# RELATIVE EFFECTIVENESS OF MONETARY AND FISCAL PÒLICIES OF ST.LOUIS MODEL : EFFECTS OF REVISED DATA

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Scope and Method of Study: This study is concerned with the updating revision of the St.Louis Econometric Model from the period 1953(I) to 1981(II). The purpose of this study is to see how the revised data has the influence on the analysis of the model. The St.Louis Model is a reduced-form single equation to show the impact of monetary and fiscal actions on total spending (GNP). Two independent variables, money stock (M1B) and high-employment Federal expenditures, represent monetary and fiscal actions, respectively. The model is calculated by using ordinary least square regression with Almon lag structure. The price equation and unemployment rate equation are also estimated.

Findings of Study: This updating revision gives the results that still support the monetarist view, that is, the monetary actions are relatively more effective than the fiscal actions. However, this study shows that the fiscal actions now are also effective which is different from the original results done by Andersen and Carlson (1970).


Adviser's Approval Frank G. Steindl

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# CHAPTER I

# INTRODUCTION

In recent years, the difference between the two schools of "monetarist and fiscalist" (38) reduces to the question of whether the money supply or fiscal variables are the major determinants of aggregate economic activity, and hence the most appropriate tool of stabilization policies.

In the monetarist view, the money stock's behavior was the primary determinant of total spending, and was taken as a major emphasis in economic stabilization programs. During the twenty-five years following the Great Depression (1930's), Keynesian Theory was accepted as a main emphasis on fiscal actions - Federal Government Spending and Taxing Programs - in economic stabilization plans. In the last half of the 1960's, such stabilization policies were called into question because they seemed to fail to control the inflation. Total spending continued to rise rapidly, largely because the money stock grew at a rapid rate during the four years ending in late 1968. These economic developments were in the expectations of the monetarist view. Examination of the historical record made by Friedman and Schwartz (25) concluded that a substantial change in the growth rate of the money supply causes a substantial change in the growth rate of money income both secularly and over the business cycle.

More recently, several authors of the Federal Reserve Bank of St.Louis (Leonall Andersen, Keith Carlson, and Jerry Jordan) have suggested that instead of using the multipliers of monetary and fiscal policies to study their policy effects from the analytical or numerical solutions of an econometric model involving a large number of equations, they should be estimated directly through "reduced form" equations by relating the change in income to current and lagged changes in some appropriate measure of the monetary and fiscal impulses. The results of the original tests showed that the contribution of money, not only current but also lagged, was large and the coefficients implied a reasonable effect of monetary policy. On the other hand, the estimated coefficients of the fiscal variables seemed to support fully the monetarist's claim that their impact was both small and insignificant (2,4). These results were immediately questioned as using the wrong measure of monetary and fiscal actions.

Various models have been developed to rationalize the view of the monetarists with regard to fiscal policy (14,42). It is noted that it is possible to construct models which support the contentions of the monetarists.

The St.Louis econometric model was developed over the period 1968 to 1970. Since published in 1970 (2), its basic form was kept unchanged so as to give more accurate evaluation of its usefulness and validity. However, the model has been reestimated as new information has become available from more accurate sources and methods. The old data have been readjusted and redefined, such as the new definition of GNP and redefinition of money supply from M1 to M1B. With the unchanged form, the assessment of the implications of the model has changed significantly.

## Purpose of Study

The main purpose of this study is to make use of new data sources and to gain the knowledge of method used by Federal Reserve Bank of St.Louis in analyzing economic activity, since new estimating procedures and definitional and conceptual changes have been developed. The latest available estimates have been derived from the most complete set of information and therefore are presumably more accurate than the preliminary estimates of these magnitudes. Since the publication of the 1974 National Income Supplement, the Department of Commerce has published seven comprehensive revisions of the national income and product account (12). The latest of these revisions was published in December 1980. New information from 1972 input-output tables, the 1977 economic censuses[1] (mining, manufacturing, wholesale and retail trade, construction, transportation, selected services and government) and the 1973 and 1976 Taxpayer Compliance Measurement Program provide the basis of the substantial changes. The most important conceptual change involves the redefinition of GNP to include reinvested earnings of incorporated foreign affiliates of U.S. direct investors and eliminate those of incorporated U.S. affiliates of foreign direct investors, and the redefinition of money stock from M1 to M1B.

Benjamin M. Friedman (23) has shown the effect of revised data and extended sample period using the St.Louis Model. His results are subject to many criticisms. Keith M. Carlson (9) also reestimated the St.Louis Model and proposed the results of alternative method, using rate-of-change

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[1]"Interaction in Economic Research", National Bureau of Economic Research, 57th Annual Report, September 1977.

equations instead of first-difference equations. Later in November 1980, Keith M. Carlson and Scott E. Hein (13) showed the relationship between GNP with the old and new concepts of monetary aggregates by using the St.Louis Model.

By these revisions, it can be seen from the model if the monetarist view has changed or not. This study has kept the purpose of the original St.Louis Model to show the influence of monetary and fiscal actions on the past evidence.

## Plan of Study

Chapter I discusses the importance of updating revision on the St.Louis Model. Chapter II explains the stabilization policies and their effectiveness. Monetarist view and some arguments are also mentioned here. Chapter III introduces the St.Louis Model with its performance. Chapter IV gives the empirical results compared with the original results and the analysis is discussed in Chapter V. Chapter VI presents the conclusion of the study with suggestions of further studies.

# CHAPTER II

# LITERATURE REVIEW

## Economic Stabilization Policies

For many reasons, the performance of economic units deviates from the expected economic goals. To help the economy in operating close to the target levels, economic stabilization policies are employed. The implementation of these policies depends upon the state of development of the economy. The two principal types of economic stabilization policies used are :

1. Monetary Policy
2. Fiscal Policy

## Economic Activity and Monetary and Fiscal Actions

Total spending for goods and services (gross national product at current prices) is commonly used as the measure of economic activity. It consists of total spending on final goods and services by households, businesses, and government plus net foreign investment. Real output of goods and services is limited by resource availability and technology, within these constraints, it is determined by the level of total spending and other factors.

Monetary actions involve primarily decisions of the Treasury and the Federal Reserve System. Treasury monetary actions consist of variations in its cash holdings, deposits at Federal Reserve banks and commercial banks, and issuance of Treasury currency (4). Federal Reserve monetary actions include changes in its portfolio of Government securities, member bank reserve requirements, and changes in the Federal Reserve discount rate. Banks and the public are also involved in monetary actions. Commercial bank decisions to hold excess reserves constitute a monetary action. By differential reserve requirements, the public's decisions to hold varying amounts of time deposits at commercial banks or currency relative to demand deposits are a form of monetary action taken into account by stabilization authorities but are not viewed as stabilization actions.

Monetary base is under direct control of the monetary authorities, with major control made by the Federal Reserve System. An increase in the monetary base and money stock, other forces held constant, is considered to be an expansionary influence on economic activity and a decrease to be a restrictive influence.

Fiscal actions are measured by Federal Government spending, changes in Federal tax rates, or Federal budget deficits and surpluses. The Keynesians view concentrates almost exclusively on the direct influence of fiscal actions on total spending. The portfolio approach developed by James Tobin (43, pp. 143-213) showed that fiscal actions by the financing of Government expenditures have both a direct influence on economic activity and an indirect influence. According to Tobin, the influence of fiscal actions results from the manner of financing the Government debt, that is, variations in the relative amounts of demand debt (monetary base), short-term debt, and long-term debt. For example, an expansionary move would be a shift from long-term to short-term debt or a shift from short-term to demand debt. A restrictive action would result from a shift in the opposite direction.

High-employment budget concepts have been developed as measures of the influence of fiscal actions on economic activity (11). The purpose of this concept is to standardize the budget position on some high-employment norm and thereby remove the effect of variations in economic activity on the measured budget surplus or deficit. In this concept, expenditures include both those for goods and services and those for transfer payments, adjusted for the influence of economic activity. Receipts, adjusted in the same manner, primarily reflect legislated changes in Federal Government tax rates, including Social Security taxes. The net of receipts and expenditures is used as a net measure of changes in expenditure provisions and in tax rates.

In all, the full (high) employment budget is an estimate of what the budget result would be, with given spending and tax programs at the full employment level of income, so that the effect of income on taxes and government transfer payments in automatic stabilized process is eliminated.

In addition, the full employment surplus increases if inflation occurs. Inflation will result in a higher portion of a high-employment basis tax receipts. As a consequence, the high-employment surplus will increase even in the absence of fiscal policy changes.

The central calculation of the high-employment budget is the estimate of potential GNP - that rate of production consistent with "full utilization of economic resources on "normal" times. With regard to the current status of estimates of potential output, sets of revised estimates are based primarily on a reevaluation of recent productivity trends and a redefinition of the "full-employment unemployment rate" (41,44). The estimates are supposedly consistent with a variable "full-employment unemployment rate", instead of being a constant 4 percent, the level of unemployment in consideration consistent with full employment now varies between 4 percent in 1955 and 4.9 percent in 1976.

## Monetarist View

The general monetarist view is that the rate of monetary expansion is the main determinant of total spending, measured by gross national product (GNP). The primary consideration of the model is the modern quantity theory of money[1] which stresses the behavior of economic units in response to changes in the money stock. A change in the stock of money will induce a discrepancy between actual and desired holdings of money, which will cause shuffling of the wealth portfolio. Included in this adjustment is a change in spending on goods and services. Changes in total spending, in turn, influence movements in output, employment, and the general price level.

The modern quantity theory of money in its modern form accepts the importance that changes in the money stock can have on real magnitudes, like output and employment in the short run, while influencing only the price level and total spending in the long run. In the long run, the real magnitudes are unaffected (24). The modern quantity theory expects that in the short run a change in the rate of growth in money is followed with a moderate lag by changes in total spending and output, while changes in the price level follow with a somewhat longer lag. These changes in total spending, output, and prices are in the same direction as the change

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[1] The classic work on the quantity theory is Irving Fisher, The Purchasing Power of Money. (New York : Macmillan, 1911).

in the rate of monetary expansion. Following the short-run responses to a change in the rate of monetary growth, total spending and the price level grow at rates determined by the rate of increase in money, while output moves toward and resumes a long-run growth path. Such growth in output is little influenced by the rate of monetary expansion, but by the growth in the economy's productive potential, which depends on the growth of natural resources, capital stock, labor force and productivity.

The basic idea of the monetarist view is that the economy is basically stable and not necessarily subject to recurring periods of severe recession and inflation. Without monetary actions, fiscal actions have only little net effect on total spending or output and price level.[2] Friedman and Schwartz[3] believe that a causal relationship exists between the money supply and economic activity over the business cycle. Most business cycle movements that have occured in the past are attributed primarily to large swings in the rate of growth in the money stock. They claimed that a change in the long-run rate of growth of the money supply will display itself mainly in a different rate of change in prices.

In contrast, a change in the short-run rate of growth of the money supply will alter the growth rate of both output and prices. The evidence from the various econometric models (15,27) and single-equation model (4) suggested that monetary policy is effective, which was consistent with the evidence provided by Friedman.

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[2] Gary Fromm and Lawrence R. Klein, " A Comparison of Eleven Econometric Models of the United States, American Economic Review, LXIII, May 1973, pp.385-93. Except for the St.Louis Model, the multiplier list showed that the fiscal policy was effective.

[3] Milton Friedman and Anna Jacobson Schwartz, " Money and Business Cycles," Review of Economics and Statistics, XLV, February 1963, pp.33-34.

In 1968, Leonall C. Andersen and Jerry L. Jordan (4) published a study of the relative effectiveness of monetary and fiscal policies using single-equation approach. In their empirical work, Andersen and Jordan established a relationship between changes in GNP and changes in the various monetary and fiscal variables with the aid of regression analysis. The empirical results obtained by Andersen and Jordan do not support the view that fiscal policy is effective in the absence of a change in the money supply. They concluded that the evidence is consistent with the view that the response of economic activity to monetary actions is much greater than the response to fiscal actions.

Frank de Leeuw and John Kalchbrenner claimed that the monetary and fiscal variables utilized by Andersen and Jordan do not satisfy statistical requirement (35). They suggested alternative variables and tested the relative effectiveness of monetary and fiscal policies by the same methodology as Andersen and Jordan used, with alternative and highly plausible measures of Federal receipts and monetary base.[4] Their results still supported the view that monetary policy is effective. On the contrary, the results of de Leeuw and Kalchbrenner suggested that fiscal policy is also effective, which many economists believe so. The difference of the results depended upon the development of measures of policy.

Franco Modigliani and Albert Ando[5] suggested that, based on simulation technique, when income is subject to substantial shocks from many

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4 Various attempts were made to replicate the Andersen-Jordan study using alternative measures of fiscal and monetary policies. These studies typically show that both fiscal and monetary policies are effective. See, E. Gerald Corrigan, "The Measurement and Importance of Fiscal Policy Changes, Federal Reserve Bank of New York Monthly Review, 52, June 1970, pp.133-45.

5 Franco Modigliani and Albert Ando, "Impact of Fiscal Actions on Aggregate Income and the Monetarist Controversy: Theory and Evidence," in Jeromi L. Stein, ed., Monetarism, Amsterdam, 1976.

sources other than monetary and fiscal, so that these variables are only a moderate portion of the variations in income (in the United States, it has been of the order of one half to two-thirds), then the St.Louis reduced form method gives highly unstable and unreliable estimates of the true structure of the system generating the data. They argued that the reduced-form equations rely on just two exogenous variables are very unreliable for the purpose of estimating structure. From the theory and evidence, they concluded that a constant rate of growth of nominal money supply can result in a stable economy only in the absence of significant exogenous shocks. Because every element in the economy is influenced by external forces, the economy has been and will continue to be exposed to money significant shocks, coming from such things as war and peace, and other large changes in government expenditures, foreign trade, agriculture, technological progress, population effects, etc..

# CHAPTER III

# METHODOLOGY

## Purpose of the Model

The St. Louis Model has been developed to analyze economic stabilization issues stressing on the influence of monetary expansion on total spending. It is designed to provide information on the most likely course of movement of certain strategic economic variables in response to monetary and fiscal actions.

There are three major purposes of the St. Louis Model (3). First, this model is created with monetarist view to assist in the development and evaluation of stabilization policies. Second, this model is to add a monetarist model that shows the important role of monetary aggregate. Third, the model produces the empirical statements of their monetarist view.

The model was designed to analyze economic stabilization policies, not for exact quarter-to-quarter forecasting. It was to indicate the general nature of the differential response of certain economic variables by monetary and fiscal policies. The St. Louis Model was not claimed as a substitute for the existing econometric models but support the analysis of those models by carrying different implications. The model did not imply that the aggregate behavior could be analyzed quite independently of the behavior of individual sectors.

## General Form of the Model

The St.Louis Model was constructed on the basis of the quantity theory. The model has primarily a policy orientation to demonstrate the impact of alternative monetary and fiscal policies, not to forecast the economic events. So the model need not contain policy variables in order to forecast well.

A summary of the model is presented in algebraic form in Table I. The definition of variables is listed in the Table II according to whether they are exogenous or endogenous in the model. This summary does not show the dimensionality and lag length. The exact form of each equation is given in the analysis section with statistical estimates of coefficients.

Equation 1 is the total spending (nominal GNP) equation. The quarterly change in total spending is specified as a function of current and past changes in money stock and current and past changes in high-employment Federal expenditures.

Equation 2 is the change in the price level as a function of current and past demand pressure and anticipated price changes. Demand pressure is defined in equation 3 as the change in total spending minus the potential increase in output. This price equation is essentially a short-run Phillips curve extended to include changes in total spending and anticipated prices.[1]

Equation 4 defines a change in total spending in terms of its components, the part associated with changes in the price level and the part

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[1] See Appendix A in (2)

TABLE I

Model in Algebraic Form

1. Total Spending Equation

$$\Delta Y_t = f_1 \left( \Delta M_t \ldots\ldots \Delta M_{t-n} , \Delta E_t \ldots\ldots \Delta E_{t-n} \right)$$

2. Price Equation

$$\Delta P_t = f_2 \left( D_t \ldots\ldots D_{t-n} , \Delta P_t^A \right)$$

3. Demand Pressure

$$D_t = \Delta Y_t - \left( X_t^F - X_{t-1} \right)$$

4. Total Spending Identity

$$\Delta Y_t = \Delta P_t + \Delta X_t$$

5. Interest Rate Equation

$$R_t = f_3 \left( \Delta M_t , \Delta X_t \ldots\ldots \Delta X_{t-n} , \Delta P_t , \Delta P_t^A \right)$$

6. Anticipated Price Equation

$$\Delta P_t^A = f_4 \left( \Delta P_{t-1} , \ldots\ldots \Delta P_{t-n} \right)$$

7. Unemployment Rate Equation

$$U_t = f_5 \left( G_t - G_{t-1} \right)$$

8. GNP Gap Identity

$$G_t = \frac{X_t^F - X_t}{X_t^F}$$

TABLE II

Definitions of Variables

Endogenous Variables

$\Delta Y_t$ = change in total spending ( nominal GNP in billion )

$\Delta P_t$ = change in price level ( GNP price deflator in billion )

$D_t$ = demand pressure

$\Delta X_t$ = change in output ( real GNP in billion based on 1972 dollars )

$R_t$ = market interest rate

$\Delta P_t^A$ = anticipated change in price level

$U_t$ = unemployment rate as a percent of civilian labor force

$G_t$ = GNP Gap

Exogenous Variables ( other than lagged variables )

$\Delta M_t$ = change in money stock (M1B) in billion

$\Delta E_t$ = change in high-employment Federal expenditures in billion

$X_t^F$ = potential ( full-employment ) output on 1972 dollars in billion

Note : Subscript 't' means in quarter t.

associated with changes in output. Changes in output can be derived by this equation.

Equation 5 is the market rate of interest as a function of current changes in the money stock, current and past changes in output, current price change and anticipated price change. Anticipated price change is assumed to depend on past price changes showed in equation 6.

Equation 7 is the unemployment rate equation and is a transformation of the GNP Gap, as defined in equation 8, into a measure of unemployment relative to the labor force. This transformation is based on "Okun's Law (40)".

## Working of the Model

The model works as described in the flow diagram shown in Figure 1. Lagged variables, with the exception of past changes in prices, are omitted. The model is constructed as a reduced form which is not completely accurate in describing each of the equations but it can be considered to be accurate enough as a general purpose.

The total spending equation is determined by monetary and fiscal (Federal spending financed by taxes or borrowing from the public) actions, though no direct information is provided as to how such actions affect spending. The change in total spending is combined with potential (full or high employment) output to provide a measure of demand pressure. An estimate of anticipated price change[2] (with the weights on past price changes taken from the long-term interest rate equation) is combined with demand pressure to determine the change in the price level.

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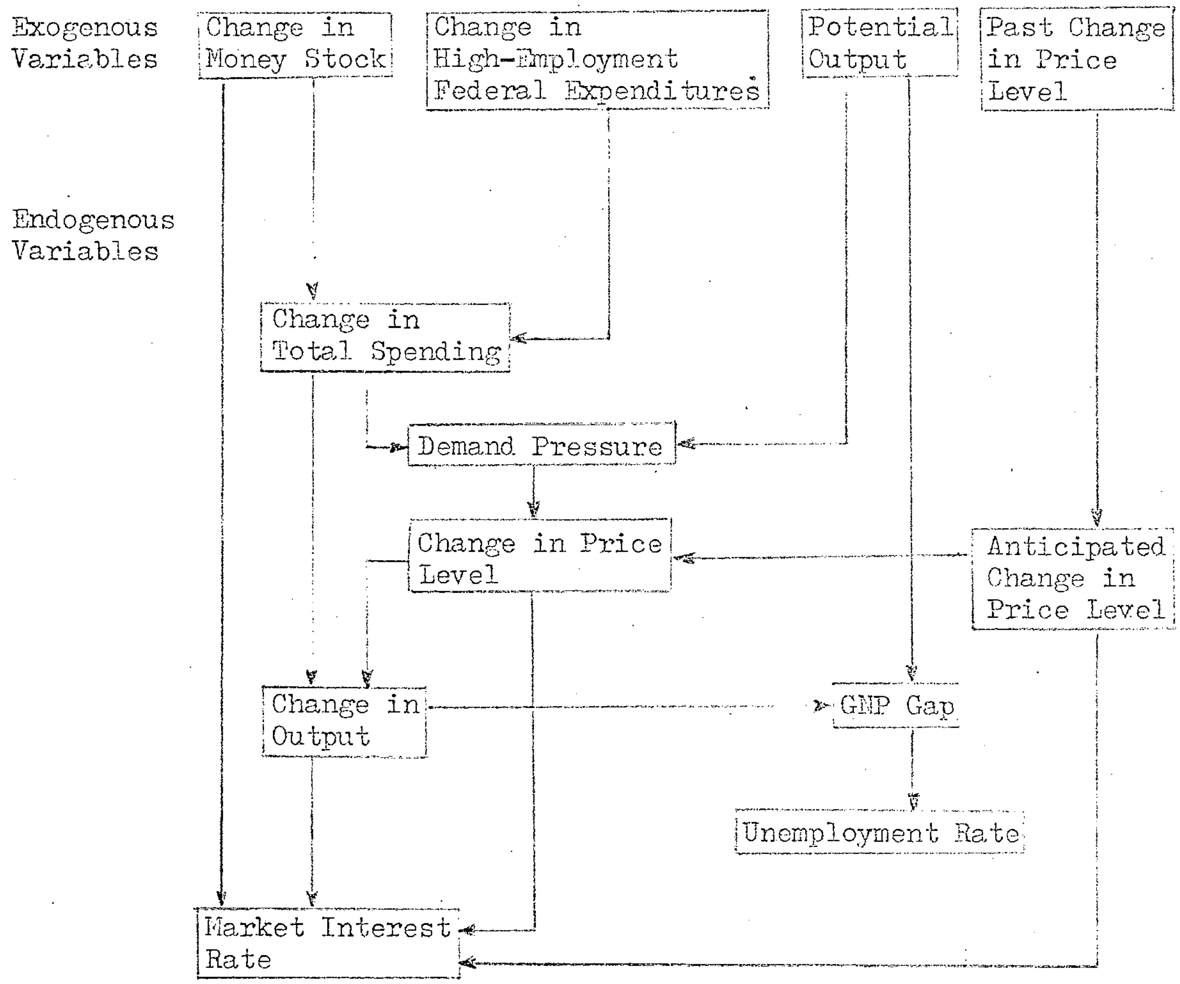
[2] Since the data of anticipated price change were obtained from the St.Louis Bank, the interest-rate equation is not calculated in this report to obtain the weights for anticipated price change calculation.

FIGURE 1

Flow Diagram of St. Louis Model



The total spending identity provides the determination of the change in output, given the change in total spending and the change in prices. This method differs from the standard procedure of most econometric models. Most models are to determine output and prices seperately, then combine to determine total spending.

The change in output, prices, anticipated prices and money stock, determine market interest rates. Interest rates do not exercise a direct role in the model in the determination of spending, output, and prices. Since the data of anticipated prices are available, the estimates of interest rate and anticipated price change in equations 5 and 6 are omitted.

To determine the unemployment rate, the change in output is first combined with potential output to determine the GNP Gap relative to potential output. The GNP Gap is then transformed into the unemployment rate.

## Data and Estimation of the Model

The model is based on what is called a "reduced form" in economics. A reduced-form equation is a derivable consequence of a system of equations which may be hypothesized to represent the structure of the economy (or a structure model). In other words, all of the factors and causal relations which determine total spending (GNP) are "summarized" in one equation.

Each equation of the model is estimated by ordinary least squares. The t-statistics of the parameter estimates are calculated by using equation shown in (29)[3]. Lag structures with degrees of polynomial are estimated by Almon lag technique (1)[4]. Statistical Analysis System (SAS) used

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[3] See (29), problem 12-7, pp.285-86.

[4] See the use and interpretation of the Almon lag technique in (32), pp.10.

in this study is available for the analysis by the computer as well as the program called "OMNITAB"[5].

Table III shows the effect of revised data (9) during the sample period 1953(I)-1969(IV),which were estimated in April 1970 and February 1978. The sum effect of monetary actions ($\Sigma m_i$) is slightly smaller, but the pattern of time distribution among these coefficients continues to hold. For fiscal actions, the effect of data revision is quite small. The peak effect changed from the first quarter ($e_0$=0.56) in April 1970 estimate to the second quarter ($e_1$=0.52) in February 1978 estimate. The sum effects on total spending of the independent variables continue to be dominated by the money variables. In general, there is nothing to indicate that data revision has changed the fundamental conclusions drawn from the original St.Louis total spending equation.

The total spending equation was then estimated through 1976(IV). The total effect of monetary actions continues to be important when the equation is estimated through 1976(IV). The pattern of the lag distribution changed substantially. Originally the effect peaked for the change in money lagged one quarter ($m_1$), but for the period through 1976, the peak came on the first quarter ($m_0$), and only $\Delta M_t$ and $\Delta M_{t-1}$ are significant. For fiscal actions, the sum effect climbed from 0.07 with the data through 1969 to 1.64 with the data through 1976, and is statistically significant. These results show that the fiscal actions are also effective.

Table IV gives the estimates of alternative total spending equation. This alternative method is to express variables in the rate-of-change form. The estimates differ substantially from those presented in the first dif-

[5] OMNITAB was developed by the National Bureau of Standards.

TABLE III

Data Revisions and Updating

of St. Louis Equation

$$\Delta Y_t = \text{constant} + \sum_{i=0}^{4} m_i \Delta M_{t-i} + \sum_{i=0}^{4} e_i \Delta E_{t-i}$$

| | April 1970 Estimate | February 1978 Estimate | |
|---|---|---|---|
| | 1953(I)-1969(IV) | 1953(I)-1969(IV) | 1953(I)-1976(IV) |
| $m_0$ | 1.22 (2.73) | 1.37 (2.96) | 2.24 (4.04) |
| $m_1$ | 1.80 (7.34) | 1.92 (7.62) | 1.55 (4.39) |
| $m_2$ | 1.62 (4.25) | 1.58 (3.96) | 0.43 (0.88) |
| $m_3$ | 0.87 (3.65) | 0.63 (2.59) | 0.07 (0.21) |
| $m_4$ | 0.06 (0.02) | -0.24 (-0.52) | 0.40 (0.70) |
| $\Sigma m_i$ | 5.57 (8.06) | 5.26 (8.01) | 4.48 (5.98) |
| $e_0$ | 0.56 (2.57) | 0.48 (2.32) | 0.34 (1.83) |
| $e_1$ | 0.45 (3.43) | 0.52 (4.07) | 0.25 (1.80) |
| $e_2$ | 0.01 (0.08) | 0.15 (0.81) | 0.21 (1.34) |
| $e_3$ | -0.43 (-3.18) | -0.40 (-3.07) | 0.36 (2.65) |
| $e_4$ | -0.54 (-2.47) | -0.67 (-3.22) | 0.48 (2.47) |
| $\Sigma e_i$ | 0.05 (0.17) | 0.07 (0.21) | 1.64 (4.50) |
| constant | 2.67 (3.46) | 2.32 (2.82) | 0.45 (0.35) |
| $R^2$ | 0.66 | 0.69 | 0.70 |
| S.E. | 3.84 | 3.97 | 7.55 |
| D.W. | 1.75 | 1.93 | 1.77 |

**Note** : All symbols are defined in Table IV. The t-statistics are in parenthesis. $R^2$ is the percent variation in the dependent variable explained by variations in the independent variables. S.E. is the standard error of the estimate. D.W. is the Durbin-Watson statistic.

TABLE IV

Alternative Equation of Total Spending

of St. Louis Equation

$$\dot{Y}_t = \text{constant} + \sum_{i=0}^{4} m_i \dot{M}_{t-i} + \sum_{i=0}^{4} e_i \dot{E}_{t-i}$$

| | 1953(I)-1969(IV) | 1953(I)-1976(IV) |
|---|---|---|
| $m_0$ | 0.30 (2.06) | 0.40 (2.96) |
| $m_1$ | 0.47 (5.09) | 0.41 (5.26) |
| $m_2$ | 0.38 (3.01) | 0.25 (2.14) |
| $m_3$ | 0.09 (1.19) | 0.06 (0.71) |
| $m_4$ | -0.16 (-1.10) | -0.05 (-0.37) |
| $\Sigma m_i$ | 1.08 (4.95) | 1.06 (5.59) |
| $e_0$ | 0.07 (1.77) | 0.08 (2.26) |
| $e_1$ | 0.09 (3.63) | 0.06 (2.52) |
| $e_2$ | 0.03 (0.75) | 0.00 (0.02) |
| $e_3$ | -0.09 (-3.68) | -0.06 (-2.20) |
| $e_4$ | -0.16 (-4.07) | -0.07 (-1.83) |
| $\Sigma e_i$ | -0.06 (-0.88) | 0.03 (0.40) |
| constant | 3.22 (4.04) | 2.69 (3.23) |
| $R^2$ | 0.53 | 0.40 |
| S.E. | 3.25 | 3.75 |
| D.W. | 1.85 | 1.78 |

Note: All symbols are defined in Table IV. The t-statistics are in parentheses. $R^2$ is the percent variation in the dependent variable explained by variations in the independent variables. S.E. is the standard error of the estimate. D.W. is the Durbin-Watson statistic. The dot over a variable signifies compounded annual rate of change.

ference form. The sum effects of both monetary and fiscal actions changed little as the equation was updated. However, the sum effect of fiscal actions changed from negative to positive and was not significantly different from zero for either the original or extended sample periods.

Two data sets were obtained from Federal Reserve Bank of St.Louis. The data are seasonally adjusted quarterly averages. The sample period of the first data set, revised in February 1978, covers 1953(I)-1976(IV). The second data set revised in August 1981 includes 1953(I)-1981(II). The first data set was used to estimate the model and compared to the result in the article (9). This is to make sure that the calculation procedure is correct before the updating revision is done (this procedure confirmation is not shown in this report). All information needed in the analysis is shown in Appendix A (data used in the analysis).

CHAPTER IV

EMPIRICAL RESULTS

For the total spending equation (eq.1) in Table I, the empirical results are shown in Table V. According to the Almon lag technique, the equation is a 4th degree polynomial with both-end restrictions ($m_{-1}=e_{-1}=0$, $m_5=e_5=0$). The t-statistic of each coefficient is in parentheses. Table VI is the result of the rate-of-change form of the total spending equation with the same constraints. The price and unemployment rate equations are shown in Tables VII and VIII, respectively. The constraint on the price equation is a 2nd degree polynomial with one-end restriction ($d_6=0$). The unemployment rate equation is estimated without any restriction. All the calculations cover the quarterly sample period from 1953(I) to 1981(II). The programming steps are shown in the Appendix B. The results of the estimates by regression are shown in Appendix C, accompanied with the covariance matrix of estimates. The plots of error pattern vs. time shown in Appendix D reflect the error pattern of predicted variables in each equation. Since the estimates of parameters are not directly obtained from the regression by ordinary least squares, such calculations to obtain these final estimates (29,34) are demonstrated in the Appendix E.

From the results in Appendix C, model 1 shows the results without end restrictions and is not used in calculation. It is just given to compare with the end-restriction results. Models 2,3,4 are used in the analysis. Model 5 is an alternative calculation similar to model 2.

TABLE V

Total Spending Equation

Constraints : 4th degree polynomial

$$( m_{-1} = e_{-1} = 0 \; ; \; m_5 = e_5 = 0 )$$

$$\Delta Y_t = \text{constant} + \sum_{i=0}^{4} m_i \, \Delta M_{t-i} + \sum_{i=0}^{4} e_i \, \Delta E_{t-i}$$

| | 1953(I)-1969(IV) | 1953(I)-1981(II) |
|---|---|---|
| $m_0$ | 1.22 (2.73) | 3.84 (6.79) |
| $m_1$ | 1.80 (7.34) | 2.95 (7.54) |
| $m_2$ | 1.62 (4.25) | 0.84 (1.83) |
| $m_3$ | 0.87 (3.65) | -0.47 (-1.22) |
| $m_4$ | 0.06 (0.02) | -0.43 (-0.69) |
| $\Sigma m_i$ | 5.57 (8.06) | 6.73 (7.01) |
| $e_0$ | 0.56 (2.57) | 0.66 (3.17) |
| $e_1$ | 0.45 (3.43) | 0.28 (1.79) |
| $e_2$ | 0.01 (0.08) | -0.11 (-0.61) |
| $e_3$ | -0.43 (-3.18) | -0.06 (-0.37) |
| $e_4$ | -0.54 (-2.47) | 0.23 (1.19) |
| $\Sigma e_i$ | 0.05 (0.17) | 1.01 (2.68) |
| constant | 2.67 (3.46) | -0.93 (-0.51) |
| $R^2$ | 0.66 | 0.78 |
| S.E. | 3.84 | 11.48 |
| D.W. | 1.75 | 2.19 |

Note : All symbols are defined in Table IV. The t-statistics are in parentheses and Appendix E shows how to calculate these values. $R^2$ is the percent variation in the dependent variable explained by variations in the independent variables. S.E. is the standard error of the estimate. D.W. is the Durbin-Watson statistic.

TABLE VI

Rate-of-Change Form of Total Spending Equation

$$\dot{Y}_t = \text{constant} + \sum_{i=0}^{4} m_i \dot{M}_{t-i} + \sum_{i=0}^{4} e_i \dot{E}_{t-i}$$

| | 1953(I)-1969(IV) | 1953(I)-1981(II) |
|---|---|---|
| $m_0$ | 0.30 (2.06) | 0.50 (4.62) |
| $m_1$ | 0.47 (5.09) | 0.46 (6.75) |
| $m_2$ | 0.38 (3.01) | 0.22 (0.23) |
| $m_3$ | 0.09 (1.19) | 0.001 (0.03) |
| $m_4$ | -0.16 (-1.10) | -0.06 (-4.60) |
| $\Sigma\ m_i$ | 1.08 (4.95) | 1.10 (6.85) |
| $e_0$ | 0.07 (1.77) | 0.07 (1.81) |
| $e_1$ | 0.09 (3.63) | 0.04 (1.69) |
| $e_2$ | 0.03 (0.75) | -0.01 (-0.40) |
| $e_3$ | -0.09 (-3.68) | -0.06 (-0.90) |
| $e_4$ | -0.16 (-0.88) | -0.07 (-0.33) |
| $\Sigma\ e_i$ | -0.06 (-0.88) | -0.04 (0.27) |
| constant | 3.22 (4.04) | 3.01 (3.66) |
| $R^2$ | 0.53 | 0.44 |
| S.E. | 3.25 | 3.65 |
| D.W. | 1.85 | 2.05 |

Note : All symbols are defined in Table IV. The dot over a variable signifies compounded annual rate of change. The t-statistics are in parentheses. $R^2$ is the percent variation in the dependent variable explained by variations in the independent variables. S.E. is the standard error of the estimate. D.W. is the Durbin-Watson statistic.

TABLE VII

Price Equation

Constraints : 2nd degree polynomial

$( d_{-1} = 0 \; ; \; d_6 = 0 )$

$$\Delta P_t = \text{constant} + \sum_{i=0}^{5} d_i \, D_{t-i} + p \Delta P_t^A$$

| | 1955(I)-1969(IV) | 1953(I)-1981(II) |
|---|---|---|
| $d_0$ | 0.02 (2.63) | 0.08 (2.76) |
| $d_1$ | 0.02 (6.33) | 0.05 (4.05) |
| $d_2$ | 0.02 (6.33) | 0.03 (0.90) |
| $d_3$ | 0.01 (2.93) | 0.01 (0.59) |
| $d_4$ | 0.01 (1.86) | -0.00 (-0.12) |
| $d_5$ | 0.00 (1.38) | -0.00 (-0.38) |
| $\Sigma d_i$ | 0.09 (9.18) | 0.16 (4.10) |
| p | 0.86 (8.55) | 1.76 (23.45) |
| constant | 2.70 (7.07) | -2.21 (-1.87) |
| $R^2$ | 0.87 | 0.85 |
| S.E. | 1.07 | 7.82 |
| D.W. | 1.41 | 1.44 |

Note : All symbols are defined in Table IV. The t-statistics are in parentheses. $R^2$ is the percent variation in the dependent variable explained by variations in the independent variables. S.E. is the standard error of the estimate. D.W. is the Durbin-Watson statistic.

TABLE VIII

Unemployment Rate Equation

$$U_t = \text{constant} + g_0 G_t + g_1 G_{t-1}$$

| | 1955(I)-1969(IV) | 1953(I)-1981(II) |
|---|---|---|
| $g_0$ | 0.04 (1.10) | 0.08 (0.98) |
| $g_1$ | 0.28 (6.80) | 0.42 (5.38) |
| constant | 3.90 (72.50) | 4.56 (51.03) |
| $R^2$ | 0.92 | 0.72 |
| S.E. | 0.30 | 0.71 |
| D.W. | 0.60 | 0.20 |

Note : All symbols are defined in Table IV. The t-statistic are in parentheses. $R^2$ is the percent variation in the depentdent variable explained by variations in the independent variables. S.E. is the standard error of the estimate. D.W. is the Durbin-Watson statistic.

Models 6,7,8 are calculated in the rate-of-change form of the total spending equation. Models 9,10 are the calculation of the price equation ($\Delta P$). Model 11 is the calculation of the unemployment rate equation.

## CHAPTER V

## ANALYSIS OF THE RESULTS

By comparison with other econometric models, the St.Louis Model is quite small and its objective is not to forecast economic events but rather, to see the impact of alternative monetary and fiscal policies. As a result, the relative impact of monetary and fiscal actions shown by the St.Louis Model requires a careful assessment.

### Total Spending

Table V indicates a comparison of original results and updating results of total spending equation. From the original results (1953(I)-1969(IV)), the pattern of the coefficients shows a large and rapid influence of monetary actions on total spending relative to that of fiscal actions. The first three quarters of monetary action account for 83% of total sum effect of monetary actions. Changes in high-employment expenditures first have a positive influence on total spending, but the influence becomes significantly negative after three quarters. For short periods, fiscal effects are significant. The peak effect of monetary actions was in quarter 2 and of fiscal actions in quarter 1.

The pattern of coefficients in the updating total spending equation (1953(I)-1981(II)) still indicates a large and rapid effect of monetary actions on total spending relative to that of fiscal actions. The money variables still dominate total spending. The lag distribution pattern of monetary actions is obviously different from the original results. The peak effect is in the first quarter ($m_0$). The effects in quarters 4 and 5 ($m_3$,$m_4$) are not significant. The sum effect of monetary actions is about 6.7 and it is highly statistically significant with t=7.01.

The sum effect of fiscal actions is only about 1.00 and it is statistically significant ($t_{0.025,102}$=1.99). The effect of fiscal actions is only in quarters 1 and 2 ($e_0$ and $e_1$), though $e_1$ is not significant at t=0.025 level but is significant at t=0.05 level ($t_{0.05,102}$=1.66). The peak is in the first quarter ($e_0$). This result shows the short-run effect of fiscal policies. The summary statistics indicate the $R^2$ is improved but larger standard error of the regression.

From the t-statistic of coefficients (in parentheses), it can be said that the monetary actions are more predictable. Since the greater the t-value, the more confidence in the estimated coefficients, and hence the greater is the reliability of the estimated change in GNP resulting from a change in that variable. The value of $R^2$=0.78 is quite good in this case.

Looking at the error pattern of total spending equation (Figure 3 in Appendix D) gives the evidence that some part of error pattern varies with time (during 1970's). This makes the assumption of constant variance of error suspect (violating the assumption of homoskedasticity). This causes inefficient estimates of coefficients (not smallest variance) and ambiguity of testing statistical hypothesis. Fortunately, the estimated coefficients are still unbiased. One possibility to keep the assumption is to add dummy variables of the period or adjusted independent variables. Another possibility is using generalized least square method instead of ordinary least squares (33, pp.73-80).

Consider the alternative results of the rate-of-change total spending equation in Table VI, the same conclusions still hold except the sum effect of fiscal actions is negative. By considering the value of $R^2$ which is only 0.44, it seems that this regression could not explain the total spending dependent variable satisfactorily. The results from this regression will not be analyzed since it is not as useful so.

## Prices

As defined in equation 3 from Table I, demand pressure gives a measure of the economy's demand for goods and services relative to its capacity to supply goods and services. Given the GNP Gap, defined as $X_t^F - X_{t-1}$, the larger is the change in total spending, the greater is the spillover into higher prices. Given a change in total spending, the larger is the GNP Gap, the greater is the expansion of output and the less the spillover into higher prices. Including past values of demand pressure is to allow lags in the determination of prices in response to changing demand. The anticipated price change is included to allow anticipations of future price movements to influence the current price changes.

Table VII shows a comparison of the price equation in the original and updated versions. In the original results, the influence on prices of the demand pressure variable, $D_{t-1}$ , is significant and positive for five quarters but very small thereafter. The pattern of influence is 70% of the total effect of demand pressure taking place in the first three quarters and 95% in the first five quarters. Anticipated price change, $\Delta P_t^A$ , is a significant determinant of current price change.

In the estimation through 1953(I)-1981(II), the influence on prices of demand pressure variable is significant and positive only for two quarters. The sum effect of demand pressure is significant. These two quarters of demand pressure account for 83% of the total effect of demand pressure. The anticipated price change plays more important role in influencing the current price change, shown by the size of coefficient and its high t-statistic of 23.45.

Looking at the error pattern of price equation (Figure 5), the error pattern is not constant by the late of 1970's. This may be caused by external influences, such as double digit inflation. However, the value of $R^2$=0.85 shows a satisfactory estimation.

Unemployment Rate

The unemployment rate is regressed by unconstrained ordinary least squares (Table VIII). The one-quarter lagged GNP Gap plays an important part to determine the unemployment rate. Moreover, the unemployment rate is a part to determine the price changes through the anticipated price changes, which is not shown in this study. The pattern of coefficients in both original and updating results are still the same.

Looking at the error pattern of unemployment rate equation (Figure 6), it seems that there is a trend of the error. This trend makes the testing of statistical hypothesis unsatisfactory. It could be avoided by some statistical procedures to give the estimated coefficients unbiased and consistent (30, pp.84-85).

Overall, this updating revision gives the results that still support the monetarist view, that the monetary actions are relatively more effective than the fiscal actions. However, the St.Louis Model indicates that the fiscal actions now are also effective. But the model does not tell how those actions affect the total spending. It is still a question whether the model has used the appropriate variables to represent the monetary and fiscal actions. Also, some questions are on the point that the model of reduced form can be chosen to analyze the economic activities. Nevertheless, this study shows that the St.Louis Model gives the results as any large econometric models, and the St.Louis Model is appropriate for the conduct of stabilization policies with some little changes of the equation and constraints (10,13).

## CHAPTER VI

## SUMMARY AND CONCLUSION

This study points out some effects of the St.Louis Model when the data are revised through the 1981(II) period. The sum effect of monetary actions still shows the strong influence on total spending compared with the original results estimated through the 1969(IV) period, but the sum effect of fiscal actions now indicates the significant influence on total spending which is opposite to the original results.

Eventhough the sum effect of fiscal actions indicates the effectiveness on total spending, examination of the estimates through 1981(II) continues to support the monetarist view that the monetary policies are more effective than the fiscal policies.

Economists try to create models that represent their views. Among the number of econometric models, the St.Louis Model is the "Monetarist" character. It is quite small compared to the other large econometric models, with 8 equations and 11 variables. Money stock (M1B) and high-employment Federal expenditures are used as independent variables to explain total spending as dependent variable. The results indicate that both monetary and fiscal policies are effective although the monetary policies remain the predominant influence in term of size and t-statistic. These results conform to other econometric models. The price equation and unemployment rate equation are also estimated in this study.

The model can be used to conduct several dynamic simulation experiments to see the performance of the model as a unit. A comparison can be made with another model. These simulations may provide more information that is helpful to policymakers. It should be remembered that the St.Louis Model is not intended for forecasting, since it is based on the assumption that other variables outside the model do not change.

The St.Louis Model is open to many criticisms, since it is a reduced form using only two variables to explain dependent variable. Some suggested the other alternative independent variables, such as using the adjusted base by deducting bank borrowings from total monetary base, or adjusted high-employment receipts using implicit price deflator for price changes. Some modified the model by not constraining the ends of lag distribution to zero or adding independent variables.

Perhaps different measures for different policy-makings are necessary so long as it can lead to appropriate stabilization actions. In general, both monetary and fiscal actions could be used in combination, depending on proportions of the size of which actions are to be taken.

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# APPENDIX A

## DATA USED IN THE ANALYSIS

SAMPLE PERIOD 1953(I)-1981(II)

SOURCE OF DATA : FEDERAL RESERVE BANK OF ST.LOUIS

| OBS | ID | Y | M | E | IPD | DELTAPA | U | XF | X |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 5301 | 366.1 | 125.601 | 76.8 | 58.76 | 2.65718 | 2.70000 | 613.521 | 623.2 |
| 2 | 5302 | 369.4 | 126.454 | 78.7 | 58.80 | 2.78640 | 2.56667 | 616.656 | 628.3 |
| 3 | 5303 | 368.4 | 126.651 | 77.1 | 59.00 | 2.77449 | 2.73333 | 618.402 | 624.4 |
| 4 | 5304 | 363.1 | 126.750 | 77.5 | 58.74 | 2.74205 | 3.70000 | 622.153 | 618.2 |
| 5 | 5401 | 362.5 | 127.111 | 73.0 | 59.38 | 2.42173 | 5.26667 | 629.152 | 610.5 |
| 6 | 5402 | 362.3 | 127.406 | 68.9 | 59.58 | 2.35365 | 5.80000 | 631.479 | 608.1 |
| 7 | 5403 | 366.7 | 128.620 | 67.9 | 59.45 | 2.13360 | 5.96666 | 637.619 | 616.9 |
| 8 | 5404 | 375.6 | 129.933 | 67.0 | 59.77 | 1.81063 | 5.33333 | 640.393 | 628.4 |
| 9 | 5501 | 388.2 | 131.443 | 67.4 | 60.27 | 1.59260 | 4.73333 | 646.033 | 644.1 |
| 10 | 5502 | 396.2 | 132.230 | 66.5 | 60.65 | 1.52229 | 4.40000 | 651.475 | 653.2 |
| 11 | 5503 | 404.8 | 132.788 | 68.8 | 61.03 | 1.43634 | 4.10000 | 661.473 | 663.2 |
| 12 | 5504 | 411.0 | 133.018 | 68.9 | 61.40 | 1.49881 | 4.23333 | 671.268 | 669.5 |
| 13 | 5601 | 412.8 | 133.477 | 69.4 | 61.91 | 1.55363 | 4.03333 | 671.386 | 666.8 |
| 14 | 5602 | 418.4 | 133.837 | 71.7 | 62.43 | 1.63139 | 4.20000 | 678.887 | 670.2 |
| 15 | 5603 | 423.5 | 133.870 | 72.3 | 63.13 | 1.76202 | 4.13333 | 682.558 | 670.7 |
| 16 | 5604 | 432.1 | 134.494 | 74.1 | 63.69 | 1.94783 | 4.13333 | 686.900 | 678.4 |
| 17 | 5701 | 440.2 | 134.756 | 78.1 | 64.40 | 2.08212 | 3.93333 | 690.446 | 683.5 |
| 18 | 5702 | 442.3 | 134.822 | 79.7 | 64.65 | 2.30204 | 4.10000 | 697.263 | 684.1 |
| 19 | 5703 | 449.4 | 134.854 | 79.7 | 65.28 | 2.36182 | 4.23333 | 706.839 | 688.5 |
| 20 | 5704 | 444.0 | 134.132 | 80.3 | 65.37 | 2.58460 | 4.93333 | 707.548 | 679.1 |
| 21 | 5801 | 436.8 | 133.968 | 81.8 | 65.63 | 2.51220 | 6.30000 | 708.237 | 665.5 |
| 22 | 5802 | 440.7 | 135.510 | 85.0 | 65.79 | 2.45621 | 7.36666 | 717.492 | 669.9 |
| 23 | 5803 | 453.9 | 136.856 | 89.0 | 66.17 | 2.37758 | 7.33333 | 725.338 | 685.9 |
| 24 | 5804 | 467.0 | 138.530 | 91.1 | 66.47 | 2.39745 | 6.36666 | 726.335 | 702.5 |
| 25 | 5901 | 477.0 | 140.400 | 89.2 | 67.04 | 2.38546 | 5.83333 | 728.189 | 711.5 |
| 26 | 5902 | 490.6 | 141.533 | 89.0 | 67.55 | 2.39724 | 5.10000 | 736.982 | 726.2 |
| 27 | 5903 | 489.0 | 142.567 | 90.6 | 67.81 | 2.41867 | 5.26667 | 744.649 | 721.2 |
| 28 | 5904 | 495.0 | 141.433 | 90.8 | 68.00 | 2.28204 | 5.60000 | 754.052 | 727.9 |
| 29 | 6001 | 506.9 | 140.933 | 89.4 | 68.44 | 2.14588 | 5.13333 | 755.595 | 740.7 |
| 30 | 6002 | 506.3 | 140.733 | 91.4 | 68.56 | 2.11744 | 5.23333 | 762.054 | 738.4 |
| 31 | 6003 | 508.0 | 142.133 | 93.0 | 68.86 | 1.92297 | 5.53333 | 766.847 | 737.7 |
| 32 | 6004 | 504.8 | 142.233 | 94.0 | 68.96 | 1.80155 | 6.26666 | 772.352 | 732.1 |
| 33 | 6101 | 508.2 | 142.733 | 96.7 | 68.88 | 1.60849 | 6.80000 | 779.628 | 737.7 |
| 34 | 6102 | 519.2 | 143.900 | 99.3 | 69.22 | 1.41448 | 7.00000 | 785.338 | 750.1 |
| 35 | 6103 | 528.2 | 144.800 | 100.8 | 69.54 | 1.36212 | 6.76666 | 793.448 | 759.6 |
| 36 | 6104 | 542.6 | 146.133 | 102.8 | 69.65 | 1.34242 | 6.20000 | 802.139 | 779.0 |
| 37 | 6201 | 554.2 | 147.167 | 107.8 | 70.23 | 1.28055 | 5.63333 | 810.689 | 789.2 |
| 38 | 6202 | 562.7 | 148.100 | 108.1 | 70.48 | 1.40809 | 5.53333 | 822.285 | 798.4 |
| 39 | 6203 | 568.9 | 147.967 | 109.5 | 70.62 | 1.41233 | 5.56667 | 826.761 | 805.5 |
| 40 | 6204 | 574.3 | 148.833 | 111.7 | 71.08 | 1.36761 | 5.53333 | 826.903 | 808.0 |
| 41 | 6301 | 582.0 | 150.333 | 112.2 | 71.41 | 1.42180 | 5.76666 | 835.361 | 815.0 |
| 42 | 6302 | 590.7 | 151.733 | 111.0 | 71.46 | 1.43523 | 5.73333 | 841.140 | 826.7 |

| ID | Y | M | E | IPD | DELTAPA | L | XF | X |
|---|---|---|---|---|---|---|---|---|
| 6303 | 601.8 | 153.333 | 113.1 | 71.66 | 1.3522 | 5.30000 | 851.66 | 839.8 |
| 6304 | 612.4 | 154.600 | 115.7 | 72.17 | 1.3418 | 5.56667 | 861.26 | 848.6 |
| 6401 | 625.3 | 155.867 | 117.3 | 72.36 | 1.4694 | 5.46666 | 869.54 | 864.2 |
| 6402 | 634.0 | 157.033 | 118.0 | 72.57 | 1.4921 | 5.20000 | 876.01 | 873.7 |
| 6403 | 642.8 | 159.633 | 117.0 | 72.97 | 1.5104 | 5.00000 | 880.34 | 880.9 |
| 6404 | 648.8 | 161.600 | 117.5 | 73.16 | 1.6354 | 4.36667 | 884.22 | 886.8 |
| 6501 | 668.8 | 162.867 | 117.6 | 73.77 | 1.6575 | 4.90000 | 895.60 | 906.7 |
| 6502 | 681.7 | 163.833 | 120.1 | 74.13 | 1.9206 | 4.66667 | 908.15 | 919.7 |
| 6503 | 696.4 | 165.767 | 126.1 | 74.56 | 2.0564 | 4.36667 | 918.55 | 934.1 |
| 6504 | 717.2 | 168.700 | 130.6 | 74.96 | 2.2316 | 4.10000 | 931.50 | 956.8 |
| 6601 | 738.5 | 171.633 | 136.1 | 75.71 | 2.4308 | 3.86667 | 944.28 | 975.4 |
| 6602 | 750.0 | 173.500 | 140.3 | 76.58 | 2.8874 | 3.83333 | 957.47 | 979.3 |
| 6603 | 760.6 | 172.967 | 147.3 | 76.99 | 3.4035 | 3.76667 | 965.21 | 987.9 |
| 6604 | 774.9 | 173.367 | 152.3 | 77.75 | 3.6564 | 3.70000 | 975.41 | 996.6 |
| 6701 | 780.7 | 175.233 | 160.3 | 78.25 | 4.1735 | 3.83333 | 983.92 | 997.8 |
| 6702 | 788.6 | 177.667 | 161.4 | 78.53 | 4.4363 | 3.83333 | 987.37 | 1004.2 |
| 6703 | 805.7 | 181.567 | 165.6 | 79.28 | 4.5627 | 3.80000 | 1000.04 | 1016.2 |
| 6704 | 823.3 | 184.367 | 169.3 | 80.13 | 5.0471 | 3.90000 | 1012.82 | 1027.3 |
| 6801 | 841.2 | 186.976 | 173.9 | 81.15 | 5.5765 | 3.73333 | 1019.78 | 1036.6 |
| 6802 | 867.2 | 190.300 | 181.6 | 82.14 | 6.2388 | 3.36667 | 1035.91 | 1055.7 |
| 6803 | 884.9 | 193.967 | 183.3 | 82.64 | 7.0077 | 3.53333 | 1044.60 | 1068.2 |
| 6804 | 900.3 | 197.967 | 186.0 | 83.99 | 7.4786 | 3.40000 | 1054.88 | 1071.8 |
| 6901 | 921.2 | 201.733 | 185.0 | 84.97 | 8.2867 | 3.10000 | 1073.82 | 1084.2 |
| 6902 | 937.4 | 203.467 | 188.0 | 86.10 | 9.0115 | 3.43333 | 1085.54 | 1088.8 |
| 6903 | 955.3 | 204.233 | 190.7 | 87.49 | 9.7654 | 3.56667 | 1096.49 | 1092.0 |
| 6904 | 962.0 | 205.600 | 193.8 | 88.62 | 10.7175 | 3.56667 | 1101.61 | 1085.6 |
| 7001 | 972.0 | 207.667 | 194.5 | 89.89 | 11.2969 | 4.16667 | 1114.43 | 1080.4 |
| 7002 | 986.3 | 209.900 | 207.5 | 91.07 | 11.8336 | 4.73333 | 1121.08 | 1083.0 |
| 7003 | 1003.6 | 212.433 | 205.2 | 91.79 | 12.2015 | 5.16667 | 1130.92 | 1093.3 |
| 7004 | 1009.0 | 215.800 | 208.8 | 93.03 | 12.2607 | 5.86666 | 1137.81 | 1084.7 |
| 7101 | 1049.3 | 219.633 | 211.2 | 94.40 | 12.3691 | 5.90000 | 1150.41 | 1111.5 |
| 7102 | 1068.9 | 224.867 | 218.2 | 95.70 | 12.8802 | 5.90000 | 1160.69 | 1116.9 |
| 7103 | 1086.6 | 228.400 | 219.5 | 96.82 | 13.0793 | 6.03333 | 1166.20 | 1125.7 |
| 7104 | 1105.8 | 230.300 | 223.1 | 97.39 | 12.9035 | 5.96666 | 1176.34 | 1135.4 |
| 7201 | 1142.4 | 235.000 | 233.1 | 98.72 | 12.8237 | 5.76666 | 1189.13 | 1157.2 |
| 7202 | 1171.7 | 239.233 | 241.8 | 99.42 | 12.7379 | 5.63333 | 1203.84 | 1178.5 |
| 7203 | 1196.1 | 244.000 | 236.5 | 100.25 | 12.3661 | 5.60000 | 1217.55 | 1193.1 |
| 7204 | 1233.5 | 249.833 | 258.2 | 101.54 | 11.9882 | 5.33333 | 1226.95 | 1214.8 |
| 7301 | 1283.5 | 255.067 | 260.1 | 102.92 | 12.0417 | 4.93333 | 1238.58 | 1247.1 |
| 7302 | 1307.6 | 258.167 | 262.5 | 104.69 | 12.2976 | 4.90000 | 1249.44 | 1249.0 |
| 7303 | 1337.7 | 261.267 | 262.3 | 106.44 | 12.6761 | 4.30000 | 1264.11 | 1256.8 |
| 7304 | 1376.7 | 264.366 | 271.3 | 108.66 | 13.1927 | 4.76667 | 1274.52 | 1267.0 |

| ID | Y | M | E | IPD | DELTAPA | U | XP | X |
|---|---|---|---|---|---|---|---|---|
| 7401 | 1387.7 | 268.767 | 279.3 | 110.60 | 14.2834 | 5.06667 | 1275.21 | 1254.7 |
| 7402 | 1423.8 | 271.267 | 294.2 | 113.33 | 14.9486 | 5.13333 | 1275.62 | 1256.3 |
| 7403 | 1451.6 | 273.733 | 303.3 | 116.26 | 16.5434 | 5.60000 | 1279.87 | 1248.6 |
| 7404 | 1473.8 | 276.933 | 313.8 | 119.59 | 18.1388 | 6.53333 | 1289.94 | 1232.4 |
| 7501 | 1479.8 | 279.000 | 324.9 | 122.67 | 19.6758 | 6.20000 | 1298.96 | 1206.3 |
| 7502 | 1516.7 | 283.333 | 340.8 | 124.22 | 20.4245 | 6.86666 | 1302.31 | 1221.0 |
| 7503 | 1578.5 | 288.633 | 352.1 | 126.44 | 20.8085 | 6.99999 | 1309.56 | 1248.4 |
| 7504 | 1621.8 | 290.967 | 361.8 | 128.74 | 21.7540 | 6.26666 | 1320.77 | 1259.7 |
| 7601 | 1672.0 | 295.000 | 365.6 | 129.90 | 22.4243 | 7.73333 | 1329.07 | 1287.2 |
| 7602 | 1698.6 | 299.967 | 368.8 | 131.08 | 22.5296 | 7.50000 | 1340.62 | 1295.8 |
| 7603 | 1729.0 | 303.233 | 377.6 | 132.66 | 22.1265 | 7.70000 | 1350.88 | 1303.3 |
| 7604 | 1772.5 | 308.667 | 390.2 | 134.75 | 21.8232 | 7.76667 | 1364.94 | 1315.4 |
| 7701 | 1839.1 | 316.167 | 393.9 | 136.64 | 21.7009 | 7.50000 | 1379.10 | 1345.9 |
| 7702 | 1893.9 | 321.600 | 404.9 | 138.91 | 21.5636 | 7.13333 | 1388.17 | 1363.4 |
| 7703 | 1950.4 | 327.267 | 421.7 | 140.75 | 21.4032 | 6.96667 | 1399.90 | 1385.8 |
| 7704 | 1988.6 | 334.267 | 434.9 | 142.91 | 20.9461 | 6.60000 | 1413.19 | 1391.5 |
| 7801 | 2032.4 | 340.533 | 442.1 | 144.93 | 20.5694 | 6.26667 | 1434.27 | 1402.3 |
| 7802 | 2129.6 | 348.400 | 447.1 | 148.63 | 20.1202 | 5.96667 | 1457.02 | 1432.8 |
| 7803 | 2190.5 | 355.300 | 460.1 | 151.42 | 21.7043 | 5.93333 | 1476.72 | 1446.7 |
| 7804 | 2271.9 | 361.600 | 477.8 | 154.99 | 22.4019 | 5.83333 | 1499.82 | 1465.8 |
| 7901 | 2340.6 | 366.533 | 485.7 | 158.16 | 24.2283 | 5.83333 | 1519.58 | 1479.9 |
| 7902 | 2374.6 | 375.833 | 491.6 | 161.17 | 25.9489 | 5.66667 | 1518.85 | 1473.4 |
| 7903 | 2444.1 | 384.366 | 513.2 | 164.23 | 27.5282 | 5.76667 | 1527.50 | 1488.2 |
| 7904 | 2496.3 | 388.800 | 535.3 | 167.47 | 29.6568 | 5.93333 | 1530.98 | 1490.6 |
| 8001 | 2571.7 | 395.433 | 560.3 | 171.23 | 31.5726 | 6.23333 | 1543.18 | 1501.9 |
| 8002 | 2564.8 | 392.400 | 578.2 | 175.28 | 34.0392 | 7.33333 | 1541.42 | 1463.3 |
| 8003 | 2637.3 | 406.000 | 602.9 | 179.18 | 35.1613 | 7.53333 | 1554.97 | 1471.9 |
| 8004 | 2730.6 | 417.000 | 628.8 | 183.81 | 36.9850 | 7.50000 | 1568.41 | 1485.6 |
| 8101 | 2853.0 | 422.067 | 647.6 | 186.14 | 39.3227 | 7.33300 | 1578.12 | 1516.4 |
| 8102 | 2881.0 | 431.333 | 652.9 | 190.91 | 41.7591 | 7.00000 | 1587.89 | 1509.1 |

# APPENDIX B

## PROGRAMMING STEPS

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

```
DATA FISCAL;
INPUT ID E;
CARDS;

DATA YINCOME;
INPUT ID Y;
CARDS;

DATA MONEY;
INPUT ID M;
CARDS;

DATA DELTAPA;
INPUT ID DELTAPA;
CARDS;

DATA IPD1972;
INPUT ID IPD;
CARDS;

DATA REALGNP;
INPUT ID X;
CARDS;

DATA POTOUT;
INPUT ID XF;
CARDS;

DATA UT;
INPUT ID U;
CARDS;

PROC SORT DATA=YINCOME;
     BY ID;
```

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

```
PROC SORT DATA=FISCAL;
     BY ID;


PROC SORT DATA=MONEY;
     BY ID;


PROC SORT DATA=DELTAPA;
     BY ID;


PROC SORT DATA=IPD1972;
     BY ID;


PROC SORT DATA=REALGNP;
     BY ID;


PROC SORT DATA=POTOUT;
     BY ID;


PROC SORT DATA=UT;
     BY ID;


DATA GNP;
    MERGE YINCOME FISCAL MONEY DELTAPA IPD1972 REALGNP POTOUT UT;
   BY ID;
IF ID=>5301 AND ID=<8102;
*FOR MODEL 1 2 3 4;
LY1=LAG(Y);
FDY=Y-LY1;
LM1=LAG(M);
FDM=M-LM1;
LE1=LAG(E);
FDE=E-LE1;
LFDM1=LAG(FDM);
LFDM2=LAG2(FDM);
LFDM3=LAG3(FDM);
LFDM4=LAG4(FDM);
ZM0=FDM+LFDM1+LFDM2+LFDM3+LFDM4;
```

```
ZM1=LFDM1+2*LFDM2+3*LFDM3+4*LFDM4;
ZM2=LFDM1+4*LFDM2+9*LFDM3+16*LFDM4;
ZM3=LFDM1+8*LFDM2+27*LFDM3+64*LFDM4;
ZM4=LFDM1+16*LFDM2+81*LFDM3+256*LFDM4;
LFDE1=LAG(FDE);
LFDE2=LAG2(FDE);
LFDE3=LAG3(FDE);
LFDE4=LAG4(FDE);
ZE0=FDE+LFDE1+LFDE2+LFDE3+LFDE4;
ZE1=LFDE1+2*LFDE2+3*LFDE3+4*LFDE4;
ZE2=LFDE1+4*LFDE2+9*LFDE3+16*LFDE4;
ZE3=LFDE1+8*LFDE2+27*LFDE3+64*LFDE4;
ZE4=LFDE1+16*LFDE2+81*LFDE3+256*LFDE4;
*FOR MODEL 5;
WT2M=-5*ZM0-4*ZM1+ZM2;
WT3M=-20*ZM0-21*ZM1+ZM3;
WT4M=-105*ZM0-104*ZM1+ZM4;
WT2E=-5*ZE0-4*ZE1+ZE2;
WT3E=-20*ZE0-21*ZE1+ZE3;
WT4E=-105*ZE0-104*ZE1+ZE4;
*FOR MODEL 6 7 8;
YDOT=(((Y/LAG(Y))**4)-1)*100;
MDOT=(((M/LAG(M))**4)-1)*100;
EDOT =(((E/LAG(E))**4)-1)*100;
LMDOT1=LAG(MDOT);
LMDOT2=LAG2(MDOT);
LMDOT3=LAG3(MDOT);
LMDOT4=LAG4(MDOT);
LEDOT1=LAG(EDOT);
LEDOT2=LAG2(EDOT);
LEDOT3=LAG3(EDOT);
LEDOT4=LAG4(EDOT);
ZMD0=MDOT+LMDOT1+LMDOT2+LMDOT3+LMDOT4;
ZMD1=      LMDOT1+2*LMDOT2+3*LMDOT3+4*LMDOT4;
ZMD2=      LMDOT1+4*LMDOT2+9*LMDOT3+16*LMDOT4;
ZMD3=      LMDOT1+8*LMDOT2+27*LMDOT3+64*LMDOT4;
ZMD4=      LMDOT1+16*LMDOT2+81*LMDOT3+256*LMDOT4;
ZED0=EDOT+LEDOT1+LEDOT2+LEDOT3+LEDOT4;
ZED1=       LEDOT1+2*LEDOT2+3*LEDOT3+4*LEDOT4;
ZED2=       LEDOT1+4*LEDOT2+9*LEDOT3+16*LEDOT4;
ZED3=       LEDOT1+8*LEDOT2+27*LEDOT3+64*LEDOT4;
ZED4=       LEDOT1+16*LEDOT2+81*LEDOT3+256*LEDOT4;
*FOR MODEL 9 10;
LX1=LAG(X);
```

```
D=FDY-(XF-LX1);
LD1=LAG(D);
LD2=LAG2(D);
LD3=LAG3(D);
LD4=LAG4(D);
LD5=LAG5(D);
ZD0=D+LD1+LD2+LD3+LD4+LD5;
ZD1=  LD1+2*LD2+3*LD3+4*LD4+5*LD5;
ZD2=  LD1+4*LD2+9*LD3+16*LD4+25*LD5;
FDX=X-LX1;
DELTAP=FDY-FDX;
*FOR MODEL 11;
GAP=((XF-X)/XF)*100;
LGAP=LAG(GAP);
```

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

```
PROC SYSREG OUTEST=EST1   OUT=OUT1;
*MODEL 1;
   MODEL FDY=ZM0 ZM1 ZM2 ZM3 ZM4 ZE0 ZE1 ZE2 ZE3 ZE4/DW;
*MODEL 2;
   MODEL FDY=ZM0 ZM1 ZM2 ZM3 ZM4 ZE0 ZE1 ZE2 ZE3 ZE4/ DW COVB;
   RESTRICT ZM0-ZM1+ZM2-ZM3+ZM4=0,
            ZE0-ZE1+ZE2-ZE3+ZE4=0,
            ZM0+5*ZM1+25*ZM2+125*ZM3+625*ZM4=0,
            ZE0+5*ZE1+25*ZE2+125*ZE3+625*ZE4=0;
   OUTPUT P=PFDY
          R=FDYERROR;
*MODEL 3;
   MODEL FDY=ZM0 ZM1 ZM2 ZM3 ZM4 ZE0 ZE1 ZE2 ZE3 ZE4/ DW COVB;
   RESTRICT ZM0-ZM1+ZM2-ZM3+ZM4=0,
            ZE0-ZE1+ZE2-ZE3+ZE4=0,
            ZM0+5*ZM1+25*ZM2+125*ZM3+625*ZM4=0,
            ZE0+5*ZE1+25*ZE2+125*ZE3+625*ZE4=0,
            5*ZM0+10*ZM1+30*ZM2+100*ZM3+354*ZM4=0;
*MODEL 4;
   MODEL FDY=ZM0 ZM1 ZM2 ZM3 ZM4 ZE0 ZE1 ZE2 ZE3 ZE4/ DW COVB;
   RESTRICT ZM0-ZM1+ZM2-ZM3+ZM4=0,
            ZE0-ZE1+ZE2-ZE3+ZE4=0,
            ZM0+5*ZM1+25*ZM2+125*ZM3+625*ZM4=0,
            ZE0+5*ZE1+25*ZE2+125*ZE3+625*ZE4=0,
            5*ZE0+10*ZE1+30*ZE2+100*ZE3+354*ZE4=0;
*MODEL 5;
   MODEL FDY=WT2M WT3M WT4M WT2E WT3E WT4E/DW;
*MODEL 6;
   MODEL YDOT=ZMD0 ZMD1 ZMD2 ZMD3 ZMD4 ZED0 ZED1 ZED2 ZED3 ZED4/D
DVB;
   RESTRICT ZMD0-ZMD1+ZMD2-ZMD3+ZMD4,
            ZED0-ZED1+ZED2-ZED3+ZED4,
            ZMD0+5*ZMD1+25*ZMD2+125*ZMD3+625*ZMD4=0,
            ZED0+5*ZED1+25*ZED2+125*ZED3+625*ZED4=0;
   OUTPUT R=YDERROR;
* MODEL 7;
   MODEL YDOT=ZMD0 ZMD1 ZMD2 ZMD3 ZMD4 ZED0 ZED1 ZED2 ZED3 ZED4;
   RESTRICT ZMD0-ZMD1+ZMD2-ZMD3+ZMD4,
            ZED0-ZED1+ZED2-ZED3+ZED4,
            ZMD0+5*ZMD1+25*ZMD2+125*ZMD3+625*ZMD4=0,
            ZED0+5*ZED1+25*ZED2+125*ZED3+625*ZED4=0,
            5*ZMD0 +10*ZMD1+30*ZMD2+100*ZMD3+354*ZMD4=0;
```

```
S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

* MODEL8;
   MODEL YDOT=ZMD0 ZMD1 ZMD2 ZMD3 ZMD4 ZED0 ZED1 ZED2 ZED3 ZED4;
   RESTRICT ZMD0-ZMD1+ZMD2-ZMD3+ZMD4,
            ZED0-ZED1+ZED2-ZED3+ZED4,
            ZMD0+5*ZMD1+25*ZMD2+125*ZMD3+625*ZMD4=0,
            ZED0+5*ZED1+25*ZED2+125*ZED3+625*ZED4=0,
            5*ZED0+10*ZED1+30*ZED2+100*ZED3+354*ZED4=0;
*MODEL 9;
   MODEL DELTAP=ZD0 ZD1 ZD2 DELTAPA/DW COVB;
   RESTRICT ZD0+6*ZD1+36*ZD2=0;
   OUTPUT R=DPERROR;
*MODEL 10;
   MODEL DELTAP=ZD0 ZD1 ZD2 DELTAPA/DW COVB;
   RESTRICT ZD0+6*ZD1+36*ZD2=0,
            6*ZD0+15*ZD1+55*ZD2=0;
*MODEL 11;
   MODEL U=GAP LGAP/DW COVB;
   OUTPUT R=UERROR;
```

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

```
PROC PRINT DATA=EST1;
   TITLE;

PROC PLOT;
   PLOT FDY*ID PFDY*ID='*'/OVERLAY;
   TITLE1 FIGURE 2;
   TITLE2  FDY AND PREDICTED FDY VS. TIME;

PROC PLOT;
   PLOT FDYERROR*ID;
   TITLE1 FIGURE 3;
   TITLE2 ERROR PATTERN OF TOTAL SPENDING EQUATION;

PROC PLOT;
   PLOT YDERROR*ID;
   TITLE1 FIGURE 4;
   TITLE2 ERROR PATTERN OF RATE-OF-CHANGE TOTAL SPENDING EQUATION

PROC PLOT;
   PLOT DPERROR*ID;
   TITLE1 FIGURE 5;
   TITLE2 ERROR PATTERN OF PRICE EQUATION;

PROC PLOT;
   PLOT UERROR*ID;
   TITLE1 FIGURE 6;
   TITLE2 ERROR PATTERN OF UNEMPLOYMENT EQUATION;

PROC PRINT DATA=GNP;
   VAR ID Y M E IPD DELTAPA U XF X;
   TITLE1;
   TITLE2 DATA USED IN THE ANALYSIS;
   TITLE3 (SOURCE OF DATA : FEDERAL RESERVE BANK OF ST.LOUIS);
```

# APPENDIX C

## RESULTS OF REGRESSION ANALYSIS

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| | | | | | |
|---|---|---|---|---|---|
| MODEL: | MODEL01 | SSE | 11396.69 | F RATIO | 42.43 |
| | | DFE | 97 | PROB>F | 0.0001 |
| DEP VAR: | FCY | MSE | 117.491623 | R-SQUARE | 0.8139 |

DURBIN-WATSON D STATISTIC = 2.0167
FIRST ORDER AUTOCORRELATION = -0.0256

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | -1.147568 | 1.710002 | -0.6711 | 0.5038 |
| ZM0 | 1 | 4.080702 | 0.615960 | 6.6249 | 0.0001 |
| ZM1 | 1 | -9.460311 | 3.837504 | -2.4652 | 0.0155 |
| ZM2 | 1 | 12.666078 | 4.840246 | 2.6168 | 0.0103 |
| ZM3 | 1 | -5.755440 | 1.941918 | -2.9638 | 0.0038 |
| ZM4 | 1 | 0.781866 | 0.242281 | 3.2271 | 0.0017 |
| ZE0 | 1 | 0.528013 | 0.246532 | 2.1418 | 0.0347 |
| ZE1 | 1 | 1.537894 | 1.505239 | 1.0217 | 0.3095 |
| ZE2 | 1 | -2.566057 | 1.895268 | -1.3539 | 0.1789 |
| ZE3 | 1 | 1.051682 | 0.757555 | 1.3883 | 0.1682 |
| ZE4 | 1 | -0.127886 | 0.094254 | -1.3568 | 0.1780 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| | | | | |
|---|---|---|---|---|
| MODEL: MODEL02 | SSE | 13313.79 | F RATIO | 60.61 |
| | DFE | 101 | PROB>F | 0.0001 |
| DEP VAR: FEY | MSE | 131.819689 | R-SQUARE | 0.7826 |

DURBIN-WATSON D STATISTIC = 2.1956
FIRST ORDER AUTOCORRELATION = -0.1435

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | -0.931424 | 1.809759 | -0.5147 | 0.6079 |
| ZM0 | 1 | 3.842603 | 0.565663 | 6.7931 | 0.0001 |
| ZM1 | 1 | 0.764795 | 0.345236 | 2.2153 | 0.0290 |
| ZM2 | 1 | -2.305548 | 0.477785 | -4.8255 | 0.0001 |
| ZM3 | 1 | 0.710179 | 0.253921 | 2.7968 | 0.0062 |
| ZM4 | 1 | -0.062080 | 0.031663 | -1.9607 | 0.0527 |
| ZE0 | 1 | 0.661096 | 0.208587 | 3.1694 | 0.0020 |
| ZE1 | 1 | -0.086405 | 0.128815 | -0.6708 | 0.5039 |
| ZE2 | 1 | -0.496587 | 0.172031 | -2.8866 | 0.0048 |
| ZE3 | 1 | 0.225343 | 0.089980 | 2.5044 | 0.0139 |
| ZE4 | 1 | -0.025572 | 0.011284 | -2.2661 | 0.0256 |
| RESTRICTION | -1 | -18.175205 | 23.009508 | -0.7899 | 0.4314 |
| RESTRICTION | -1 | -38.025009 | 51.572313 | -0.7373 | 0.4626 |
| RESTRICTION | -1 | 56.200204 | 22.761249 | 2.4691 | 0.0152 |
| RESTRICTION | -1 | 15.103851 | 51.598100 | 0.2927 | 0.7703 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

COVARIANCE OF B VALUES

| | INTERCEPT | ZM0 | ZM1 |
|---|---|---|---|
| INTERCEPT | 3.27522659 | -0.21048293 | -0.01926815 |
| ZM0 | -0.21048293 | 0.31997497 | -0.06215424 |
| ZM1 | -0.01926815 | -0.06215424 | 0.11918802 |
| ZM2 | 0.12213460 | -0.25629970 | 0.09888862 |
| ZM3 | -0.06122887 | 0.11338898 | -0.07271937 |
| ZM4 | 0.00785131 | -0.01244054 | 0.00973427 |
| ZE0 | 0.00250028 | -0.02113413 | 0.00702253 |
| ZE1 | 0.00377800 | 0.00895410 | -0.00472903 |
| ZE2 | 0.00186986 | 0.01716846 | -0.00762032 |
| ZE3 | 0.00040261 | -0.01137028 | 0.00371887 |
| ZE4 | -0.00018954 | 0.00154950 | -0.00041237 |

| | ZM2 | ZM3 | ZM4 |
|---|---|---|---|
| INTERCEPT | 0.12213460 | -0.06122887 | 0.00785131 |
| ZM0 | -0.25629970 | 0.11338898 | -0.01244054 |
| ZM1 | 0.09888862 | -0.07271937 | 0.00973427 |
| ZM2 | 0.22827856 | -0.11368494 | 0.01322482 |
| ZM3 | -0.11368494 | 0.06447596 | -0.00794746 |
| ZM4 | 0.01322482 | -0.00794746 | 0.00100253 |
| ZE0 | 0.01714535 | -0.00976624 | 0.00124507 |
| ZE1 | -0.00909205 | 0.00414856 | -0.00044252 |
| ZE2 | -0.01528152 | 0.00846001 | -0.00104725 |
| ZE3 | 0.00967704 | -0.00484230 | 0.00056982 |
| ZE4 | -0.00127884 | 0.00061250 | -0.00007053 |

| | ZE0 | ZE1 | ZE2 |
|---|---|---|---|
| INTERCEPT | 0.00250028 | 0.00377800 | 0.00186986 |
| ZM0 | -0.02113413 | 0.00895410 | 0.01716846 |
| ZM1 | 0.00702253 | -0.00472903 | -0.00762032 |
| ZM2 | 0.01714535 | -0.00909205 | -0.01528152 |
| ZM3 | -0.00976624 | 0.00414856 | 0.00846001 |
| ZM4 | 0.00124507 | -0.00044252 | -0.00104725 |
| ZE0 | 0.04350871 | -0.00566283 | -0.03376896 |
| ZE1 | -0.00566283 | 0.01659323 | 0.01163109 |
| ZE2 | -0.03376896 | 0.01163109 | 0.02959470 |
| ZE3 | 0.01394086 | -0.00934492 | -0.01419013 |
| ZE4 | -0.00146173 | 0.00128005 | 0.00161522 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| | ZE3 | ZE4 |
|---|---|---|
| INTERCEPT | 0.00040261 | -0.00018954 |
| ZM0 | -0.01137028 | 0.00154950 |
| ZM1 | 0.00371887 | -0.00041237 |
| ZM2 | 0.00967704 | -0.00127384 |
| ZM3 | -0.00484230 | 0.00061250 |
| ZM4 | 0.00056982 | -0.00007053 |
| ZE0 | 0.01394086 | -0.00146173 |
| ZE1 | -0.00934492 | 0.00128005 |
| ZE2 | -0.01419013 | 0.00161522 |
| ZE3 | 0.00809642 | -0.00099923 |
| ZE4 | -0.00099923 | 0.00012733 |

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| | | | | | |
|---|---|---|---|---|---|
| MODEL: MODEL03 | SSE | 19787.03 | F RATIO | 42.75 |
| | DFE | 102 | PROB>F | 0.0001 |
| DEP VAR: FDY | MSE | 193.990460 | R-SQUARE | 0.6769 |

DURBIN-WATSON D STATISTIC = 1.5010
FIRST ORDER AUTOCORRELATION = 0.2108

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | 5.808997 | 1.859675 | 3.1237 | 0.0023 |
| ZM0 | 1 | 2.207472 | 0.625110 | 3.5313 | 0.0006 |
| ZM1 | 1 | 0.606140 | 0.417908 | 1.4504 | 0.1500 |
| ZM2 | 1 | -1.349328 | 0.555465 | -2.4292 | 0.0169 |
| ZM3 | 1 | 0.247996 | 0.297462 | 0.8337 | 0.4064 |
| ZM4 | 1 | -0.00400724 | 0.037071 | -0.1081 | 0.9141 |
| ZE0 | 1 | 1.076310 | 0.242616 | 4.4363 | 0.0001 |
| ZE1 | 1 | 0.038104 | 0.154773 | 0.2462 | 0.8060 |
| ZE2 | 1 | -0.689550 | 0.206002 | -3.3473 | 0.0011 |
| ZE3 | 1 | 0.311842 | 0.108124 | 2.8841 | 0.0048 |
| ZE4 | 1 | -0.036813 | 0.013550 | -2.7169 | 0.0077 |
| RESTRICTION | -1 | -11.231994 | 27.938923 | -0.4020 | 0.6885 |
| RESTRICTION | -1 | -33.111275 | 62.568651 | -0.5292 | 0.5978 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| RESTRICTION | -1 | 44.629930 | 27.684442 | 1.6121 | 0.1100 |
| RESTRICTION | -1 | 11.128997 | 62.597933 | 0.1778 | 0.8592 |
| RESTRICTION | -1 | 960.996486 | 166.360872 | 5.7766 | 0.0001 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

COVARIANCE OF B VALUES

| | INTERCEPT | ZM0 | ZM1 |
|---|---|---|---|
| INTERCEPT | 3.45839034 | 0.02053821 | 0.00369218 |
| ZM0 | 0.02053821 | 0.39076210 | -0.09924272 |
| ZM1 | 0.00369218 | -0.09924272 | 0.17464692 |
| ZM2 | -0.01341646 | -0.33032314 | 0.15007437 |
| ZM3 | 0.00325319 | 0.14421944 | -0.10921386 |
| ZM4 | -0.00017638 | -0.01546224 | 0.01460141 |
| ZE0 | -0.08019262 | -0.01075553 | 0.01230877 |
| ZE1 | -0.01959067 | 0.01927833 | -0.00636741 |
| ZE2 | 0.04172980 | 0.01581018 | -0.01213179 |
| ZE3 | -0.01688026 | -0.01249426 | 0.00588409 |
| ZE4 | 0.00199189 | 0.00172943 | -0.00066030 |

| | ZM2 | ZM3 | ZM4 |
|---|---|---|---|
| INTERCEPT | -0.01341646 | 0.00325319 | -0.00017638 |
| ZM0 | -0.33032314 | 0.14421944 | -0.01546224 |
| ZM1 | 0.15007437 | -0.10921386 | 0.01460141 |
| ZM2 | 0.30854118 | -0.15405838 | 0.01779795 |
| ZM3 | -0.15405838 | 0.08848351 | -0.01089141 |
| ZM4 | 0.01779795 | -0.01089141 | 0.00137429 |
| ZE0 | 0.01333330 | -0.00862133 | 0.00110967 |
| ZE1 | -0.01694811 | 0.00782970 | -0.00086792 |
| ZE2 | -0.01695925 | 0.00977737 | -0.00120535 |
| ZE3 | 0.01176232 | -0.00592801 | 0.00068803 |
| ZE4 | -0.00155984 | 0.00074566 | -0.00008422 |

| | ZE0 | ZE1 | ZE2 |
|---|---|---|---|
| INTERCEPT | -0.08019262 | -0.01959067 | 0.04172980 |
| ZM0 | -0.01075553 | 0.01927833 | 0.01581018 |
| ZM1 | 0.01230877 | -0.00636741 | -0.01213179 |
| ZM2 | 0.01333330 | -0.01694811 | -0.01695925 |
| ZM3 | -0.00862133 | 0.00782970 | 0.00977737 |
| ZM4 | 0.00110967 | -0.00086792 | -0.00120535 |
| ZE0 | 0.05886237 | -0.00988291 | -0.04729451 |
| ZE1 | -0.00988291 | 0.02395459 | 0.01783672 |
| ZE2 | -0.04729451 | 0.01783672 | 0.04243674 |
| ZE3 | 0.01943953 | -0.01407506 | -0.02038249 |
| ZE4 | -0.00201124 | 0.00192572 | 0.00231201 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| | ZE3 | ZE4 |
|---|---|---|
| INTERCEPT | -0.01688026 | 0.00199189 |
| ZM0 | -0.01249426 | 0.00172943 |
| ZM1 | 0.00588409 | -0.00066030 |
| ZM2 | 0.01176232 | -0.00155984 |
| ZM3 | -0.00592801 | 0.00074566 |
| ZM4 | 0.00068303 | -0.00008422 |
| ZE0 | 0.01943953 | -0.00201124 |
| ZE1 | -0.01407506 | 0.00192572 |
| ZE2 | -0.02038249 | 0.00231201 |
| ZE3 | 0.01169075 | -0.00144135 |
| ZE4 | -0.00144135 | 0.00018360 |

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|---|---|---|---|---|---|
| MODEL: MODEL04 | SSE | 14264.57 | F RATIO | 67.19 |
| | DFE | 102 | PROB>F | 0.0001 |
| DEP VAR: FDY | MSE | 139.848720 | R-SQUARE | 0.7671 |

DURBIN-WATSON D STATISTIC = 2.0970
FIRST ORDER AUTOCORRELATION = -0.0794

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | -1.490727 | 1.851677 | -0.8051 | 0.4227 |
| ZM0 | 1 | 4.472506 | 0.530191 | 8.4356 | 0.0001 |
| ZM1 | 1 | 0.869407 | 0.353324 | 2.4607 | 0.0155 |
| ZM2 | 1 | -2.666652 | 0.472232 | -5.6469 | 0.0001 |
| ZM3 | 1 | 0.857501 | 0.255364 | 3.3580 | 0.0011 |
| ZM4 | 1 | -0.078945 | 0.031965 | -2.4697 | 0.0152 |
| ZE0 | 1 | 0.488948 | 0.204450 | 2.3915 | 0.0186 |
| ZE1 | 1 | -0.122958 | 0.131937 | -0.9319 | 0.3536 |
| ZE2 | 1 | -0.412782 | 0.174253 | -2.3689 | 0.0197 |
| ZE3 | 1 | 0.179864 | 0.091024 | 1.9760 | 0.0509 |
| ZE4 | 1 | -0.019260 | 0.011368 | -1.6942 | 0.0933 |
| RESTRICTION | -1 | -17.722987 | 23.700531 | -0.7478 | 0.4563 |
| RESTRICTION | -1 | -37.869290 | 53.119746 | -0.7129 | 0.4775 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| RESTRICTION | -1 | 57.794231 | 23.452157 | 2.4643 | 0.0154 |
| RESTRICTION | -1 | 14.407534 | 53.146944 | 0.2711 | 0.7869 |
| RESTRICTION | -1 | 926.911065 | 355.489774 | 2.6074 | 0.0105 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

COVARIANCE OF B VALUES

| | INTERCEPT | ZM0 | ZM1 |
|---|---|---|---|
| INTERCEPT | 3.42870595 | -0.17148313 | -0.01183565 |
| ZM0 | -0.17148313 | 0.28110298 | -0.07563247 |
| ZM1 | -0.01183565 | -0.07563247 | 0.12483798 |
| ZM2 | 0.09986682 | -0.23845390 | 0.11046824 |
| ZM3 | -0.05283856 | 0.10664584 | -0.07941553 |
| ZM4 | 0.00694210 | -0.01163572 | 0.01058668 |
| ZE0 | -0.01150951 | -0.00647163 | 0.01009915 |
| ZE1 | 0.00100100 | 0.01288619 | -0.00445462 |
| ZE2 | 0.00887813 | 0.01044952 | -0.00937399 |
| ZE3 | -0.00331425 | -0.00784918 | 0.00464518 |
| ZE4 | 0.00031813 | 0.00105912 | -0.00053460 |

| | ZM2 | ZM3 | ZM4 |
|---|---|---|---|
| INTERCEPT | 0.09986682 | -0.05283856 | 0.00694210 |
| ZM0 | -0.23845390 | 0.10664584 | -0.01163572 |
| ZM1 | 0.11046824 | -0.07941553 | 0.01058668 |
| ZM2 | 0.22300306 | -0.11278451 | 0.01313456 |
| ZM3 | -0.11278451 | 0.06521077 | -0.00806608 |
| ZM4 | 0.01313456 | -0.00806608 | 0.00102176 |
| ZE0 | 0.00904615 | -0.00663076 | 0.00089387 |
| ZE1 | -0.01158733 | 0.00519333 | -0.00056015 |
| ZE2 | -0.01176106 | 0.00715930 | -0.00090315 |
| ZE3 | 0.00785090 | -0.00415175 | 0.00049171 |
| ZE4 | -0.00102151 | 0.00051304 | -0.00005917 |

| | ZE0 | ZE1 | ZE2 |
|---|---|---|---|
| INTERCEPT | -0.01150951 | 0.00100100 | 0.00887813 |
| ZM0 | -0.00647163 | 0.01288619 | 0.01044952 |
| ZM1 | 0.01009915 | -0.00445462 | -0.00937399 |
| ZM2 | 0.00904615 | -0.01158733 | -0.01176106 |
| ZM3 | -0.00663076 | 0.00519333 | 0.00715930 |
| ZM4 | 0.00089387 | -0.00056015 | -0.00090315 |
| ZE0 | 0.04179983 | -0.00693332 | -0.03370377 |
| ZE1 | -0.00693332 | 0.01740738 | 0.01279011 |
| ZE2 | -0.03370377 | 0.01279011 | 0.03036424 |
| ZE3 | 0.01363843 | -0.01015863 | -0.01449384 |
| ZE4 | -0.00139095 | 0.00139196 | 0.00163580 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| | ZE3 | ZE4 |
|---|---|---|
| INTERCEPT | -0.00331425 | 0.00031813 |
| ZM0 | -0.00784918 | 0.00105912 |
| ZM1 | 0.00464518 | -0.00053460 |
| ZM2 | 0.00785090 | -0.00102151 |
| ZM3 | -0.00415175 | 0.00051304 |
| ZM4 | 0.00049171 | -0.00005917 |
| ZE0 | 0.01363843 | -0.00139095 |
| ZE1 | -0.01015863 | 0.00139196 |
| ZE2 | -0.01449384 | 0.00163580 |
| ZE3 | 0.00828535 | -0.00101787 |
| ZE4 | -0.00101787 | 0.00012923 |

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| | | | | | |
|---|---|---|---|---|---|
| MODEL: | MODEL05 | SSE | 13313.79 | F RATIO | 60.61 |
| | | DFE | 101 | PROB>F | 0.0001 |
| DEP VAR: | FDY | MSE | 131.819689 | R-SQUARE | 0.7826 |

DURBIN-WATSON D STATISTIC = 2.1956
FIRST ORDER AUTOCORRELATION = -0.1435

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | -0.931424 | 1.809759 | -0.5147 | 0.6079 |
| WT2M | 1 | -2.305548 | 0.477785 | -4.8255 | 0.0001 |
| WT3M | 1 | 0.710179 | 0.253921 | 2.7968 | 0.0062 |
| WT4M | 1 | -0.062080 | 0.031663 | -1.9607 | 0.0527 |
| WT2E | 1 | -0.496587 | 0.172031 | -2.8866 | 0.0048 |
| WT3E | 1 | 0.225343 | 0.089980 | 2.5044 | 0.0139 |
| WT4E | 1 | -0.025572 | 0.011284 | -2.2661 | 0.0256 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| | | | | | |
|---|---|---|---|---|---|
| MODEL: MODEL06 | SSE | 1348.036 | F RATIO | 13.19 |
| | DFE | 101 | PROB>F | 0.0001 |
| DEP VAR: YDOT | MSE | 13.346890 | R-SQUARE | 0.4394 |

DURBIN-WATSON D STATISTIC = 2.0555
FIRST ORDER AUTOCORRELATION = -0.0471

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | 3.008761 | 0.821335 | 3.6633 | 0.0004 |
| ZMD0 | 1 | 0.502863 | 0.108858 | 4.6194 | 0.0001 |
| ZMD1 | 1 | 0.163363 | 0.070086 | 2.3309 | 0.0217 |
| ZMD2 | 1 | -0.267863 | 0.097333 | -2.7520 | 0.0070 |
| ZMD3 | 1 | 0.066867 | 0.053251 | 1.2557 | 0.2121 |
| ZMD4 | 1 | -0.00477036 | 0.006634482 | -0.7190 | 0.4738 |
| ZED0 | 1 | 0.068602 | 0.037820 | 1.8139 | 0.0727 |
| ZED1 | 1 | 0.011501 | 0.020914 | 0.5499 | 0.5836 |
| ZED2 | 1 | -0.045652 | 0.030600 | -1.4919 | 0.1388 |
| ZED3 | 1 | 0.010895 | 0.015525 | 0.7017 | 0.4845 |
| ZED4 | 1 | -0.000554637 | 0.00190179 | -0.2916 | 0.7712 |
| RESTRICTION | -1 | 5.110939 | 9.374581 | 0.5452 | 0.5868 |
| RESTRICTION | -1 | 1.546084 | 34.471642 | 0.0449 | 0.9643 |
| RESTRICTION | -1 | 2.096973 | 9.303645 | 0.2254 | 0.8221 |
| RESTRICTION | -1 | -30.601878 | 34.756245 | -0.8805 | 0.3807 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

COVARIANCE OF B VALUES

| | INTERCEPT | ZMD0 | ZMD1 |
|---|---|---|---|
| INTERCEPT | 0.67459122 | -0.01965024 | -0.00186306 |
| ZMD0 | -0.01965024 | 0.01135004 | -0.00368523 |
| ZMD1 | -0.00186306 | -0.00368523 | 0.00491199 |
| ZMD2 | 0.01151338 | -0.01013711 | 0.00487566 |
| ZMD3 | -0.00557333 | 0.00484513 | -0.00329166 |
| ZMD4 | 0.00070048 | -0.00055302 | 0.00042991 |
| ZED0 | -0.00796330 | -0.00064066 | 0.00034847 |
| ZED1 | -0.00186028 | 0.00005257 | -0.00015155 |
| ZED2 | 0.00446891 | 0.00045310 | -0.00032065 |
| ZED3 | -0.00148771 | -0.00021471 | 0.00016071 |
| ZED4 | 0.00014641 | 0.00002542 | -0.00001866 |

| | ZMD2 | ZMD3 | ZMD4 |
|---|---|---|---|
| INTERCEPT | 0.01151338 | -0.00557333 | 0.00070048 |
| ZMD0 | -0.01013711 | 0.00484513 | -0.00055302 |
| ZMD1 | 0.00487566 | -0.00329166 | 0.00042991 |
| ZMD2 | 0.00947381 | -0.00495059 | 0.00058838 |
| ZMD3 | -0.00495059 | 0.00283567 | -0.00035053 |
| ZMD4 | 0.00058838 | -0.00035053 | 0.00004402 |
| ZED0 | 0.00060545 | -0.00034139 | 0.00004230 |
| ZED1 | -0.00011032 | 0.00008278 | -0.00001102 |
| ZED2 | -0.00046555 | 0.00027388 | -0.00003431 |
| ZED3 | 0.00022396 | -0.00013447 | 0.00001699 |
| ZED4 | -0.00002626 | 0.00001582 | -.0000020058 |

| | ZED0 | ZED1 | ZED2 |
|---|---|---|---|
| INTERCEPT | -0.00796330 | -0.00186028 | 0.00446891 |
| ZMD0 | -0.00064066 | 0.00005257 | 0.00045310 |
| ZMD1 | 0.00034847 | -0.00015155 | -0.00032065 |
| ZMD2 | 0.00060545 | -0.00011032 | -0.00046555 |
| ZMD3 | -0.00034139 | 0.00008278 | 0.00027388 |
| ZMD4 | 0.00004230 | -0.00001102 | -0.00003431 |
| ZED0 | 0.00143037 | -0.00018115 | -0.00109771 |
| ZED1 | -0.00018115 | 0.00043740 | 0.00033402 |
| ZED2 | -0.00109771 | 0.00033402 | 0.00093634 |
| ZED3 | 0.00046406 | -0.00025092 | -0.00044481 |
| ZED4 | -0.00004974 | 0.00003361 | 0.00005059 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| | ZED3 | ZED4 |
|---|---|---|
| INTERCEPT | -0.00148771 | 0.00014641 |
| ZMD0 | -0.00021471 | 0.00002542 |
| ZMD1 | 0.00016071 | -0.00001866 |
| ZMD2 | 0.00022396 | -0.00002626 |
| ZMD3 | -0.00013447 | 0.00001582 |
| ZMD4 | 0.00001699 | -.0000020058 |
| ZED0 | 0.00046406 | -0.00004974 |
| ZED1 | -0.00025092 | 0.00003361 |
| ZED2 | -0.00044481 | 0.00005059 |
| ZED3 | 0.00024103 | -0.00002915 |
| ZED4 | -0.00002915 | 0.0000036168 |

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| MODEL: MODEL07 | SSE | 1973.651 | F RATIO | 4.45 |
|---|---|---|---|---|
| | DFE | 102 | PROB>F | 0.0011 |
| DEP VAR: YDOT | MSE | 19.349515 | R-SQUARE | 0.1792 |

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | 6.422569 | 0.785834 | 8.1729 | 0.0001 |
| ZMD0 | 1 | 0.206068 | 0.120229 | 1.7140 | 0.0896 |
| ZMD1 | 1 | 0.164020 | 0.084387 | 1.9437 | 0.0547 |
| ZMD2 | 1 | -0.078381 | 0.112357 | -0.6976 | 0.4870 |
| ZMD3 | 1 | -0.029033 | 0.061859 | -0.4693 | 0.6398 |
| ZMD4 | 1 | 0.007299941 | 0.007701049 | 0.9479 | 0.3454 |
| ZED0 | 1 | 0.099043 | 0.045222 | 2.1902 | 0.0308 |
| ZED1 | 1 | 0.019250 | 0.025145 | 0.7656 | 0.4457 |
| ZED2 | 1 | -0.059726 | 0.036760 | -1.6247 | 0.1073 |
| ZED3 | 1 | 0.018453 | 0.018646 | 0.9896 | 0.3247 |
| ZED4 | 1 | -0.00161393 | 0.002282262 | -0.7072 | 0.4811 |
| RESTRICTION | -1 | 5.980079 | 11.288512 | 0.5297 | 0.5974 |
| RESTRICTION | -1 | -5.548080 | 41.524374 | -0.1336 | 0.8940 |
| RESTRICTION | -1 | -0.045506 | 11.208402 | -0.0041 | 0.9968 |
| RESTRICTION | -1 | -25.450418 | 41.858109 | -0.6080 | 0.5445 |
| RESTRICTION | -1 | 563.592479 | 99.116683 | 5.6862 | 0.0001 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| | | | | | |
|---|---|---|---|---|---|
| MODEL: MODEL03 | | SSE | 1348.971 | F RATIO | 15.96 |
| | | DFE | 102 | PROB>F | 0.0001 |
| DEP VAR: YDCT | | MSE | 13.225204 | R-SQUARE | 0.4390 |

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | 2.927711 | 0.758631 | 3.8592 | 0.0002 |
| ZMD0 | 1 | 0.496940 | 0.106046 | 4.6861 | 0.0001 |
| ZMD1 | 1 | 0.163639 | 0.069758 | 2.3458 | 0.0209 |
| ZMD2 | 1 | -0.263833 | 0.095696 | -2.7570 | 0.0069 |
| ZMD3 | 1 | 0.064931 | 0.052505 | 1.2367 | 0.2191 |
| ZMD4 | 1 | -0.00453715 | 0.00654567 | -0.6932 | 0.4898 |
| ZED0 | 1 | 0.073192 | 0.033456 | 2.1877 | 0.0310 |
| ZED1 | 1 | 0.012628 | 0.020383 | 0.6195 | 0.5369 |
| ZED2 | 1 | -0.048047 | 0.029097 | -1.6513 | 0.1018 |
| ZED3 | 1 | 0.011851 | 0.015030 | 0.7885 | 0.4322 |
| ZED4 | 1 | -0.000666422 | 0.001845828 | -0.3610 | 0.7188 |
| RESTRICTION | -1 | 5.117949 | 9.331786 | 0.5484 | 0.5846 |
| RESTRICTION | -1 | 1.760772 | 34.323640 | 0.0513 | 0.9592 |
| RESTRICTION | -1 | 2.092387 | 9.261153 | 0.2259 | 0.8217 |
| RESTRICTION | -1 | -30.933413 | 34.619905 | -0.8935 | 0.3737 |
| RESTRICTION | -1 | -50.801142 | 191.061357 | -0.2659 | 0.7909 |

| | | | | | |
|---|---|---|---|---|---|
| MODEL: MODEL09 | | SSE | 6360.161 | F RATIO | 201.90 |
| | | DFE | 104 | PROB>F | 0.0001 |
| DEP VAR: DELTAP | | MSE | 61.155391 | R-SQUARE | 0.8535 |

DURBIN-WATSON D STATISTIC = 1.4376
FIRST ORDER AUTOCORRELATION = 0.1906

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | -2.112967 | 1.130512 | -1.8690 | 0.0644 |
| ZD0 | 1 | 0.082671 | 0.029968 | 2.7586 | 0.0069 |
| ZD1 | 1 | -0.035804 | 0.022506 | -1.5908 | 0.1147 |
| ZD2 | 1 | 0.00367084 7 | 0.002965259 | 1.2380 | 0.2185 |
| DELTAPA | 1 | 1.762819 | 0.075183 | 23.4472 | 0.0001 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| RESTRICTION | -1 | 1779.298 | 623.948233 | 2.8517 | 0.0052 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

COVARIANCE OF B VALUES

| | INTERCEPT | ZD0 | ZD1 |
|---|---|---|---|
| INTERCEPT | 1.27805666 | -0.00024607 | 0.00259851 |
| ZD0 | -0.00024607 | 0.00089809 | -0.00064483 |
| ZD1 | 0.00259851 | -0.00064483 | 0.00050653 |
| ZD2 | -0.00042625 | 0.00008252 | -0.00006651 |
| DELTAPA | -0.06066299 | 0.00018713 | -0.00021431 |

| | ZD2 | DELTAPA |
|---|---|---|
| INTERCEPT | -0.00042625 | -0.06066299 |
| ZD0 | 0.00008252 | 0.00018713 |
| ZD1 | -0.00006651 | -0.00021431 |
| ZD2 | .00000879276 | 0.00003052 |
| DELTAPA | 0.00003052 | 0.00565243 |

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| | | | | | |
|---|---|---|---|---|---|
| MODEL: | MODEL10 | SSE | 7378.381 | F RATIO | 256.32 |
| | | DFE | 105 | PROB>F | 0.0001 |
| DEP VAR: | DELTAP | MSE | 70.270297 | R-SQUARE | 0.8300 |

DURBIN-WATSON D STATISTIC = 1.2942
FIRST ORDER AUTOCORRELATION = 0.2652

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | -3.567912 | 1.149980 | -3.1026 | 0.0025 |
| ZD0 | 1 | 0.056282 | 0.031367 | 1.7943 | 0.0756 |
| ZD1 | 1 | -0.043150 | 0.024048 | -1.7943 | 0.0756 |
| ZD2 | 1 | 0.005628214 | 0.003136697 | 1.7943 | 0.0756 |
| DELTAPA | 1 | 1.805592 | 0.079804 | 22.6254 | 0.0001 |
| RESTRICTION | -1 | 951.503188 | 703.297201 | 1.3529 | 0.1790 |
| RESTRICTION | -1 | 6329.564 | 1662.795 | 3.8066 | 0.0002 |

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

COVARIANCE OF B VALUES

| | INTERCEPT | ZD0 | ZD1 |
|---|---|---|---|
| INTERCEPT | 1.32245372 | -0.00293241 | 0.00224818 |
| ZD0 | -0.00293241 | 0.00098389 | -0.00075431 |
| ZD1 | 0.00224818 | -0.00075431 | 0.00057831 |
| ZD2 | -0.00029324 | 0.00009839 | -0.00007543 |
| DELTAPA | -0.06540968 | 0.00029292 | -0.00022457 |

| | ZD2 | DELTAPA |
|---|---|---|
| INTERCEPT | -0.00029324 | -0.06540968 |
| ZD0 | 0.00009839 | 0.00029292 |
| ZD1 | -0.00007543 | -0.00022457 |
| ZD2 | .00000983887 | 0.00002929 |
| DELTAPA | 0.00002929 | 0.00636863 |

---

| | | | | | |
|---|---|---|---|---|---|
| MODEL: | MODEL11 | SSE | 52.262959 | F RATIO | 133.50 |
| | | DFE | 105 | PROB>F | 0.0001 |
| DEP VAR: U | | MSE | 0.497742 | R-SQUARE | 0.7177 |

DURBIN-WATSON D STATISTIC = 0.1993
FIRST ORDER AUTOCORRELATION = 0.8923

| VARIABLE | DF | PARAMETER ESTIMATE | STANDARD ERROR | T RATIO | PROB>\|T\| |
|---|---|---|---|---|---|
| INTERCEPT | 1 | 4.558523 | 0.089322 | 51.0349 | 0.0001 |
| GAP | 1 | 0.075671 | 0.077307 | 0.9788 | 0.3299 |
| LGAP | 1 | 0.418173 | 0.077732 | 5.3797 | 0.0001 |

COVARIANCE OF B VALUES

| | INTERCEPT | GAP | LGAP |
|---|---|---|---|
| INTERCEPT | 0.00797837 | -0.00088858 | -0.00087922 |
| GAP | -0.00088858 | 0.00597639 | -0.00554546 |
| LGAP | -0.00087922 | -0.00554546 | 0.00604219 |

| OBS | _TYPE_ | _MODEL_ | _SIGMA_ | FDY | ZM0 | ZM1 | ZM2 | ZM3 | ZM4 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | OLS | MODEL01 | 13.8394 | -1 | 4.08070 | -9.4603 | 12.6661 | -5.7554 | 0.781866 |
| 2 | OLS | MODEL02 | 11.4813 | -1 | 3.84260 | 0.7648 | -2.3055 | 0.7102 | -0.062080 |
| 3 | OLS | MODEL03 | 13.9280 | -1 | 2.20747 | 0.6061 | -1.3493 | 0.2480 | -0.004007 |
| 4 | OLS | MODEL04 | 11.8258 | -1 | 4.47251 | 0.8694 | -2.6667 | 0.8575 | -0.078945 |
| 5 | OLS | MODEL05 | 11.4813 | -1 | . | . | . | . | . |
| 6 | OLS | MODEL06 | 3.6533 | . | . | . | . | . | . |
| 7 | OLS | MODEL07 | 4.3988 | . | . | . | . | . | . |
| 8 | OLS | MODEL08 | 3.6366 | . | . | . | . | . | . |
| 9 | OLS | MODEL09 | 7.8202 | . | . | . | . | . | . |
| 10 | OLS | MODEL10 | 8.3827 | . | . | . | . | . | . |
| 11 | OLS | MODEL11 | 0.7055 | . | . | . | . | . | . |

| OBS | ZE0 | ZE1 | ZE2 | ZE3 | ZE4 | WT2M | WT3M | WT4M |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.52801 | 1.53789 | -2.5661 | 1.05168 | -0.12789 | . | . | . |
| 2 | 0.66110 | -0.08640 | -0.4966 | 0.22534 | -0.02557 | . | . | . |
| 3 | 1.07631 | 0.03810 | -0.6896 | 0.31184 | -0.03681 | . | . | . |
| 4 | 0.48895 | -0.12296 | -0.4128 | 0.17986 | -0.01926 | . | . | . |
| 5 | . | . | . | . | . | -2.3055 | 0.710179 | -0.06208 |
| 6 | . | . | . | . | . | . | . | . |
| 7 | . | . | . | . | . | . | . | . |
| 8 | . | . | . | . | . | . | . | . |
| 9 | . | . | . | . | . | . | . | . |
| 10 | . | . | . | . | . | . | . | . |
| 11 | . | . | . | . | . | . | . | . |

| OBS | WT2E | WT3E | WT4E | YDOT | ZMD0 | ZMD1 | ZMD2 | ZMD3 |
|---|---|---|---|---|---|---|---|---|
| 1 | . | . | . | . | . | . | . | . |
| 2 | . | . | . | . | . | . | . | . |
| 3 | . | . | . | . | . | . | . | . |
| 4 | . | . | . | . | . | . | . | . |
| 5 | -0.49659 | 0.225343 | -0.025572 | . | . | . | . | . |
| 6 | . | . | . | -1 | 0.502863 | 0.163363 | -0.26786 | 0.066867 |
| 7 | . | . | . | -1 | 0.206068 | 0.164020 | -0.07838 | -0.029033 |
| 8 | . | . | . | -1 | 0.496940 | 0.163639 | -0.26383 | 0.064931 |
| 9 | . | . | . | . | . | . | . | . |
| 10 | . | . | . | . | . | . | . | . |
| 11 | . | . | . | . | . | . | . | . |

| OBS | ZND4 | ZED0 | ZED1 | ZED2 | ZED3 | ZED4 | DELTAP |
|---|---|---|---|---|---|---|---|
| 1 | . | . | . | . | . | . | . |
| 2 | . | . | . | . | . | . | . |
| 3 | . | . | . | . | . | . | . |
| 4 | . | . | . | . | . | . | . |
| 5 | . | . | . | . | . | . | . |
| 6 | -0.0047704 | 0.0686019 | 0.0115010 | -0.045652 | 0.0108947 | -0.0005546 | . |
| 7 | 0.0072999 | 0.0990426 | 0.0192501 | -0.059726 | 0.0184525 | -0.0016139 | . |
| 8 | -0.0045372 | 0.0731922 | 0.0126278 | -0.048047 | 0.0118509 | -0.0006664 | . |
| 9 | . | . | . | . | . | . | -1 |
| 10 | . | . | . | . | . | . | -1 |
| 11 | . | . | . | . | . | . | . |

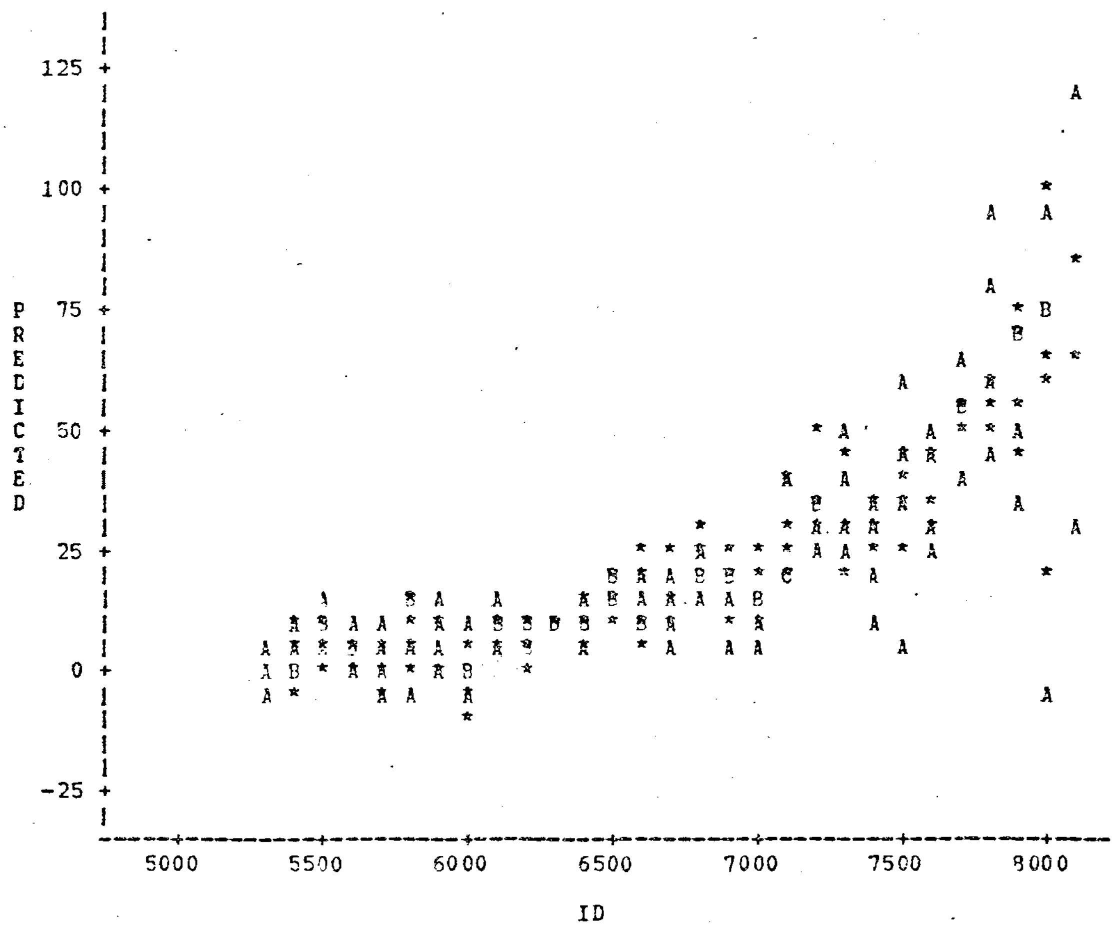
| OBS | ZD0 | ZD1 | ZD2 | DELTAPA | U | GAP | LGAP | INTERCEP |
|---|---|---|---|---|---|---|---|---|
| 1 | . | . | . | . | . | . | . | -1.1476 |
| 2 | . | . | . | . | . | . | . | -0.9314 |
| 3 | . | . | . | . | . | . | . | 5.8090 |
| 4 | . | . | . | . | . | . | . | -1.4907 |
| 5 | . | . | . | . | . | . | . | -0.9314 |
| 6 | . | . | . | . | . | . | . | 3.0088 |
| 7 | . | . | . | . | . | . | . | 6.4226 |
| 8 | . | . | . | . | . | . | . | 2.9277 |
| 9 | 0.0826706 | -0.035804 | 0.00367085 | 1.76282 | . | . | . | -2.1130 |
| 10 | 0.0562821 | -0.043150 | 0.00562821 | 1.80559 | . | . | . | -3.5679 |
| 11 | . | . | . | . | -1 | 0.0756711 | 0.418173 | 4.5585 |

# APPENDIX D

# ERROR PATTERN PLOTS

FIGURE 2
FDY AND PREDICTED FDY VS. TIME

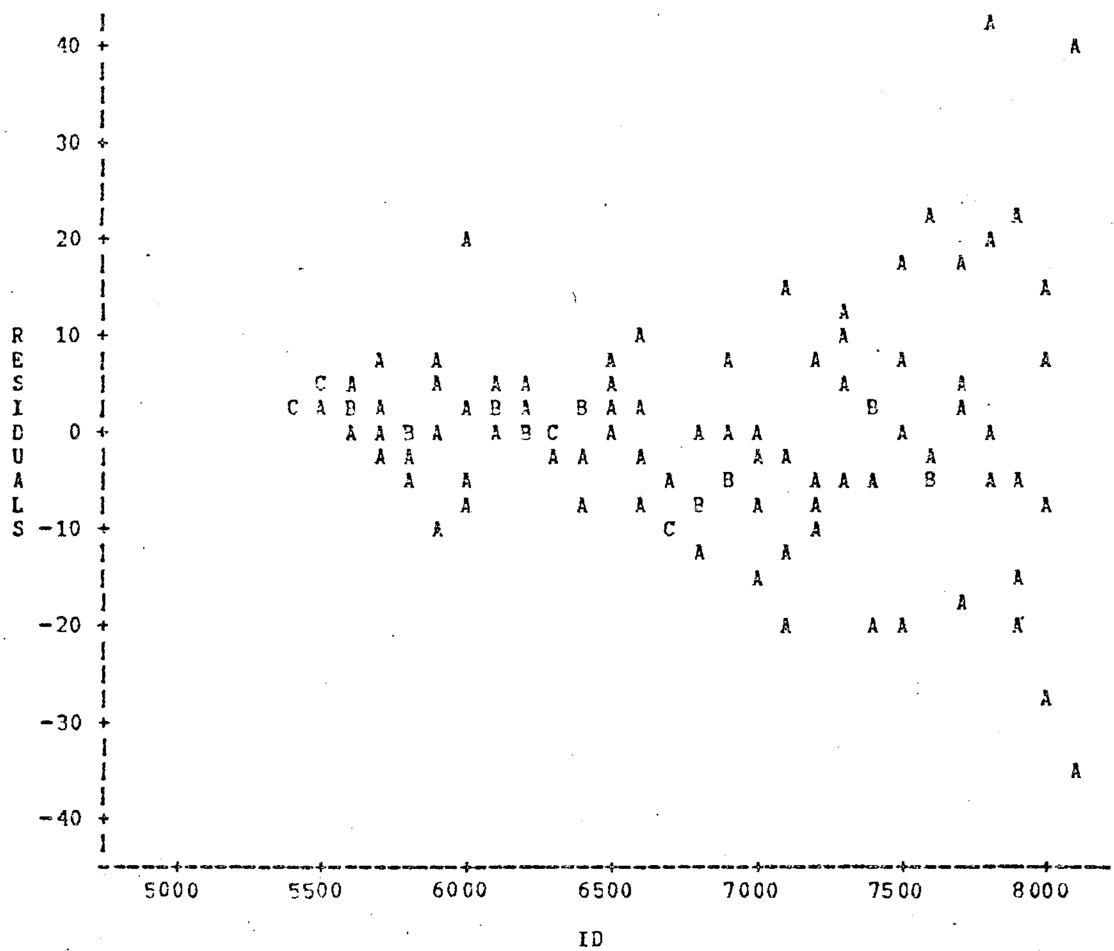
PLOT OF FDY*ID LEGEND: A = 1 OBS, B = 2 OBS, ETC.
PLOT OF PFDY*ID SYMBOL USED IS *




NOTE: 6 OBS HAD MISSING VALUES 27 OBS HIDDEN

FIGURE 3
ERROR PATTERN OF TOTAL SPENDING EQUATION

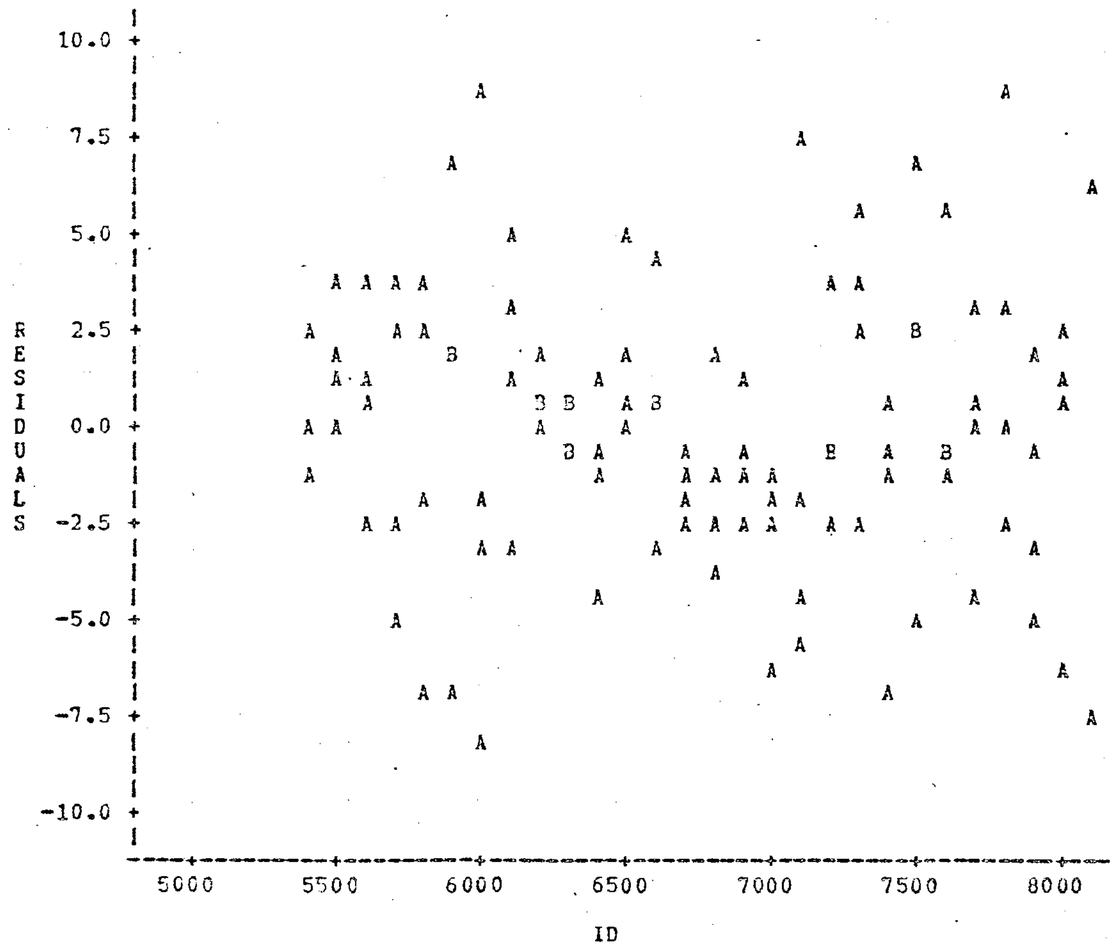
PLOT OF FDYERROR*ID    LEGEND: A = 1 OBS, B = 2 OBS, ETC.




NOTE:    5 OBS HAD MISSING VALUES

FIGURE 4
ERROR PATTERN OF RATE-OF-CHANGE TOTAL SPENDING EQUATION

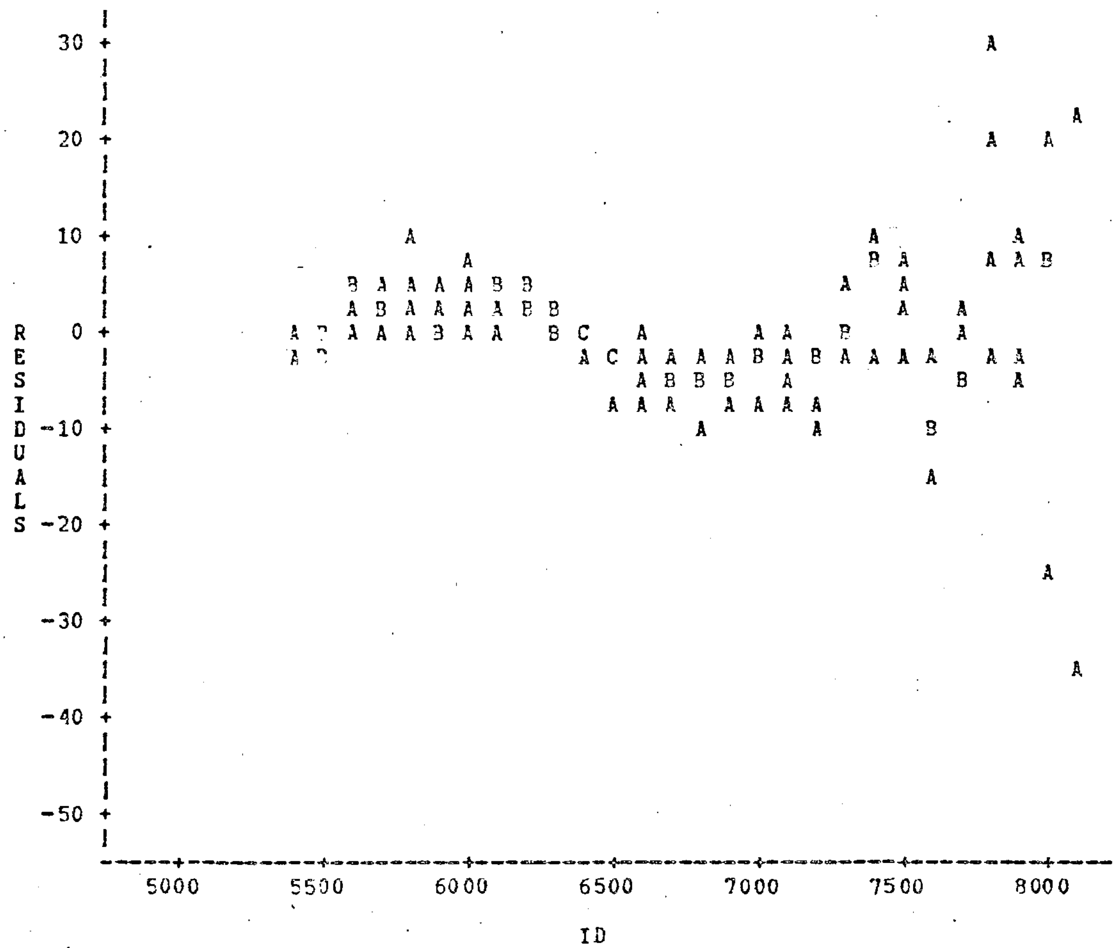
PLOT OF YDERROR*ID    LEGEND: A = 1 OBS, B = 2 OBS, ETC.




NOTE:    5 OBS HAD MISSING VALUES

FIGURE 5
ERROR PATTERN OF PRICE EQUATION

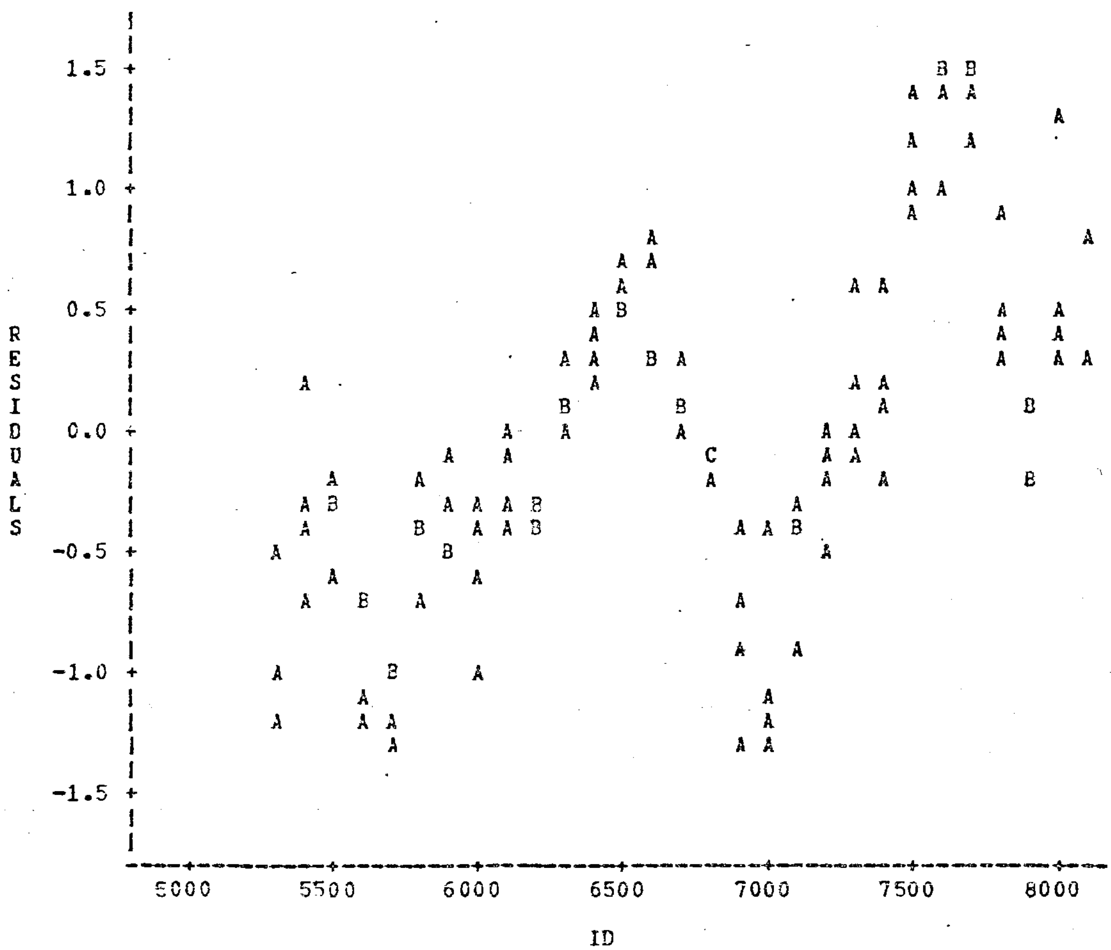
PLOT OF DPERROR*ID    LEGEND: A = 1 OBS, B = 2 OBS, ETC.




NOTE:     6 OBS HAD MISSING VALUES

FIGURE 6
ERROR PATTERN OF UNEMPLOYMENT EQUATION

PLOT OF UERPOP*ID    LEGEND: A = 1 OBS, B = 2 OBS, ETC.




NOTE: 1 OBS HAD MISSING VALUES

# APPENDIX E

# EXAMPLE OF CALCULATION

EXAMPLES OF CALCULATION

$$\Delta Y_t = \text{constant} + \sum_{i=0}^{4} m_i \Delta M_{t-i} + \sum_{i=0}^{4} e_i \Delta E_{t-i}$$

$$\Delta Y_t = \text{constant} + m_0 \Delta M_t + m_1 \Delta M_{t-1} + m_2 \Delta M_{t-2} + m_3 \Delta M_{t-3} + m_4 \Delta M_{t-4}$$
$$+ e_0 \Delta E_t + e_1 \Delta E_{t-1} + e_2 \Delta E_{t-2} + e_3 \Delta E_{t-3} + e_4 \Delta E_{t-4} \quad .....($$

constraint : 4th degree polynomial

$$m_i = a_0 + a_1 i + a_2 i^2 + a_3 i^3 + a_4 i^4 \quad .....$$

$$e_i = b_0 + b_1 i + b_2 i^2 + b_3 i^3 + b_4 i^4 \quad .....$$

so that

$$m_0 = a_0$$
$$m_1 = a_0 + a_1 + a_2 + a_3 + a_4$$
$$m_2 = a_0 + 2a_1 + 4a_2 + 8a_3 + 16a_4$$
$$m_3 = a_0 + 3a_1 + 9a_2 + 27a_3 + 81a_4$$
$$m_4 = a_0 + 4a_1 + 16a_2 + 64a_3 + 256a_4$$
$$e_0 = b_0$$
$$e_1 = b_0 + b_1 + b_2 + b_3 + b_4$$
$$e_2 = b_0 + 2b_1 + 4b_2 + 8b_3 + 16b_4$$
$$e_3 = b_0 + 3b_1 + 9b_2 + 27b_3 + 81b_4$$
$$e_4 = b_0 + 4b_1 + 16b_2 + 64b_3 + 256b_4$$

substituting $m_0 - m_4$ in (1) and $e_0 - e_4$ in (1)

$$\Delta Y_t = \text{constant} + a_0 \sum_0^4 \Delta M_{t-i} + a_1 \sum_0^4 i\Delta M_{t-i} + a_2 \sum_0^4 i^2 \Delta M_{t-i}$$
$$+ a_3 \sum_0^4 i^3 \Delta M_{t-i} + a_4 \sum_0^4 i^4 \Delta M_{t-i}$$
$$+ b_0 \sum_0^4 \Delta E_{t-i} + b_1 \sum_0^4 i\Delta E_{t-i} + b_2 \sum_0^4 i^2 \Delta E_{t-i}$$
$$+ b_3 \sum_0^4 i^3 \Delta E_{t-i} + b_4 \sum_0^4 i^4 \Delta E_{t-i} \quad .....(4)$$

$$\Delta Y_t = \text{constant} + a_0 ZM0 + a_1 ZM1 + a_2 ZM2 + a_3 ZM3 + a_4 ZM4 \quad \text{.....(5)}$$

$$+ b_0 ZE0 + b_1 ZE1 + b_2 ZE2 + b_3 ZE3 + b_4 ZE4$$

where

$$ZM0 = \sum_0^4 \Delta M_{t-i} \qquad ZE0 = \sum_0^4 \Delta E_{t-i}$$

$$ZM1 = \sum_0^4 i\Delta M_{t-i} \qquad ZE1 = \sum_0^4 i\Delta E_{t-i}$$

$$ZM2 = \sum_0^4 i^2\Delta M_{t-i} \qquad ZE2 = \sum_0^4 i^2\Delta E_{t-i}$$

$$ZM3 = \sum_0^4 i^3\Delta M_{t-i} \qquad ZE3 = \sum_0^4 i^3\Delta E_{t-i}$$

$$ZM4 = \sum_0^4 i^4\Delta M_{t-i} \qquad Ze4 = \sum_0^4 i^4\Delta E_{t-i}$$

constraints : $m_{-1} = m_5 = e_{-1} = e_5 = 0$

$$m_{-1} = a_0 - a_1 + a_2 - a_3 + a_4 = 0$$

$$e_{-1} = b_0 - b_1 + b_2 - b_3 + b_4 = 0$$

$$m_5 = a_0 + 5\,a_1 + 25\,a_2 + 125\,a_3 + 625\,a_4 = 0$$

$$e_5 = b_0 + 5\,b_1 + 25\,b_2 + 125\,b_3 + 625\,a_4 = 0$$

a. To find $m_0 - m_4$ and $e_0 - e_4$

From Appendix C, model 2

$$m_0 = a_0 = 3.842603$$

$$m_1 = a_0 + a_1 + a_2 + a_3 + a_4$$

$$m_1 = 3.8426 + 0.7648 - 2.3055 + 0.7102 - 0.0621 = 2.9500$$

$m_2$, $m_3$, $m_4$, $e_0$, $e_1$, $e_2$, $e_3$, $e_4$ are obtained in the same manner.

b. To find t-statistic - see (28)

$$m_i = a_0 + a_1 i + a_2 i^2 + a_3 i^3 + a_4 i^4$$

$$V(m_i) = \sum_{j=0}^{m} i^{2j} V(a_j) + 2 \sum_{j<p} i^{(j+p)} \operatorname{cov}(a_j a_p)$$

$$V(m_i) = V(a_0) + i^2 V(a_1) + i^4 V(a_2) + i^6 V(a_3) + i^8 V(a_4)$$

$$+ 2 \Big[ i \operatorname{cov}(a_0 a_1) + i^2 \operatorname{cov}(a_0 a_2) + i^3 \operatorname{cov}(a_0 a_3) + i^4 \operatorname{cov}(a_0 a_4)$$

$$+ i^3 \operatorname{cov}(a_1 a_2) + i^4 \operatorname{cov}(a_1 a_3) + i^5 \operatorname{cov}(a_1 a_4)$$

$$+ i^5 \operatorname{cov}(a_2 a_3) + i^6 \operatorname{cov}(a_2 a_4)$$

$$+ i^7 \operatorname{cov}(a_3 a_4) \Big]$$

from the covariance matrix of model 2

$$V(m_0) = V(a_0) = 0.319975$$

$$V(m_1) = 0.319975 + 0.119188 + 0.228279 + 0.064476 + 0.001003$$

$$+ 2 \,(-0.062154 - 0.256300 + 0.113389 - 0.012441$$

$$+ 0.098889 - 0.072719 + 0.009734$$

$$- 0.113685 + 0.013225$$

$$- 0.007947)$$

$$= 0.152905$$

$$t(m_0) = m_0 / \sqrt{V(m_0)} = 3.842603 / \sqrt{0.319975} = 6.79$$

The t-statistics of $m_1$, $m_2$, $m_3$, $m_4$, $e_0$, $e_1$, $e_2$, $e_3$, $e_4$, are obtained in the same manner.

c. To find the t-statistic for $\sum m_i$ and $\sum e_i$

For $\sum m_i$, put one more restriction on model 2, i.e. model 3

$$m_0 + m_1 + m_2 + m_3 + m_4 = 0$$

or $$5\, a_0 + 10\, a_1 + 30\, a_2 + 100\, a_3 + 354\, a_4 = 0$$

$$F\,(\sum m_i) = \frac{ESS_{model\ 3} - ESS_{model\ 2}}{MSE_{model\ 2}}$$

$$= \frac{19787.03 - 13313.79}{131.81969}$$

$$= 49.11$$

$$t\,(\sum m_i) = \sqrt{F\,(\sum m_i)}$$

$$= 49.11$$

$$= 7.01$$

The t-statistic of $\sum e_i$ is obtained in the same manner from model 2 and model 4.

VITA

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