THE DEMAND FOR MONEY BY STATE AND LOCAL GOVERNMENTS

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PREFACE

This dissertation tests widely accepted demand for money hypotheses on the state and local government sector, on the states of Washington and Wisconsin, and on Northampton County, State of Pennsylvania. The study utilizes the motives approach to the demand for money and derives a number of testable models. Sixteen models are tested with ordinary least squares at the state and local government sector level. Two models are tested at the state and county level. The study extends earlier studies by applying various statistical tests which were not used in previous studies. The tests are applied to detect specification errors in the regression models.

The findings of this study are that state and local governments' demand for currency, demand deposits, and time deposits (money broadly defined) depends upon a long-term interest rate and state and local governments' purchases of goods and services. The correctly specified model at the sector level is implied to be one in which the variables are in nominal terms, and the form of the model is either linear or log-log. Based on the sector level test results, testing was done on the states of Washington and Wisconsin, and on Northampton County. The results were that the sector model did not explain the demand for money at the state and county level.

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CHAPTER I

INTRODUCTION

Economic theory provides extensive analysis on the demand for money both as a concept and in relation to monetary policy. Empirical work on the demand for money has been conducted mainly with aggregate data and based on postulates about the two basic economic units: the household and the firm. Direct testing of the basic micro-units is prevented by data limitations; therefore, the aggregate testing may or may not accurately represent behavior of the micro-units. On an *a priori* basis it is possible to question the aggregate results due to the buildup procedure of aggregating micro-units. Intermediate levels of aggregation can be defined and tested against the aggregate models. A reasonable expectation is for the aggregate models to explain the demand for money at an intermediate level of aggregation.

The state and local government sector is a sector for which data are available to test aggregate demand models at an intermediate level. State and local governments' holdings of narrowly defined money (M1) ranged from 4.9 to 7.7 percent of total M1 from 1953 to 1968. Their holdings of broadly defined money (M2) ranged from 4.9 to 8.2 percent of total M2 during the same period. While the percentages are not large when compared with other sectors, they are significant. Furthermore, state and local government expenditures and receipts have increased faster than expenditures and receipts of most sectors for the past 20 years, indicating a growing importance for this sector in relation to the overall economy.

Previous studies which applied aggregate models to the study of state and local governments' demand for money were done by Aronson (3), Ashby (4), Maldonado and Ritter (35), and McMahon (38).[1] Aronson applied the Baumol (5) inventory model to determine optimal cash balances for the state and local government sector and for Northampton County, State of Pennsylvania. The Baumol model provided theoretical estimates of optimal transactions balances, but it ignored precautionary and speculative balances. Aronson assumed optimal precautionary balances were 100 percent of optimal transactions balances; thus, theoretical optimal balances (transactions and precautionary) were twice the Baumol model estimates. Speculative balances were excluded on the basis of doubt as to the need for governments to maintain speculative balances.[2] It was assumed that state and local government expenditures were regular enough to meet the model requirement of a constant rate of expenditures. It was also assumed that the interest return on short-term investments was four percent and the cost of a transaction into or out of earning assets was $100. Due to the nature

[1]For research on the legal limitations on state and local governments' investment of temporary cash balances, see Advisory Commission on Intergovernmental Relations (1), Funk (18), Public Affairs Research Council of Louisiana (43), and Webb and Epley (62). For research on the constraint of "keeping the money at home," i.e., investment within the governmental area only, see Cooper (7), Dobson (10), Hollenhorst (20), Monsen and Mangum (41), Webb (61), and Wheeler (63). Cooper explicitly examines the economics of public funds and the economics of the "keeping the money at home" argument.

[2]The theoretical foundation developed in this study establishes a speculative motive for state and local governments. See Chapter II.

of the available data, the actual cash balances, consistent with the model requirements, had to be estimated.[3]

Aronson found large excess cash balances for the state and local government sector. The excess balances were measured two ways. First, the theoretical optimal balances were subtracted from the estimated actual balances. Second, the total of state and local expenditures were divided by 52 to obtain a one week balance, and the one week balance was subtracted from the estimated actual balances. For 1957 the calculated excess balances ranged from $7.8 billion to $8.6 billion, while for 1962 the range was $8.2 billion to $9.3 billion. With an assumed interest rate of four percent, the foregone earnings from not investing excess balances in short-term interest-earning assets were $312-343 million in 1957 and $328-370 million in 1962.[4]

The Baumol model has a major implication that economies of scale exist in cash management. Although this point has been subject to debate, Aronson does not extend the debate but accepts economies of scale as an implicit part of the model. If economies of scale exist then the aggregated data used by Aronson could have resulted in low calculations of optimal balances. Thus, the excess balances could be overestimated. To test the efficiency of cash management at the micro

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[3]Detailed state by state financial data are available in the U. S. Bureau of the Census, "Census of Governments," Compendium of Government Finances (U. S. Government Printing Office, Washington, D.C.). Aronson utilized the 1957 and 1962 compendia. A compendium is published every five years. Aronson's data were aggregated (a state and its local units combined).

[4]The Advisory Commission on Intergovernmental Relations (ACIR) (1) in a germinal 1961 study of idle cash balances of state and local governments estimated the foregone interest earnings at $50-100 million per year. The calculation procedure used by the ACIR was not given.

level, Aronson applied the Baumol model to monthly data for 1964 and 1965 on Northampton County. The results were that Northampton County had large excess cash balances in both years. Aronson concluded that the picture of inefficient cash management at the sector level was repeated at the micro level; hence, the aggregate sector calculations of optimal balances were probably reasonable. However, if economies of scale did exist then centralization would improve cash management whether the micro units were already efficient or not.

In an unpublished study, Ashby (4) utilized demand for money theory to formulate a testable hypothesis on state and local governments' demand for cash balances. Ashby's justification for his study rested on the arguments that the techniques of aggregate demand for money studies were applicable to the state and local government sector, and the state and local sector was unique in its growing importance since 1945. His basic function was derived under the assumption that state and local governments desire to minimize the probability of loss of portfolio principal. While minimizing the principal loss, the governments were expected to maintain acceptable levels for compensating balances and earnings.

The derived function was a detailed, meticulous one which required data observations on a monthly basis for revenue, expenditures, portfolio of interest-earning financial assets, portfolio of cash and demand deposits, and yield on invested portfolio. Usable data were found for the states of Nebraska (1963-66), Washington (1956-66), and Wisconsin (1961-66). Data for the aggregate state and local government sector (1945-62) were available only in quarterly observations; nevertheless, they were used for testing. Data on local governments were not available.

The estimation technique of ordinary least squares (OLS) was used to estimate an equation for each state and the aggregate sector. Dummy variables were used to detect seasonality and any effect from different treasurers. Allowing for the possibility of autoregressive errors, Ashby assumed the errors took the general form of $u_t = \underline{P}u_{t-1} + e_t$. Rather than using an estimating technique to calculate $\underline{P}$, he allowed $\underline{P}$ to take values from 0 to 1 in one-tenth increments. This yielded 11 equations for each set of data. The selected equation was the one with the smallest sum of squared errors, i.e., the equation with the largest R^2. No tests were made on the residuals for heteroscedasticity, non-normality, or other misspecifications.

Ashby's findings were: (1) the net acquisition of financial assets over its amount one year earlier positively influenced the demand for cash balances; (2) strong evidence existed of seasonality; (3) for the state functions, lagged values of the financial asset portfolio, holdings of interest-earning financial assets, net acquisitions of financial assets, and the Treasury bill rate were significant independent variables; and, (4) the functions were not sensitive to changes in state treasurers. The results on the aggregate sector were poorer than for the states. This was probably caused by a deterioration of Ashby's sophisticated approach when applied at the sector level.

Maldonado and Ritter applied the Baumol (5), the Baumol-Sastry (49), and the Miller-Orr (40) models to estimate optimal cash balances for the city and county of Honolulu, "one of the better financial-managed municipalities."[5] During fiscal year 1969, Honolulu held an "average cash balance as a proportion of its operating expenditures of only six percent."[6] The national average was ten percent in fiscal 1969, a decline from 14 percent in 1960. Honolulu held interest-earning liquid assets equal to 85 percent of its total liquid assets. The national average was 70 percent in fiscal year 1969.

The data used by Maldonado and Ritter consisted of monthly observations for fiscal year 1969 (July 1, 1968 to June 30, 1969) on demand deposits and withdrawals, and total operating expenditures. As would be expected, the deposits and withdrawals were not perfectly synchronized; hence, Honolulu had a cash management problem. The basic question of the Maldonado and Ritter study was "could Honolulu have managed its cash more effectively?"[7]

In applying the models, Maldonado and Ritter assumed a 5.8 percent return on liquid assets purchased with idle funds. The 5.8 percent return was equal to the average yield on three-month Treasury bills during the study period. Each transaction from idle cash to interest earning assets or from assets to cash was assumed to cost $100. This was thought to be high because "large commercial banks acting as brokers charge about $25 per transaction for either the purchase or sale of Treasury bills regardless of the dollar amount involved."[8]

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[5]Rita M. Maldonado and Lawrence S. Ritter, "Optimal Municipal Cash Management: A Case Study," Review of Economics and Statistics, LIII, No. 4 (November, 1971), p. 384.

[6]Ibid.

[7]Ibid., p. 385.

[8]Ibid.

The result with the Baumol model was an optimal daily average cash balance equal to only $334,767 when compared to the actual balance of $7,654,000. Assuming investment of the excess idle balances at 5.8 percent, the loss of annual interest earnings was calculated at $425,000.

The Baumol-Sastry model allows the economic unit to borrow temporarily as actual cash balances approach zero. Although temporary borrowing raises the cost of cash management, the cost can be outweighed by the earnings due to lower average cash balances. For this model, Maldonado and Ritter estimated Honolulu could borrow "at 6.9 percent, the average bank prime loan rate over the year."[9] This rate ignores the tax exemption aspect; thus, it is a high estimate. Despite the expensive borrowing rate, the estimate of the optimal average cash balance with the Baumol-Sastry model was $246,723, almost $100,000 below the Baumol model estimate. The loss of annual interest earnings was calculated at $430,000.

The Miller-Orr model extends the other two models by allowing cash inflows or outflows to be random. The fluctuations in cash flows are accounted for by introducing the variance of cash flows as a variable. The model provides a range for cash balances. Over the range there is a lower limit, a return-to-point, and an upper limit. As cash balances approach the lower limit securities are sold to bring cash balances to the return-to point. Maldonado and Ritter set the lower limit at zero; and, estimated the return-to point, the upper limit, and optimal average daily cash balance. The average balance was $1,350,000, an

[9]Ibid., p. 386.

amount considerably above the results of the first two models. Nevertheless, investment of excess idle balances implied by the Miller-Orr model would have yielded Honolulu an annual return of $366,000 at 5.8 percent.

Since none of the models incorporated compensating balances, Maldonado and Ritter extended the Miller-Orr model to consider compensating balances. The procedure was to estimate a unit cost of $.36 for each of the 190,000 warrants handled for Honolulu by the banks.[10] The resulting annual cost was $69,000, which could be generated by a minimum balance of $1,190,000 at 5.8 percent.

The new minimum balance was used as the lower limit for the Miller-Orr model and the optimal average daily cash balance was reestimated. The average balance was $2,540,000, highest of the four estimates, but still below Honolulu's actual balances by enough to yield an annual return of $147,000 at 5.8 percent.

The Honolulu results were generalized to the state and local government sector by taking Honolulu's optimal average cash balances as two percent of annual operating expenditures and applying the two percent figure to the $130 billion annual expenditures by state and local governments in 1970. If state and local governments held only two percent of $130 billion in cash balances they would reduce their cash balances from $12.2 to $2.5 billion, a reduction of $9.7 billion. Investment of the $9.7 billion would yield about $560 million per year

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[10] Foster and Epley report that banks in Sedgwick County, Kansas, charged Sedgwick County $.05 per county issued warrant during the period, 1961-64. See Robert D. Foster and Donald R. Epley, _A Source of Local Government Revenue: An Investment Program_ (Wichita, Kansas: Wichita State University, 1966), p. 55.

at 5.8 percent.

In an unpublished study, McMahon (38) utilized two inventory models to examine cash management by the State of Washington, and Lehigh and Northampton counties, State of Pennsylvania. The two models used were (1) a Simple Model in which cash management decisions were made at regularly scheduled intervals and (2) the Miller-Orr (40) model of the demand for money by firms. The Simple Model allowed cash management decisions to be made at intervals of one month or one week. It minimized the cost of cash management subject to "...(a) the interest opportunity cost, (b) the penalty cost incurred by insufficient cash on hand, and (c) the extent of the variability of the net disbursements for any given time period."[11] The Miller-Orr model was discussed above with regard to Maldonado and Ritter's study.

Application of the Simple Model to data from the State of Washington and Northampton County indicated actual annual average demand deposit balances were in excess of optimal average cash balances. For Washington, the estimated foregone interest earnings were from $1.2 million to $2.3 million for the period, 1961-68. For Northampton County, the estimated foregone interest earnings were from $2,353 to $10,772 for the period, 1964-68.

Application of the Miller-Orr model to data from Washington and Northampton also indicated actual annual average demand deposits were in excess of computed average cash balances. For Washington, the annual foregone interest earnings were estimated to be from $1,526,446

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[11]Robert C. McMahon, "Optimal Cash Balances of State and Local Governments" (unpublished Ph.D. dissertation, Lehigh University, 1970), p. 80.

to $2,352,525 for the period, 1961-68. For Northampton County, the annual foregone interest earnings were estimated to be from $7,477 to $11,153 for the period, 1964-68.

Calculations of the optimal cash balances with both the Simple Model and the Miller-Orr model were made from data on Lehigh County for the period, 1963-67. Demand deposit data were unavailable for Lehigh County; therefore, no comparisons could be made between actual and optimal balances.

This study uses widely accepted aggregate demand for money hypotheses and tests these hypotheses at the sector level, on the states of Washington and Wisconsin, and on Northampton County, State of Pennsylvania.[12] Data limitations prevent extensive testing below the sector level. Two firmly established aggregate models, linear and log-log, are tested with OLS. Variations on the definitions of money and independent variables allow 16 testable models at the sector level. Two models are tested at the state and county level. In addition to standard tests (F-ratio and t-test) on the OLS equations, the study extends previous studies by applying various statistical tests to detect specification errors. The residuals are corrected for degrees of freedom to Theil's (53, 54) best linear unbiased scalar-covariance-matrix (BLUS) residuals. The test statistics calculated are (1) runs test Z to detect a nonrandom arrangement of signs (9); (2) WSET, the Shapiro-Wilk (47, 50) test, to detect a non-normal distribution; and, (3) BAMSET, a variation on Bartlett's test, to detect heteroscedasticity

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[12]For a test of widely accepted aggregate models at the business sector level, see Kliman (29).

(26, 47). The Durbin-Watson statistic to detect autocorrelation is calculated for the OLS residuals, and the von Neumann ratio is calculated to test for autocorrelation in the BLUS residuals (22).

The findings of this study justify the _a priori_ questioning of the aggregate models. Of the 16 models tested, one linear model and one log-log model yielded the expected results. Variations in the definitions of money and interest rates yielded mixed results at the sector level. At the state and county level neither of the two models did well. The general conclusions of this study are (1) more attention should be paid to the buildup process in demand for money models, and (2) more specific functions, based on theorizing directly related to state and local governments, should be developed.

Chapter II presents the theoretical foundation and the testable hypotheses. Chapter III contains the data, tests and results. Chapter IV gives the conclusions.

CHAPTER II

THEORETICAL FOUNDATION

The theoretical foundation for this study is the motives approach to the demand for money as explained in Keynes (27). The three motives for holding money are transactions, precautionary, and speculative. In practice, the first two are combined in one motive, labeled the transactions motive.

The rationale for the transactions motive is economic units require money balances to bridge the gap between receipts and expenditures. Either receipts, expenditures, or both can be unevenly distributed; therefore, there can exist a lack of synchronization between receipts and expenditures. In the case of state and local governments, tax receipts generally occur at one or more payment dates during the fiscal year, while expenditures are distributed throughout the year. Thus, state and local governments have a transactions motive for holding money balances.

The usual economic explanation for the level of transactions balances is they are a function of the aggregate value of transactions, given the institutional arrangements which caused the lack of synchronization. Although the aggregate value of transactions can explain the existence of transactions balances, it does not explain the division between earning assets and cash. Baumol (5) and Tobin (56) extended the analysis of transactions balances to explain the composition of the balances. Under the Baumol-Tobin analysis, transactions balances are a direct function of the aggregate value of transactions and an inverse function of the rate of interest. The inverse relationship to the rate of interest is explained by considering transactors with balances large enough to hold part as earning assets and part as cash. The attraction of interest earnings induces the economic unit to invest in bonds, provided the interest earnings exceed the costs of purchasing and selling bonds. Hence, the transactions motive can be explained as a function of the aggregate value of transactions and the rate of interest. In equation form, the relation is

$$M_T = M_T(T,r)$$

where M_T = transactions balances,

T = aggregate value of transactions,

r = the rate of interest,

$$\frac{\partial M_T}{\partial T} > 0, \text{ and}$$

$$\frac{\partial M_T}{\partial r} < 0.$$

The speculative motive has been traditionally explained by Keynes' liquidity preference theory. This theory holds that speculative balances are inversely related to the rate of interest. Speculative balances will not be converted to cash to meet immediate expenditures; instead, they will be held for investment and future liquidation. If speculative balances are to be held as cash it must be due to expectations on the future rate of interest.

The Keynesian expectations can be divided into two sources: (1)

inelasticity of expectations of future interest rates, and (2) uncertainty about future interest rates. The necessity to postulate inelastic expectations led to criticism of Keynes' approach; however, Tobin (55) reinterpreted liquidity preference in the context of uncertainty. Under the Tobin explanation, the economic unit seeks to avert risk by increasing the ratio of money to financial assets in its portfolio, given a decline in the expected yield on risky assets. In equation form, the relation is

$$M_S = M_S\ (r)$$

where M_S = speculative balances, and

$$\frac{dM_S}{dr} < 0.$$

The speculative motive is explained as a function of the rate of interest within the context of uncertainty. State and local governments manage their portfolios subject to uncertainty; consequently, they have a speculative motive for holding money balances.

Combining the transactions and speculative motives implies state and local governments' demand for money is a direct function of their aggregate value of transactions and an inverse function of the rate of interest. The structural equation is

$$M_{S\&L} = M_{S\&L}(T, r)$$

where $M_{S\&L}$ = state and local government money balances,

$$\frac{\partial M_{S\&L}}{\partial T} > 0, \text{ and}$$

$$\frac{\partial M_{S\&L}}{\partial r} < 0.$$

The structural equation resembles the approach used in aggregate demand for money studies (31, 33, 39). From this general foundation, aggregate studies characteristically utilize two equation forms: linear and log-log; therefore, this study will test the above structural equation with linear and log-log specifications.

In addition to the specification of the function, three essential problems remain. First, what is the proper definition of money; second, what is the relevant interest rate; and, third, what is the measure of the aggregate value of transactions? Aggregate models provide no clear answers to these questions; hence, the procedure in this study is to utilize various definitions for money, interest rates, and the aggregate value of transactions. The next chapter describes the empirical examination of the structural equation and solutions to the three substantive problems.

CHAPTER III

DATA, TESTS AND RESULTS

Data

The three problems mentioned at the end of the previous chapter were first resolved by an examination of the available data. At the sector level, data on money balances were available from the Flow of Funds sector data of the Federal Reserve System. The data allowed two definitions of money, M1 and M2, consisting of quarterly values in billions of dollars at seasonally adjusted annual rates for the study period, 1957-68. The nominal M1 and M2 data were deflated to obtain data in real terms. The deflation was done with the implicit price deflator for state and local government purchases of goods and services, calculated by the Department of Commerce. Thus, the data allowed four definitions of money: M1, nominal and real; and, M2, nominal and real.

Data on numerous interest rates were available from the Federal Reserve (60). Two rates were selected: the three-month Treasury bill rate (RS), and the United States Government long-term bond rate (RL). Quarterly values were calculated as averages of published monthly values. Thus, two interest rates were used: RS, nominal; and, RL, nominal.

For the aggregate value of transactions term (PR), three data series in billions of dollars existed. They were available from the Department of Commerce (57, 58, 59) and were (1) state and local government receipts, (2) state and local government expenditures, and (3) state and local government purchases of goods and services. The latter series was selected because the implicit price deflator used to adjust money balances was in relation to purchases of goods and services. The data on state and local government purchases of goods and services consisted of quarterly values at seasonally adjusted annual rates. The series was deflated to obtain real data. Thus, two terms were used for the aggregate value of transactions: PR, nominal and real.[1]

Data requirements at the state and county level were established after testing at the sector level. Given the two specifications (linear and log-log) and the sector data, 16 sector models were constructed. Testing of the models (discussed in the next section) eliminated 14 models. The two remaining models were tested at the state and county level. These models required nominal data on M2, PR, and RL. The RL data were the same at all levels.

The State of Washington provided monthly data on cash balances and disbursements for the study period, 1957-68 (51). Quarterly values in millions of dollars were calculated as averages of the monthly data. The quarterly cash balances (M1) data on Washington were the basis of a constructed M2 data series on Washington. The ratio between M1 and M2 in Washington was assumed to equal the Flow of Funds sector ratio between M1 and M2; therefore, M1 for Washington was adjusted upward to

[1]State and local government expenditures, nominal and real, were also used for testing. The results were slightly better for state and local government purchases of goods and services; however, the difference was slight.

yield M2 for Washington. The result was M1 and M2 for the State of Washington had the same ratio as M1 and M2 at the sector level, for each quarterly value. Although the adjustment procedure yielded the required M2 series, tests were also performed using Washington's published M1 values. Washington disbursements were accepted as conceptually corresponding to the sector term PR. Testing results are discussed in the next section.

The State of Wisconsin provided monthly data on cash balances and disbursements for the period, 1960-68; however, a gap in the data reduced the useable period to 1960 through the second quarter of 1966 (52). Quarterly values in millions of dollars were calculated as averages of the monthly data. The quarterly cash balances (M1) data were adjusted in the same manner as in the case of Washington to yield M2 for Wisconsin. Tests were also performed using Wisconsin's published M1 values. Wisconsin disbursements were accepted as corresponding to the sector term PR. Testing results are discussed in the next section.

Data for Northampton County, State of Pennsylvania, were obtained from McMahon's study for the period, 1964-68. Quarterly dollar values were calculated as averages of the monthly data. The quarterly demand deposits (M1) data were adjusted on the basis of the same assumption as the state adjustments to yield M2 data. Tests were performed with both M1 and M2. Northampton's expenditures were accepted as corresponding to the sector term PR. Testing results are discussed in the next section. All data series are listed in the Appendix.[2]

Tests and Results

The 16 sector regression models, consisting of linear and log-log specifications and various combinations of the data, are listed in Table I on the next page. The models are divisible into four groups of four models each. The first two groups (Models 1-4 and 5-8) have a common linear specification, and the last two groups (Models 9-12 and 13-16) have a common log-log specification. Models 1-4 and 9-12 utilize nominal data, while Models 5-8 and 13-16 utilize real data except for the interest rate (RS or RL). In a choice between money and bonds only the nominal interest rate is relevant.

Each model has two independent variables suggested by the theoretical model: an interest rate term (RS or RL) and a value of transactions term (PR). A third independent variable, time (T), has been included for two reasons. First, the stability of aggregate demand for money functions is an important issue in aggregate studies because an unstable function has serious implications for monetary policy (16, 39). This stability issue is consequently important at the intermediate level of state and local governments; therefore, the time variable is included to test each model for stability during the study period. Second, the literature on state and local governments' management of cash balances suggests a shift toward more aggressive manage-

[2]Ashby (4) obtained data from the State of Nebraska, Office of the State Treasurer; however, the State Treasurer refused to provide Treasurer's Reports for this study because the reports are kept for only five years and personnel could not spend time searching for the data.

TABLE I

SECTOR REGRESSION MODELS

Number	Specification	Variables Nominal/Real	Dependent	Independent
1.	Linear	Nominal	M1	RS, PR, T
2.	Linear	Nominal	M1	RL, PR, T
3.	Linear	Nominal	M2	RS, PR, T
4.	Linear	Nominal	M2	RL, PR, T
5.	Linear	Real	M1	RS, PR, T
6.	Linear	Real	M1	RL, PR, T
7.	Linear	Real	M2	RS, PR, T
8.	Linear	Real	M2	RL, PR, T
9.	Log-log	Nominal	M1	RS, PR, T
10.	Log-log	Nominal	M1	RL, PR, T
11.	Log-log	Nominal	M2	RS, PR, T
12.	Log-log	Nominal	M2	RL, PR, T
13.	Log-log	Real	M1	RS, PR, T
14.	Log-log	Real	M1	RL, PR, T
15.	Log-log	Real	M2	RS, PR, T
16.	Log-log	Real	M2	RL, PR, T

ment occurred in the late 1950's and early 1960's (1, 11, 12, 13, 14). The Chicago Federal Reserve Bank (12) dates the shift as occurring in 1959. Since the period of this study is 1957-68, the time variable tests for the hypothesized attitude shift. The time variable is entered as a linear sequence from 1 to 48, corresponding to the 48 quarterly data values, a procedure suggested by Klein (28).

The models in Table I are all single equation models. A problem of single equation models is the possibility of simultaneous-equation bias, i.e., the dependent variable and the error term may be related. Simultaneous-equation bias could exist in the 16 models if the dependent variable of any model explained or determined one of the independent variables in the model. Such a possibility exists between the M1 and M2 terms and the PR term. If the PR term is determined by either M1 or M2 then simultaneous-equation bias is a problem.

In considering the relation between M1 and M2 and PR, one can find examples in the press where the spending decisions made by public officials seemed to be determined by available funds. For example, if a surplus occurs in a fiscal year, public officials are seen to alter their spending decisions. Normally such events receive wide public attention; however, they are not the primary determinant of state and local government expenditures. More important explanatory variables are population, population density, per capital income, size of the governmental unit's area, etc.[3] Moreover, for the models in Table I, the term PR is an empirical measure of the theoretical variable, aggregate value of transactions. Hence, the simultaneous-equation bias problem is not considered relevant to this study.

Testing of the models is accomplished with OLS under the classical linear regression model assumptions (CLRMA) (22, 25, 26). The classical model itself is

$$(1) \quad Y = X\underline{B} + \underline{u},$$

where Y is the (n x 1) dependent variable vector; X is the (n x k) independent variable matrix; $\underline{B}$ is the (k x 1) coefficients vector; and, $\underline{u}$ is the (n x 1) residuals vector. The CLRMA are as follows:

1. $E(\underline{u}) = 0$.
2. $E(\underline{uu}') = \underline{s}^2 I_n$.
3. X is a set of nonstochastic numbers.
4. X has rank of k less than n, where k is the number of parameters estimated and n is the number of observations.
5. $\underline{u}$ is normally distributed.[4]

The first assumption requires all residuals to be random variables with zero expectation. The second assumption requires the residuals to have constant variance, be homoscedastic, and have no autocorrela-

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[3]See V. Kerry Smith and William W. Fibiger, "An Approach for Efficient Estimation of State and Local Government Expenditure Determinants," Applied Economics, IV, No. 2 (June, 1972), pp. 101-123, for a summary of 12 empirical studies which attempted to explain state and local government expenditures. None of the studies utilized money balances as an explanatory variable.

[4]This assumption is in order to utilize the t-test on the coefficients. In the event the residuals are not normally distributed, confidence intervals for the coefficients can be constructed with the Bienayme'-Tchebycheff inequality (8).

tion. The third assumption implies that on repeated samples variation in the Y vector is caused by variation in the $\underline{u}$ vector only, and the estimators and tests are conditional on X. The fourth assumption requires the number of observations to exceed the number of estimated parameters; otherwise, the $\underline{B}$ vector cannot be estimated. Lastly, the fifth assumption is required in order to use the t-tests and derive confidence intervals on the estimated coefficients. Explicit recognition of these assumptions places the researcher on a Procrustean bed.[5] To utilize OLS and, at the same time, rest comfortably, the researcher should demonstrate that his empirical results are consistent with the assumptions.

In practice, the researcher, using OLS, estimates a residual vector which cannot meet the above assumptions. From the classical model, the calculated residuals are

$$(2) \quad \underline{u}^* = Y - X\underline{B},$$

where $\underline{B} = (X'X)^{-1}X'Y$. Letting $M = I - X(X'X)^{-1}X'$, (2) can be rewritten as

$$(3) \quad \underline{u}^* = MY.$$

The matrix M is symmetric, idempotent, positive semi-definite and has rank (n - k) (53, 54). Thus, M has the following properties:

$$(4) \quad M' = M = M^2; \; MX = 0.$$

Substituting (1) into (3) gives $\underline{u}^* = M(X\underline{B} + \underline{u})$; however, since $MX = 0$, the substitution yields

$$(5) \quad \underline{u}^* = M\underline{u}.$$

The estimated residuals, $\underline{u}^*$, are linearly transformed from the "true"

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[5]The Procrustean bed analogy is from Gilbert (19).

residuals. They depend not only on $\underline{u}$, but also on the independent variables, the X matrix, because M is calculated from the X matrix. Applying this to the second of the CLRMA, yields

$$(6) \quad E(\underline{uu}') = E(M\underline{uu}'M') = \underline{s}^2MM' = \underline{s}^2M.$$

Since $\underline{u}$ has a nonscalar covariance matrix, the CLRMA are violated.

Despite the fact that OLS residuals violate the CLRMA, the OLS technique has desirable features. The parameter estimates associated with OLS are best linear unbiased (BLU). Building on these desirable features, Theil (53, 54) has developed a procedure for calculating a set of best linear unbiased scalar-covariance-matrix (BLUS) residuals. The procedure developed by Theil defines a (n - k) residual vector as

$$(7) \quad \bar{\underline{u}} = A'Y.$$

(Note the similarity to equation (3) on the preceding page.) The matrix A is a n x (n - k) matrix with the following properties:

$$(8) \quad A'X = 0; \; A'A = I_{(n-k)}.$$

The solution for the matrix A is obtained by partitioning M, X, and A conformably

$$(9) \quad M = \begin{bmatrix} M_{00} & M_{01} \\ M_{10} & M_{11} \end{bmatrix}; \; X = \begin{bmatrix} X_{00} \\ X_{10} \end{bmatrix}; \; A = \begin{bmatrix} A_{01} \\ A_{11} \end{bmatrix}.$$

The subscript 0 indicates k rows or columns and the subscript 1 indicates (n - k) rows or columns. Explicitly,

$$(10a) \quad M_{00} = I - X_{00}(X'X)^{-1}X'_{00},$$

$$(10b) \quad M_{01} = -X_{00}(X'X)^{-1}X'_{10},$$

$$(10c) \quad M_{10} = M'_{01},$$

$$(10d) \quad M_{11} = I - X_{10}(X'X)^{-1}X'_{10},$$

(10e) $A_{01} = -(X_{10}X_{00}^{-1})'A_{11}$, and

(10f) $A_{11} = PD^{1/2}P'$.

The P in (10f) is the (n - k) x (n - k) matrix of eigenvectors of M_{11}. The D in (10f) is $P'M_{11}P$ and is a diagonal matrix. The non-zero elements in D are the eigenvalues of M_{11}. The matrix A' is a (n - k) x n; whereas, the matrix M is n x n. Thus, the $\bar{u}$ vector will be only (n - k) x 1 as opposed to the u^* vector of (n x 1). This is because the parameter vector $\underline{B}$ must be estimated and k degrees of freedom are lost.

Ramsey (47) has proven the k eliminated residuals can be the k smallest of the OLS residuals. In practice the matrix M is sorted to have the diagonal of M in an increasing order. The smallest elements along the diagonal are eliminated until k observations are eliminated. The calculation of $\bar{u}$ is then continued.[6]

Given Ramsey's calculation procedure, a technical problem remains. Computer calculation of BLUS residuals requires large arrays which, in turn, requires large storage space on the computer. (The size of the arrays is directly related to the number of observations and/or variables.) Since no computer has unlimited storage space, a limitation has to be placed on the number of data observations. For this study, the number of observations was limited to 48, which kept the arrays within a reasonable size, but did not seriously restrict the study period.

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[6]The computer program used to calculate the BLUS residuals was provided by Professor Cliff J. Huang, Department of Economics, Vanderbilt University. See Huang (21) and Gilbert (19) for applications of BLUS residuals.

Turning again to the CLRMA, the BLUS residuals corrected the estimated residuals, but they did not insure the CLRMA had been met. Therefore, in addition to calculating BLUS residuals, three test statistics were calculated for both OLS and BLUS residuals, one test statistic for OLS residuals only, and one test statistic for BLUS residuals only. The test statistics were as follows. First, the runs test Z was used to detect a nonrandom arrangement of signs. This statistic served two purposes: it raised general suspicions about the normality of the residuals, and it suggested autocorrelation in the residuals (9). An extremely high number of runs (extremely low Z value) suggested negative autocorrelation. An extremely low number of runs (extremely high Z value) suggested positive autocorrelation. Explicit tests for autocorrelation (Durbin-Watson and D_{BLUS}) were used and are discussed later.

Second, testing of the normality of the residuals was extended by calculating the Shapiro-Wilk (50) test for normality. The test statistic (WSET) was applied to both OLS and BLUS residuals to detect nonnormality in the distribution of the residuals. Ramsey (47) has shown that WSET has the desirable property of detecting incorrect scaling of the dependent variable. Since frequent alternative specifications to the linear and log-log are the inverse, square root, etc., WSET provided guidance as to changing the specifications used in this study.

Third, a variation on Bartlett's test was used to detect heteroscedasticity. Bartlett's test requires a physical examination of the residuals to arrange them into subclasses before calculating the test (26). Ramsey (47) has modified the calculation procedure to facilitate routine use of Bartlett's test. Ramsey's BAMSET specifically tests for simple heteroscedasticity by setting the number of subclasses of squared residuals at three; thus, BAMSET can be programmed for repeated applications.

Fourth, explicit testing for autocorrelation consisted of two tests. First, the von Neumann ratio was considered for detecting autocorrelation; however, the OLS residuals do not meet the underlying condition required to use the von Neumann ratio. (The condition is the true residuals are available.) In this situation, the Durbin-Watson (DW) statistic was applicable because it did not require the true residuals. Thus, the DW statistic was used with the OLS residuals. Second, the von Neumann ratio was appropriate with the BLUS residuals because the required normal distribution in the residuals was met. Thus, the von Neumann ratio (D_{BLUS}) was used with the BLUS residuals.[7]

The OLS calculations were performed with a stepwise regression program, Biomedical Computer Program BMD02R. The independent variables were forced into the program to obtain the desired regression runs. The computer used was a XDS Sigma 6 (Zerox) with a 32 bit word length. The word length, although as long as the popular IBM Model 360's, is rather short. Rounding error has been noted as a problem, especially with the short word length type computer used for this study (17, 45). The characteristic recommendation to prevent rounding error is to use double precision arithmetic (double the word length), even if there is no proof rounding error exists. Since double precision was not available with the BMD program, a test was used to detect rounding error,

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[7]The use of the von Neumann ratio with BLUS residuals is discussed in David S. Huang, Regression and Econometric Methods (New York: John Wiley and Sons, Inc., 1970), pp. 142-143.

rather than assume a priori it existed.[8] The test was to repeat the regression runs with a slight change in the value of one variable. If the change resulted in significantly different coefficients then rounding error would have been detected. The results of the test were negative; rounding error was not suspected.

Sector Results

Estimates of the parameters and test statistics for the 16 models are listed in two groups of eight models each in Table II (Models 1-8) and Table III (Models 9-16) on pages 29 and 30. The information reported in the Tables consists of the estimates of the coefficients, F-ratio, $\bar{R}^2$ (R^2, corrected for degrees of freedom), and the test statistics discussed above. In parentheses below the coefficients is the calculated t-value under the appropriate null hypothesis.

Table II contains information on the linear models with Models 1-4 in nominal data and 5-8 in real data. Models 1-2 and 5-6 have M1 as the dependent variable, while Models 3-4 and 7-8 have M2. The results are as follows. First, the regression results on the independent variables show a preference for RL as opposed to RS. In all cases the coefficient for RL has the expected sign. In two of the four cases, the coefficient is highly significant. RS does not always have the expected sign and has no significant coefficients. Second, the

[8]Technically the BMD program could have been run with double precision by rewriting the program, but this was too costly a solution. Actually, one would not expect rounding error to be serious in this study because the variables in the models are not highly correlated. One would expect rounding error if the terms in the models were powers and cross products. See Freund (17).

TABLE II

SECTOR TEST RESULTS, MODELS 1-8
1957-68

								OLS / BLUS				
Mod.	Const.	RS	RL	PR	T	F-ratio	R^2	Z	WSET	BAMSET	DW	D_{BLUS}
1.	8.09	+0.722		-0.113	+0.156	3.2	.104	+0.85	0.984	1.06	2.06	2.15
		(1.63)		(-1.86)*	(2.02)*			-0.03*	0.984	1.24		
2.	11.63		-1.334	-0.027	+0.126	2.6	.070	+0.85	0.980	1.43	1.97	1.95
			(-1.00)	(-0.39)	(1.60)			-0.41	0.985	1.06		
3.	1.01	-0.052		+0.202	+0.161	104.4**	.865	-1.60	0.984	0.36	1.32*	2.05
		(-0.09)		(2.54)*	(1.59)			+1.39	0.980	0.00		
4.	17.70		-6.709	+0.405	+0.107	168.4**	.912	-1.90	0.983	1.66	1.57	2.06
			(-4.86)**	(5.69)**	(1.31)			-0.96	0.985	0.15		
5.	15.02	+0.586		-0.274	+0.140	2.0	.057	+0.85	0.985	1.59	1.98	1.77
		(1.57)		(-2.06)*	(1.61)			-0.56	0.988	2.86		
6.	14.05		-1.217	-0.091	+0.088	1.5	.032	+0.85	0.983	1.39	1.92	1.59
			(-1.11)	(-0.62)	(1.00)			-1.27	0.988	1.21		
7.	4.06	-0.160		+0.136	+0.155	43.5**	.730	-2.74**	0.987	0.39	1.29*	1.91
		(-0.33)		(0.79)	(1.37)			+0.07*	0.984	0.30		
8.	9.02		-5.674	+0.538	+0.056	76.4**	.828	-2.18*	0.970	1.86	1.64	1.89
			(-5.01)**	(3.56)**	(0.62)			-0.15	0.977	1.18		

* Significant at the 0.05 level.
** Significant at the 0.01 level.
n = 48.

TABLE III

SECTOR TEST RESULTS, MODELS 9-16
1957-68

Mod.	Const.	RS	RL	PR	T	F-ratio	$\bar{R}^2$	Z (OLS / BLUS)	WSET (OLS / BLUS)	BAMSET	DW	D_{BLUS}
9.	1.36	+0.173		+0.103	-0.001	1.5	.011	+0.20	0.967	0.76	1.92	1.84
		(0.99)		(0.30)	(-0.01)			+0.59	0.969	1.63		
10.	0.77		-0.929	+0.640	-0.025	1.8	.024	+0.35	0.961	0.60	1.90	1.83
			(-1.26)	(1.73)*	(-0.27)			+0.21	0.966	1.53		
11.	-2.64	-0.135		+1.418	-0.065	93.1**	.851	-3.06**	0.989	0.71	1.22*	1.73
		(-1.41)		(7.67)**	(-1.22)			-0.67	0.977	2.59		
12.	-2.26		-1.739	+1.868	-0.033	157.6**	.907	-1.31	0.968	2.66	1.66	1.74
			(-5.43)**	(11.63)**	(-0.83)			+0.28	0.948	0.63		
13.	3.44	+0.168		-0.462	-0.000	0.8	-.013	-0.13	0.966	0.68	1.89	2.02
		(0.96)		(-0.82)	(-0.000)			-0.46	0.977	1.62		
14.	1.59		-0.950	+0.424	-0.025	1.1	.004	0.05*	0.962	0.58	1.89	1.98
			(-1.30)	(0.70)	(-0.27)			-0.44	0.976	1.20		
15.	-3.67	-0.136		+1.698	-0.068	41.3**	.720	-3.06**	0.990	0.80	1.23*	1.81
		(-1.43)		(5.57)**	(-1.26)			-1.07	0.974	1.46		
16.	-4.31		-1.713	+2.417	-0.037	74.0**	.823	-0.72	0.968	2.58	1.69	1.35*
			(-5.37)**	(9.16)**	(-0.90)			-1.06	0.968	0.76		

* Significant at the 0.05 level.
** Significant at the 0.01 level.
n = 48.

PR term has the expected positive sign when the dependent variable is M2, nominal or real. PR has a negative sign when the dependent variable is M1, nominal or real. Two coefficients are highly significant; three are significant; and, both the highly significant coefficients occur only with M2. Lastly, the T variable has a consistently positive sign, low coefficient magnitude, and only one significant coefficient. The hypothesized attitude shift is not supported and the functions are apparently stable.

The F-ratio and $\bar{R}^2$ values support the preference for M2, nominal or real, which was shown by the PR term. $\bar{R}^2$ values with any model containing M1 are low.

The test statistics on the residuals are presented in the last five columns of Table II. Values for Z, WSET, and BAMSET are presented with the calculations using BLUS residuals below the calculations using OLS residuals. In the Z column, the values tend to be lower with BLUS residuals. In only one case (Model 7) is a Z value highly significant. In Model 7, the high OLS Z value implies a non-normal distribution and positive autocorrelation. Support for positive autocorrelation is found in the significant low DW value of 1.29; however, the positive autocorrelation is not implied by the BLUS Z value or the D_{BLUS} value. In fact, the Z values yield conflicting results. Autocorrelation in Model 7 is not considered serious, based on the D_{BLUS} value.

In the WSET column the reported values enable one not to reject the hypothesis that the tested distributions are normal. Low values of WSET are significant, i.e., indicate rejection of the hypothesis. Based on the reported values, both OLS and BLUS residuals are normally distributed.

In the BAMSET column, the reported values enable one not to reject the hypothesis that the tested residuals are homoscedastic. BAMSET is distributed as a central Chi-square with two degrees of freedom; therefore, high values of BAMSET are significant. Most BAMSET values are low and show the same tendency as the Z values to be lower with BLUS residuals.

The DW and D_{BLUS} values are reported in the final two columns. The DW values for Models 3 and 7 are significant. The values imply positive autocorrelation; however, the D_{BLUS} values are not significant. Hence, positive autocorrelation is not considered serious.

Table III contains information on the log-log models with Models 9-12 in nominal data and Models 13-16 in real data. Models 9-10 and 13-14 have M1 as the dependent variable, while Models 11-12 and 15-16 have M2. The results are as follows. First, the regression results again show a preference for RL in comparison with RS. All RL coefficients have the expected negative sign; two of the four coefficients are highly significant. The RS coefficients have the expected sign in two of the four models; however, the RS coefficients are not significant. Second, the PR term again has the expected positive sign when associated with M2, nominal or real. PR has the expected sign with M1, nominal, but it has one negative and one positive sign with M1, real. All PR coefficients in models with M2, nominal or real, are highly significant. One PR coefficient is significant with M1, nominal. Lastly, the T variable has all negative signs. None of the coefficients for T is significant; thus, the hypothesized attitude shift is not supported and the functions are apparently stable.

The F-ratio and $\bar{R}^2$ values provide additional support for M2, nominal or real, as the definition of money. The values for any model containing M1, nominal or real, are low, and, in fact, $\bar{R}^2$ for Model 13 is negative.

The test statistics on the residuals are listed in the last five columns of Table III. The Z values show a wide range and have two highly significant values and one significant value, all associated with OLS residuals. The Z values with Models 11 and 15 imply positive autocorrelation, while the Z value (0.05) with Model 14 implies negative autocorrelation because the value is extremely low. All Z values calculated with BLUS do not have significance.

The possibility of positive autocorrelation, raised by the OLS Z values, is supported by the DW values for Models 11 and 15. The two models have low DW values. The support for positive autocorrelation in Models 11 and 15 is reduced when the D_{BLUS} values are considered. Furthermore, the BLUS Z values and D_{BLUS} values for Models 11 and 15 consistently do not reject the hypothesis of no autocorrelation. For Model 16, the possibility of positive autocorrelation is indicated by the value for D_{BLUS}; however, the Z and DW values are satisfactory. Hence, the conclusion for Models 9-16 is autocorrelation is not a problem.

The WSET and BAMSET values are not significant; therefore, the conclusions for Models 9-16 are (1) residuals (OLS and BLUS) are normally distributed; and, (2) the residuals are homoscedastic. Based on the tests used, there is no basis to suspect misspecification for any of the 16 models, and use of the t-tests appears justified.

For all models, an additional problem to consider is multicollinearity. Before doing this, consider the models with regard to their overall features. The insignificant F-ratios and low $\bar{R}^2$ values for the eight models utilizing M1, nominal or real, lead to the conclusion that M2, nominal or real, is the better definition of money. The absence of a significant RS coefficient, and variation in the signs associated with RS, lead to the conclusion that RL, nominal or real, is the better interest rate term. No conclusion can be made about PR, nominal or real. Considering only the eight models with M2 (Models 3-4, 7-8, 11-12, and 15-16), four (Models 4, 8, 12, and 16) have highly significant coefficients on both RL and PR. The magnitudes of the coefficients on Models 4 and 8 are similar as are the magnitudes on the coefficients on Models 12 and 16. Of these four, Models 8 and 16 have considerably lower $\bar{R}^2$'s (0.828 and 0.823 versus 0.912 and 0.907). In addition, Models 8 and 16 have slight question as to the existence of positive autocorrelation; therefore, Models 4 and 12 are selected as the best of the 16. The two models utilize the same variables, but differ as to specification.

For Models 4 and 12, the test for multicollinearity was a simple one, suggested by Huang (22) and Klein (28). If the sample correlation between two variables, x_i and x_j, represented by r_{ij}, is less than the square root of the coefficient of multiple determination, R, then the multicollinearity is "tolerable." Table IV below presents the sample correlations and the square root of the coefficient of multiple determination for Models 4 and 12. All sample correlations are large which is undesirable; however, only the sample correlation larger than R is $r_{PR \cdot T}$ for Model 4. Since T is not significant in Model 4 and 0.969 is close to 0.959, multicollinearity is accepted as tolerable.

For Models 4 and 12, elasticity measurements, associated with the RL and PR terms, are presented in Table V on the next page. The elasticity measurements are based on 95 percent confidence intervals on each coefficient. For Model 4, the linear model, this procedure differs from the customary method of calculating the elasticity at the mean value. The interval procedure relies on the statistical properties of the coefficient estimates. The estimated coefficients and associated standard deviations yield confidence intervals. The true value of the estimated coefficient is expected to lie within the interval with some degree of confidence. The elasticity measurements are calculated at each end of the 95 percent confidence intervals on each coefficient; thus, the true value of the elasticity measurement lies within the intervals presented with 95 percent probability. Since the theory provides no prediction as to the elasticity coefficient, the interval procedure is suitable.

TABLE IV

MULTICOLLINEARITY TEST

	Model 4	Model 12
R	0.959	0.956
$r_{RL \cdot PR}$	0.924	0.906
$r_{RL \cdot T}$	0.881	0.804
$r_{PR \cdot T}$	0.969	0.878

For Model 4, the elasticity intervals are rather wide. For Model 12, the elasticity intervals are somewhat narrower. For both models the elasticity coefficients implied by the intervals are higher than those estimated in Meltzer's (39) aggregate study.[9] Meltzer reported estimates of -1.77 to -0.05 on his interest rate term and -0.10 to 1.05 on his income term. (Note that Meltzer's specifications did not correspond to this study's.)

TABLE V

ELASTICITY MEASUREMENTS

Variable	Model 4	Model 12
RL	-4.73 to -1.95	-2.39 to -1.09
PR	2.06 to 4.33	1.54 to 2.19

Before proceeding to test Models 4 and 12 at the state and county level, the two models were examined for possible improvements. In Model 4, it should be noted that the DW value of 1.57 falls within the inconclusive range for the DW test; therefore, Model 4 could be modified to increase the DW value, but with the satisfactory D_{BLUS} value,

[9]Allan H. Meltzer, "The Demand for Money: The Evidence from the Time Series," Monetary Theory and Policy, ed. Richard S. Thorn (New York: Random House, 1966), p. 143.

this refinement is not justified. In Model 12, the WSET values are relatively low (0.968, OLS and 0.948, BLUS). For the OLS WSET the tabulated WSET is 0.947 at the 0.05 level and 0.954 at the 0.10 level; thus, although the calculated 0.968 is above the critical values, it is close. For the BLUS WSET the tabulated WSET is 0.944 at the 0.05 level and 0.952 at the 0.10 level. The BLUS WSET is very close to the critical 0.05 level.

It was decided to transform the dependent variable for Model 12 to seek an improved specification. The procedure was first to require a noticeable increase in R^2 before considering a transformed model in preference to Model 12. The dependent variable for Model 12 was in logarithms, and the logarithmic variable was transformed in three ways: (1) square root, (2) cube root, and (3) inverse. Since the original variable was logarithmic, the fourth transformation was to enter the variable in its original data form without a logarithmic transformation. The results of the transformations were increases in R^2 from -0.0223 to 0.0032. These increases were considered too small to justify further testing; therefore, sector Models 4 and 12 were accepted as described in Tables II and III.[10] The substantive problem of the definition of money was resolved in favor of nominal M2. The interest rate term was

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[10]In addition to transforming the dependent variable on Model 12, the other 15 models were transformed to seek an improved specification. The transformed models did not yield a large enough increase in R^2 to justify further testing. The 16 models were also tested with the addition of a fourth independent variable, credit market instruments. This eclectic approach was based on the fact the data were available from the Federal Reserve System. Although the R^2's obviously increased, the increases were not large, and the signs and significance of the coefficients were much the same. Hence, neither transformations nor an additional variable improved on the reported test results.

settled as RL, nominal; the value of transactions term as PR, nominal. And, finally, the specification of the function was still either linear or log-log. The test results at the sector level yielded two satisfactory models, 4 (linear) and 12 (log-log).

State of Washington Results

Testing on the State of Washington was accomplished with the sector Models 4 and 12 as the basic foundation. As discussed above, the data for Washington M1 were adjusted to yield the required M2, nominal. Both M1, nominal, and M2, nominal, were used with Models 4 and 12 to test the State of Washington. In addition, the T variable in Models 4 and 12 was eliminated because it was nonsignificant. Since the data for Washington were not seasonally adjusted, a test for seasonality was included by adding three dummy variables (D1, D2, D3) to the Washington quarterly data observations.

The test results for the State of Washington are presented in Tables VI and VII on the next two pages. The first two models utilize M2 as the dependent variable and conceptually conform to sector Models 4 and 12. The second two models utilize the published M1 data as the dependent variable. The results are as follows. First, the coefficients on RL are consistently positive and highly significant with the linear specification. They are insignificant with the log-log specification. Second, the PR term always has the expected sign, but is never significant. Third, the dummy variables are highly significant with the linear specification and M2. They are significant with the linear specification and M1. The F-ratios are all highly significant.

The test statistics on the residuals provide implications for

TABLE VI

WASHINGTON TEST RESULTS
1957-68

Dependent Variable	Constant	RL	PR	D1	D2	D3	F-ratio	R^2
M2, nominal, linear	-61.9	+10.44 (15.9)**	+1.06 (0.3)	+21.07 (10.0)**	+5.59 (10.0)**	+15.11 (10.0)**	27.0**	.734
M2, nominal, log-log	-1.7	+0.78 (0.6)	+1.09 (0.2)	+0.28 (0.1)	+0.04 (0.1)	+0.24 (0.1)	33.9**	.778
M1, nominal linear	-8.8	+8.63 (4.0)**	+0.06 (0.1)	+7.73 (2.5)*	+0.19 (2.5)*	+4.9 (2.5)*	13.24**	.565
M1, nominal, log-log	1.0	+1.00 (0.4)	+0.23 (0.1)	+0.23 (0.1)	-0.01 (0.1)	+0.17 (0.1)	17.57**	.638

* Significant at the 0.05 level.
** Significant at the 0.01 level.
n = 48.

TABLE VII

WASHINGTON TEST STATISTICS
1957-68

Dependent Variable	Z	OLS WSET	BAMSET	Z	BLUS WSET	BAMSET	DW	D_{BLUS}
M2, nominal, linear	1.55	.933*	5.61	0.85	.939*	0.18	2.13	2.19
M2, nominal, log-log	1.74	.964	0.44	-0.10	.971	0.57	2.08	1.97
M1, nominal, linear	-0.75	.928**	2.92	-1.54	.935*	0.90	1.65	1.48*
M1, nominal, log-log	0.05*	.968	1.26	0.29	.988	0.81	1.86	1.45*

* Significant at the 0.05 level.
** Significant at the 0.01 level.

improvements. For the first model, both the OLS and BLUS WSET values are significant. This implies a transformation of the dependent variable might improve the specification. The third model has highly significant OLS WSET and significant BLUS WSET which also imply a transformation. The third model might have an autocorrelation problem, but the DW and D_{BLUS} values yield conflicting interpretations. The second and fourth models apparently are correctly specified with the exception of the fourth model's conflicting Z and D_{BLUS} values. The extremely low Z value (0.05) implies negative autocorrelation, while the D_{BLUS} value of 1.45 implies positive autocorrelation. The promising models for transformation are, therefore, the first and third models.

Transformations on the dependent variables in the first and third models were tried in four forms: (1) logarithmic, (2) inverse, (3) square root, and (4) cube root. For the first model, the increases in R^2 ranged from -0.1015 to 0.0067. The increases were too small to justify further testing, and signs and significance of the coefficients did not change in any meaningful way. For the third model, the increases in R^2 ranged from 0.0153 to 0.0243. The latter increase in R^2 was favorable; however, it was not large enough to justify further testing. As with the first model, the signs and significance of the coefficients did not noticeably change. Thus, the first and third models remained as reported in Table VI. The sector Models 4 and 12 provided a less than satisfactory explanation of the State of Washington's demand for money.

State of Wisconsin Results

Testing on the State of Wisconsin utilized the sector Models 4 and 12 as the foundation. The procedures discussed above on data adjustments and seasonal dummy variables were repeated for Wisconsin.

The test results for the State of Wisconsin are presented on Tables VIII and IX on the next two pages. The results are generally poor. No coefficient is significant. The F-ratios are extremely low and the $\bar{R}^2$ values are all negative. The test statistics do not imply specification problems; thus, the conclusion is that the sector Models 4 and 12 failed to explain Wisconsin's demand for money.

Northampton County Results

The testing procedure used on Washington and Wisconsin was repeated on Northampton County, Pennsylvania. The results are presented in Tables X and XI on pages 45-46. As discussed above, the data for Northampton were in dollars which account for the sizeable coefficients on some of the terms. The results are as follows. First, only in the first model with M2 and the linear specification are the signs on RL and PR as expected. Second, except for D3 no coefficients have significant values. Third, the F-ratios are small but generally highly significant. The associated $\bar{R}^2$ values are small. Lastly, the test statistics imply autocorrelation is a slight problem in all models and the OLS WSET value is significant in the second model. The sector Models 4 and 12 again do not explain the demand for money at a lower level of aggregation. Thus, the difficulty of applying the aggregate models to the sector level is paralleled in the difficulty of applying

TABLE VIII

WISCONSIN TEST RESULTS
1960-66

Dependent Variable	Constant	RL	PR	D1	D2	D3	F-ratio	R^2
M2, nominal, linear	0.6	+1.22 (0.4)	+0.01 (0.7)	-0.35 (-0.3)	+0.28 (1.4)	+0.48 (0.4)	0.5	-.117
M2, nominal, log-log	-0.4	+0.65 (0.4)	+0.24 (0.7)	+0.00 (0.0)	+0.07 (0.4)	+0.13 (0.8)	0.5	-.111
M1, nominal, linear	3.2	-0.21 (-0.2)	+0.00 (0.9)	+0.31 (0.8)	+0.23 (0.5)	+0.54 (1.4)	0.6	-.082
M1, nominal, log-log	0.4	-0.18 (-0.2)	+0.17 (0.8)	+0.11 (0.9)	+0.09 (0.7)	+0.18 (1.5)	0.6	-.081

* Significant at the 0.05 level.
n = 26.

TABLE IX

WISCONSIN TEST STATISTICS
1960-66

Dependent Variable	Z	OLS WSET	BAMSET	Z	BLUS WSET	BAMSET	DW	D_{BLUS}
M2, nominal, linear	-0.20	.950	0.07	-0.65	.954	1.34	1.97	1.52
M2, nominal, log-log	-0.49	.941	0.22	-0.30	.914*	0.90	1.94	1.59
M1, nominal, linear	-0.98	.949	0.09	-0.65	.946	0.82	1.48	1.93
M1, nominal, log-log	-0.98	.941	0.25	-0.53	.953	0.01	1.47	1.75

* Significant at the 0.05 level.

TABLE X

NORTHAMPTON COUNTY TEST RESULTS
1964-68

Dependent Variable	Constant	RL	PR	D1	D2	D3	F-ratio	R^2
M2, nominal,	-206,010	-30,452	+1.87	+28,225	+153,420	+573,730	4.9**	.509
linear		(0.1)	(1.19)	(0.1)	(0.3)	(3.2)**		
M2, nominal,	-3.12	+0.07	+1.23	-0.23	+0.31	+0.7	5.8**	.559
log-log		(0.0)	(1.1)	(-0.6)	(0.9)	(2.5)*		
M1, nominal,	-3,894	+58.78	-0.27	-86,099	+88,649	+196,780	4.6*	.487
linear		(0.6)	(-0.5)	(-1.2)	(1.3)	(3.4)**		
M1, nominal,	15.1	+1.48	-0.42	-0.66	+0.47	+0.79	5.6**	.548
log-log		(0.7)	(-0.4)	(-1.8)	(1.5)	(2.9)**		

* Significant at the 0.05 level.
** Significant at the 0.01 level.
n = 20.

TABLE XI

NORTHAMPTON COUNTY TEST STATISTICS
1964-68

Dependent Variable	Z	OLS WSET	BAMSET	Z	BLUS WSET	BAMSET	DW	D_{BLUS}
M2, nominal, linear	2.07*	.971	1.25	0.37	.960	0.28	2.77	2.57
M2, nominal, log-log	0.71	.892*	0.08	1.26	.917	0.01	2.04	3.10*
M1, nominal, linear	2.14*	.936	2.67	0.37	.952	1.74	2.53	2.32
M1, nominal, log-log	2.07*	.934	0.23	1.39	.934	0.15	2.17	2.94

* Significant at the 0.05 level.

the sector models to the micro-unit level. The next chapter contains the conclusions of the study and discusses pertinent factors related to the findings.

CHAPTER IV

CONCLUSIONS

This study has tested a widely accepted aggregate model of the demand for money at the intermediate level of the state and local government sector. The aggregate model suggested general testing procedures which, when applied to the sector level, yielded mixed results. All tested sector models containing M1 as the dependent variable failed to explain the state and local governments' demand for money in accordance with the theory. Tested models with M2 as the dependent variable did better.

The poor performance of the M1 models can be related to the findings of Aronson (3), Maldonado and Ritter (35), and McMahon (38). These studies found large excess cash balances for the state and local government sector; the state of Washington; Northampton County, Pennsylvania; and, the City and County of Honolulu. If state and local governments' actual cash balances exceed optimal balances then it may be implied that actual balances are a function of noneconomic variables; thus, the M1 demand for money models of this study could fail to show the expected relationships.

Four other factors are pertinent to the results. First, the aggregate models generally utilize annual data, whereas, this study utilized quarterly data. Since the quarterly sector data were, except for the interest rate terms, quarterly observations at seasonally adjusted annual rates, this factor probably did not seriously affect the results. Second, the time periods used in aggregate studies generally do not coincide with the time period used in this study. This is not an unusual situation, but it does qualify slightly the results of this study. Third, this study implicitly accepted the aggregate demand for money models as correctly specified. The study then relies on the two aggregate specifications of linear and log-log. While this procedure is sound within the framework of this study, a relevant question in regard to the results is whether or not the aggregate models were correctly specified. Gilbert (19) found that most aggregate demand for money models were significantly misspecified. The log-log model was the best specification, based on Gilbert's study; the linear specification was unsatisfactory. This study found the linear and log-log specifications to yield satisfactory models; hence, the preference for a log-log model established by Gilbert was supported, but the unsatisfactory quality of the linear specification established by Gilbert was not supported. Fourth, PAR (44) found state funds of Louisiana were kept in many bank accounts; thus, if a scale factor is important to invest efficiently idle balances, the fragmented accounts hinder effective investment.

The best sector models were tested at the state and county micro-unit level. Here the results were poorer than the aggregate models at the sector level. The sector models failed to explain the State of Wisconsin's demand for money and gave poor results on the State of Washington and Northampton County. The difficulty of applying aggregate models to the sector level was repeated in applying intermediate aggregate models to the micro-unit level.

The important findings of this study for state and local governments' demand for money are as follows. First, the appropriate definition of money at the state and local government level is M2. Second, the appropriate interest rate term is RL. Third, the value of transactions term may be represented by state and local governments' purchases of goods and services. Fourth, all variables are on a nominal basis. Fifth, the state and local governments' demand for money functions are stable over time. Lastly, tests on the regression results implied the models were correctly specified as linear or log-log. Since some of the OLS DW statistics indicated autocorrelation, the further testing with BLUS residuals, which implied autocorrelation did not exist, saved the costly procedure of correcting for autocorrelation. The savings allowed by the BLUS residuals were not without cost. To use BLUS residuals substantially increased the cost of this study. Ignoring the programming and loading costs, and considering just the computer time, the calculation of BLUS residuals required about five times the computer time required to calculate the OLS parameters and OLS residuals for one equation of 48 observations and four variables. This differential varied with the number of equations, observations, and/or variables; nevertheless, the calculation of BLUS residuals did substantially increase the research cost. Because the study approach was to search in a general framework for a "correct" model, the increased cost was justified. Confidence in the results was increased by the satisfactory test statistics associated with the BLUS residuals.

The results of this study suggest more attention should be paid to the buildup procedure in aggregate demand for money models. The results suggest specific theoretical models for state and local governments' demand for money should be developed. The aggregate models are based on the behavior of two theoretical units: the household and the firm. State and local governments are unlike households in that they have more permanency. Presumably state and local governments have an unlimited life; however, this must be qualified by the fact that the number of state and local governments fell from 155,116 in 1942 to 81,304 in 1967.[1] The decline was mainly in the number of school districts (108,579 in 1942 to 21,782 in 1967) due to consolidations with an offset in an increase (8,299 in 1942 to 21,264 in 1967) in the number of special districts.[2]

State and local governments are similar enough to business firms to apply inventory models to examine their demand for money balances. This similarity underlies the approach used by Aronson (3), Maldonado and Ritter (35), and McMahon (38). However, state and local governments do manage their cash balances subject to constraints absent in the business firm models. State and local governments frequently have legal limitations on the investments suitable for short-term investment of idle funds. A compilation of these limitations was done in 1956 by the Public Affairs Research Council of Louisiana (PAR) (43). Some of the state limitations listed by PAR were prohibition on investing in bank time deposits, prohibition on investing in securities other than

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[1]James A. Maxwell, Financing State and Local Governments (rev. ed.; Washington: The Brookings Institution, 1966), p. 70.

[2]Ibid.

federal securities, and prohibition on purchase of commercial paper.[3]

Funk (18) tabulated the legal authority for the investment of municipal funds for 33 of the 48 states as of 1952. Nine of the states were silent as to the legal authority for investment of temporarily idle funds; however, in three of these states municipal charters provided for investments. For the 24 states with investment authority, in general the provisions allowed investment in obligations of the United States, the state itself, or subdivisions of the state. The tone of the legal provisions was for temporary investments to be conservatively invested, for example, the State of Maine allowed municipalities to invest in the same securities as savings banks.

Webb and Epley (62) reported on a survey of the states taken in 1968 as to the states' authority to invest idle balances, types of securities permitted, rates of return on invested idle funds, and deposit policies and restrictions on the rate of return from invested funds in time deposits. The survey yielded responses from 22 states. Information on one state (Kansas) was obtained by means other than the survey. The data collected were for the years 1956 and 1967. With regard to authority to invest, in 1967 only one of the 23 states did not permit investment of idle balances, an improvement from 1956 when four of the 23 could not invest idle balances. The types of securities permitted were of a broader spectrum in 1967 than 1956; thus, investment restrictions were eased from 1956 to 1967 for the sampled states. Of the 23 states, four "in 1967 did not hold interest-bearing time

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[3]Public Affairs Research Council of Louisiana, Investment of Idle State Funds (Baton Rouge: Public Affairs Research Council, 1956), p. 7 and pp. 31-32.

deposits or certificates of deposit with commercial banks: Minnesota, Nebraska, Idaho, and Mississippi."[4] These states ranked 15th or lower as to rates of return on idle funds for 1967. Rates of return ranged from a high of 8.63 percent for New York to a low of zero percent for Mississippi. The New York figure was based on the data received; however, Webb and Epley estimated 6 percent as more realistic. The low figure for Mississippi was due to no authority to invest idle cash balances. In most of the states, there were no restrictions on receiving a rate of return in excess of 4 percent on time deposits.

State and local governments tend to heed a constraint of "keeping the money at home." This constraint requires money balances to be deposited within the geographical limits of the governmental units. For example, the money could be placed in a time deposit at a local commercial bank, The deposit is expected to generate additional bank credit, to expanded business, to increase local income, and eventually to increase tax revenue. The latter result justifies the lower interest earnings on the original time deposit as compared to higher yielding alternatives such as Treasury bills. Support for this approach is found in studies by Dobson (10), and Monsen and Mangum (41). Wheeler (63) challenges this approach by analyzing the pledging requirement which arises with public deposits. Given the increase in public deposits, banks must first meet the pledging requirement before expanding bank credit. Using data on the State of Missouri, Wheeler found the pledging requirement offset the supposed gain from "keeping the money

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[4] Samuel C. Webb and Donald R. Epley, "Returns and Restrictions on Inactive State Balances," University of Washington Business Review, XXIX (Winter, 1970), p. 58.

at home." Cooper (7) is also critical of the "keeping the money at home" argument. Cooper argues that if public time deposits generate sufficient tax revenue for the governmental unit to offset the loss in earnings from foregone investments, then the governmental unit would be well advised to borrow externally and place the borrowed funds in a public time deposit for the purpose of generating tax revenue. Such a procedure would enable the governmental unit to expand its tax revenue up to the limit of its borrowing capability. The absurdity of this procedure illustrates the weakness of the "keeping the money at home" argument. The argument relies on the implicit assumption that the public funds never leave the local area. This is an unrealistic restraint on regional capital movements. After the first round deposit in a local bank, the funds are free to seek the highest return which may not be within the governmental unit's geographical area.

The effect of the two constraints on the results of this study is not measurable. The legal limitations have been relaxed in some states, but the effect of such change cannot be recognized in this study. The "keeping the money at home" argument may guide state and local government management of cash balances; however, the magnitude of the constraint is unknown.

In summary, this study found that state and local governments' demand for money (broadly defined) was inversely related to the long-term government bond rate and directly related to state and local governments' purchases of goods and services. This finding was consistent with the theoretical model. The theoretical model was not confirmed for models with narrowly defined money or the three-month Treasury bill rate as variables. The correctly specified model was chosen as one with nominal variables and a functional form of either linear or log-log. The study justifies the a priori questioning of the buildup procedure used in aggregate models. It is also suggestive of additional study which can be done in the relatively open field of the demand for money by state and local governments.

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APPENDIX

DATA

TABLE XII

STATE AND LOCAL GOVERNMENT SECTOR DATA

Time Period		M1	M2	PR	RS	RL	P
		(Billions of Dollars)					
1957	I	7.126	9.910	35.3	3.10	3.27	95.9
	II	6.848	9.659	36.2	3.13	3.43	97.2
	III	6.588	10.258	36.9	3.35	3.63	97.7
	IV	7.395	10.494	37.9	3.30	3.53	98.4
1958	I	6.532	12.009	38.9	1.76	3.25	98.3
	II	8.240	14.554	39.9	1.00	3.15	99.4
	III	6.264	9.439	41.1	1.68	3.57	100.5
	IV	6.472	9.601	42.2	2.69	3.75	101.7
1959	I	6.757	9.762	43.1	2.77	3.91	102.4
	II	7.273	10.716	43.4	3.00	4.06	102.2
	III	8.819	11.124	43.5	3.54	4.15	102.8
	IV	5.188	8.387	43.4	4.23	4.16	102.7
1960	I	7.053	10.443	44.3	3.87	4.22	104.0
	II	6.921	11.885	45.9	2.32	4.10	105.0
	III	7.377	13.717	46.6	2.36	3.82	106.9
	IV	2.977	9.482	47.3	2.30	3.90	107.3
1961	I	6.615	12.154	49.0	2.35	3.82	107.8
	II	4.103	10.749	49.4	2.30	3.80	109.0
	III	5.420	11.766	50.6	2.30	3.97	109.8
	IV	6.006	11.963	52.1	2.46	4.00	111.0
1962	I	4.378	12.233	52.5	2.72	4.06	111.9
	II	7.843	15.244	53.1	2.71	3.89	112.6
	III	6.154	12.633	54.1	2.84	3.97	113.5
	IV	9.579	16.777	55.0	2.81	3.88	114.6
1963	I	8.976	18.953	56.9	2.90	3.91	115.1
	II	9.945	18.407	57.5	2.93	3.98	115.7
	III	6.166	14.884	58.7	3.29	4.01	116.5
	IV	9.617	19.358	59.8	3.49	4.10	117.7
1964	I	10.661	19.294	61.4	3.53	4.15	118.3
	II	5.645	16.225	63.2	3.47	4.16	118.6
	III	10.051	21.062	64.3	3.49	4.14	120.2
	IV	12.478	24.866	65.3	3.68	4.14	121.3

XII (Continued)

Time Period	M1	M2	PR	RS	RL	P
	(Billions of Dollars)					
1965 I	6.885	19.111	67.0	3.89	4.15	121.8
II	8.776	20.521	68.9	3.87	4.14	123.1
III	10.795	25.120	71.3	3.86	4.19	124.2
IV	7.971	23.429	73.2	4.15	4.34	124.7
1966 I	10.703	22.279	75.2	4.60	4.55	126.6
II	7.762	22.548	77.7	4.58	4.58	128.5
III	8.880	23.617	80.1	5.03	4.77	130.6
IV	8.761	23.867	83.0	5.20	4.69	131.9
1967 I	6.128	26.896	86.5	4.51	4.44	133.3
II	5.257	24.917	88.2	3.65	4.71	135.1
III	8.643	25.169	89.9	4.29	4.93	137.7
IV	5.175	19.955	92.9	4.74	5.32	139.3
1968 I	7.130	25.294	96.8	5.04	5.24	141.3
II	10.155	28.465	99.5	5.51	5.30	143.4
III	7.070	30.470	101.8	5.19	5.07	146.1
IV	8.653	31.275	105.1	5.58	5.41	148.2

TABLE XIII

STATE OF WASHINGTON DATA

Time Period		(Millions of Dollars) M1	M2	PR
1957	I	28.3	39.4	47.7
	II	20.0	28.2	52.5
	III	25.9	40.3	50.0
	IV	26.4	37.5	57.5
1958	I	30.7	56.4	58.0
	II	18.9	33.4	62.1
	III	28.1	42.3	52.0
	IV	21.2	31.4	61.6
1959	I	30.2	43.6	58.5
	II	31.2	46.0	62.7
	III	38.8	48.9	49.0
	IV	27.3	44.1	64.7
1960	I	37.8	56.0	60.7
	II	24.4	41.9	60.8
	III	35.5	66.0	56.2
	IV	27.0	86.0	69.2
1961	I	33.2	61.0	64.7
	II	24.1	63.2	73.6
	III	38.6	83.8	71.9
	IV	27.3	54.4	88.8
1962	I	52.5	146.7	85.0
	II	31.3	60.8	81.1
	III	37.7	77.4	68.9
	IV	26.4	46.2	91.8
1963	I	34.1	72.0	88.5
	II	30.2	55.9	101.5
	III	37.4	90.3	82.9
	IV	34.4	69.2	89.7
1964	I	47.5	86.0	86.9
	II	31.0	89.1	89.1
	III	35.8	75.0	84.8
	IV	42.8	85.3	94.0

XIII (Continued)

Time Period	M1	M2	PR
	(Millions of Dollars)		
1965 I	55.0	152.7	96.1
II	39.9	93.3	100.5
III	38.0	88.4	95.2
IV	43.8	128.7	110.0
1966 I	46.1	96.0	114.6
II	52.1	151.4	115.4
III	43.5	115.7	112.4
IV	48.8	132.9	123.7
1967 I	41.6	182.6	125.1
II	39.0	184.8	126.3
III	46.8	136.3	154.0
IV	40.6	156.6	150.6
1968 I	39.9	138.1	158.6
II	49.5	138.8	155.1
III	47.4	204.3	163.9
IV	45.9	167.0	172.8

TABLE XIV

STATE OF WISCONSIN DATA

Time Period		(Millions of Dollars)	
	M1	M2	PR
1960 I	2.8	4.2	219.8
II	4.5	7.7	306.0
III	4.1	7.6	225.4
IV	3.4	10.8	207.7
1961 I	2.9	5.3	201.4
II	3.8	10.0	349.4
III	3.8	8.2	227.2
IV	3.1	6.2	255.1
1962 I	2.7	7.5	246.6
II	2.6	5.0	400.7
III	3.5	7.2	309.9
IV	3.3	5.8	282.5
1963 I	4.0	8.4	386.1
II	2.7	5.0	398.7
III	2.8	6.8	274.4
IV	2.2	4.4	306.5
1964 I	4.6	8.3	426.9
II	3.8	11.0	397.8
III	3.4	7.1	343.5
IV	2.3	4.6	321.1
1965 I	3.0	8.3	400.0
II	3.9	9.1	390.2
III	3.8	8.8	337.1
IV	3.9	11.5	373.4
1966 I	4.0	8.3	455.9
II	3.0	8.7	446.9

TABLE XV

NORTHAMPTON COUNTY, PENNSYLVANIA DATA

Time Period		(Dollars) M1	M2	PR
1964	I	41,804	75,656	243,064
	II	214,890	617,642	393,224
	III	383,508	803,646	342,915
	IV	214,926	428,302	303,187
1965	I	80,152	222,481	246,032
	II	331,298	774,677	376,500
	III	142,864	332,445	349,547
	IV	127,330	374,258	386,193
1966	I	118,828	247,348	278,998
	II	198,194	575,738	480,229
	III	545,132	1,449,817	441,443
	IV	131,244	357,539	467,612
1967	I	70,517	309,501	365,945
	II	219,898	1,042,267	575,614
	III	319,313	929,861	408,245
	IV	221,062	852,424	477,526
1968	I	143,886	497,873	427,815
	II	168,867	473,343	544,875
	III	365,265	1,574,204	567,533
	IV	99,345	361,364	569,531

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VITA

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Candidate for the Degree of

Doctor of Philosophy

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