the basic complementarity between money and physical capital" [pp. 59-60]. It is reflected in the following demand for money function:

$$(\frac{M}{P})^D = L(y, \bar{r}, d - \dot{P}^*) \qquad (6)$$

where y is real income, $\bar{r}$ is an average return to capital and $d - \dot{P}^*$ is the opportunity cost to wealthholders of holding money. This approach suggests that in contrast to the situation where $\frac{\partial L}{\partial r} < 0$ in the asset portfolio demand models, the complementary relationship is exhibited with $\frac{\partial L}{\partial \bar{r}} > 0$.

Our preliminary results using the narrow definition of money do not tend to support the hypothesis. Given the focus of our investigation of this study, we have chosen not to pursue the issue further. However, Abe, Fry, Min and Yu [1975] and Akhtar [1974] do obtain strong support for this theory.

One view of the demand for money function in the developing economies suggests the inclusion of index of industrial production, IIP, in the money demand function (Khetan and Waghmare [1972], Rao and Choudhary [1973]). Our results do not tend to support the explanatory power of this variable as shown by equation (7).

$$\underset{(-4.2)}{\ln m = -3.8} + \underset{(9.15)}{1.43} \ln y - \underset{(-4.19)}{.25} \ln r_c - \underset{(-.28)}{.001} \ln IIP \qquad (7)$$

$$R^2 = .98 \quad D.W. = .82 \quad SER = .030 \quad \rho = .68$$

5. Summary and Evaluation of Money Demand Models

At a first glance, the results suggest that equation (2) seems to do a satisfactory job of explaining money demand based on statistics obtained within the sample period. The income elasticity of money demand is generally greater than unity and seems to contradict what a quantity theorist would expect in the long run. The demand for money function seems to be homogeneous in prices. The appropriate interest rate reflecting

the true opportunity cost of holding cash balances is the interbank call money rate, r_c.[7] The problem of serial correlation seems to exist in a mild degree.

We do not find any strong evidence that rate of inflation influenced the demand for money over the period under study. We have not estimated a disaggregated form of the function, but results of other studies do not seem to suggest a pressing need to do so. The nature of the data and the sample size makes it difficult to address the question of stability of the model or structural shift. The same is true within a forecasting context.

C. Money Multiplier Models

In Chapter III, we mentioned that models which combine elements of supply and demand in a single equation framework are also known as money multiplier models. We also observed that the appropriate specification of the multiplier depends on whether one is using the source base, B, or the net source base, B^a (the two differ by the volume of commercial banks borrowing from the SBP) as the scale variable. When B^a is the scale variable, the linearized version of the money multiplier is

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[7]Our results of income and interest rate elasticities are generally consistent with the previous findings on demand for money in Pakistan (Bhuiyan [1971], Rao and Chaudhry [1973], Akhtar [1974], and Fry, Min and Yu [1975]).

$$M^S = \alpha_0 + \alpha_1 B^a + \alpha_2 k + \alpha_3 t + \alpha_4 r + \alpha_5 e + \alpha_6 b + \varepsilon. \qquad (8)$$

Where k, t, r, e and b are ratios defined on page 40. When B is the scale variable, b drops out as an element in the multiplier. We first discuss estimates using B^a and then turn to estimates using B as the scale variable.

1. Brunner Model Using Net Source Base

The regression results (OLS) with unconstrained e and b are shown in Table 6.5(a). Equations with primes indicate use of the Cochrane-Orcutt technique. The estimated coefficients in all equations have the right signs except for that of t, and in most cases are significantly different from zero. The coefficients in all regressions display instability as the sample size increases in steps of four quarterly observations. The D.W. statistics in equations (1) to (4) are in such a zone that we can reject the hypothesis of significant autocorrelation of residuals.

The wrong sign on the coefficient of the time deposit ratio, t, is not surprising, given the historical growth of time deposits in the decade of the 1960's. Time deposits grew much faster over this period than demand deposits as discussed in Chapter II. Our results are quite close to the reestimated results of Pfaff

TABLE 6.5(a).--Estimated Coefficients of Brunner Model.

Equ. #	C	B[a]	k	r	t	e	b	S_5	R^2/SE	D.W.	ρ
(1)	1052.8	1.64	-1976.8	-1991.4	1830.5	-2644.9	9376.4	-113.6	.99/192.63	1.72	--
	(1.09)	(12.65)*	(-5.84)*	(-.29)	(3.62)*	(-.18)	(8.53)*	(1.14)			
(2)	2378.1	1.61	-2403.3	-1043.9	2364.2	-13526.1	9812.3	-257.5	.98/283.9	1.36	--
	(2.13)*	(10.51)*	(-6.01)*	(-1.49)	(4.72)*	(-.80)	(7.27)*	(2.33)*			
(3)	2528.13	1.88	-2655.7	-1590.5	1879.3	16401.1	10554.5	-313.6	.98/279.7	1.14	--
	(2.02)*	(14.34)*	(-5.92)*	(-1.99)*	(3.55)*	(.84)	(6.78)*	(-2.54)			
(4)	3251.05	1.97	-2948.0	-2095.1	1511.7	2116.1	11455.4	-366.9	.99/290.05	1.23	--
	(2.60)*	(21.08)*	(-6.62)*	(-2.66)*	(3.08)*	(1.06)	(7.38)*	(-3.05)*			
(1')	3668.01	1.74	-3339.2	-9714.3	1221.8	2091.6	11478.5	-164.6	.99/132.3	1.66	.78
	(4.26)*	(14.93)*	(-8.61)*	(-2.36)*	(2.48)*	(2.05)*	(11.13)*	(-2.92)*			
(2')	4732.0	1.84	-4036.6	-15414.3	1057.6	2718.4	12882.0	-189.7	.99/171.1	2.09	.78
	(4.49)*	(12.56)*	(-9.22)*	(-3.27)*	(1.94)	(2.26)*	(10.54)*	(-2.71)*			
(3')	5103.3	1.87	-4485.3	-17706.6	1164.8	2797.64	14342.8	-205.0	.99/193.7	2.00	.81
	(4.74)*	(13.22)*	(-9.36)*	(-3.58)*	(1.88)	(2.10)*	(10.77)*	(-2.82)*			
(4')	6193.4	1.82	-4840.0	-22068.5	1049.9	3090.2	15204.6	-262.13	.99/210.6	2.10	.80
	(6.01)*	(15.31)*	(-10.45)*	(-4.47)*	(1.68)	(2.23)*	(11.45)*	(-3.56)*			

[1973] for the U.S. economy, where the coefficient of t had the wrong sign.

The model was also estimated by constraining the coefficients of e and b to equality. Since there was no significant improvement of D.W. statistics when corrected for serial correlation, we only present the estimates by the OLS method. Again all coefficients have the right sign except that of t, and in most cases they are significantly different from zero. These results are given in Table 6.5(b). When the sample size consisted of 44 observations, the coefficient of t had the right sign but was insignificant. The results of Tables 6.5(a) and 6.5(b) do not differ appreciably from each other.

Ex-post forecasts of the money stock for 1968-1971 using Brunner's linear money supply equation were made using Goldfeld's procedure as described on page 62. The forecasts based on equations (1) to (4) and (1') to (4') of Table 6.5(a) and equations (1) to (4) of Table 6.5(b) are shown in Table 6.6. Columns 1, 3 and 5 give the forecast values of money stock, whereas 2, 4 and 6 are the corresponding percent errors of the forecast in each quarter.

The results of Table 6.6 are too broad and diversified to make any specific statement about the

TABLE 6.5(b).--Estimated Coefficients of Brunner Model Using Net Source Base.

Equ. #	N	C	B^a	k	r	t	e-b	S_5	R^2/SE	D.W.
(1)	28	928.6	1.64	-1912.5	-3949.3	1754.9	-9147.0	-102.4	.99/188.9	1.26
		(1.02)	(12.91)*	(-6.35)*	(-.76)	(3.75)*	(-9.59)*	(-1.08)		
(2)	32	2085.4	1.59	2198.0	-5141.5	2239.0	-8951.0	-237.5	.99/242.8	1.50
		(1.88)	(10.27)*	(-5.87)*	(-.87)	(4.48)*	(-7.41)*	(-2.14)*		
(3)	36	2204.3	1.86	-2424.4	-9867.0	1730.9	-9579.5	-292.7	.98/283.4	1.27
		(1.77)	(14.11)*	(-5.78)*	(-1.48)	(3.30)*	(-6.88)*	(-2.35)*		
(4)	40	2902.9	1.96	-2686.7	-14023.5	1295.7	-10335.5	-345.0	.99/296.7	13.7
		(2.30)*	(20.55)*	(-6.34)*	(-2.09)*	(2.69)*	(-7.31)*	(-2.83)*		
(5)	44	2729.4	2.27	-3111.3	-11066.8	-75.8	-12432.5	-87.7	.98/398.7	1.49
		(1.42)	(21.58)*	(-4.85)*	(-1.08)	(-.12)	(-6.38)*	(-.49)		

TABLE 6.6.--Forecast of Money Stock Based on Brunner Linear Model Using Net Source Base.

YEAR-Q	(1) $\hat{M}$	(2) ERPC	(3) $\hat{M}$	(4) ERPC	(5) $\hat{M}$	(6) ERPC
1968:1	9700.2	-2.98	9726.7	-2.71	9674.23	-3.24
2	9712.5	-6.63	9886.8	-4.95	9991.5	-2.83
3	9897.9	-1.70	9929.7	-1.39	9869.9	-1.99
4	10460.8	-7.31	10688.7	-5.29	10429.0	-7.59
1969:1	10812.9	-4.20	10800.4	-4.31	10801.6	-4.30
2	11164.4	-3.88	11393.7	-1.90	11166.7	-3.86
3	11124.4	-1.41	11241.8	-0.37	11138.7	-1.29
4	11616.4	-8.25	12080.6	-4.58	11599.9	-8.38
1970:1	12680.7	2.27	12598.3	1.60	12695.0	2.38
2	12678.7	-0.57	12822.3	0.54	12620.6	-1.04
3	12214.5	-2.93	12383.2	-1.59	12224.4	-2.85
4	13695.9	-4.97	13895.1	-3.59	13628.7	-5.44
1971:1	13372.8	-4.89	13356.0	-5.01	13423.5	-4.53
2	13870.2	-11.88	13796.6	-12.35	14165.2	-10.00
3	13358.9	-16.82	13378.9	-16.70	13580.6	-15.40
4	14869.2	-4.75	14778.1	-5.33	15095.3	-3.30

predictive performance of each equation. All forecasts are distinctly different from the actual series of the money stock and hence have high error percentages. All regressions do a poor job of fourth quarter forecast in terms of picking the turning points. Among the three forecasts, the regression with constrained e and b ratios, column 5, gives a better forecast than the other two. The common pattern of all equations and their respective poor forecasts might suggest that there is not much information contained in the data using the net source base or that the specification of the model is poor in our context or both.

2. Brunner Model Using Source Base

When the source base, B, is the scale variable, the estimated equation was of the form

$$M^S = \alpha_0 + \alpha_1 B + \alpha_2 k + \alpha_3 t + \alpha_4 r + \alpha_5 e + \varepsilon. \tag{9}$$

The estimated coefficients using the Cochrane-Orcutt technique are given in Table 6.7. The results are quite assuring; all the variables generally have significant coefficients with the theoretically expected sign, except e. The sign of the coefficient e is positive but not significantly different from zero. However, when the full sample period is used it has the expected sign.

TABLE 6.7.--Estimated Coefficients of Brunner Model Using Source Base.

Equ. #	C	B	k	t	r	e	S_5	R^2/SE	D.W.	ρ
(1)	2950.5	1.56	-1510.5	-312.9	-4953.5	313.2	-38.2	.99/55.8	1.61	.63
	(9.73)*	(42.48)*	(-12.69)*	(-1.57)	(-3.35)*	(.08)	(-1.56)			
(2)	3481.4	1.63	1857.9	-417.6	-7958.9	2103.3	-40.0	.99/99.6	2.19	.68
	(6.69)*	(26.25)*	(-9.46)*	(-1.34)	(-3.34)*	(.33)	(-.95)			
(3)	4025.1	1.69	-2066.8	-763.0	-10382.9	1237.2	-59.6	.99/119.6	2.12	.67
	(7.07)*	(26.56)*	(-9.25)*	(-2.19)*	(-3.78)*	(.16)	(-1.25)			
(4)	4428.5	1.68	-2200.3	-730.7	-12595.3	5985.5	-89.9	.99/130.7	2.52	.53
	(7.42)*	(32.73)*	(-9.61)*	(2.20)*	(-4.24)*	(.70)	(-1.77)			
(5)	6993.1	1.69	-3059.9	-1785.7	-16197.8	-16335.2	14.07	.98/412.4	2.00	.22
	(4.40)*	(17.68)*	(-5.08)*	(-2.86)*	(-1.81)	(-.67)	(.09)			

The D.W. statistics in most equations do not suggest the presence of serial correlation. None of the seasonal dummy coefficients is statistically different from zero.

A casual inspection of the results suggests that the estimated coefficients display a quite reasonable degree of variation as the sample period increases. The proper test of short-run stability of the model, its short run out of sample forecasts, will be discussed in section D. The forecasts of money stock for 1968:1 to 1971:4 are given in Table 6.8. Column 1 gives the ex-post forecast, while the percent error in the forecast is given in Column 2. With the exception of only the last two quarters of 1971 forecasts of the money stock are quite close to the actual series and hence have lower error percentages than the forecasts reported in Table 6.6. The tendency to underestimate is still observed in most quarters.

3.a. Liquidity Model

In Chapter IV, we developed a money multiplier model based on the stock of liquid assets of the commercial banks rather than on the monetary base, as a more appropriate hypothesis for studying the money supply process in Pakistan. The equation (L.7') derived for empirical testing was of the form:[8]

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[8]See Chapter IV, p. 57.

TABLE 6.8.--Forecast of Money Stock of Brunner Linear Model Using Source Base.

Year-Q	(1) M	(2) ERPC
1968:1	9855.8	-1.43
2	9944.0	-4.40
3	9851.9	-2.16
4	10857.5	-3.79
1969:1	11264.8	-0.20
2	11479.9	-1.16
3	11241.2	-0.38
4	12183.9	-3.77
1970:1	12490.7	0.74
2	12513.2	-1.88
3	12464.2	-0.95
4	14275.9	-0.95
1971:1	14174.0	0.80
2	15510.2	-1.46
3	13427.5	-16.39
4	14792.3	-5.24

$$M^S = \alpha_0 + \alpha_1 L' + \alpha_2 k + \alpha_3(e'+e'') + \alpha_4 \ell + \alpha_5 t + \varepsilon.$$

The regression equations for different sample sizes were estimated by OLS with and without correction for serial correlation. The results with either procedure were qualitatively the same. The estimated coefficients of the regression including a seasonal dummy, S_5, for the fourth quarter and using the Cochrane-Orcutt technique are given in Table 6.9.

All coefficients except k have the right sign and are significantly different from zero. The seasonal dummy variable coefficients are significant in some cases. The D.W. statistics do not suggest the presence of serial correlation even when equations were not corrected, as can be seen from the last regression (5') for the whole sample period. The individual coefficients of (e'+e"), k and t on casual inspection do appear to shift around as the sample size increases, suggesting the instability of the coefficients. The standard error of the regressions is modest.

The quarterly forecasts of money stock for 1968-1971 period based on equation (L.7') are reported in Table 6.10. Columns (1) and (3) give the predicted values of money stock based on OLS regression results and on results obtained using the Cochrane-Orcutt technique, respectively; columns (2) and (4) give the corresponding

TABLE 6.9.--Estimated Coefficients of the Liquidity Model.

Regression #	C	L'	ℓ	(e'+e")	k	t	S_5	R^2/SE	D.W.	ρ
(1)	5880.4 (15.08)*	4.23 (24.96)*	-26140.9 (-15.50)*	-19673.6 (-15.51)*	3729.5 (12.72)*	-4844.9 (-8.87)*	151.8 (2.61)*	.99/117.7	2.00	.27
(2)	5828.9 (15.92)*	4.20 (26.84)*	-25584.6 (-15.84)*	-19415.0 (-16.66)*	3638.2 (13.23)*	-4743.7 (-10.02)*	153.7 (2.77)*	.99/116.3	2.10	.28
(3)	8411.7 (11.89)*	3.35 (19.68)*	-25595.9 (-7.92)	-22112.8 (-15.58)	2480.9 (8.33)	-3740.0 (-8.02)	39.11 (.81)	.99/127.93	2.00	.69
(4)	6190.14 (9.58)	3.64 (29.76)	-24359.6 (-8.33)	-20731.6 (-10.78)	3634.7 (8.01)	-3718.6 (-8.11)	31.44 (.38)	.99/203.4	1.81	.19
(5)	5743.5 (5.33)	3.61 (27.40)	-23407.8 (-4.91)	-27364.9 (-11.10)	5020.0 (7.81)	-4708.4 (-7.17)	256.8 (1.92)	.98/355.3	1.73	.25
(5')	6071.6 (5.02)	3.52 (23.07)	-22105.6 (-3.91)	-27117.6 (-9.97)	4740.8 (6.78)	-4688.2 (-6.20)	214.5 (1.65)	.98/355.0	1.88	---

TABLE 6.10.--Forecasts of Money Stock of Liquidity Model Based on Equation (L.7').

YEAR-Q	(1) $\hat{M}$	(2) ERPC	(3) $\hat{M}$	(4) ERPC
1968:1	9908.5	-0.89	9900.8	-0.97
2	10195.4	-1.98	10194.8	-1.99
3	10122.7	0.52	10115.0	0.45
4	11164.0	-1.08	11181.8	-0.92
1969:1	11383.6	0.84	11405.9	1.13
2	11870.2	2.19	11923.4	2.65
3	11944.0	5.84	12016.1	6.48
4	13375.7	5.64	13461.4	6.31
1970:1	12258.6	-1.13	12195.8	-1.63
2	12407.2	-2.71	12446.5	-2.40
3	12979.7	3.14	12966.1	3.03
4	13663.0	-5.20	13694.3	-4.97
1971:1	13595.2	-3.74	13572.7	-3.47
2	14965.2	-4.92	14931.5	-5.14
3	15491.6	-3.54	15496.4	-3.51
4	17475.4	11.94	17458.5	11.83

percentage forecasts of errors. The ex-post forecasting ability of (L.7') compares favorably to that of the models studied so far. However, the wrong sign of k and the realization that the use of linear regression is inappropriate, since the ceteris paribus assumption is untenable, led us to further investigate the model as discussed in Chapter IV.

3.b. Liquidity Model Forecast: An Alternative Approach

The analysis in Chapter IV culminated in equation (L.22).

$$\frac{dM}{M} = \sum_j \varepsilon^j \frac{dj}{j} \qquad j = k,\ \ell,\ (e'+e''),\ t \qquad \text{(L.22)}$$

where ε^j is the sum of the elasticities of the multiplier, m_L', and of the liquidity total, L', with respect to parameter j. It would be possible to use regression techniques to estimate the elasticities in equation (L.22). However, the use of regression commits the investigator to the maintained hypothesis that the unknown values of the parameters he is estimating have remained constant over the sample period. Since we have derived the analytical expressions (L.9)-(L.12) and (L.18)-(L.21) of Chapter IV it is easy to see that this hypothesis is untenable. An alternative is to use the analytical expressions to calculate the elasticities period by period, calculate their means and standard deviations, substitute the means in equation (L.22), and use it to forecast changes in the money stock. Rather than using the mean values of the elasticities we may also try the values of the elasticities prevailing during the period in which the forecast is made.

Since in any application the variables in equation (L.22) will be discrete percentage changes, Chapter IV's analytical expressions for the elasticities, (L.9)-(L.12) and (L.18)-(L.21), which are point elasticities based on infinitesimal changes, are not strictly appropriate. Rather two sets of analytical expressions for the elasticities, when discrete changes are involved, were derived.[9] One set uses the original values of the variables as the base from which to measure percentage changes:

$$E_{j1}^{m_{L'}} = \frac{\Delta m_{L'}}{\Delta j} \cdot \frac{j_{t-1}}{m_{L'_{t-1}}} \quad \text{and} \quad E_{j1}^{L'} = \frac{\Delta L'}{\Delta j} \cdot \frac{j_{t-1}}{L'_{t-1}} \, .$$

The other set uses the new values of the variables as the base from which to measure percentage changes:

$$E_{j2}^{m_{L'}} = \frac{\Delta m_{L'}}{\Delta j} \cdot \frac{j_t}{m_{L'_t}} \quad \text{and} \quad E_{j2}^{L'} = \frac{\Delta L'}{\Delta j} \cdot \frac{j_t}{L'_t}$$

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[9] Derivations are given in the Appendix.

We then have two versions of equation (L.22) of Chapter IV:

$$\frac{dM}{M} = \sum_j \varepsilon_1^j \frac{dj}{j} \qquad j = k,\ \ell,\ (e'+e''),\ t \qquad \text{(L.22a)}$$

$$\frac{dM}{M} = \sum_j \varepsilon_2^j \frac{dj}{j} \qquad j = k,\ \ell,\ (e'+e''),\ t \qquad \text{(L.22b)}$$

where

$$\varepsilon_1^j = E_{j1}^{mL'} + E_{j1}^{L'}$$

and

$$\varepsilon_2^j = E_{j2}^{mL'} + E_{j2}^{L'}$$

As mentioned, two procedures were used to implement equations (L.22a) and (L.22b). The first was to calculate the period by period values of the ε^j using the analytical expressions derived in the appendix to this chapter, obtain the mean values, and insert them into (L.22a) and (L.22b). The second was to use as our values of the ε^j the values prevailing during the period in which the forecast would have been made (again calculated by use of the expressions given in the appendix to this chapter).

The forecast of money stock based on (L.22a) and (L.22b) using Goldfeld's procedure for different sample sizes are reported in Tables 6.11(a) and 6.11(b), respectively.[10] In Table 6.11(a), column 1 is the forecast using means of the elasticities derived from the original values of the variables whereas column 3 is the forecast using immediately lagged values of the elasticities rather than their means. This is also the case in Table 6.11(b) except that the elasticities were derived from new values of the variables. The results based on both versions of equation (L.22) produce the best forecast of the money stock as judged by ERPC criteria at least for the first three quarters of each year. Fourth quarter forecasts obtained from all sets of elasticities are poor--a feature common to almost all the models tested in this project. In the case of this version of the liquidity model, where no regressions are involved, there is no way to capture the seasonal effect through the use of seasonal dummies. Overall, the use of liquidity model seems to represent the salient features of the money stock process in Pakistan.

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[10]After computing $(\frac{dM}{M})_{t+j}$ for quarter j, the forecast of the money stock was made as $\hat{M}_{t+j} = (1 + (\frac{dM}{M})_{t+j}) \cdot M_t$, where M_t is the actual level of money stock prior to quarter j.

TABLE 6.11(a).--Forecast of Money Stock of Liquidity Model Based on (L.22a).

YEAR-Q	(1) $\hat{M}$	(2) ERPC	(3) $\hat{M}$	(4) ERPC
1968:1	9787.5	-2.11	9754.5	-2.43
2	10468.1	0.63	10490.7	0.85
3	9863.5	-2.04	9923.1	-1.45
4	10432.2	-7.56	10495.4	-7.00
1969:1	10870.8	-3.69	10889.6	-3.52
2	11481.7	-1.15	11544.9	-0.61
3	11213.7	-0.62	11300.9	0.14
4	11753.5	-7.16	11828.2	-6.58
1970:1	12591.1	1.55	12593.5	1.57
2	12871.1	0.92	12857.9	0.82
3	12435.5	-1.18	12623.5	0.31
4	12929.5	-10.29	12924.4	-10.33
1971:1	13739.0	-2.28	13875.5	-1.31
2	14238.7	-9.54	14255.2	-9.43
3	14934.5	-7.01	16176.6	0.71
4	16318.4	4.53	16380.0	4.92

TABLE 6.11(b).--Forecast of Money Stock of Liquidity Model Based on (L.22b).

YEAR-Q	(1) $\hat{M}$	(2) ERPC	(3) $\hat{M}$	(4) ERPC
1968:1	9786.9	-2.11	9742.6	-2.55
2	10455.9	0.51	10402.2	0.01
3	9871.6	-1.96	9806.6	-2.61
4	10430.6	-7.58	10406.5	-7.79
1969:1	11286.1	-0.01	10843.7	-3.93
2	11287.7	-2.82	11516.1	-0.85
3	11615.5	2.93	11156.6	-1.13
4	11284.4	-10.87	11755.1	-7.15
1970:1	12597.4	1.60	12429.1	0.24
2	12855.4	0.79	12770.1	0.13
3	12445.9	-1.09	12517.7	-0.52
4	12928.0	-10.30	12777.3	-11.35
1971:1	13762.0	-2.12	13740.9	-2.27
2	14239.9	-9.54	14213.8	-9.70
3	14942.3	-6.96	13677.9	-14.84
4	16316.3	4.51	16339.8	4.66

D. Evaluation of Predictive Performance

An important question is how useful these estimated models are for short-run predictions of the money stock. In order to evaluate forecasting performance, it is necessary to have some measure of forecasting inaccuracy. There is a wide range of prediction evaluation statistics available in the literature. The most commonly used is the root mean square error (RMSE), calculated by the formula:

$$\text{RMSE} = \sqrt{\frac{1}{T} \sum_{t} (F_t - A_t)^2}$$

where F_t and A_t are respectively the predicted and actual values of the t'th observation and T is the number of observations.

Goldfeld's procedure used estimates of a particular sample period to predict the money stock over each of the next four quarters. He then calculated the RMSE of these four predicted values. The procedure was repeated for each sample period. Since we are comparing different models, his procedure of calculating the RMSE of each year's quarterly predictions is not very helpful for our purposes, particularly since none of the models had a consistently low or high RMSE (compared to the other models) for all of the years from 1968 to 1971. A more useful procedure for our purposes is to calculate the RMSE of each model's first quarter forecasts, second quarter forecasts, third quarter forecasts and fourth quarter forecasts over the entire forecast period, and rank the models separately based on the RMSE of each quarter's predictions across the years 1968-1971. This is in contrast to Goldfeld's method in which we would rank the models separately based on the RMSE of each year's four quarterly predictions. It is much more useful to know that a particular model predicts the second quarter relatively well and the third quarter relatively badly (say), than it is to know that that model predicts 1969 relatively well and 1970 relatively badly.

For all the models estimated in this chapter, except LME_3 and LME_4 (see Table 6.11), the first quarter is a one period forecast, the second quarter forecast is a two period forecast and so on. We would expect the RMSE to increase as we increase the forecast horizon.

In comparing the forecasts of all the models, it will also be of interest to compare the RMSE of naive money stock models with the RMSE of various single equation models, the presumption being that the predictive accuracy of the econometric models should at least equal if not surpass that of naive models in order to justify the use of the former in forecasting. Before we

TABLE 6.12.--Summary of Notations.

GU	Gibson model with unconstrained interest rates
GC	Gibson model with constrained interest rates
BB	Brunner linear money supply model using source base
BB^aU	Brunner linear money supply model using net source base and unconstrained ratios
BB^aC	Brunner model using net source base and constrained ratios
LMR	Liquidity model using equation (L.7')
LME1	Liquidity model using mean of the elasticities at original values of the variables, equation (L.22a)
LME2	Liquidity model using mean of elasticities at new values of the variables, equation (L.22b)
LME3	Liquidity model using actual values of the elasticities at original values of the variables
LME4	Liquidity model using actual values of the elasticities at new values of the variables
	-A at the end of notation implies that the model was estimated using Cochrane-Orcutt technique

make such comparisons, the notation used in this section is summarized in Table 6.11 for the models estimated in this chapter. Such notation has already been defined for naive models in Chapter V (p. 70).

Table 6.12, then, presents the rankings of different models according to the RMSE of prediction criterion. Among the naive models, we have only included

TABLE 6.13.--Root Mean Square Errors of Prediction (billions of Rupees).

Rank	First Quarter Predictions		Second Quarter Predictions		Third Quarter Predictions		Fourth Quarter Predictions	
	Model	RMSE	Model	RMSE	Model	RMSE	Model	RMSE
1	BB-A	.102	LMR-A	.246	LME4	.095	N1	.443
2	LME2	.208	BB-A	.291	LMR	.479	GC-A	.486
3	LMR	.217	GC-A	.430	LMR-A	.500	BB-A	.524
4	LME4	.269	N5B	.425	LME1	.578	N5B	.566
5	N1	.271	N2B	.432	LME2	.595	N2B	.585
6	LMR-A	.275	N1	.439	N1	.662	BB^aU-A	.643
7	LME1	.299	LMR	.495	N2B	.809	BB^aC	.828
8	LME3	.302	LMR4	.746	GC-A	.838	BB^aU	.842
9	N5B	.315	LME1	.757	LME3	1.201	LME4	1.015
10	BB^aU-A	.398	LME3	.765	BB^aC	1.259	LME1	1.031
11	BB^aC	.456	LME2	.770	BB-A	1.323	GU-A	1.047
12	BB^aU	.465	BB^aC	.847	BB^aU-A	1.345	LMR	1.068
13	N2B	.482	BB^aU-A	1.012	GU-A	1.355	LMR-A	1.070
14	GU-A	.668	BB^aU	1.022	BB^aU	1.368	LME3	1.095
15	GC	.992	GU-A	1.050	N5B	1.467	GC	1.137
16	GC-A	1.117	GC	1.760	GC	1.669	LME2	1.154

in this table the autoregressive money stock model, N1, the money multiplier no-change model using source base, N2B, and the Burger model using source base, N5B,[11] because these models had the lowest RMSE. We observe at the outset that as we forecast further into the future, the error in the forecasts tends to increase.

In comparing the predictions of different models of this chapter, it is clear from Table 6.12 that there is little to choose between the Brunner linear model, BB, and the linear version of the liquidity model, LMR. The Brunner model outperforms all other models for a one quarter forecast, comes in second in the second and fourth quarter forecasts, but gives a poor forecast for the third quarter. The linear version of the liquidity model and its alternative approaches are second best in the first quarter forecasts, outperform all models in the second and third quarter forecasts and provide a poor forecast for the fourth quarter. Generally, the liquidity model using elasticities gives comparatively good predictions for the first and third quarters but

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[11] The Burger model using B^a gave poor forecasts and hence had very high RMSE's of prediction as given in Table 5.8 (p. 86). His use of B^a was in the context of his proposed money stock control procedure rather than in the context of an attempt to predict the money stock. To be fair to his model, used as a predictive tool, we estimated its parameters using both the source base and the net source base. The former gives much better predictions.

comparatively poor predictions for the even quarters. The liquidity model using elasticities did not allow for the seasonal variation of the fourth quarter which occurs in the Pakistani data and this may provide a plausible explanation for the poor fourth quarter forecast. The high RMSE of these models' second quarter predictions is due entirely to their errors of second quarter forecast for 1971. For the other three years, the second quarter forecast errors are almost always less than 1% but for 1971 the second quarter predictions of all four models were in error by between 9 and 10%.

In general, the Gibson model's performance is quite poor. But when the absolute values of the coefficients of the two interest rates were constrained to equality (GC-A), its second and fourth quarter predictions were comparatively good, exactly the opposite of the liquidity elasticity models. Gibson's better forecast for the fourth quarter can be attributed to the same phenomenon that caused the poor forecasts of the liquidity models. The annual behavior of Pakistan's money stock is characterized by a marked increase in the fourth quarter, which is not being taken account of by the liquidity elasticity models, and the seasonal dummy in the Gibson model contains most of the explanatory power in the estimates and influences its forecasts of the money stock.

The forecasts of naive models are generally mediocre. With the exception of the third quarter, the forecasts of Burger's model are respectable and superior to the no-change money multiplier model. However, the autoregressive model, N1, outperforms Burger's model and the money multiplier models in its first, third and fourth quarter forecasts.

E. Summary

We have estimated a number of single equation models of money supply process in Pakistan in this chapter. The estimated models were used to obtain out of sample ex-post predictions of the money stock, one, two, three and four quarters ahead. We conclude that the Brunner linear money supply hypothesis and an analogous model based on banks' holdings of liquid assets and its alternative version provided the best short-term predictions for the first three quarters forecasts. For the fourth quarter forecast, Gibson's model had the lowest RMSE statistics. It is also observed that as we forecast further into the future, the prediction error of each model increases. The seasonal effect of the fourth quarter is strong and persistent.

Appendix to Chapter VI

The purpose of this appendix is to derive the elasticities of the total liquid assets and the multiplier with respect to parameter j, used in equation (L.22a) and (L.22b), by using the original values of the variables and the new values of the variables as the base when discrete changes are involved. We begin by recalling equation (L.14) of Chapter IV,

$$L' = \frac{\ell'}{k} C$$

$$\Delta L' = C_{t-1}\, \Delta\ell' k^{-1} + (\ell' k^{-1})_t\, \Delta C$$

$$= C_{t-1}(k_{t-1}^{-1}\, \Delta\ell'_t + \ell'_t\, \Delta k^{-1}) + (\ell' k^{-1})_t\, \Delta C$$

$$= C_{t-1}\, \{\frac{1}{k_{t-1}}\, [(1+t)_t\, \Delta(\ell+e'+e") + (\ell+e'+e")_{t-1}\, \Delta(1+t)] -$$

$$\frac{\ell'_t}{k_t\, k_{t-1}}\, \Delta k\} + (\ell' k^{-1})_t\, \Delta C$$

Substitute $\Delta C = -\Delta L$, and rearranging the terms, we have

$$\Delta L' = C_{t-1}\{\frac{1}{k_{t-1}}\, [(1+t)_t\, \Delta(\ell+e'+e") + (\ell_t+e'+e")_{t-1}\, \Delta(1+t)] -$$

$$\frac{\ell'_t}{k_t\, k_{t-1}}\, \Delta k\} + \frac{k_t}{(k_t+\ell'_t)} \tag{A1}$$

The elasticities of total liquid assets with respect to parameter j using the original values of the variables can be derived as:

$$\frac{\Delta L'}{\Delta k} \frac{k_{t-1}}{L'_{t-1}} = -\frac{\ell'_t \, k_{t-1}}{\ell'_{t-1}(k_t + \ell'_t)} \tag{L.18'}$$

$$\frac{\Delta L'}{\Delta \ell} \frac{\ell_{t-1}}{L'_{t-1}} = (1+t)_t \frac{\ell_{t-1}}{\ell'_{t-1}} \frac{k_t}{(k_t+\ell'_t)} \tag{L.19'}$$

$$\frac{\Delta L'}{\Delta(e'+e'')} \frac{(e'+e'')_{t-1}}{L'_{t-1}} = \frac{(1+t)_t (e'+e'')_{t-1}}{\ell'_{t-1}} \frac{k_t}{(k_t+\ell'_t)} \tag{L.20'}$$

$$\frac{\Delta L'}{\Delta t} \cdot \frac{t_{t-1}}{L'_{t-1}} = \frac{t_{t-1}}{(1+t)_{t-1}} \frac{k_t}{(k_t+\ell'_t)} \tag{L.21'}$$

When the new values of the variables are used as the base, the relationship (A1) can be written as:

$$\Delta L' = C_t \left\{\frac{1}{k_{t-1}} [(1+t)_t \, \Delta(\ell+e'+e'') + (\ell+e'+e'')_{t-1}] - \frac{\ell'_t}{k_t \, k_{t-1}} \Delta k\right\} \frac{k_{t-1}}{(k+\ell')_{t-1}} \tag{A2}$$

The liquidity elasticities with respect to parameter j are:

$$\frac{\Delta L'}{\Delta k} \cdot \frac{k_t}{L'_t} = -\frac{k_t}{(k+\ell')_{t-1}} \tag{L.18''}$$

$$\frac{\Delta L'}{\Delta \ell} \cdot \frac{\ell_t}{L'_t} = \frac{\ell_t}{\ell''_t} \cdot \frac{k_t}{(k+\ell')_{t-1}} \qquad \text{(L.19")}$$

$$\frac{\Delta L'}{\Delta (e'+e")} \cdot \frac{(e'+e")_t}{L'_t} = \frac{(e'+e")_t}{\ell''_t} \cdot \frac{k_t}{(k+\ell')_{t-1}} \qquad \text{(L.20")}$$

$$\frac{\Delta L'}{\Delta t} \cdot \frac{t_t}{L'_t} = \frac{\ell''_{t-1}\, t_t}{\ell'_t} \cdot \frac{k_t}{(k+\ell')_{t-1}} \qquad \text{(L.21")}$$

Similarly, the multiplier elasticities with respect to the parameter j can be derived by using the original and new values of the variables as the base. Recalling equation (L.6') of Chapter IV,

$$m_{L'} = (1+k)_t \cdot \ell'^{-1}_t$$

$$\Delta m_{L'} = (1+k)_t \cdot \Delta \ell'^{-1} + \ell'^{-1}_{t-1}\, \Delta(1+k) = -(1+k)_t \frac{1}{\ell'_t\, \ell'_{t-1}} \Delta \ell' + \frac{1}{\ell'_{t-1}} \Delta k$$

$$= -(1+k)_t \frac{1}{\ell'_t\, \ell'_{t-1}} \Delta[(\ell+e'+e")(1+t)] + \frac{1}{\ell'_{t-1}} \Delta k$$

$$= -(1+k)_t \frac{1}{\ell'_t\, \ell'_{t-1}} [(1+t)_t\, \Delta(\ell+e'+e") + (\ell+e'+e")_{t-1}\, \Delta(1+t)] + \frac{1}{\ell'_{t-1}} \Delta k \qquad \text{(B1)}$$

The multiplier elasticities at the original values of the variables can now be written as:

$$\frac{\Delta m_{L'_t}}{\Delta k} \cdot \frac{k_{t-1}}{m_{L'_{t-1}}} = \frac{k_{t-1}}{(1+k)_{t-1}} \qquad (L.9')$$

$$\frac{\Delta m_{L'_t}}{\Delta \ell} \cdot \frac{\ell_{t-1}}{m_{L'_{t-1}}} = -\frac{(1+k)_t}{(1+k)_{t-1}} \cdot \frac{\ell_{t-1}}{\ell''_t} \qquad (L.10')$$

$$\frac{\Delta m_{L'_t}}{\Delta (e'+e'')} \cdot \frac{(e'+e'')_{t-1}}{m_{L'_{t-1}}} = -\frac{(1+k)_t}{(1+k)_{t-1}} \cdot \frac{(e'+e'')_{t-1}}{\ell''_t} \qquad (L.11')$$

$$\frac{\Delta m_{L'_t}}{\Delta t} \cdot \frac{t_{t-1}}{m_{L'_{t-1}}} = -\frac{(1+k)_t \; \ell''_{t-1}}{(1+k)_{t-1}} \cdot t_{t-1} \qquad (L.12')$$

The multiplier elasticities using the new values of the variables as the base are:

$$\frac{\Delta m_{L'}}{\Delta k} \cdot \frac{k_t}{m_{L'_t}} = \frac{1}{\ell'_{t-1}} \cdot \frac{k_t}{(1+k_t)} \cdot \ell'_t = \frac{k_t}{1+k_t} \cdot \frac{\ell'_t}{\ell'_{t-1}} \qquad (L.9'')$$

$$\frac{m_{L'}}{\Delta \ell} \cdot \frac{\ell_t}{m_{L'_t}} = -\frac{(1+t)_t \; \ell_t}{\ell'_{t-1}} \qquad (L.10'')$$

$$\frac{\Delta m_{L'}}{\Delta(e'+e")} \cdot \frac{(e'+e")_t}{m_{L'_t}} = - \frac{(1+t)_t \ (e'+e")_t}{\ell'_{t-1}} \qquad (L.11")$$

$$\frac{\Delta m_{L'}}{\Delta t} \cdot \frac{t_t}{m_{L'_t}} = - \frac{t_t}{(1+t)_{t-1}} \qquad (L.12")$$

Note that (L.9')-(L.12') and (L.9")-(L.12") are multiplier elasticities using the original and new values of the variables as the base rather than point elasticities; (L.18')-(L.21') and (L.18")-(L.21") are total liquid assets elasticities with the same qualification.

CHAPTER VII

SUMMARY AND CONCLUSIONS

We have reviewed a number of existing models of the money supply process and have developed one of our own to examine the money stock process in Pakistan. After estimating the parameters of the various models, using Pakistani data, we used these estimates to obtain out of sample ex-post predictions of the money stock one, two, three, and four quarters ahead. Given the nature of our study, the immediate question is: which of the models of money stock gives the best short-term forecasts for Pakistan? In addition, what do we learn from the behavior of money stock process in Pakistan?

Our empirical work examined two kinds of models, naive money stock models and single equation structural models. The latter were of three types: models focusing on the behavior of the suppliers of money, money demand models, and money multiplier models. Among the naive money stock models, the autoregressive money stock model had the best prediction for the first, third and fourth quarter. Its second quarter forecast was outperformed by the Burger and the no-change multiplier models. The second best predictions were given by the Burger model using source base. The forecasts of this model with the exception of third quarter were respectable. All other models considered in Chapter V had generally poor predictive performance.

From the single equation models of money supply of Chapter VI, the evidence seems to suggest that there is little to choose between the Brunner linear money supply hypothesis and our liquidity model for the first three quarters forecasts. For the fourth quarter forecast, Gibson's model had the lowest RMSE statistics. The RMSE of the first quarter was lowest in the Brunner model, whereas in the second and third quarters, a version of the liquidity model has the lowest prediction errors. The present evidence is also consistent with earlier findings that as we try to forecast further into the future, the prediction error of each model increases.

Comparing the evidence of Chapters V and VI, we find that the results of single equation models provide reasonably good forecasts one, two, and three quarters ahead. The seasonal effect of the fourth quarter is strong and persistent. However, none of the mechanistic models gave better predictive performance than the structural models with the exception of the lagged money stock model (N1) in the fourth quarter. This result is in marked contrast to Pfaff's [1973] findings for the U.S. data, where two naive models had lower forecasting errors than any of the one or two equation structural models.

We were unable to use money demand models for forecasting purposes. However, our estimated results generally support the prevalent theoretical proposition and empirical findings. Our results are consistent with the general consensus for the U.S. economy that the elasticity of demand for money with respect to short-term interest rate is around -0.2. However, our income elasticity of money demand seems to favor Friedman's proposition that money is a luxury good.

In all estimation and forecast procedures we have tried to correct for temporal interrelatedness by correcting for first order autocorrelation. Generally, whenever such corrections were made, the RMSE of the forecast was reduced. No attempt was made in this study to make use of judgment corrections of the constant term or various mechanical constant adjustment techniques. We also have not looked at the predictive performance of some two equation money stock models. Given the restricted nature of the data, and the estimation procedure used, we could not address the question of structural shift. It is our hope that further work can be directed towards these issues.

The main conclusion of this study is that even in the absence of financially developed security markets, of proper open market operations, and of attempts by the State Bank of Pakistan to influence short-term interest rates in a particular direction or to influence the cost and availability of credit, it does appear possible to build economic models that can be used in making short-term forecast of the money stock with reasonable accuracy. Brunner and Meltzer's hypothesis of a base-multiplier relationship has proved useful in organizing the discussion of the determinants of money stock, and in obtaining short-term forecast. We conclude, however, that the liquidity model gives us additional insight in understanding the money supply process and behavior of the banking system in Pakistan.

Given the empirical results, it is also evident that money multiplier predictability cannot be taken as a sufficient condition for accurate forecasts of the money stock. Inclusion of the various ratios which determine the money multiplier, as was done in the Brunner and liquidity models of Chapter VI, gives better forecasts of money stock. It might be possible to improve the forecasts further by relating these ratios to their ultimate determinants and using these relationships to predict the value of the multiplier and of the money stock.

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