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A Neoclassical Analysis of Investment and Energy Prices

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A NEOCLASSICAL ANALYSIS OF INVESTMENT AND ENERGY PRICES

BY

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INTRODUCTION

Investment, in national income analysis, is the value of that part of the economy's output for any time period that takes the form of new structures, new producers' durable equipment, and change in inventories. In practice, apart from the change in inventories, the value of this output is measured by the amount of expenditure on these items (Shapiro 1978).

Investment is a flow variable whose counterpart stock variable is capital, and that is the accumulated stock of plant and equipment held by business. Net investment is an addition to the stock of capital. Other things being equal, an addition to the stock of capital means an increase in the productive capacity of the economy. This must be the result when a larger physical stock of capital is available for use with an existing labor force, natural resources, and technology. We treat all of these as variables in order to study their relationships. With the state of the technology as a variable, we may have a growth in the stock of capital that is intended not as a means of increasing capacity but rather as a means of reducing the cost of producing the level of output attained with existing capacity.

For long-term growth, a portion of the nation's output must be devoted to productive investment in order to renew, expand and modernize its capital stock. Not only does investment spending provide for the development of capital resources, but as a component of the aggregate demand for goods and services in the economy, investment spending provides an important source of demand for current output (Kopcke 1977).

Business expenditure for plant and equipment, business fixed investment, does not account for an especially large share of total demand for goods and services in the economy and it is a relatively volatile component of GNP. During the recession from late 1973 to early 1975, the drop in real business fixed investment spending was approximately one-half the total decline in real final sales. But the impact of business investment behavior is more complicated. Swings in the demand for capital goods induce changes in wage and salary income and profits in industries supplying capital goods. In turn, these income swings lead to changes in other components of GNP such as consumption spending and inventory accumulation. Thus, volatility in business fixed investment can generate ripple effects which tend to unsettle the smooth growth of GNP, and business fixed investment can have a much greater influence on the level of economic activity than the level of investment spending itself might indicate.

The recovery of business capital spending may be important not only for securing a return to adequate levels of aggregate demand in the business cycle, but also in order to achieve long-run goals for adequate growth of employment opportunity and of real output per capita.

The enormous increase in oil costs in 1973-74, that quadrupled the price of liquid gold, means that present capital will not be as productive as it would have been when oil was $2.00 a barrel. Simply put, the economy has become less capital intensive and less productive.

However, in the long run, an increase in the relative price of one input to production will lead to some substitution of other relatively less expensive inputs to arrive at the least cost methods of production. OPEC may have upped the relative attractiveness of labor over capital (Weimer 1977).

In the short run, there is little doubt that higher expected operating costs of new plant and equipment squeezes the projected return on investment and probably causes some marginal projects to be cancelled or postponed until market prices rise enough to restore expected returns to acceptable levels. However, in the long run, it may well lead to the development of more energy-efficient machinery and equipment; that is, there may indeed be some substitution of labor for energy-intensive machines, but there also may be some substitution of more energy-efficient machines for energy-intensive machines and for labor.

The purpose of this paper is to test if the price of energy is an important factor in the study of the investment behavior and if such variable should be included in the investment model. Chapter 1 is the literature survey and it is divided in two parts. The first part is a review of different studies related to the effects of the rising energy prices, and the second part is a review of the most important models of investment.

Chapter 2 is an explanation of the model of investment selected. Chapter 3 explains where the data was obtained and how the analysis was performed. Chapter 4 is an explanation of the results obtained. The conclusions are presented in Chapter 5.

CHAPTER I

LITERATURE SURVEY

Effects of the Rising Energy Prices

From 1950 to 1973 the real price of energy to the consumer, that is, the price of energy adjusted for inflation, declined at a rate of 1.8 percent per year. While real gross national product grew at 3.7 percent per year, the consumption of primary energy sources, mainly petroleum, natural gas, and coal, was increasing at 3.5 percent per year. The ratio of energy consumption to real GNP declined very gradually over the period (Darmstadter, Dunkerley, and Alterman 1977). This decline was an important facilitating factor in the relatively high rates of economic growth in the U.S. during the postwar period.

Although government policy has been very important to domestic producers of petroleum and natural gas, energy policy was not a significant political issue before 1973. In late 1973 and early 1974, world petroleum prices underwent a four-fold increase, following the Arab oil embargo of October 1973. At the time of the embargo, a system of price and wage controls was in effect in the United States. The response to the increase in world petroleum prices by the Republican

Administration was to view this increase in terms of the war against inflation. The resulting energy policy rapidly evolved into a complex system of price controls on domestically produced crude petroleum and refined products that had the effect of maintaining the prices of domestic petroleum products below world levels.

The Arab oil embargo had very little impact on the supply of petroleum products in the United States. However, uncontrolled prices for petroleum products in Europe reached levels that had not been seen neither before nor have been seen since. The continuation of price controls on domestically produced petroleum products gave producers and consumers an opportunity for successful speculation on an increase in petroleum prices (Jorgenson 1978).

Energy price developments have provided a major shock to the world economy in the seventies and have affected productivity, output prices, and growth. However, there are discrepancies about what the effect has been.

Rasche and Tatom (1977) have argued that the rise in the price of energy resources relative to that of business output reduced the economic capacity of the business sector, raised prices of output, and sharply reduced productivity of existing capital and labor resources.

DeLeeuw (1977) has argued that for productivity to have been adversely affected by energy price developments, a significant decline in energy use would have had to occur, and he noted that the reduction in energy use that followed the sharp rise in energy prices in 1973-74 was quite small.

Hudson and Jorgenson (1978) believe that the reduction in the intensity of energy use throughout the economy was significant and reduced the demand for capital input, which in turn lead to a reduction in investment levels and to a slowing in the rate of growth of capital stock and productive capacity. Finally, the energy price increases significantly affected the level and growth of real GNP. They argue that the entire future economic growth path has been shifted down as a result of the energy changes so that, even if long-term future growth rates are not affected, the level of real GNP will always be less than it would have been in the absence of the oil price increase.

The decline in real plant and equipment investment in the 1974 recession was the severest of all the postwar cycles in terms of both magnitude and duration. The steep decline in plant and equipment spending was signalled by a steep decline in capital investment commitments. The downturn in investment spending measured in constant prices in the 1973-75 recession was as severe, for example, as in the 1957-58 downturn. However, investment commitments fell much more sharply in the 1973-75 downturn indicating a sharp deterioration in the prospective return on investments that had not characterized prior periods of economic recession.

One important factor adversely impinging on business investment commitments in the recovery was the widespread concern shared by many businessmen for solvency and the state of balance sheets. That such a concern was well founded, was underscored by the widespread incidence of business failures. The goal of solvency became a target of immediate concern in many business firms and the entailed strategy of repairing their balance sheet positions was widely adopted. The debt structure was lengthened and cash flows and the equity market were used to build up ownership claims and reduce indebtedness. In the process, the expansion strategy based on increased net investment outlays was temporarily deferred and the rebound in investment outlays lagged. Business cash flows were used to augment balance sheet positions rather than to increase spending on capital goals (Yang 1977).

A rise in energy prices represents an increase in the cost of a significant productive input. Consequently, an increase in energy prices relative to other prices precipitates a decline in the amount of goods and services supplied by the economy at any given level of prices (Tatom 1980). A higher general price level is then necessary if the same amounts of labor, capital and energy inputs are to be used. Because of the increase in energy prices and the economic obsolescence of existing plant and equipment, however, producers will reduce their use of energy. The results of these related actions are a decline in real output and an increase in the price level (Hafer 1981).

Just as an increase in the relative price of energy precipitates a reduction in economic activity, so a substantial decrease in the growth of the money supply relative to its trend path also leads to declining economic activity, however, there is evidence that the general level of prices is temporarily unaffected by such restrictive money growth (Carlson 1980).

In the study conducted by Hafer (1981), he concluded that stable money growth may well be the correct response to supply shocks, because with no change in money growth, rising energy prices will affect the rate of inflation only temporarily.

Jorgenson (1977) analyzed the relationship between energy and the outlook for U.S. economic growth over the next decade. He concluded that reduced rates of growth are in prospect as a consequence of the four-fold increase in world petroleum prices resulting from the establishment of the OPEC cartel in late 1973 and early 1974. Slower economic growth will be accompanied by a reduction in the growth of real disposable income, a shift away from capital formation toward consumption, and a sharply reduced "fiscal dividend" available for disposal by the government through tax cuts.

An increase in business expenditures on equipment and structures is seen to provide the impetus to achieve the long-run economic goals of lower inflation and higher labor productivity growth. Indeed, some economistics claim that a significant part of the poor preformance of labor productivity since the mid-1970 is directly due to a slowdown in capital formation. Moreover, it seems that substantial future investment will be required to reverse the slowdown in capital formation (Berson, and Roley 1981).

Econometric Models of Investment

The point of departure for the large body of empirical research on investment behavior during the past decade has been the flexible accelerator model of Chenery and Koyck. This model has been gradually modified and extended under the impact of new empirical findings, but its basic outlines have found substantial empirical support. Desired capital is determined by long-run considerations and changes in desired capital are translated into investment expenditures by a distributed lag function (Jorgenson 1971).

Alternative models of investment behavior differ substantially in the determinants of desired capital. Jorgenson (1971) studied this question, and he concluded that real output is the most important single determinant of investment expenditures. The second most important determinant of investment is the availability of finance.

Financial considerations can be introduced into a model of investment expenditures in two forms: internal funds or liquidity and external funds or the cost of capital. These two alternative formulations are associated with the theories of finance of Duesenberry, Meyer, and Kuh and of Modigliani and Miller, respectively. Jorgenson (1971) says that the evidence clearly favors the Modigliani and Miller theory. Internal liquidity is not an important determinant of investment, given the level of output and the cost of external funds.

In the study of investment behavior, the most important current problem is the integration of the time structure of the investment process into the representation of technology, and models retaining the durable goods model of capital and augmenting the production function with internal adjustment costs have been proposed (Lucas 1967).

An important secondary problem is the time structure of financial determinants of investment. Bischoff (1971) has suggested that real output and the cost of capital should have separate lag structures in the determination of investment expenditures.

Among the numerous investment functions that have been developed, each set of investment functions corresponds to an econometric model of investment behavior. The alternative models have widely different implications for the determinants of investment behavior and for the time structure of the investment process. The resulting investment functions differ markedly in the weights that are associated with various explanatory variables and in the relative degree of explanation of the postwar data on investment expenditures.

One of these models was proposed by W.H. Locke Anderson (1967). The determinants of investment expenditures in Anderson's model included pressure on capacity, profits, interest rates, stocks of government securities held at the beginning of the period, accrued tax liability at the end of the period, and long-term debt capacity. This model is characterized as a restatement of the neoclassical position that investment is determined by the intersection of the marginal efficiency schedule with the marginal cost of funds schedule.

Robert Eisner (1962) developed a model that is a version of the flexible accelerator originated by Chenery and Koyck. The determinants of investment include changes in sales and changes in profits together with the level of capital stock. The level of capital stock is taken to determine investment for replacement purposes.

Another model has been proposed by Jorgenson and Stephenson (1967). The determinants of investment expenditures in this model include the value of output in current prices and the price of capital services, together with capital stock, which is taken to determine investment for replacement. The price of capital services depends in turn on the price of investment goods, the cost of capital, and the tax structure for business income. The theoretical basis for the model is the neoclassical theory of optimal accumulation of capital, in which the criterion for optimal accumulation is to maximize the present value of the firm.

Another model has been proposed by Meyer and Glauber (1964). The determinants of investment expenditures include capacity utilization, profits, and interest rates together with the percentage change in the price of common stocks. The theoretical basis of this model is similar to that proposed by Anderson and Duesenberry. The cost of funds schedule is assumed to depend on the availability of internal funds as well as the cost of external finance as reflected in the bond rate and the percentage rate of change of stock prices.

Jorgenson, Hunter, and Nadiri (1970) compared these four econometric models of investment behavior for the industries within manufacturing for which data are published in the OBE-SEC Survey. Their ranking was (1) Jorgenson and Stephenson, (2) Eisner, (3) Meyer and Glauber, (4) Anderson, and they concluded that a good part of the superiority of the Jorgenson and Stephenson model may be traced to the specification of the underlying determinants of investment expenditures.

CHAPTER II

THE INVESTMENT MODEL

The model used in this paper is a version of the standard neoclassical model developed by Jorgenson (Ackley 1978). It is called the generalized neoclassical model of investment theory (Kopcke 1977):

$$I_t = b_o + \sum_{i=o}^{n} b_i (P/R)_{t-i-1} Q_{t-i} + \sum_{i=o}^{n} b_{n+i} (P/R)_{t-i-1} Q_{t-i-1} + b_{2n+1} K_{t-1}$$

b = all coefficients

P = price index for output

R = user cost of capital

Q = real output

K = real stock of capital

I = real investment

The neoclassical theory is based on the profit maximizing theory of the firm. The objective of the firm is to maximize its market value; maximization of market value is implied by maximization of profit at every point of time, where profit is defined as net revenue on current account less the rental value of capital services. This theory assumes that, in the long run, firms do not strive to attain a fixed ratio between levels of output and stocks of capital. Instead, by varying the mix of capital and other factors of production, optimal capital-output ratios can be expected to vary with prices, interest rates, and the features of federal tax laws.

Each business selects a production plan designed to maximize its present value, that is, the sum of discounted future revenues less discounted future outlays, including taxes. In order to obtain a complete description of investment behavior, it is necessary to specify the production function of the firm relating the flow of output to the flows of capital services as well as services of other factors of production. Then, in the context of the production function, a firm determines its optimal investment program based on its outlook concerning the strength of demand for output, the relationship between capital goods prices and other prices, and the tax laws.

If we use the Cobb and Douglas production function assuming that no firm can influence, by its action alone, changes in interest rates or prices, then the optimal capital-output ratio is proportional to the price of output divided by the user cost of capital. When a firm acquires capital resources, it is committing itself to pay an implicit "rental fee" for using that capital; this fee is defined to be the user cost of capital, and it includes depreciation and interest charges adjusted for their treatment under the tax laws.

Thus, under these assumptions, the optimal relationship between output and capital takes on a particularly simple form. The optimal stock of capital for a firm is proportionate to the value of its output divided by the user cost of capital. Increasing final product demands or rising product prices stimulate the expansion of plant and equipment, while rising interest rates, reduced investment tax credits, or less generous depreciation allowances deter capital expansion.

Due to lags in the implementation of investment plans as well as adaptations in the outlook, investment outlays are expressed as a distributed lag over past values of the optimal capital stock, that is, revenue divided by the user cost of capital. It also includes the lagged capital stock itself to explain, in part, replacement investment.

The generalized neoclassical model has one further set of terms which require explanation (Kopcke 1977). Even though the optimal capital-output ratio can vary in theory for a firm, it may not be variable for a particular piece of equipment. Consequently, once machines are put in place, they embody a particular technology and a particular productive capacity which cannot vary substantially with interest rates, tax laws, or prices. Firms adjust to a change in the price of output relative to the user cost of capital by changing the capital intensity of new investment projects rather than the whole capital stock. The two sets of lag distributions permit the firm to respond differently to a change in output than to change in interest rates, taxes, or prices. This can be a fairly important distinction, because if only the first set of lags were included, output prices and capital rents must influence investment spending with identical time patterns since they would all be bound together in one variable.

The introduction of more variables into an investment function can be beneficial leading to superior results. Since the purpose of this paper is to study the influence of rising energy prices on investment, another variable will be included in the model, that is the relative price of energy.

If firms maximize economic profits, they employ energy at a rate where the value of the additional product obtained from employing more energy equals its price. Using the Cobb and Douglas production function (Rasche, and Tatom 1977):

$$Y = A\, e^{rt}\, L^{a}\, K^{b}\, E^{c}$$

where:

Y = output

A = scaling factor

r = trend rate of growth due to technological change

t = time

L = labor (man hours)

K = effective flow of capital services

E = flow of energy resources

a, b, c = output elasticities of the respective inputs

a + b + c = 1 constant return to scale and partial elasticities of substitution of unity

The demand for energy would be:

$$E = c\, Y(P_E/P_B)^{-1}$$

where:

P_E = price of energy

P_B = price of output

Then the production function will be (Rasche and Tatom 1977):

$$Y = Ae^{rt}\ L^a\ K^b\ E^c$$

$$E = cY(P_E/P_B)^{-1} = cY(P')^{-1}$$

$$E^c = (cY(P')^{-1})^c = c^cY^c(P')^{-c}$$

$$Y = Ae^{rt}\ L^a\ K^b\ c^c\ Y^c\ (P')^{-c} = A*\ e^{rt}\ L^a\ K^b\ Y^c\ (P')^{-c}$$

$$Y/Y^c = Y^{1-c} = A*\ e^{rt}\ L^a\ K^b\ (P')^{-c}$$

$$Y = (A^*\ e^{rt}L^aK^b(P')^{-c})^{1/1-c}$$

where:

A* = scaling factor

P' = relative price of energy

The relative price of energy can be measured by the ratio of the wholesale price index for fuel, related products, and power to the implicit price deflator for the output.

From the postwar period through mid-1973, the variance in this relative price was very small, and it is unlikely that its inclusion in the model would have had any impact. But after the dramatic change in energy prices in 1973-74, explicit consideration of energy resources and the relative price of energy resources would probably be required in order to obtain stable estimates of investment spending. Thus the investment model tested in this paper will be:

$$I_t = b_o + \sum_{i=o}^{n} b_i (P/R)_{t-i-1} Q_{t-i} + \sum_{i=o}^{n} b_{n+i} (P/R)_{t-i-1} Q_{t-i-1} + b_{2n+1} K_{t-1} +$$

$$+ b_{2n+2} P'_{t-1}$$

CHAPTER III

THE DATA AND ANALYSIS

The Data

The generalized neoclassical model of investment theory (Kopcke 1977) developed in the previous chapter, is used in this study:

$$I_t = b_o + \sum_{i=o}^{n} b_i (P/R)_{t-i-1} Q_{t-i} + \sum_{i=o}^{n} b_{n+i} (P/R)_{t-i-1} Q_{t-i-1} + b_{2n+1} K_{t-1} +$$

$$+ b_{2n+2} P'_{t-1}$$

where:

n = 5 for the distributed lags

b = all coefficients

I = GPI72 = gross private domestic investment in constant dollars, quarterly data (Table 1, Tables follow this section)

P = GDPB = implicit price deflator for gross domestic business product, quarterly data (Table 2)

R = user cost of capital. Two alternative definitions can be used

The first definition is as follows:

$$R = P \frac{(K_1)(RAA')(1-TAX)+(1-K_1)(D/P + DEP)(1-ITC-(TAX)(WE)(1-ITC)Z)}{(1-TAX)}$$

K_1 = debt-equity ratio based on the market value of debt and equity for U.S. nonfinancial corporations

RAA' = four-quarter moving average of the Aa utility new issue, deferred call bond yield

Tax = statutory corporate tax rate

D/P = four-quarter moving average of Standard and Poor's quarterly composite stock yields, the dividend-price ratio

DEP = quarterly depreciation rate

WE = present value of the depreciation allowance for equipment under the tax law

ITC = investment tax credit

Z = 0 for all quarters after 1963 3, otherwise Z = 1 (to account for a change in the tax law effective during 1963)

The alternative definition for user cost of capital is the long-term U.S. government security yield, and since it has been used by Jorgenson, it is the definition used in this paper.

R = FYGL2 = long-term U.S. government security yield, monthly data (Table 3)

Q = GND72 = gross domestic business product in constant dollars, quarterly data (Table 4)

K = KS = constant dollar net stocks of capital equipment and nonresidential structures, yearly data (Table 5)

P_E = PE = wholesale price index for fuel, related products and power, quarterly data (Table 6)

Before the empirical analysis, some rearrangement of the data if required.

The user cost of capital, R, is monthly data. In order to use it in the equation, it has to be compacted to quarterly data. The average of the three correspondent months is considered as the quarter data. The result is defined as FYGL24 and replaces R in the theoretical model (Table 7).

Only yearly data of the constant dollar net stocks of capital was available. The computer system used is the Standard Troll System, and it has the function called SPATQ, which converts an annual series to a quarterly series. SPATQ calculates a spline function for the input vector and evaluates the function at quarterly intervals.

Before SPATQ calculates the spline function, it calculates the cumulative series of the input values. The output from the spline is decumulated, so that the sum of the output values will equal the sum of the input values. SPATQ uses Newton's divided-difference interpolation formula to obtain a system of equations for the second derivative of the spline function (evaluated at the knots). These equations are reduced so that they use only the second derivative and second derivative differences. Since the second derivative is linear, and the start and end values are known to equal zero, the system can be solved. The matrix of coefficients for the equation system is symmetric and triple-diagonal; the system is iteratively solved using successive over-relaxation. The values obtained for the second derivative are then reintroduced into the original equations to obtain solutions for the values of the spline function at quarterly intervals. The derived quarterly observations are defined as KS4 and replace K in the theoretical model (Table 8). These quarterly observations are obviously deseasonalized and consistent with the rest of the data.

Finally, in order to make it simpler, two operations are performed before writing the equation for the model:

$P' = RPE = P_E/P = P_E/GDPB$ = relative price of energy, quarterly data (Table 9).

GDFY = GDPB/FYGL24, quarterly data (Table 10)

The resulting empirical equation is as follows:

$$GPI72 = b_o + \sum_{i=o}^{n} b_i (GDFY)_{t-i-1} (GND72)_{t-1} + \sum_{i=o}^{n} b_{n+i} (GDFY)_{t-i-1} (GND72)_{t-i-1} + b_{2n+1} (KS4)_{t-1} + b_{2n+2} (RPE)_{t-1}$$

TABLE 1

NBER4_GPI72 - DATE REVISED: 3/08/82
QUARTERLY DATA FROM 1947 1 TO 1981 4

GROSS PRIVATE DOMESTIC INVESTMENT, 1972 DOLLARS

1947 1	69.6	66.5	66.5	77.3
1948 1	81.	82.8	83.4	81.2
1949 1	71.3	61.6	65.8	62.8
1950 1	79.6	89.8	96.	108.7
1951 1	96.6	100.1	93.8	85.3
1952 1	86.4	77.4	80.5	97.6
1953 1	87.6	89.1	86.	78.6
1954 1	79.1	79.7	84.	89.7
1955 1	97.7	103.9	105.8	107.9
1956 1	103.9	102.7	102.2	101.7
1957 1	98.4	98.	99.8	91.7
1958 1	82.9	80.8	88.1	98.
1959 1	103.7	114.1	104.	110.2
1960 1	117.4	105.1	102.5	93.8
1961 1	94.	101.1	107.9	112.6
1962 1	116.8	118.3	119.1	116.
1963 1	118.7	124.6	127.3	129.6
1964 1	131.8	132.4	131.5	136.1
1965 1	149.4	150.5	152.4	155.4
1966 1	164.8	165.	160.3	162.
1967 1	152.6	148.9	155.1	163.
1968 1	157.2	162.7	161.6	164.9
1969 1	172.5	173.1	175.4	164.8
1970 1	158.1	158.3	161.6	156.2
1971 1	169.8	175.1	175.3	175.4
1972 1	186.	194.5	196.8	202.7
1973 1	215.7	217.2	215.4	221.8
1974 1	206.3	200.9	190.3	184.3
1975 1	145.8	146.8	163.3	163.3
1976 1	181.4	185.7	184.6	186.3
1977 1	203.3	213.7	220.6	216.5
1978 1	224.9	232.9	229.3	231.8
1979 1	237.7	238.7	232.6	221.5
1980 1	218.3	200.5	195.3	200.5
1981 1	211.6	219.7	221.5	207.2

TABLE 2

NBER4_GDPB - DATE REVISED: 3/08/82
QUARTERLY DATA FROM 1947 1 TO 1981 4

IMPLICIT PR DEFLATOR: PRIVATE BUSINESS SECTOR

1947	1	51.9	52.5	53.6	55.1
1948	1	56.1	56.7	57.8	57.4
1949	1	57.	56.5	56.3	56.2
1950	1	55.9	56.4	58.	59.2
1951	1	61.3	61.6	61.4	62.
1952	1	62.	62.	62.4	63.
1953	1	63.	63.	63.2	62.9
1954	1	63.6	63.8	63.5	63.9
1955	1	64.2	64.4	64.9	65.3
1956	1	65.8	66.4	67.2	67.7
1957	1	68.5	68.9	69.4	69.4
1958	1	69.7	69.8	70.1	70.3
1959	1	70.8	71.3	71.6	71.8
1960	1	72.2	72.4	72.6	72.7
1961	1	72.6	72.8	73.1	73.1
1962	1	73.6	73.9	74.	74.4
1963	1	74.6	74.6	74.8	75.1
1964	1	75.2	75.4	75.7	75.9
1965	1	76.5	76.8	77.1	77.4
1966	1	78.1	79.1	79.4	80.2
1967	1	80.7	80.9	81.6	82.3
1968	1	83.2	84.2	84.7	85.8
1969	1	86.8	88.	89.1	90.2
1970	1	91.1	92.2	92.8	94.1
1971	1	95.1	96.4	97.2	97.9
1972	1	98.9	99.5	100.2	101.3
1973	1	102.6	104.4	106.1	108.4
1974	1	110.5	113.4	116.4	119.8
1975	1	123.1	124.5	126.7	128.8
1976	1	129.8	130.8	132.4	134.3
1977	1	136.1	138.5	140.3	142.2
1978	1	144.3	148.3	151.1	154.6
1979	1	157.9	161.	164.3	167.3
1980	1	171.2	175.4	179.5	183.8
1981	1	188.2	191.1	195.8	199.9

SOURCE: Citibase, Citibank Economic Data Base

TABLE 3

NBER12_FYGL2 - DATE REVISED: 3/08/82
MONTHLY DATA FROM 1947 1 TO 1982 1

U.S.GOV'T SECURITY YIELD:10 YRS+(LONG TERM),TREAS.COMPIL.(%PER ANN

1947	1	2.21	2.21	2.19	2.19
1947	5	2.19	2.22	2.25	2.24
1947	9	2.24	2.27	2.36	2.39
1948	1	2.45	2.45	2.44	2.44
1948	5	2.42	2.41	2.44	2.45
1948	9	2.45	2.45	2.44	2.44
1949	1	2.42	2.39	2.38	2.38
1949	5	2.38	2.39	2.27	2.24
1949	9	2.22	2.22	2.2	2.19
1950	1	2.2	2.24	2.27	2.3
1950	5	2.31	2.33	2.34	2.33
1950	9	2.36	2.39	2.38	2.39
1951	1	2.39	2.4	2.47	2.56
1951	5	2.63	2.65	2.63	2.57
1951	9	2.56	2.61	2.66	2.7
1952	1	2.74	2.71	2.7	2.64
1952	5	2.57	2.61	2.61	2.7
1952	9	2.71	2.74	2.71	2.75
1953	1	2.8	2.83	2.89	2.97
1953	5	3.11	3.13	3.02	3.02
1953	9	2.98	2.83	2.86	2.79
1954	1	2.69	2.62	2.53	2.48
1954	5	2.54	2.55	2.47	2.48
1954	9	2.52	2.54	2.57	2.59
1955	1	2.68	2.78	2.78	2.82
1955	5	2.81	2.82	2.91	2.95
1955	9	2.92	2.87	2.89	2.91
1956	1	2.88	2.85	2.93	3.07
1956	5	2.97	2.93	3.	3.17
1956	9	3.21	3.2	3.3	3.4
1957	1	3.34	3.22	3.26	3.32
1957	5	3.4	3.58	3.6	3.63
1957	9	3.66	3.73	3.57	3.3
1958	1	3.24	3.28	3.25	3.12
1958	5	3.14	3.2	3.36	3.6
1958	9	3.75	3.76	3.7	3.8
1959	1	3.91	3.92	3.92	4.01
1959	5	4.08	4.09	4.11	4.1
1959	9	4.26	4.11	4.12	4.27
1960	1	4.37	4.22	4.08	4.18
1960	5	4.16	3.98	3.86	3.79
1960	9	3.84	3.91	3.93	3.88

TABLE 3 - Continued

1961	1	3.89	3.81	3.78	3.8
1961	5	3.73	3.88	3.9	4.
1961	9	4.02	3.98	3.98	4.06
1962	1	4.08	4.09	4.01	3.89
1962	5	3.88	3.9	4.02	3.98
1962	9	3.94	3.89	3.87	3.87
1963	1	3.89	3.92	3.93	3.97
1963	5	3.97	4.	4.01	3.99
1963	9	4.04	4.07	4.11	4.14
1964	1	4.15	4.14	4.18	4.2
1964	5	4.16	4.13	4.13	4.14
1964	9	4.16	4.16	4.12	4.14
1965	1	4.14	4.16	4.15	4.15
1965	5	4.14	4.14	4.15	4.19
1965	9	4.25	4.28	4.34	4.43
1966	1	4.43	4.61	4.63	4.55
1966	5	4.57	4.63	4.75	4.8
1966	9	4.79	4.7	4.74	4.65
1967	1	4.4	4.47	4.45	4.51
1967	5	4.76	4.86	4.86	4.95
1967	9	4.99	5.19	5.44	5.36
1968	1	5.18	5.16	5.39	5.28
1968	5	5.4	5.23	5.09	5.04
1968	9	5.09	5.24	5.36	5.66
1969	1	5.74	5.86	6.05	5.84
1969	5	5.85	6.05	6.07	6.02
1969	9	6.32	6.27	6.52	6.81
1970	1	6.86	6.41	6.39	6.53
1970	5	6.94	6.99	6.57	6.75
1970	9	6.63	6.59	6.24	5.97
1971	1	5.92	5.84	5.71	5.75
1971	5	5.96	5.94	5.91	5.78
1971	9	5.56	5.46	5.48	5.62
1972	1	5.62	5.67	5.66	5.74
1972	5	5.64	5.59	5.59	5.59
1972	9	5.7	5.69	5.51	5.63
1973	1	5.96	6.14	6.2	6.11
1973	5	6.25	6.32	6.53	6.85
1973	9	6.41	6.25	6.3	6.35
1974	1	6.56	6.54	6.81	7.04
1974	5	7.09	7.02	7.18	7.33
1974	9	7.3	7.22	6.93	6.77
1975	1	6.68	6.66	6.77	7.05
1975	5	7.01	6.86	6.89	7.11
1975	9	7.28	7.29	7.21	7.17
1976	1	6.93	6.92	6.88	6.73
1976	5	7.01	6.92	6.85	6.82
1976	9	6.7	6.65	6.62	6.38
1977	1	6.68	7.16	7.2	7.13
1977	5	7.17	6.99	6.98	7.01
1977	9	6.94	7.08	7.16	7.24
1978	1	7.51	7.6	7.63	7.74
1978	5	7.87	7.94	8.1	7.88
1978	9	7.82	8.07	8.16	8.36
1979	1	8.43	8.43	8.45	8.44
1979	5	8.55	8.32	8.35	8.42
1979	9	8.68	9.44	9.8	9.58
1980	1	10.03	11.55	11.87	10.83
1980	5	9.82	9.4	9.83	10.53
1980	9	10.94	11.2	11.83	11.89
1981	1	11.65	12.23	12.15	12.62
1981	5	12.96	12.39	13.05	13.61
1981	9	14.14	14.13	12.68	12.88
1982	1	13.73			

SOURCE: Citibase, Citibank Economic Data Base

TABLE 4

NBER4_GND72 - DATE REVISED: 3/08/82
QUARTERLY DATA FROM 1947 1 TO 1981 4

GNP BY SECTOR:CONSTANT $: GROSS DOMESTIC PRODUCT

1947 1	463.7	467.	467.6	473.
1948 1	476.6	485.2	489.9	494.9
1949 1	489.6	487.4	492.1	488.3
1950 1	510.	523.6	540.5	553.
1951 1	561.3	572.2	581.	584.9
1952 1	589.8	590.3	596.5	610.7
1953 1	619.4	624.3	620.8	614.6
1954 1	606.7	604.3	613.	624.1
1955 1	639.6	648.8	658.6	664.8
1956 1	661.6	665.	665.4	673.7
1957 1	678.	678.1	682.8	674.5
1958 1	660.8	665.2	681.3	697.9
1959 1	707.	721.7	716.2	722.5
1960 1	735.6	733.3	732.4	726.7
1961 1	732.	744.6	754.	773.3
1962 1	783.4	792.1	799.	800.6
1963 1	808.	819.9	832.9	841.5
1964 1	856.4	866.2	873.2	879.6
1965 1	898.5	911.3	926.2	949.6
1966 1	969.1	972.	980.7	989.2
1967 1	990.5	997.1	1008.4	1019.6
1968 1	1028.7	1047.6	1059.9	1063.6
1969 1	1075.9	1080.8	1084.3	1077.9
1970 1	1073.5	1074.7	1085.	1077.1
1971 1	1102.4	1107.2	1116.4	1125.3
1972 1	1146.6	1168.1	1181.8	1203.6
1973 1	1233.9	1234.6	1240.2	1250.6
1974 1	1236.	1238.1	1231.6	1217.3
1975 1	1192.9	1208.1	1234.9	1244.1
1976 1	1272.6	1280.	1287.3	1299.4
1977 1	1328.9	1346.5	1368.3	1375.2
1978 1	1382.7	1414.9	1427.	1442.6
1979 1	1454.6	1447.8	1458.6	1462.4
1980 1	1471.5	1435.5	1443.4	1458.9
1981 1	1488.4	1483.8	1487.1	1468.5

SOURCE: Citibase <u>Citibank Economic Data Base</u>

TABLE 5

KS - DATE REVISED: 3/24/82
ANNUAL DATA FROM 1960 TO 1977

1960	533.	547.1	565.3	584.5
1964	609.5	645.9	689.2	725.6
1968	763.2	802.5	833.7	859.5
1972	889.8	929.5	965.1	981.2
1976	999.	1024.3		

SOURCE: Survey of Current Business

TABLE 6

PE - DATE REVISED: 3/24/82
QUARTERLY DATA FROM 1961 1 TO 1982 4

1961 1	103.	100.2	100.1	99.8
1962 1	100.1	99.8	100.1	100.8
1963 1	100.5	100.5	99.4	98.7
1964 1	98.5	96.3	96.1	97.5
1965 1	98.1	98.2	99.	100.1
1966 1	100.2	100.6	101.7	102.6
1967 1	103.2	103.8	104.4	102.8
1968 1	102.1	102.8	102.8	102.
1969 1	103.1	104.7	104.8	105.7
1970 1	106.1	104.6	106.	110.4
1971 1	113.1	113.7	114.8	114.8
1972 1	116.2	117.5	119.5	121.3
1973 1	125.	131.3	135.7	145.
1974 1	176.3	204.2	224.2	228.3
1975 1	232.5	239.4	231.3	257.1
1976 1	256.2	259.2	268.3	279.2
1977 1	289.2	301.8	308.8	311.
1978 1	313.6	319.9	325.3	330.8
1979 1	343.8	377.6	433.1	477.7
1980 1	531.4	571.7	589.8	602.9
1981 1	666.2	706.2	704.1	699.1
1982 1	0.	0.	0.	0.

SOURCE: <u>Survey of Current Business</u>

TABLE 7

FYGL24 - DATE REVISED: 3/29/82
QUARTERLY DATA FROM 1947 1 TO 1981 4

FYGL24 = COMPACT(FYGL2,0,4)

1947 1	2.20333	2.2	2.24333	2.34
1948 1	2.44667	2.42333	2.44667	2.44333
1949 1	2.39667	2.38	2.24333	2.20333
1950 1	2.33667	2.31333	2.34333	2.39333
1951 1	2.42	2.61333	2.58667	2.65667
1952 1	2.71667	2.60667	2.67333	2.73333
1953 1	2.84	3.07	3.00667	2.92667
1954 1	2.61333	2.52333	2.49	2.56667
1955 1	2.74667	2.81667	2.92667	2.89
1956 1	2.88667	2.99	3.12667	3.3
1957 1	3.27333	3.43333	3.63	3.53333
1958 1	3.25667	3.15333	3.57	3.75333
1959 1	3.91667	4.06	4.15667	4.16667
1960 1	4.22333	4.10667	3.83	3.90667
1961 1	3.82667	3.80333	3.97333	4.00667
1962 1	4.06	3.89	3.98	3.87667
1963 1	3.91333	3.98	4.01333	4.10667
1964 1	4.15667	4.16333	4.14333	4.14
1965 1	4.15	4.14333	4.19667	4.35
1966 1	4.55667	4.58333	4.79	4.69667
1967 1	4.44	4.71	4.93333	5.33
1968 1	5.24333	5.30333	5.07333	5.42
1969 1	5.88333	5.91333	6.13666	6.53333
1970 1	6.56333	6.82	6.65	6.26666
1971 1	5.82333	5.88333	5.75	5.52
1972 1	5.65	5.65666	5.62666	5.60999
1973 1	6.1	6.22666	6.59666	6.3
1974 1	6.63666	7.05	7.27	6.97333
1975 1	6.70333	6.97333	7.09333	7.22333
1976 1	6.91	6.88666	6.79	6.55
1977 1	7.01333	7.09666	6.97666	7.16
1978 1	7.58	7.85	7.93333	8.19666
1979 1	8.43667	8.43666	8.48333	9.60666
1980 1	11.15	10.0167	10.4333	11.64
1981 1	12.01	12.6567	13.6	13.23

TABLE 8

KS4 - DATE REVISED: 3/24/82
QUARTERLY DATA FROM 1960 1 TO 1977 4

KS4 = SPATQ(KS,4)

1960 1	523.938	529.979	536.021	542.062
1961 1	543.502	544.942	547.819	552.137
1962 1	557.601	562.983	567.99	572.626
1963 1	577.013	581.711	586.85	592.427
1964 1	598.5	605.306	612.903	621.291
1965 1	630.456	640.306	650.824	662.014
1966 1	673.61	684.591	694.689	703.909
1967 1	712.422	721.031	729.591	739.047
1968 1	748.406	758.094	768.031	778.266
1969 1	788.578	798.344	807.391	815.687
1970 1	823.312	830.516	837.297	843.672
1971 1	849.734	856.047	862.641	869.878
1972 1	876.875	884.922	893.928	903.362
1973 1	913.969	924.406	934.703	944.922
1974 1	954.687	962.875	969.187	973.641
1975 1	976.516	979.406	982.656	986.219
1976 1	990.25	995.328	1001.53	1008.89
1977 1	1016.84	1023.23	1027.48	1029.62

TABLE 9

RPE - DATE REVISED: 3/29/82
QUARTERLY DATA FROM 1961 1 TO 1981 4

RPE = PE/GDPB

1961 1	1.41973	1.37637	1.36936	1.36525
1962 1	1.36005	1.35047	1.3527	1.35484
1963 1	1.34718	1.34718	1.32898	1.31425
1964 1	1.30984	1.27719	1.26948	1.28458
1965 1	1.28235	1.27865	1.28405	1.29329
1966 1	1.28297	1.27181	1.28086	1.2793
1967 1	1.27881	1.28306	1.27941	1.24909
1968 1	1.22716	1.2209	1.21369	1.18891
1969 1	1.18779	1.18977	1.17621	1.17184
1970 1	1.16465	1.13449	1.14224	1.17322
1971 1	1.18927	1.17946	1.18107	1.17262
1972 1	1.17492	1.1809	1.19261	1.19743
1973 1	1.21832	1.25766	1.27898	1.33764
1974 1	1.59547	1.8007	1.92612	1.90568
1975 1	1.88871	1.92289	1.98747	1.99612
1976 1	1.97391	1.974	2.03795	2.07893
1977 1	2.12491	2.17906	2.201	2.19706
1978 1	2.17325	2.15711	2.15258	2.13972
1979 1	2.17733	2.34534	2.63603	2.85535
1980 1	3.10397	3.25941	3.28579	3.2802
1981 1	3.53985	3.69545	3.59602	3.49725

TABLE 10

GDFY - DATE REVISED: 3/29/82
QUARTERLY DATA FROM 1947 1 TO 1981 4

GDFY = GDPB/FYGL24

1947 1	23.5552	23.8636	23.893	23.547
1948 1	22.9292	23.3975	23.624	23.4925
1949 1	23.783	23.7395	25.0966	25.5068
1950 1	24.9925	24.3804	24.7511	24.8392
1951 1	25.3306	23.5714	23.7371	23.3375
1952 1	22.8221	23.7852	23.3416	23.0488
1953 1	22.1831	20.5212	21.0199	22.2523
1954 1	24.3367	25.284	25.502	24.8961
1955 1	23.3738	22.8639	22.1754	22.5952
1956 1	22.7944	22.2074	21.4925	20.5152
1957 1	20.9267	20.0388	19.1195	19.6415
1958 1	21.4023	22.1353	19.6358	18.73
1959 1	18.0766	17.5616	17.2253	17.232
1960 1	17.0955	17.6299	18.9556	18.6092
1961 1	18.9721	19.1411	18.3976	18.2446
1962 1	18.1281	18.9974	18.593	19.1917
1963 1	19.063	18.7437	18.6379	18.2873
1964 1	18.0914	18.1105	18.2703	18.3333
1965 1	18.4337	19.5358	18.3717	17.7931
1966 1	17.1397	17.2582	16.6109	17.0759
1967 1	18.1757	17.1762	16.5405	15.4409
1968 1	15.8678	15.8768	16.6951	15.8303
1969 1	14.7535	14.8816	14.5193	13.8061
1970 1	13.8802	13.5191	13.9549	15.016
1971 1	16.3309	16.3853	16.9043	17.7355
1972 1	17.5044	17.5899	17.8081	18.0571
1973 1	16.8197	16.7666	16.0839	17.2063
1974 1	16.6499	16.0851	16.011	17.1797
1975 1	18.364	17.8537	17.8618	17.8311
1976 1	18.7844	18.9932	19.4993	20.5038
1977 1	19.4059	19.5162	20.1099	19.8603
1978 1	19.0369	18.8917	19.0462	18.8613
1979 1	18.7159	19.0834	19.3674	17.415
1980 1	15.3543	17.5108	17.2045	15.7904
1981 1	15.6703	15.0988	14.3971	15.1096

The Analysis

A multiple regression is computed based on the data ranging from the first quarter of 1962 to the fourth quarter of 1977. The regression task estimates values of the coefficients in the equation for the specified range of dates. The relative price of energy is only available from 1960 and the latest data available for the constant dollar net stocks of capital is the last quarter of 1977. Thus, the range has been restricted to the period of 1960 to 1977.

Ordinary least squares is used to solve the regression, and in addition to coefficient estimates, a wide range of statistics is computed (see Appendix A). Distributed lag estimation are requested for the level of output variable and the capital rents variable, the number of quarters requested for the lags is five periods.

The empirical results are shown in Table 11. The results show that positive autocorrelation is present (DW = 0.89). Multicollinearity is not a problem in this case because the COND (X) $<$ 900 (Judge, Hill, Griffiths, Lutkepohl, and Lee 1982).

It is assumed that the lags will have an important effect on the value of the COND (X) and to this end the same equation is calculated without the lags and its value diminishes to 383.40 (Table 12). However, if polynomial distributed lags are requested instead of distributed lags then the COND (X) becomes 100,000 (table 13).

Given autocorrelation, a measure of the correction for was sought. The correlation coefficient, ρ, is unknown and the generalized least squares estimator, ρ^*, is used as an alternative (Judge, Hill, Griffiths, Lutkepohl, and Lee 1982):

$$\rho^* = 1 - \tfrac{1}{2}d$$

where d is the Durbin-Watson statistic.

$\rho^* = 1 - \tfrac{1}{2}(0.89) = 1 - 0.445 = 0.555$

Given a measure of the autocorrelation coefficient, the variables are transformed and generalized differences are calculated:

GPI72A = GPI72 - .555 x GPI72(-1)

GDFYA = GDFY - .555 x GDFY(-1)

GND72A = GND72 - .555 x GND72(-1)

KS4A = KS4 - .555 x KS4(-1)

RPEA = RPE - .555 x RPE(-1)

and a new regression equation is computed. These results are shown in Table 14.

In order to compare the results, another regression equation is computed of the same equation but limiting the range from the first quarter of 1962 to the fourth quarter of 1971. The results are shown in Table 15. Here again only autocorrelation presents a problem and the generalized least squares estimator is used again:

$\rho^* = 1 - \tfrac{1}{2}(1.21) = 1 - 0.605 = 0.395$

The generalized differences are calculated:

GPI72B = GPI72 - .395 x GPI72(-1)

GDFYB = GDFY - .395 x GDFY(-1)

GND72B = GND72 - .395 x GND72(-1)

KS4B = KS4 - .395 x KS4(-1)

RPEB = RPE - .395 x RPE(-1)

and a new regression equation is computed. The results are shown in Table 16.

Finally, another regression equation is computed of the same equation but excluding the relative price of energy from the first quarter of 1962 to the fourth quarter of 1977. The results are shown in Table 17. Autocorrelation is the only problem present and the generalized least squares estimator is used.

$$\rho^* = 1 - \tfrac{1}{2}(0.58) = 1 - 0.29 = 0.71$$

The generalized differences are calculated:

GPI72C = GPI72 - .71 x GPI72(-1)

GDFYC = GDFY - .71 x GDFY(-1)

GND72C = GND72 - .71 x GND72(-1)

KS4C = KS4 - .71 x KS4(-1)

The results of the regression equation computed with the transformed variables are shown in Table 18.

TABLE 11

1: GPI72 = B0+B1*GDFY(-1)*GND72+B6*GDFY(-1)*GND72(-1)+B11*KS4(-1)+B12*RPE(-1)

NOB = 64 NOVAR = 13
RANGE = 1962 1 TO 1977 4
RSQ = 0.95175 CRSQ = 0.9404 F(12/51) = 83.840
SER = 7.0170 SSR = 2511.160 DW(0) = 0.89 COND(X) = 788.08
LHS MEAN = 166.98100 SR = 0.00098

COEF	VALUE	ST ER	T-STAT	MEAN
B0	25.60380	5.76076	4.44452	1.00000
B1	0.00775	0.00627	1.23597	18614.10000
(-1)	0.01348	0.00599	2.24841	18404.30000
(-2)	0.00961	0.00625	1.53735	18212.60000
(-3)	0.01169	0.00616	1.89910	18025.00000
(-4)	0.01668	0.00653	2.55414	17812.10000
B6	-0.01044	0.00666	-1.56713	18445.00000
(-1)	-0.01075	0.00625	-1.72081	18231.80000
(-2)	-0.00717	0.00652	-1.09935	18043.90000
(-3)	-0.00804	0.00646	-1.24478	17858.00000
(-4)	-0.01714	0.00675	-2.53888	17653.00000
B11	0.12816	0.01944	6.59313	796.77600
B12	-50.54870	6.45804	-7.82726	1.42087

COEF	PARTIAL	BETA
B0	0.52838	0.00000
B1	0.17053	0.93966
(-1)	0.30031	1.56387
(-2)	0.21045	1.06949
(-3)	0.25700	1.25250
(-4)	0.33676	1.68112
B6	-0.21434	-1.24813
(-1)	-0.23426	-1.22892
(-2)	-0.15215	-0.78839
(-3)	-0.17172	-0.85178
(-4)	-0.33497	-1.71762
B11	0.67834	0.67732
B12	-0.73873	-0.56411

TABLE 11 - Continued

COVARIANCE MATRIX

B0	3.319E+01					
B1	-7.966E-03	3.927E-05				
(-1)	-1.852E-03	-4.200E-06	3.593E-05			
(-2)	-4.558E-03	4.032E-06	-4.290E-06	3.904E-05		
(-3)	-1.339E-04	-1.520E-06	1.842E-06	-3.246E-06	3.792E-05	
(-4)	-6.665E-03	8.998E-06	8.581E-07	6.362E-06	2.040E-07	4.267E-05
B6	9.216E-03	-4.080E-05	3.063E-06	-5.521E-06	-1.444E-07	-1.115E-05
	4.435E-05					
(-1)	1.961E-03	1.408E-06	-3.570E-05	4.164E-06	-1.455E-06	-1.485E-06
	-1.839E-06	3.903E-05				
(-2)	4.499E-03	-2.759E-06	1.250E-06	-3.899E-05	2.793E-06	-6.152E-06
	4.328E-06	-2.878E-06	4.256E-05			
(-3)	1.458E-03	-3.708E-07	-1.931E-07	-7.285E-07	-3.783E-05	-2.015E-06
	2.375E-06	-3.097E-07	-5.565E-07	4.173E-05		
(-4)	3.634E-03	-5.970E-06	-6.497E-07	-3.717E-06	-2.109E-06	-4.280E-05
	8.001E-06	1.312E-06	3.480E-06	1.766E-06	4.555E-05	
B11	-2.035E-02	3.246E-05	3.145E-05	4.197E-05	4.778E-05	6.241E-05
	-4.348E-05	-3.417E-05	-4.429E-05	-5.249E-05	-6.552E-05	3.778E-04
B12	-4.790E+00	7.596E-03	7.051E-03	1.223E-02	1.413E-02	2.066E-02
	-1.126E-02	-7.367E-03	-1.293E-02	-1.594E-02	-2.135E-02	8.230E-02
	4.171E+01					

COEF	METHOD	PARAMETERS
B1	DL	LAGS=5
B6	DL	LAGS=5

TABLE 12

```
1:  GPI72 = B0+B1*GDFY(-1)*GND72+B6*GDFY(-1)*GND72(-1)+B11*KS4(-1)+B12*RPE(-1)

NOB = 64       NOVAR = 5
RANGE =   1962 1 TO 1977 4
RSQ =     0.85604      CRSQ =    0.84628      F(4/59) =     87.707
SER =   11.2695       SSR =   7493.090      DW(0) =   0.87      COND(X) =    383.40
LHS MEAN =      166.98100      SR =        0.0078
```

COEF	VALUE	ST ER	T-STAT	MEAN
B0	44.77000	8.04534	5.56471	1.00000
B1	0.00115	0.00882	0.13083	18614.10000
B6	0.00575	0.00941	0.61130	18445.00000
B11	0.09923	0.01929	5.14374	796.77600
B12	-59.41380	7.36777	-8.06401	1.42087

COEF	PARTIAL	BETA
B0	0.58668	0.00000
B1	0.01703	0.13996
B6	0.07933	0.68784
B11	0.55642	0.52446
B12	-0.72409	-0.66304

COVARIANCE MATRIX

B0	6.473E+01				
B1	-3.565E-03	7.776E-05			
B6	2.437E-03	-8.251E-05	8.853E-05		
B11	-3.924E-02	7.221E-05	-8.950E-05	3.722E-04	
B12	-7.079E+00	1.443E-02	-1.986E-02	3.483E-02	5.428E+01

TABLE 13

1: GPI72 = B0+B1*GDFY(-1)*GND72+B6*GDFY(-1)*GND72(-1)+B11*KS4(-1)+B12*RPE(-1)

NOB = 64 NOVAR = 11
RANGE = 1962 1 TO 1977 4
RSQ = 0.95131 CRSQ = 0.94212 F(10/53) = 103.545
SER = 6.9152 SSR = 2534.430 DW(0) = 0.89 COND(X) = 1.0E+05
LHS MEAN = 166.98100 SR = -0.01733

COEF	VALUE	ST ER	T-STAT	MEAN
B0	25.26440	5.64185	4.47803	1.00000
B1	0.00887	0.00588	1.50826	18614.10000
(-1)	0.01213	0.00500	2.42730	18404.30000
(-2)	0.01100	0.00392	2.80291	18212.60000
(-3)	0.01089	0.00520	2.09380	18025.00000
(-4)	0.01721	0.00626	2.75105	17812.10000
B6	-0.01135	0.00632	-1.79523	18445.00000
(-1)	-0.01018	0.00534	-1.90805	18231.80000
(-2)	-0.00746	0.00420	-1.77576	18043.90000
(-3)	-0.00816	0.00564	-1.44642	17858.00000
(-4)	-0.01726	0.00655	-2.63383	17653.00000
B11	0.12830	0.01915	6.70018	796.77600
B12	-50.49760	6.35712	-7.94347	1.42087

COEF	PARTIAL	BETA
B0	0.52392	0.00000
B1	-0.20287	1.07558
(-1)	0.31630	1.40705
(-2)	-0.35930	1.22425
(-3)	0.27640	1.16587
(-4)	-0.35349	1.73436
B6	-0.23942	-1.35691
(-1)	0.25353	-1.16401
(-2)	-0.23697	-0.81996
(-3)	0.19487	-0.86421
(-4)	-0.34020	-1.73053
B11	0.67719	0.67808
B12	-0.73722	-0.56354

TABLE 13 - Continued

COVARIANCE MATRIX

B0	3.183E+01					
B1	-6.551E-03	3.455E-05				
(-1)	-3.748E-03	1.527E-06	2.496E-05			
(-2)	-1.716E-03	-3.600E-06	1.038E-05	1.539E-05		
(-3)	-1.862E-03	3.271E-06	-7.652E-06	1.160E-05	2.703E-05	
(-4)	-5.593E-03	6.238E-06	5.427E-06	-8.343E-07	4.667E-06	3.914E-05
B6	7.835E-03	-3.633E-05	-2.519E-06	2.370E-06	-5.089E-06	-8.319E-06
	3.995E-05					
(-1)	3.500E-03	-2.911E-06	-2.573E-05	-1.031E-05	8.093E-06	-5.802E-06
	2.806E-06	2.848E-05				
(-2)	2.207E-03	2.839E-06	-1.162E-05	-1.617E-05	-1.180E-05	5.092E-07
	-2.116E-06	1.186E-05	1.765E-05			
(-3)	2.519E-03	-3.017E-06	6.767E-06	-1.300E-05	-2.839E-05	-5.518E-06
	5.565E-06	-8.845E-06	1.359E-05	3.182E-05		
(-4)	3.005E-03	-4.414E-06	-3.650E-06	1.409E-06	-5.344E-06	-4.002E-05
	6.230E-06	4.584E-06	-1.957E-06	4.780E-06	4.297E-05	
B11	-1.947E-02	3.072E-05	3.213E-05	3.832E-05	4.800E-05	5.986E-05
	-4.140E-05	-3.476E-05	-4.064E-05	-5.231E-05	-6.309E-05	3.667E-04
B12	-4.497E+00	6.964E-03	7.715E-03	1.048E-02	1.465E-02	1.964E-02
	-1.049E-02	-8.077E-03	-1.111E-02	-1.632E-02	-2.040E-02	7.977E-02
	4.041E+01					

TABLE 13 - Continued

COEF	METHOD	PARAMETERS
B1	PDL	LAGS=5,DEGREE=3
B6	PDL	LAGS=5,DEGREE=3

POLYNOMIAL STATISTICS AND COEFFICIENTS

B1 MEAN LAG = 2.257 ST. ER. = 3.451
SUM OF LAG COEF = 0.060 ST. ER. = 0.014

VALUE	ST ER	T-STAT
-0.00420	0.02876	-0.14605
0.11864	0.22495	0.52743
-0.27395	0.50103	-0.54678
0.19490	0.33210	0.58686

COVARIANCE MATRIX

0.0008			
-0.0063	0.0506		
0.0134	-0.1114	0.2510	
-0.0085	0.0721	-0.1653	0.1103

B6 MEAN LAG = 2.180 ST. ER. = 5.757
SUM OF LAG COEF = -0.054 ST. ER. = 0.015

VALUE	ST ER	T-STAT
-0.00597	0.03078	-0.19381
-0.06188	0.24076	-0.25702
0.20749	0.53762	0.38594
-0.17940	0.35668	-0.50298

COVARIANCE MATRIX

0.0009			
-0.0072	0.0580		
0.0155	-0.1280	0.2890	
-0.0098	0.0830	-0.1905	0.1272

TABLE 14

```
1:   GPI72A = B0+B1*GDFYA(-1)*GND72A+B6*GDFYA(-1)*GND72A(-1)+B11*KS4A(-1)+B12*RPEA(-1)

NOB = 64        NOVAR = 13
RANGE =   1962 1 TO 1977 4
RSQ =    0.8811       CRSQ =     0.85312      F(12/51) =     31.493
SER =    5.4371        SSR =   1507.690       DW(0) =   1.38        COND(X) =    443.70
LHS MEAN =       75.20770       SR =         0.01311
```

COEF	VALUE	ST ER	T-STAT	MEAN
B0	11.39730	4.05624	2.80982	1.00000
B1	0.04106	0.01002	4.09851	3737.89000
(-1)	0.03989	0.01058	3.77180	3691.72000
(-2)	0.02613	0.01122	2.32993	3652.71000
(-3)	0.02609	0.01105	2.36135	3622.03000
(-4)	0.03226	0.01075	3.00193	3571.64000
B6	-0.04697	0.01055	-4.45016	3704.71000
(-1)	-0.03617	0.01131	-3.19674	3656.07000
(-2)	-0.02109	0.01199	-1.75858	3618.38000
(-3)	-0.01851	0.01181	-1.56674	3586.56000
(-4)	-0.03307	0.01106	-2.99129	3538.54000
B11	0.14227	0.02500	5.69134	358.72500
B12	-42.56220	8.54032	-4.98368	0.63950

COEF	PARTIAL	BETA
B0	0.36613	0.00000
B1	0.49776	2.22067
(-1)	0.46702	2.06620
(-2)	0.31017	1.30191
(-3)	0.31394	1.27778
(-4)	0.38751	1.46264
B6	-0.52887	-2.49724
(-1)	-0.40857	-1.83336
(-2)	-0.23911	-1.03024
(-3)	-0.21429	-0.88809
(-4)	-0.38634	-1.48990
B11	0.62324	0.67667
B12	-0.57228	-0.46538

TABLE 14 - Continued

COVARIANCE MATRIX

B0	1.645E+01					
B1	-3.297E-03	1.003E-04				
(-1)	-9.872E-05	3.569E-05	1.119E-04			
(-2)	-2.019E-03	2.377E-05	4.666E-05	1.258E-04		
(-3)	2.250E-04	-1.071E-06	2.451E-05	5.243E-05	1.221E-04	
(-4)	-4.785E-03	4.322E-06	5.940E-06	3.591E-05	4.955E-05	1.155E-04
B6	4.248E-03	-1.029E-04	-3.907E-05	-2.950E-05	-4.784E-06	-1.291E-05
	1.114E-04					
(-1)	-9.254E-05	-4.395E-05	-1.165E-04	-4.999E-05	-2.580E-05	-5.713E-06
	4.544E-05	1.280E-04				
(-2)	1.386E-03	-2.474E-05	-5.589E-05	-1.312E-04	-5.647E-05	-3.747E-05
	2.977E-05	5.795E-05	1.439E-04			
(-3)	-1.809E-04	-3.125E-06	-2.465E-05	-6.403E-05	-1.268E-04	-5.751E-05
	9.653E-06	2.484E-05	6.679E-05	1.395E-04		
(-4)	2.194E-03	3.942E-06	-5.115E-06	-3.156E-05	-5.636E-05	-1.150E-04
	3.558E-06	4.539E-06	3.209E-05	6.116E-05	1.222E-04	
B11	-1.847E-02	5.229E-05	1.035E-04	1.323E-04	1.358E-04	1.051E-04
	-7.119E-05	-1.175E-04	-1.484E-04	-1.533E-04	-1.163E-04	6.249E-04
B12	-8.645E-01	1.277E-02	2.455E-02	3.750E-02	3.806E-02	3.643E-02
	-1.900E-02	-2.817E-02	-4.281E-02	-4.485E-02	-3.742E-02	9.059E-02
	7.294E+01					

COEF	METHOD	PARAMETERS
B1	DL	LAGS=5
B6	DL	LAGS=5

TABLE 15

1: GPI72 = B0+B1*GDFY(-1)*GND72+B6*GDFY(-1)*GND72(-1)+B11*KS4(-1)+B12*RPE(-1)

```
NOB = 40        NOVAR = 13
RANGE =   1962 1 TO 1971 4
RSQ =     0.97062      CRSQ =    0.95756      F(12/27) =     74.324
SER =     3.8928       SSR =    409.151       DW(0) =  1.21       COND(X) =    991.09
LHS MEAN =     151.09000      SR =       0.00726
```

COEF	VALUE	ST ER	T-STAT	MEAN
B0	45.59470	56.48830	0.80715	1.00000
B1	0.02641	0.00635	4.15739	16298.90000
(-1)	0.02095	0.00604	3.46589	16179.00000
(-2)	0.00905	0.00624	1.45053	16082.50000
(-3)	0.00592	0.00614	0.96410	15983.60000
(-4)	0.02652	0.00695	3.81247	15910.40000
B6	-0.02458	0.00667	-3.68479	16145.60000
(-1)	-0.02113	0.00609	-3.46832	16020.50000
(-2)	-0.00747	0.00630	-1.18693	15923.30000
(-3)	-0.00279	0.00640	-0.43588	15820.40000
(-4)	-0.02721	0.00741	-3.67408	15754.20000
B11	0.13270	0.02676	4.95949	699.95300
B12	-72.74250	34.51410	-2.10761	1.25865

COEF	PARTIAL	BETA
B0	0.15350	0.00000
B1	0.62474	1.57695
(-1)	0.55490	1.20358
(-2)	0.26887	0.50994
(-3)	0.18243	0.33140
(-4)	0.59156	1.56732
B6	-0.57845	-1.43298
(-1)	-0.55517	-1.19334
(-2)	-0.22269	-0.41373
(-3)	-0.08359	-0.15333
(-4)	-0.57733	-1.58165
B11	0.69044	0.71235
B12	-0.37587	-0.25958

TABLE 15 - Continued

COVARIANCE MATRIX

B0	3.191E+03					
B1	-2.767E-02	4.034E-05				
(-1)	-9.560E-05	-1.564E-06	3.653E-05			
(-2)	-4.603E-02	1.977E-09	-5.065E-07	3.895E-05		
(-3)	-2.309E-02	8.760E-07	-8.465E-07	1.210E-06	3.772E-05	
(-4)	1.828E-02	8.008E-06	-1.547E-07	-5.185E-06	-2.251E-06	4.837E-05
B6	4.080E-02	-4.158E-05	-1.572E-07	-1.658E-06	-2.295E-06	-5.924E-06
	4.451E-05					
(-1)	-8.195E-04	2.374E-07	-3.540E-05	5.049E-08	1.142E-06	-2.993E-06
	3.921E-08	3.711E-05				
(-2)	5.526E-02	1.342E-06	-1.041E-06	-3.793E-05	-2.287E-06	5.222E-06
	4.320E-07	7.400E-08	3.965E-05			
(-3)	2.530E-02	-2.934E-06	1.564E-06	-3.750E-06	-3.764E-05	3.595E-06
	4.976E-06	-2.054E-06	3.145E-06	4.096E-05		
(-4)	-3.465E-02	-6.676E-06	5.954E-08	6.677E-06	1.867E-06	-5.069E-05
	4.227E-06	3.434E-06	-6.417E-06	-5.111E-06	5.486E-05	
B11	-1.285E+00	3.937E-05	2.380E-05	4.562E-05	4.170E-05	2.759E-05
	-5.106E-05	-2.567E-05	-4.969E-05	-4.439E-05	-2.482E-05	7.160E-04
B12	-1.907E+03	1.919E-02	2.095E-03	3.419E-02	2.217E-02	-1.094E-02
	-3.076E-02	-1.348E-03	-3.985E-02	-2.548E-02	1.960E-02	8.251E-01
	1.191E+03					

COEF	METHOD	PARAMETERS
B1	DL	LAGS=5
B6	DL	LAGS=5

TABLE 16

1: GPI72B = B0+B1*GDFYB(-1)*GND72B+B6*GDFYB(-1)*GND72B(-1)+B11*KS4B(-1)+B12*RPEB(-1)

```
NOB = 40        NOVAR = 13
RANGE =  1962 1 TO 1971 4
RSQ =    0.93569      CRSQ =    0.90711      F(12/27) =     32.739
SER =    3.5630       SSR =    342.766       DW(0) =  1.55       COND(X) =    710.74
LHS MEAN =      92.02960      SR =       0.01428
```

COEF	VALUE	ST ER	T-STAT	MEAN
B0	12.86030	44.45060	0.28932	1.00000
B1	0.04328	0.00921	4.69837	5994.35000
(-1)	0.03429	0.00972	3.52814	5944.69000
(-2)	0.01586	0.01020	1.55478	5909.95000
(-3)	0.00828	0.00998	0.82911	5867.62000
(-4)	0.03589	0.01125	3.18970	5830.50000
B6	-0.04029	0.00975	-4.13075	5939.31000
(-1)	-0.03445	0.00986	-3.49348	5886.80000
(-2)	-0.01313	0.01038	-1.26580	5852.58000
(-3)	-0.00392	0.01038	-0.37793	5805.86000
(-4)	-0.03593	0.01186	-3.02926	5773.39000
B11	0.13652	0.03414	3.99867	423.47200
B12	-58.29720	45.14690	-1.29128	0.75963

COEF	PARTIAL	BETA
B0	0.05559	0.00000
B1	0.67069	1.79445
(-1)	0.56174	1.36639
(-2)	0.28666	0.61904
(-3)	0.15757	0.30575
(-4)	0.52315	1.36756
B6	-0.62229	-1.62940
(-1)	-0.55794	-1.35203
(-2)	-0.23668	-0.50514
(-3)	-0.07254	-0.14061
(-4)	-0.50364	-1.35373
B11	0.60987	0.71658
B12	-0.24117	-0.20534

TABLE 16 - Continued

COVARIANCE MATRIX

B0	1.976E+03					
B1	1.229E-02	8.484E-05				
(-1)	2.368E-03	3.090E-05	9.444E-05			
(-2)	-7.968E-02	9.265E-06	3.699E-05	1.041E-04		
(-3)	-4.662E-02	-2.234E-06	7.288E-06	4.137E-05	9.968E-05	
(-4)	5.813E-02	-4.335E-06	-1.468E-05	-1.100E-05	2.114E-05	1.266E-04
B6	1.051E-02	-8.776E-05	-3.714E-05	-1.638E-05	-2.948E-06	1.239E-05
	9.513E-05					
(-1)	-6.279E-03	-3.330E-05	-9.359E-05	-3.883E-05	-8.544E-06	7.834E-06
	3.743E-05	9.723E-05				
(-2)	9.458E-02	-7.044E-06	-3.866E-05	-1.037E-04	-4.378E-05	9.227E-06
	1.378E-05	3.903E-05	1.077E-04			
(-3)	4.463E-02	-1.752E-06	-8.430E-06	-4.647E-05	-1.010E-04	-1.687E-05
	8.287E-06	8.942E-06	4.689E-05	1.077E-04		
(-4)	-8.153E-02	6.890E-06	1.528E-05	1.323E-05	-2.242E-05	-1.317E-04
	-1.559E-05	-7.846E-06	-1.162E-05	1.565E-05	1.407E-04	
B11	-1.287E+00	3.314E-05	6.509E-05	1.406E-04	1.202E-04	3.007E-06
	-6.356E-05	-6.952E-05	-1.529E-04	-1.264E-04	4.294E-06	1.166E-03
B12	-1.949E+03	-8.052E-03	7.997E-03	1.016E-01	7.007E-02	-7.685E-02
	-2.490E-02	-5.433E-03	-1.172E-01	-7.470E-02	9.611E-02	1.375E+00
	2.038E+03					

COEF	METHOD	PARAMETERS
B1	DL	LAGS=5
B6	DL	LAGS=5

TABLE 17

1: GPI72 = B0+B1*GDFY(-1)*GND72+B6*GDFY(-1)*GND72(-1)+B11*KS4(-1)

NOB = 64 NOVAR = 12
RANGE = 1962 1 TO 1977 4
RSQ = 0.8938 CRSQ = 0.87133 F(11/52) = 39.784
SER = 10.3104 SSR = 5527.820 DW(0) = 0.58 COND(X) = 712.90
LHS MEAN = 166.98100 SR = 0.01733

COEF	VALUE	ST ER	T-STAT	MEAN
B0	19.79850	8.39409	2.35862	1.00000
B1	0.01695	0.00904	1.87438	18614.10000
(-1)	0.02202	0.00866	2.54306	18404.30000
(-2)	0.02443	0.00875	2.79197	18212.60000
(-3)	0.02882	0.00846	3.40821	18025.00000
(-4)	0.04172	0.00837	4.98588	17812.10000
B6	-0.02408	0.00944	-2.54979	18445.00000
(-1)	-0.01968	0.00903	-2.18053	18231.80000
(-2)	-0.02284	0.00912	-2.50309	18043.90000
(-3)	-0.02736	0.00877	-3.11900	17858.00000
(-4)	-0.04301	0.00865	-4.97391	17653.00000
B11	0.22790	0.02157	10.56710	796.77600

COEF	PARTIAL	BETA
B0	0.31088	0.00000
B1	0.25157	2.05663
(-1)	0.33258	2.55551
(-2)	0.36106	2.71969
(-3)	0.42731	3.08715
(-4)	0.56872	4.20411
B6	-0.33337	-2.87984
(-1)	-0.28944	-2.24963
(-2)	-0.32792	-2.51041
(-3)	-0.39698	-2.89808
(-4)	-0.56779	-4.31085
B11	0.82600	1.20448

TABLE 17 - Continued

COVARIANCE MATRIX

B0	7.046E+01					
B1	-1.531E-02	8.180E-05				
(-1)	-2.251E-03	-1.184E-05	7.500E-05			
(-2)	-6.808E-03	3.897E-06	-1.373E-05	7.654E-05		
(-3)	3.215E-03	-8.840E-06	-1.183E-06	-1.596E-05	7.153E-05	
(-4)	-9.267E-03	1.130E-05	-5.688E-06	6.595E-07	-1.467E-05	7.002E-05
B6	1.711E-02	-8.366E-05	1.072E-05	-4.795E-06	7.925E-06	-1.204E-05
	8.920E-05					
(-1)	2.408E-03	5.936E-06	-7.438E-05	1.365E-05	2.248E-06	4.672E-06
	-8.264E-06	8.146E-05				
(-2)	6.508E-03	-8.735E-07	7.416E-06	-7.600E-05	1.549E-05	5.401E-07
	1.812E-06	-1.114E-05	8.324E-05			
(-3)	-8.051E-04	5.467E-06	5.401E-06	8.516E-06	-7.002E-05	1.270E-05
	-4.160E-06	-6.747E-06	-1.187E-05	7.695E-05		
(-4)	2.552E-03	-4.495E-06	6.389E-06	5.486E-06	1.106E-05	-6.957E-05
	4.835E-06	-5.309E-06	-6.770E-06	-1.380E-05	7.476E-05	
B11	-2.352E-02	3.773E-05	3.786E-05	3.852E-05	4.295E-05	4.673E-05
	-4.592E-05	-4.238E-05	-4.055E-05	-4.542E-05	-5.052E-05	4.651E-04

COEF	METHOD	PARAMETERS
B1	DL	LAGS=5
B6	DL	LAGS=5

TABLE 18

```
1:   GPI72C = B0+B1*GDFYC(-1)*GND72C+B6*GDFYC(-1)*GND72C(-1)+B11*KS4C(-1)

NOB = 64       NOVAR = 12
RANGE =  1962 1 TO 1977 4
RSQ =    0.77388      CRSQ =    0.72605      F(11/52) =     16.179
SER =    5.6918       SSR =   1684.600       DW(0) =  1.21       COND(X) =    256.34
LHS MEAN =       49.57720      SR =        0.01541
```

COEF	VALUE	ST ER	T-STAT	MEAN
B0	8.27220	4.10971	2.01284	1.00000
B1	0.07595	0.01486	5.11004	1608.66000
(-1)	0.08198	0.01610	5.09095	1587.09000
(-2)	0.06343	0.01655	3.83237	1570.09000
(-3)	0.05988	0.01611	3.71669	1559.80000
(-4)	0.06463	0.01516	4.26434	1534.91000
B6	-0.08694	0.01540	-5.64630	1594.46000
(-1)	-0.07948	0.01707	-4.65530	1571.10000
(-2)	-0.06060	0.01749	-3.46541	1554.90000
(-3)	-0.05396	0.01698	-3.17767	1543.56000
(-4)	-0.06705	0.01557	-4.30697	1520.09000
B11	0.16824	0.03237	5.19712	236.38600

COEF	PARTIAL	BETA
B0	0.26885	0.00000
B1	0.57818	2.59288
(-1)	0.57674	2.69166
(-2)	0.46930	2.01263
(-3)	0.45814	1.89012
(-4)	0.50902	1.87491
B6	-0.61650	-2.90691
(-1)	-0.54237	-2.53655
(-2)	-0.43315	-1.87181
(-3)	-0.40325	-1.65692
(-4)	-0.51277	-1.92994
B11	0.58468	0.67931

TABLE 18 - Continued

COVARIANCE MATRIX

B0	1.689E+01					
B1	-1.711E-03	2.209E-04				
(-1)	2.402E-03	9.191E-05	2.593E-04			
(-2)	4.520E-05	5.713E-05	1.161E-04	2.739E-04		
(-3)	1.438E-03	-2.359E-06	5.787E-05	1.169E-04	2.596E-04	
(-4)	-5.254E-03	-4.173E-06	-2.622E-06	5.951E-05	9.437E-05	2.297E-04
B6	2.533E-03	-2.222E-04	-9.335E-05	-6.303E-05	-5.068E-06	-1.187E-05
	2.371E-04					
(-1)	-3.060E-03	-1.089E-04	-2.679E-04	-1.206E-04	-5.747E-05	7.017E-06
	1.064E-04	2.915E-04				
(-2)	-1.375E-03	-5.914E-05	-1.348E-04	-2.821E-04	-1.220E-04	-5.758E-05
	6.241E-05	1.368E-04	3.058E-04			
(-3)	-1.868E-03	-6.236E-06	-5.725E-05	-1.380E-04	-2.655E-04	-1.060E-04
	1.359E-05	5.382E-05	1.401E-04	2.884E-04		
(-4)	2.229E-03	2.008E-05	-2.953E-07	-5.384E-05	-1.116E-04	-2.265E-04
	-7.400E-06	-5.006E-06	5.005E-05	1.174E-04	2.424E-04	
B11	-3.930E-02	7.324E-05	1.597E-04	1.839E-04	1.895E-04	1.201E-04
	-1.004E-04	-1.868E-04	-2.127E-04	-2.174E-04	-1.503E-04	1.048E-03

COEF	METHOD	PARAMETERS
B1	DL	LAGS=5
B6	DL	LAGS=5

CHAPTER IV

THE EVIDENCE

The model of investment behavior utilized in this study includes the real output, the cost of capital, the real stock of capital and the relative price of energy as explanatory variables.

The results of the multiple regression are shown in Table 11. However, after correcting for first order serial correlation the results are shown in Table 14, and with the exception of R^2 and $\bar{R}^2$ that have decreased as expected, all the other statistics have improved.

The R^2 of .88 implies that the regression equation explains 88 percent of the variation in the dependent variable. R^2 and $\bar{R}^2$ are very close in magnitude as expected, since there are a large number of degrees of freedom in the model. The standard error of 5.4371 is small and represents only a 7.23 percentage standard error. The F statistic with 12 and 51 degrees of freedom is highly significant allowing us to reject the null hypothesis that all explanatory variable coefficients are jointly zero.

The value of the DW statistic has improved and is now in the inconclusive range, and the condition number has an acceptable value considering the presence of distributed lags.

All the estimated coefficients are significant at the one percent level, with the exceptions of B8 which is significant at the five percent level and B9 at the ten percent level.

As expected, the capital rents and the relative price of energy coefficients are negative. That means that an increase in any of these two variables will result in a decrease in investment.

The partial correlation coefficients measure the effect of each of the independent variables on the dependent variable that is not accounted for by the other variables in the model. The beta coefficients represent the relative importance of the independent variables in the multiple regression model. Both beta coefficients and partial correlation coefficients are connected with the variance of the dependent variable.

The beta coefficient of the constant term is undefined since the constant term drops out in the normalization process performed to determine the beta coefficients. The beta of -0.465 on the relative price of energy can be interpreted to mean that a one standard deviation increase in the relative price of energy will lead to a 0.465 standard deviation decrease in investment. The partial correlation coefficient of -0.57 on the relative price of energy variable implies that 32.5% of the variance of investment not accounted for by the other independent variables is accounted for by the relative price of energy.

Finally, all diagonal elements of the covariance matrix are positive. These are the variances of the estimated coefficients and are equal to the square of the standard errors of the coefficients. The off-diagonal terms are covariances.

If these results are compared with the results obtained regressing the same equation but only from 1962 to 1971 (Table 16), we can see that the t-statistics have decreased in value and the intermediate periods of the distributed lags are no longer significant. And, what it is more important for this paper, the relative price of energy coefficient is not statistically significant.

Finally, if the relative price of energy is dropped from the model (Table 18), the explanatory power of the equation decreases. All the estimated coefficients are highly significant, but R^2 and the F statistic have decreased.

CHAPTER V

CONCLUSIONS

The generalized neoclassical model gives a good representation of the investment behavior. The first lag in the model shows that levels of output for the past five quarters will affect the level of investment. The second lag shows that the level of capital rents will affect the level of investment but only the last two periods changes will be significant. And the capital stock is proportional to the replacement investment and is highly significant in the model. A summary of the results is given at the end of this chapter (Table 19). This summary includes the elasticities of the most important variables. The elasticities measure the percentage change in the dependent variable divided by the percentage change of each independent variable.

Prior to 1972, the relative price of energy was not an important factor and did not warrant inclusion in the model. Moreover, before the four-fold increase in energy prices, the real price of energy adjusted for inflation declined at a rate of 1.8 percent per year. But after the dramatic change in energy prices, the evidence shows that explicit consideration of the relative price of energy resources should be made in the model. And we can conclude that the capital input has been reduced as a result of the higher energy prices.

The investment process is fundamentally a process of adjusting the firms' existing capital stock to some desired level. The amount of business fixed investment needed at a given time is generally determined by the desired increase in the growth rate of the nation's capital stock. And the desired capital stock is ultimately determined by the expected net return.

For a given amount of labor, greater capital accumulation would accelerate the amount of output, that may be potentially produced. An increase in the growth of the capital stock may also accelerate the amount of technical progress by embodying technical advances in new capital. Such gains in technical progress would further increase potential output growth.

The growth rate of the capital stock during the late 1970's grew at a 2.7 percent rate, more than a percentage point below that of the previous five-year period and about 1.75 percentage points below the rate recorded during the 1948-69 period.

Demand for capital input is reduced as a result of the higher energy prices. This leads to a reduction in investment levels and to a slowing in the rate of growth of capital stock and productive capacity. When the price of energy rises relatively more than the price of business output, firms find that the real net cash flows expected from plant and equipment are smaller because of higher operating costs. Moreover, to the extent that the production of capital goods is relatively more energy-intensive than the production of other products, a rise in energy prices rises the costs of capital goods relative to the future prices of the products that these capital goods eventually will produce. Taken together, these forces create incentives to reduce energy, plant, and equipment usage per unit of output, by employing less energy per unit of capital and more labor-intensive methods of production. This effect has been shown to be quite substantial in temporarily reducing the growth of plant and equipment.

In the short run, aggregate investment slows temporarily with a rise in the price of energy. And in this case the low levels of investment continued after the price increase, probably because of the businessmen's concern for solvency and the state of balance sheets, which induced them to use the cash flows to augment balance sheets positions rather than to increase spending on capital goals.

Slowdown in capital formation, as well as the sharp increase in the relative price of energy resources rendered some of the nation's capital stock obsolete. To the extent that estimates series do not capture these losses in normal measures of discards and depreciation, the net capital stock measures led to an overstatement of the growth of the net capital stock in the Seventies.

Consequently, substantial increases in business fixed investment will probably be required in the years ahead in order to achieve past rates of capital stock growth and related benefits such as higher labor productivity growth. In addition, the 1980's are likely to have extraordinary investment requirements related to types of investment that do not add directly to measured output or that result from special circumstances unique to the 1980's, such as pollution abatement and the need to accelerate the development of domestic energy supplies.

In the long run, the rise in energy prices may well lead to the development of more energy-efficient machinery and equipment which will lead to substitution of more energy-efficient machines for energy-intensive machines and for labor and may lead to an increase in the level of investment in order to accelerate such substitution. Further study will be necessary when more data will become available.

Table 19

GPI72A=BO+B1xGDFYA(-1)xGND72A+B6xGDFYA(-1)xGND72A(-1)+B11xKS4A(-1)+
+B12xRPEA(-1)

1962 1 to 1977 4

Variable	Coefficient	t-statistic	Beta	Elasticity
B1	0.04106	4.09851	2.22067	2.0422423
B6	- 0.04697	-4.45016	-2.49724	-2.3154562
B11	0.14227	5.69134	0.67667	0.6791047
B12	-42.56220	-4.98368	-0.46538	-0.3621816

GPI72B=BO+B1xGDFYB(-1)xGND72B+B6xGDFYB(-1)xGND72B(-1)+B11xKS4B(-1)+
+B12xRPEB(-1)

1962 1 to 1971 4

Variable	Coefficient	t-statistic	Beta	Elasticity
B1	0.04328	4.69837	1.79445	3.2739223
B6	- 0.04029	-4.13075	-1.62940	-3.0197589
B11	0.13652	3.99867	0.71658	0.7295583
B12	-58.29720	-1.29128	-0.20534	-0.5588417

GPI72C=BO+B1xGDFYC(-1)xGND72C+B6xGDFYC(-1)xGND72C(-1)+B11xKS4C(-1)

1962 1 to 1977 4

Variable	Coefficient	t-statistic	Beta	Elasticity
B1	0.07595	5.11004	2.59288	2.9570846
B6	- 0.08694	-5.64630	-2.90691	-3.3550963
B11	0.16824	5.19712	0.67931	0.9625487

APPENDIX A

EXPLANATION OF TERMS

This appendix is an explanation of the statistics given by the computer.

NOB = Number of observations

NOVAR = Number of coefficients being estimated

RSQ = R^2 - squared statistic (Coefficient of multiple determination)

R^2 = RSS/TSS = 1 - ESS/TSS

RSS = $\sum(\hat{Y}_t - \bar{Y})^2$ = explained variation of Y (or regression sum of squares)

TSS = $\sum(Y_i - \bar{Y})^2$ = total variation of Y (or total sum of squares)

ESS = $\sum(\hat{Y}_i - Y_i)^2$ - residual variation of Y (or error sum of squares)

RSQ is the proportion of the total variation of Y explained by the multiple regression equation (R^2: $0 \div 1$)

$R^2 = 0$, poor fit

$R^2 = 1$, perfect fit

CRSQ = Corrected R-squared statistic = $\bar{R}^2$

CRSQ eliminates the dependence of goodness of fit on the number of independent variables in the model. Thus it is a better measure than RSQ

$\bar{R}^2 = 1 - \mathrm{Var}(\hat{\epsilon})/\mathrm{Var}(Y) = 1-(1-R^2)(n-1/n-k)$

$\mathrm{Var}(\hat{\epsilon}) = \sum \epsilon_i^2/n-k$

$Var(Y) = \sum (y_i - \bar{Y})^2 / n-1$

n = number of observations

k = number of independent variables

$F_{k-1,n-k}$ = F-statistic for zero regression

$F_{k-1,n-k} = (R^2/1-R^2)(n-k/k-1)$

The F-statistic can be used to test the significance of the R^2 statistic. The F-statistic with k-1 and n-k degress of freedom allows to test the hypothesis that none of the explanatory variables help to explain the variation of Y about its mean. If the null hypothesis was true $\rightarrow R^2 \approx 0$ and $F \approx 0$

SER = Standard error of the regression = S

$$s = (\sum \hat{\epsilon}_i^2 / n-k)^{\frac{1}{2}} = (\sum (Y_i - \bar{Y})^2 / n-m-1)^{\frac{1}{2}}$$

SSR = Sum of the squared residual (unexplained variation)

$$SSR = \sum \hat{\epsilon}_i^2$$

DW = Durbin-Watson statistic

DW is used to test for serial correlation. It is an statistic test based on the residual terms

$$d = \sum_{i=2}^{n} (e_i - e_{i-1})^2 / \sum_{i=1}^{n} (e_i)^2$$

The value obtained is compared with the value given in the DW table

(d_1). If $DW < d_1$, there is positive autocorrelation. Autocorrelation is caused by the omitted variables in the model, and the effect is normally cumulative.

COND (X) = Condition number of the X matrix. It is used to test for multicollinearity. If COND (X) is greater than about 900 then a linear dependence among the columns of X exists that may seriously effect the standard errors of the estimated coefficients.

LHS MEAN = Mean of the left side of the equation

SR = Sum of the residuals

COEF VALUE = Coefficient values calculated by DOEQ

ST ER = Standard error of the coefficient values. It is a measure of the dispersion of the estimates

T-STAT = T-statistic for each coefficient ($\alpha = .05 \rightarrow Z = 1.96$)

MEAN = Mean value of the expression multiplicatively associated with each coefficient (this expression is usually a single variable but can be a multivariable term).

PARTIAL = Partial correlation coefficients

BETA = Beta coefficients. They are used to estimate the relative importance of the independent variables in a multiple regression model.

COVAR = Coefficient covariance matrix.

APPENDIX B

AUTOCORRELATION

When the error terms from different time periods are correlated, it is said that the error term is autocorrelated or serially correlated.

The most common form of autocorrelation is first-order serial correlation, in which errors in one time period are correlated directly with errors in the ensuing time period. This correlation can be positive or negative. In negative autocorrelation the previous value and the value itself always have different signs. But the most common case is positive autocorrelation in which the previous value and the value itself have the same sign except for one value.

Positive serial correlation frequently occurs in time series studies, either because of correlation in the measurement error component of the error term, or more likely because of the high degrees of correlation over time present in the cumulative effects of the omitted variables in the regression model. Essentially what causes autocorrelation are the omitted variables in the model, and the effect is normally cumulative.

As a general rule, the presence of serial correlation will not affect the unbiasedness or consistency of the ordinary least-squares regression estimators, but it does affect their efficiency. In the case of positive serial correlation, this loss of efficiency will be masked by the fact that the estimates of the standard errors obtained from the least-squares regression will be smaller than the true standard errors. In other words, the regression estimators will be unbiased, but the standard error of the regression will be biased downward. This will lead to the conclusion that the parameter estimates are more precise than they actually are.

When the model includes lagged variables, the problems are much more severe. The presence of serial correlation and lagged variables is sufficient to render the ordinary least-squares estimation process biased and inconsistent. Correct procedures for the estimation of single-equation models with serially correlated errors and lagged variables involve the use of modified instrumental variables or maximum-likelihood techniques.

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