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U.S. INVESTMENT DEMAND IN THE 1970's: ITS STRUCTURE AND IMPACT

by

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I. Introduction

This paper is a preliminary report on the estimation of an investment sector for the University of Maryland's input-output forecasting model. Unlike previous treatments of investment in input-output models, the one described in this paper does not utilize the customary matrix of capital coefficients for calculating investment demand. On the contrary, the general approach is to fit regression equations to historical data for each of the investment purchasing industries. These equations are then used, in conjunction with the remaining parts of the forecasting model, to obtain simultaneous solutions for the time paths of industry outputs and investment.

The investment theory which underlies the equations is largely an extension of work done on aggregate data by Hall and Jorgenson [4]. Accordingly, investment is viewed as a lagged response to changes in demand and the cost of capital. But whereas Hall and Jorgenson constrained the ultimate impact of the cost of capital variable by assuming a Cobb-Douglas production function, this study estimates that impact with the use of the more general constant elasticity of substitution production function. The results indicate that Hall and Jorgenson have significantly overstated the effects of changes in the cost of capital on investment.

The following sections describe the derivation of the regression model and its estimation for 68 equipment purchasing sectors. The concluding section briefly outlines the way in which the equations are used for forecasting and presents some investment forecasts for several alternative defense assumptions.

II. The Theory of the Investment Equations

In recent years, the investment process has been fruitfully viewed as the result of two rather distinct business decisions: the choice of the appropriate size of an investment program and the choice of an appropriate schedule for its implementation. The first decision concerns the optimal stock of capital; the second concerns the optimal timing of the investment flows, that is, the speed at which the gap between desired and actual capital stocks is closed.

The neoclassical theory of optimal capital accumulation provides several different, yet equivalent, ways of determining optimal stocks. One approach is to assume that firms maximize their net worth (the discounted value of net receipts) subject to a production function. Alternatively, the same result is achieved by setting the price of a unit of capital equal to the discounted value of its future earnings.

A third equivalent approach is to equate the price of a unit of capital goods, q, to the present value of a permanent one unit increase in the stock of capital. At time, t, and with a discount rate of r

$$(1)\quad q = \int_t^\infty [(1-u)G + uD + C - M]e^{-r(s-t)}ds,$$

where G, D, C and M represent the gross earnings of a unit of capital, depreciation for tax purposes, tax credits, and replacement spending respectively. Direct taxes are a constant proportion, u, of taxable income.

The right-hand side of (1) consists of the present value for four separate terms. For a constant output price, p, and a given production function, $Q = f(K,L)$, G is given by $p\partial f/\partial K$, the marginal value product of capital; and the present value of $(1-u)G$, the first of the four terms, is simply $[(1-u)p\partial f/\partial K]/r$. If replacement spending, M, equals δq, its present value is $-\delta q/r$. Similarly, the present value of the stream of tax credits is cq, the present value of the initial credit, plus $c\delta q/r$, the present value of the stream of credits due to replacement spending.

The present value of uD, the remaining term, equals the sum of two components: (1) the present value of depreciation from the initial investment, call it $q(1-c)z$, z being the present value of depreciation on an investment of one dollar; and (2) the present value of depreciation arising from an infinite stream of replacement investment. Let a denote the age of an investment good, g(a) the depreciation at age a on one dollar of the good, and v the time at which $a=0$ (so that $s=v+a$). The present value of replacement depreciation is the sum of the present values for each vintage. On the assumption that the depreciable base is reduced by the tax credit, the final expression for the present value of all depreciation charges arising from an increase in the capital stock of one unit is:

$$(2)\quad \int_t^{\infty} De^{-r(s-t)}ds = (1-c)q\left[\int_t^{\infty} g(a)e^{-ra}da + \delta\int_t^{\infty}\int_0^{\infty} g(a)e^{-r(a+v-t)}da\,dv\right]$$

$$= \frac{(1-c)q\ z(r+\delta)}{r}\ .$$

Substitution of the various present values back into (1) and a rearrangement of terms produces the following expression for the "real rental rate," R, on capital:

$$(3) \quad R = \frac{\partial f}{\partial K} = \frac{q(r+\delta)(1-c)(1-uz)}{p(1-u)} \quad .$$

When the tax credit does not reduce the depreciable base, as has been the case since 1964, (3) must be replaced by:

$$(4) \quad R = \frac{\partial f}{\partial K} = \frac{q(r+\delta)(1-uz-c)}{p(1-u)} \quad .$$

For most industries, equations (3) and (4) should adequately reflect the cost of capital as it is affected by tax policy and other variables. But there does exist an important exception. In some of the extraction industries, most notably oil and gas, depletion allowances and extremely rapid write-offs are common practices. The latter can be handled in the calculation of z, but depletion allowances alter the standard rental rate formulations. If the proportion of output allowed for depletion purposes is denoted by h, taxes are given by $u[(1-h)G-D]$, and the term $(1-u)G$ in (1) must be replaced by $(1-u+uh)G$. Under these circumstances (3) must be replaced by

$$(5) \quad R = \frac{\partial f}{\partial K} = \frac{q(r+\delta)(1-c)(1-uz)}{p(1-u+uh)} \quad ,$$

and (4) must be replaced by

$$(6) \quad R = \frac{\partial f}{\partial K} = \frac{q(r+\delta)(1-uz-c)}{p(1-u+uh)} \quad ,$$

The calculation of z requires information on the discount rate, the length of life for tax purposes, and the method of depreciation. Prior to 1954 most assets were depreciated on a straight-line basis. Thereafter, the Internal Revenue Code provided for more accelerated methods of depreciation, the most important being double declining balance and sum of the years' digits. Formulae for calculating z according to these various schemes appear in [4].

The final derivation of the optimal capital stock requires a specific assumption concerning the production function, $f(K,L)$. Jorgenson [5] and Hall and Jorgenson [4] assumed a Cobb-Douglas function for their work, thus constraining the elasticity of substitution between capital and other factors to unity. In order to avoid such an unnecessary restriction, this study utilizes a constant elasticity of substitution production function of the following form:

(7) $$Q = \beta[\gamma K^{-\rho} + (1-\gamma)L^{-\rho}]^{-1/\rho},$$

where β is the "Hicks Neutral" efficiency parameter, γ is the distribution parameter, and ρ is the substitution parameter. Noting that the elasticity of substitution, σ, equals $1/(1+\rho)$ and solving for K as a function of Q and the rental rate, $R(=\partial Q/\partial K)$, one obtains an expression for the optimal stock of capital, K^*:

(8) $$K^* = \frac{\gamma^{\sigma}}{\beta^{1-\sigma}} \frac{Q}{R^{\sigma}} .$$

Over time, technological progress (broadly interpreted) undoubtedly affects β and may affect γ. But for the assumption of Harrod neutrality, changes in the two parameters are offsetting so that $\gamma^{\sigma}/\beta^{1-\sigma} = \alpha$ has a constant value. The optimal stock of capital then becomes

(9) $$K^* = \alpha \frac{Q}{R^{\sigma}} .$$

To translate the theory of capital into a theory of investment, I assume that changes in K^* lead to changes in net investment according to a distributed lag. Accordingly gross investment in time t, I_t, is given by

$$(10) \qquad I_t = \sum_{i=0}^{\infty} w_i \Delta K^*_{t-i} + \delta K_t,$$

the sum of expansion and replacement spending. The fraction of the change in the optimal stock of capital arising in year t-i and undertaken in year t is denoted by w_i.

Naturally some restrictions must be imposed on the distributed lag. In addition to the usual restriction that $\sum_{i=0}^{\infty} w_i = 1$, I have assumed that the first two (or three) coefficients are arbitrary and that successive coefficients decline geometrically at rate λ. The exact number of arbitrary coefficients is determined by the regression results.

When the first two coefficients are arbitrary, the resulting non-linear regression model for net investment, I^N_t, is:

$$(11) \qquad I^N_t = \alpha w_o \left(\frac{Q_t}{R^\sigma_t} - \frac{Q_{t-1}}{R^\sigma_{t-1}} \right) + \alpha(w_1 - \lambda w_o) \left(\frac{Q_{t-1}}{R^\sigma_{t-1}} - \frac{Q_{t-2}}{R^\sigma_{t-2}} \right) + \lambda I^N_{t-1} + \epsilon_t .$$

When the second and third coefficients are arbitrary and the first is dropped, the regression model is:

$$(12) \qquad I^N_t = \alpha w_1 \left(\frac{Q_{t-1}}{R^\sigma_{t-1}} - \frac{Q_{t-2}}{R^\sigma_{t-2}} \right) + \alpha(w_2 - \lambda w_1) \left(\frac{Q_{t-2}}{R^\sigma_{t-2}} - \frac{Q_{t-3}}{R^\sigma_{t-3}} \right) + \lambda I^N_{t-1} + \epsilon'_t ,$$

where ϵ'_t and ϵ_t are the usual stochastic terms. In both cases, one can obtain estimates of the w's from the regression coefficients and the condition that the sum of the w's is unity.

III. Derivation of the Data

In order to estimate equations (11) and (12) for the 68 equipment purchasing sectors, data were collected on investment, output, and the determinants of the rental rate for the 1947-67 period. Current dollar investment and output estimates, as well as the price indexes necessary for their deflation, are mainly those of the Office of Business Economics and the Census Bureau. In the case of investment, deflation depends upon the conversion of O.B.E. price indexes for producing industries into price indexes for purchasing sectors. This was accomplished by weighting the price indexes of the producing industries according to their respective shares of total sales to purchasing sectors. An updated version of O.B.E.'s 1958 capital matrix provides the weights.[1]

Equipment stocks are constructed by cumulating estimates of gross equipment investment less replacements. For years prior to 1947, investment estimates are typically available for only broad aggregates. Consequently, for most industries benchmark stocks in 1947 were estimated on the assumption that investment shares in the larger aggregates remained at their 1947-48 levels throughout the pre-1947 period.[2]

Equations (3), (4), (5) and (6) provide the basis for calculating capital rental rates for each equipment sector. In these calculations, I have assumed, in the absence of solid evidence to the contrary, that the discount rate, r, is approximated by Moody's AAA bond rates. These rates are available for industrials, rails, utilities, and all corporations. Relative prices, q/p, and the replacement rates, δ, are as previously described.

In 1962 the government instituted a 7% tax credit on eligible investment. Except for a brief period in late 1966 and early 1967, the credit has remained in effect. The only significant change in the provisions of the law occurred in 1964 when businesses were not required to reduce the depreciable base of assets by the amount of the tax credit. The credit does not apply to structures (for rather dubious reasons) or to assets with lives shorter than three years. To handle the exclusion of such short-lived assets, I have assumed that the effective credit has been 6.6% rather than the full 7% [3].

In the calculation of z, the present value of depreciation arising from an investment of one dollar, the depreciation method used by businesses was taken to be straight-line for years prior to 1953 and a combination of straight-line, sum of years' digits, and double declining balance thereafter.[3] The special Treasury Depreciation Survey provides estimates of the value of various types of assets acquired in the 1954-59 period according to the type of depreciation method used, straight-line or accelerated. These figures are available for 57 industries. The average proportion of equipment depreciated with new methods over this period was found by calculating a weighted average for various types of equipment: production equipment, power plant equipment, motor vehicles, office furniture and similar items. These average proportions were then converted into annual estimates on the assumption that the proportion of assets depreciated with straight-line methods declined after 1954 at a rate of 5% per year. The split between the two types of accelerated methods was effected by taking the ratio of sum of years' digits depreciation charges to double declining balance depreciation charges for all corporations from [11]. Double declining balance was used for approximately 60% of assets in accelerated accounts over this period.

An additional complication arises with respect to the emergency amortization provisions which were in effect from 1950 to 1957 and, on a much smaller scale, through 1959. The provisions called for a 5 year straight-line write-off of eligible facilities. The weight attached to the rental rate for such facilities depends upon their value relative to total investment. The average proportion of new investment subject to the amortization provisions was calculated by taking estimates of amortization in 1955 to average investment (including structures) over the 1951-55 period.[4] For some industries, e.g. steel and petroleum refining, amortized investment was a very sizeable fraction of the total.

The special Treasury Depreciation Survey also provides estimates of tax lives for various types of assets by industry for (1) assets acquired prior to December 31, 1953 and (2) assets acquired from December 31, 1953 through 1959. Annual tax lives from 1947 to 1961 are linear interpolations of these two average lives on the assumption that the pre-1954 average life equals the tax life in 1946 and that the 1954-59 average life equals the tax life in 1957. In 1962 new depreciation guidelines [9] were instituted which reduced suggested tax lives by a wide margin. I assumed that the actual 1962 lives were an average of the new guidelines and the old lives and that the 1963 lives were equal to the guidelines. Thereafter, I assumed that tax lives fell 2% a year so that they were approximately 10% below the guidelines by 1967, as was predicted in an unpublished Treasury memorandum [13].

In summary, the rental rate calculations take into account the following items: (1) the emergency amortization provisions for 1950-1957; (2) the introduction of accelerated depreciation methods in 1953; (3) the postwar reduction in tax lives, particularly after the 1962 change in the guidelines; (4) the 7% tax credit in effect since 1962; (5) changes in tax rates; and (6) changes in relative prices and discount rates.

IV. Estimates of the Investment Equations

Since only the elasticity of substitution enters equations (11) and (12) in a non-linear fashion, a simple scanning procedure proved to be an effective estimation technique. The program calculated regressions for elasticities between zero and 1.5, selecting the equation which produced the lowest residual sum of squares. Table 1. presents the results of these calculations along with the coefficients of determination for gross and net investment and the Durbin-Watson ratio.

The investment hypothesis performs remarkably well by all of the standard criteria. The fits are good despite the high degree of disaggregation; and, fortunately, the Durbin-Watson ratios are superb. The latter result is especially important when lagged dependent variables are used for forecasting, as is the case here.

In addition, estimates of the structural coefficients conform admirably to *a priori* judgments, thus lending additional support to the hypothesis. The distributed lag coefficients, for example, are positive, as is required, for all industries save two; and in both of these exceptional cases the coefficients are not statistically significant. Moreover, the pattern of the lags appears reasonable for almost all industries and corroborates the findings of recent investment work on more aggregate data. Table 2 gives the first ten terms of the estimated lag functions for a sample of the largest equipment purchasers. On the basis of these calculations, the shortest lags appear to be in non-manufacturing, a result previously found with aggregate data [4]. In some sectors the shorter lags appear to make sense. Contract construction, trade, finance, and services are examples. But in transportation and communications short lags seem less probable. Overall, however, the estimated lag structures are quite believable.[5]

Estimates of the elasticity of substitution, σ, are generally less than one, as is frequently true with time series data.[6] In a few cases, however, the minimum residual sum of squares occurs at $\hat{\sigma} = 1.5$, indicating that the least squares estimate is greater than or equal to 1.5. In every case, however, the least squares estimate is not far from 1.5; and, judging from the rate of change in the residual sum of squares, one suspects that the standard errors are rather large. Since $\sigma = 1.5$ seems high <u>a priori</u> and since the fits are not significantly improved by using the absolute least squares estimates, the scanning is constrained to $0 \leq \sigma \leq 1.5$.

In order to compare these elasticities with those obtained in aggregate studies, I have calculated an average elasticity using the 1966 equipment stock estimates as weights. The resulting aggregate elasticity of substitution is .30, substantially below the commonly employed Cobb-Douglas assumption, but remarkably close to some aggregate elasticity estimates.[7]

V. The Forecasts

Making use of an updated version of the 1958 input-output table, the University of Maryland interindustry model forecasts all of the final demands comprising gross national product--government, exports minus imports, consumption, construction, and equipment--as well as the industry outputs and interindustry flows. The final demand forecasts for government and exports minus imports are, at present, exogenous. They depend upon judgment or assumption. Consumption demand, on the other hand, is endogenous. It is built up from forecasts of demand for 80 separate types of consumer goods. These forecasts are based upon regression equations relating demand to such variables as the level and change in disposable income, relative prices, population growth, and time (a proxy for changes in taste). The equations presently employed in the Maryland model are updated versions of those given in [1, Ch. 2].

The construction sector consists of 28 construction types, 17 of which are private. All public construction and some types of private construction are exogenous. The remaining private construction types are explained by regression equations relating construction spending to various lagged industry outputs, population, disposable income, interest rates, and time.

Final equipment demands are, of course, calculated according to the regressions reported in Table 1. Thus equipment spending depends upon past and present changes in outputs and rental rates, lagged net investment, and capital stocks.

Forecasts are obtained through the simultaneous solution of industry outputs, disposable income, and final demands subject to an employment constraint. The procedure is as follows for each forecast year. We begin by specifying the percent of the work force which will be unemployed. For long-run forecasting the appropriate assumption is frequently "full employment," defined, for example, as a 4% rate of unemployment. We then try to guess the level of disposable income which is consistent with the employment assumptions and the other sectors of the model. Using this trial solution, we calculate consumption demand and add it to the exogenous final demands. Next, we calculate the construction component of final demand using the trial value of disposable income, when needed, and past values of output. The remaining component of final demand, equipment spending, is calculated by making an initial guess about current industry outputs. At present, we simply assume that current outputs equal last year's outputs.

Having computed a trial final demand vector based on initial guesses for disposable income and industry outputs, we then make the input-output calculations to solve for the required industry outputs. If they differ from the initial guesses, we use them as a new trial solution and recompute equipment demand. A new final demand vector is formed based on the corrected equipment demands, and industry outputs are again computed. This process is continued, in iterative fashion, until successive trial solutions differ by less than one percent. In general, only two or three iterations are required.

Once investment has converged, we calculate employment in each industry on the basis of productivity projections and the industry outputs. If total employment equals the projected work force less the assumed amount of unemployment, we have reached the final solution. Otherwise, we adjust the level of disposable income and repeat the above process until the level of unemployment converges to its target value. When that occurs we move on to the next year of the forecasts.

The rental rate projections used for the equipment computations shown in this paper assume that interest rates, tax credits, and tax lives will remain at their 1967 values during the forecasting period and that the corporate tax rate will remain at its post surtax level. Relative prices, however, are assumed to follow their historical trends. Hence for most industries, rental rates rise slightly over the forecasting period. Naturally there is nothing sacrosanct about these assumptions.

For purposes of illustration, Table 3 presents a brief summary of some investment forecasts calculated, as outlined above, for "high," "medium," and "low" defense projections. The high projection assumes that defense spending in the 1970's will equal the 1967 level plus an extra $8 billion for an anti-ballistic missile system and related items. This is essentially a war assumption. The medium projection assumes that the present level of defense spending will linearly decline to a 1975 level and structure equal to that of 1965 plus the additional $8 billion. This projection assumes an end to

Viet Nam but a continuation of the postwar pattern of high defense spending. In contrast, the low projection assumes some progress toward disarmament, so that defense spending declines to 80 percent of its 1965 value by 1975 and remains fixed thereafter.

The specification of the investment sector is also well suited for simulating the impact of many non-defense policies. Prime candidates are monetary and tax policies, which affect investment through changes in capital rental rates. In the near future we hope to report on the results of such simulations.

FOOTNOTES

1. The capital matrix was balanced to 1966 row and column controls using a least squares procedure. For a description, see [2].

2. There are several reasons why errors in the stock estimates may be less troublesome than one might suppose. First, the stock variable enters the regression equations beginning with 1949 and 1950. Hence two or three years of relatively good investment data appear in the first stock estimates. Second, the relatively high replacement rates for equipment mean that errors in the data for the early years are less serious than they might be.

3. Hall and Jorgenson [4] assumed that the appropriate depreciation method after 1953 was exclusively sum of the years' digits. But since businesses have continued to use a variety of depreciation methods, such an assumption seems undesirable.

4. Amortization estimates by industry are available in [12].

5. Experimentation with numerous alternative specifications has failed to yield consistently plausible results for the structural parameters, although some specifications produce comparable R^2's [7].

6. Of course, such estimates are based on substantially different specifications. See [6] and [8].

7. See [14].

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TABLE 1

ESTIMATES OF THE INVESTMENT EQUATIONS[a]

Industry	ΔK^*_t	ΔK^*_{t-1}	ΔK^*_{t-2}	I^n_{t-1}	σ	R^2_g	R^2_n	d
	Regression Coefficients and Standard Errors[b]							
Agriculture	.022 (.017)	.020 (.015)		.832 (.096)	.79	.70	.75	2.19
Mining Except Oil and Gas	.140 (.060)	.167 (.050)		.685 (.134)	.13	.57	.63	2.29
Oil & Gas Wells	.334 (.163)	.332 (.177)		.768 (.149)	.03	.80	.74	1.28
Contract Construction	.066 (.023)	-.007 (.028)		.676 (.159)	.10	.56	.63	2.10
Meat Packing		.0048 (.0026)	.0011 (.0028)	.926 (.124)	.00	.85	.68	1.68
Dairy Products	.035 (.006)	-.017 (.006)		.942 (.127)	.09	.69	.78	1.66

[a] R^2_g, R^2_n, and d represent the ratio of the explained sum of squares to the total sum of squares for gross investment, the ratio of the explained sum of squares to the total sum of squares for net investment, and the Durbin-Watson ratio.

[b] Standard errors are computed by constraining σ to the value which minimizes the residual sum of squares.

Industry	ΔK^*_t	ΔK^*_{t-1}	ΔK^*_{t-2}	I^n_{t-1}	σ	R^2_g	R^2_n	d
Preserved Foods		.0077 (.0022)	.0036 (.0028)	.541 (.167)	1.02	.81	.60	2.13
Grain Mill Products	.00014 (.00015)	.00004 (.00015)		.710 (.150)	1.50	.61	.11	1.26
Bakery Products	.00035 (.00085)	.00061 (.00084)		.749 (.194)	1.50	.51	.31	1.76
Sugar Products	.0185 (.009)	.0411 (.009)		.745 (.102)	.35	.85	.73	2.60
Confection Products		.0128 (.0072)	.0150 (.0088)	.884 (.138)	.49	.86	.84	2.31
Beverages	.00065 (.005)	.0088 (.0053)		.730 (.178)	1.00	.73	.64	1.81
Miscellaneous Foods	.0111 (.009)	.0133 (.0107)		.280 (.220)	.07	.49	.13	2.24
Tobacco Products		.0154 (.0090)	-.0080 (.0079)	.914 (.120)	.00	.76	.00	2.20
Fabrics and Yarn	.0115 (.0041)	.0141 (.0043)		.416 (.137)	.57	.80	.77	2.17
Miscellaneous Textiles	.0038 (.0023)	.0016 (.0023)		.693 (.155)	.63	.54	.54	2.22

Industry	ΔK^*_t	ΔK^*_{t-1}	ΔK^*_{t-2}	I^n_{t-1}	σ	R^2_g	R^2_n	d
Apparel		.0010 (.0004)	.0005 (.0005)	.724 (.094)	1.50	.68	.89	2.31
Household Textiles, Upholstery	.0021 (.0025)	.0045 (.0024)		.403 (.201)	.72	.52	.44	2.73
Lumber Products	.0192 (.0063)	.0053 (.0067)		.817 (.109)	.42	.71	.36	2.35
Wooden Containers	.0096 (.0039)	-.0007 (.0023)		.500 (.203)	1.50	.34	.39	2.39
Household Furniture	.0115 (.0053)	.0104 (.0056)		.790 (.113)	.00	.82	.65	2.15
Office Furniture		.000211 (.000175)		.867 (.142)	.00	.33	.06	2.50
Paper Products	.0552 (.0330)	.0698 (.0355)		.791 (.144)	.00	.85	.71	1.49
Paper Containers		.057 (.014)	.0159 (.0192)	.592 (.183)	.00	.84	.65	2.21
Printing and Publishing	.0174 (.0119)	.0200 (.0133)		.411 (.207)	.33	.83	.56	1.88
Basic Chemicals		.0343 (.0110)	.0357 (.0142)	.465 (.136)	.56	.87	.78	1.62

Industry	ΔK^*_t	ΔK^*_{t-1}	ΔK^*_{t-2}	I^n_{t-1}	σ	R^2_g	R^2_n	d
Plastics and Synthetics		.0436 (.0098)	.0221 (.0124)	.511 (.144)	.71	.87	.80	1.64
Drugs and Toilet Items		.0180 (.0061)	-.0100 (.0075)	.622 (.220)	.53	.50	.57	1.51
Paint and allied Products		.0026 (.0010)	.0002 (.0009)	.578 (.230)	1.30	.33	.40	2.36
Petroleum Refining		.0058 (.0062)	.0098 (.0068)	.577 (.169)	.58	.39	.65	1.66
Rubber and Miscellaneous Items	.0301 (.0093)	.0355 (.0108)		.774 (.114)	.00	.96	.91	2.53
Leather Tanning	.0050 (.0016)	.0022 (.0011)		.349 (.168)	.87	.14	.66	1.81
Footwear	.0071 (.0035)	.0030 (.0036)		.441 (.200)	.43	.48	.41	1.99
Glass Products		.0092 (.0036)	.0088 (.0040)	.487 (.175)	1.50	.57	.45	2.25
Stone and Clay Products	.0006 (.0012)	.0041 (.0011)		.797 (.1057)	1.50	.72	.57	1.80
Iron and Steel	.0479 (.0119)	.0590 (.0118)		.641 (.128)	.00	.69	.69	2.36
Non-Ferrous Metals	.0285 (.0214)	.0581 (.0228)		.629 (.160)	.00	.61	.55	1.80

Industry	ΔK^*_t	ΔK^*_{t-1}	ΔK^*_{t-2}	I^n_{t-1}	σ	R^2_g	R^2_n	d
Metal Containers	.0136 (.0112)	.0195 (.0115)		.649 (.142)	.40	.54	.08	2.21
Fabricated Metal Products	.0111 (.0045)	.0035 (.0049)		.779 (.104)	.14	.71	.71	1.58
Screw Machine Products & Stampings	.0045 (.0023)	.0012 (.0023)		.842 (.136)	.90	.59	.27	2.77
Hardware	.0045 (.0013)	.0015 (.0014)		.900 (.065)	.80	.93	.77	1.84
Engines and Turbines	.0185 (.0131)	.0081 (.0141)		.829 (.162)	.00	.69	.46	2.02
Farm Machinery		.0080 (.0031)	.0073 (.0030)	.750 (.136)	.30	.75	.76	2.31
Construction and Material Handling	.0155 (.0052)	.0024 (.006)		.699 (.176)	.29	.51	.20	2.90
Metalworking Machinery	.0057 (.0015)	.0044 (.0015)		.856 (.084)	1.00	.88	.89	2.25
Special Industrial Machinery		.0010 (.0004)	.0005 (.0005)	.883 (.158)	1.50	.80	.75	2.45

Industry	ΔK^*_t	ΔK^*_{t-1}	ΔK^*_{t-2}	I^n_{t-1}	σ	R^2_g	R^2_n	d
General Industrial Machinery[c]		.0042	.0263	.724	.00	.76	.64	1.81
Machine Shops[c]		.0012	.0104	.532	.00	.72	.22	1.91
Office & Computing Machines	.0074 (.0058)	.0257 (.0060)		.515 (.138)	.37	.94	.81	2.15
Service Industry Machines		.0193 (.0076)	.0010 (.0089)	.692 (.221)	.10	.58	.59	1.75
Electrical Equipment	.0201 (.0044)	.0116 (.0051)		.685 (.130)	.06	.84	.81	1.86
Household Appliances		.0047 (.0023)	.0023 (.0026)	.531 (.223)	1.18	.22	.41	1.97
Electric Lighting Equipment	.0019 (.0013)	.0033 (.0013)		.920 (.110)	1.07	.83	.69	1.77

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[c]The regressions for general industrial machinery and machine shops yielded negative distributed lag coefficients (although they were not significantly different at the 95% level). Since such equations are not desirable for forecasting purposes, the distributed lag coefficients were constrained to positive values by specifying the values of λ and σ and estimating the remaining regression coefficients by least squares.

Industry	ΔK^*_t	ΔK^*_{t-1}	ΔK^*_{t-2}	I^*_{t-1}	σ	R^2_g	R^2_n	d
Communications Equipment	.00066 (.00074)	.00079 (.00075)		.918 (.128)	1.50	.93	.78	1.95
Electronic Components	.0337 (.009)	-.001 (.014)		.451 (.238)	.00	.91	.79	1.93
Miscellaneous Electrical Equipment	.0015 (.0016)	.0083 (.0018)		.405 (.159)	.88	.69	.69	2.34
Motor Vehicles and Equipment	.00057 (.00065)	.00236 (.00064)		.688 (.137)	1.35	.65	.69	2.29
Aircraft and Parts	.0098 (.0053)	-.0068 (.0056)		.855 (.189)	.00	.69	.31	2.09
Ships, Trains, and Cycles		.0005 (.0003)	.0005 (.0003)	.722 (.156)	1.50	.76	.78	1.95
Scientific Instruments	.0055 (.0041)	.0043 (.0054)		.844 (.109)	.00	.68	.00	2.23
Optical Equipment	.0246 (.0114)	.0271 (.0131)		.420 (.175)	.15	.80	.50	2.30
Miscellaneous Manufacturing	.0153 (.0103)	-.0060 (.0124)		.792 (.155)	.00	.00	.29	2.11

Industry	ΔK^*_t	ΔK^*_{t-1}	ΔK^*_{t-2}	I^*_{t-1}	σ	R^2_g	R^2_n	d
Transportation	.338 (.084)	.060 (.084)		.432 (.173)	.00	.83	.78	2.10
Communications	.504 (.159)	.158 (.214)		.479 (.202)	.07	.98	.91	1.47
Utilities		.103 (.034)		.908 (.081)	.60	.85	.73	1.99
Trade	.0760 (.0461)	.0589 (.0552)		.583 (.168)	.00	.77	.28	1.89
Finance, Insurance and Real Estate		.0528 (.0309)	-.034 (.035)	.800 (.167)	.00	.71	.22	1.59
Services		.401 (.190)		.610 (.226)	.14	.70	.43	2.27

TABLE 2

ESTIMATES OF THE DISTRIBUTED LAG COEFFICIENTS
FOR A SAMPLE OF LARGE EQUIPMENT PURCHASERS [a]

Industry	W_0	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Oil and Gas Wells	.12	.21	.16	.12	.09	.07	.05	.04	.03	.02
Contract Construction	.36	.21	.14	.09	.06	.04	.03	.02	.01	.01
Fabrics and Yarn	.26	.43	.18	.07	.03	.01	.01	.00	.00	.00
Lumber	.14	.16	.13	.10	.09	.07	.06	.05	.04	.03
Paper except Boxes	.09	.19	.15	.12	.09	.07	.06	.05	.04	.03
Printing and Publishing	.27	.43	.18	.07	.03	.01	.01	.00	.00	.00
Basic Chemicals	.00	.26	.39	.18	.09	.04	.02	.01	.00	.00
Plastics and Synthetics	.00	.32	.33	.17	.09	.04	.02	.01	.01	.00
Petroleum Refining	.00	.16	.36	.21	.12	.07	.04	.02	.01	.01
Stone and Clay Products	.02	.20	.16	.13	.10	.08	.06	.05	.04	.03
Iron and Steel	.16	.30	.19	.12	.08	.05	.03	.02	.01	.01
Nonferrous Metals	.12	.33	.20	.13	.08	.05	.03	.02	.01	.01
Electronic Components	.57	.24	.11	.05	.02	.01	.00	.00	.00	.00
Motor Vehicles and Equipment	.06	.29	.20	.14	.10	.07	.05	.03	.02	.01
Transportation	.48	.29	.13	.05	.02	.01	.00	.00	.00	.00
Communications	.40	.31	.15	.07	.03	.02	.01	.00	.00	.00
Wholesale and Retail Trade	.23	.32	.19	.11	.06	.04	.02	.01	.01	.00
Finance, Insurance, Real Estate	.00	.56	.09	.07	.06	.04	.04	.03	.02	.02
Services	.00	.39	.24	.14	.09	.05	.03	.02	.01	.01

[a]The first ten coefficients of the infinite sequence are calculated and rounded to the nearest hundredth.

TABLE 3

SELECTED FORECASTS OF INVESTMENT IN 1975
FOR ALTERNATIVE DEFENSE ASSUMPTIONS

Industry	Equipment Investment by Industry in Constant 1966 Prices			
	1966 Actual	1975 Forecasts		
		High	Medium	Low
Oil and Gas Wells	3555.8	6620.6	6562.7	6569.9
Contract Construction	980.9	1600.4	1630.3	1811.2
Fabrics and Yarn	194.1	282.2	287.8	290.8
Paper Except Boxes	979.8	1666.3	1686.9	1692.0
Printing and Publishing	537.4	579.0	591.7	596.0
Basic Chemicals	1109.9	1615.0	1462.3	1486.4
Plastics and Synthetics	676.1	660.3	662.3	655.0
Petroleum Refining	254.1	335.2	327.4	327.2
Stone and Clay Products	484.5	518.2	518.7	549.9
Iron and Steel	1613.7	1744.1	1729.6	1745.2
Nonferrous Metals	814.4	915.4	827.0	781.4
Metalworking Machinery	251.8	392.3	366.3	346.7
Office and Computing Machines	149.0	308.2	297.0	309.9
Electronic Components	304.0	247.5	240.9	219.6
Motor Vehicles & Equipment	893.9	928.5	964.6	970.1
Transportation	5068.3	5826.4	5784.6	5904.7
Communications	4134.6	5969.6	6058.7	6086.8
Wholesale and Retail Trade	5862.1	6928.0	6963.6	6937.8
Finance, Insurance, Real Estate	1479.8	2415.5	2508.0	2527.3