SOME TESTS OF THE THEORY OF BUSINESS FIXED INVESTMENT USING DATA FROM THE MINERAL INDUSTRY

(Including the Development of Equations for use with the Econometric Model CANDIDE)

by

W.E. van Steenburgh

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ABSTRACT

The objectives of the study are:

(1) to develop aggregated and disaggregated investment equations for the mines, quarries and oil wells industry and to choose those that can be used in conjunction with the econometric model Candide;

(2) to determine whether the simplified neoclassical or the simplified eclectic model provide a better explanation of mining investment;

(3) to determine whether the goodness of fit can be improved using net rather than gross capital stock in the specifications of the models; and

(4) to determine if inflation, as measured by the rate of change in the price of capital goods, will improve the results of the neoclassical model.

The neoclassical and eclectic models described in this study are simplified versions to the extent that tax rates on business income, tax credits on investment expenditures, and capital consumption allowances are not included in the rental cost of capital of the specifications. In addition, the eclectic model does not contain the cost of internal finance, which is obtained from the short term assets, liabilities and expected flow of gross retained earnings of the industry in question. These variables could not be included as the data has not been compiled for the mines, quarries and oil wells (MQ&O) industry and considerable time, expert advice and computer manipulation of data would have been required in order to obtain consistent time series.

The specifications for the two models are estimated with annual data from 1950 to 1974 inclusive by the method of ordinary least squares. A number of different lag structures are used for the combined output, relative price variable in the neoclassical model, and for the separate output and relative price variables in the eclectic model, in order to determine which provides the best explanation of investment.

The eclectic model, even without inclusion of the dividend price yield, provides in general a better explanation of investment for the various subdivisions of the mining industry. And inclusion of the dividend price yield improves the predictive ability of the eclectic model. However, in several instances the neoclassical model provides somewhat better results.

Theoretically, both the neoclassical and the eclectic models of investment behaviour require net capital stock as an explanatory variable. The investment equations in CANDIDE use gross capital stock because of the way investment is measured in the National Accounts. The estimation results show that the use of net capital stock provides no consistent, significant improvement in the goodness of fit over that of gross capital stock.

The neoclassical theory attributes considerable importance to the effect of the rate of change in the price of investment goods on gross fixed capital formation. This study finds that such inflation has no consistent, substantial impact on investment.

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CHAPTER I

INTRODUCTION

CANDIDE is a large scale, medium term (eight to twelve years) econometric model of the Canadian economy. The model was developed and is continually being updated under the direction of the Economic Council of Canada. The model is used by a number of federal and provincial government departments and by industry to explain, forecast and carry out policy simulations concerning the Canadian economy.

The business fixed investment equations in CANDIDE are not disaggregated with respect to the mines, quarries and oil wells industry. In the first version, CANDIDE 1.0, which used historical data from 1946 to 1971, the investment equations were based on a simplified version of Jorgenson's neoclassical model.[1] In the revised CANDIDE 1.1, the investment equations were re-estimated using data up to 1973. A simplified version of the eclectic stock adjustment model, developed by C. Braithwaite,[2] was found to give superior results for a number of equations.

The neoclassical and eclectic models described in this study are simplified versions to the extent that tax rates on business income, tax credits on investment expenditures and capital consumption allowances

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[1]See Derek A. White, "Les investissements fixes des entreprises dans le modèle 1.0", Cahier No. 5 du projet CANDIDE, pages 13 to 40.

[2]See F.C. Braithwaite, "Business Fixed Investment", in CANDIDE Model 1.1, Paper No. 18, Volume 1, Chapter 6, edited by R. Bodkin and S. Tanny.

are not included in the specification. In addition, the eclectic model does not contain the cost of internal finance, which is obtained from the short term assets, liabilities and expected flow of gross retained earnings of the industry in question. These variables could not be included as the data has not, as yet, been compiled for the mines, quarries and oil wells (MQ&O) industry. Corporation financial and taxation statistics were collected up to the year 1964 by National Revenue and from 1965 onwards by Statistics Canada. During this time, there have been a number of changes in the methods of compilation of the data. Considerable time, expert advice and computer manipulation of data will be required in order to obtain consistent time series for the variables in question. It is hoped that we can carry out such a study in the near future. The complete neoclassical and eclectic models should provide a much better explanation of investment. And it would be possible to analyze the effects of taxes on business fixed investment during the historical period and carry out policy simulations of the possible effects of proposed tax changes on future investment.

Theoretically, both Jorgenson's neoclassical model and Braithwaite's eclectic model of investment behaviour require net capital stock as an explanatory variable. Net capital stock is gross capital stock minus the depreciation due to physical deterioration and obsolescence. The econometric model Candide uses gross rather than net capital stock as an explanatory variable. The reason for the use of gross capital stock in Candide and some arguments for the use of net capital stock are outlined in Chapter IV, "Data Sources, Definitions and Problems".

The objectives of this study are:

(1) to develop aggregated and disaggregated investment equations for the mines, quarries and oil wells industry and to choose those that can be used in conjunction with the econometric model Candide.

(2) to determine whether the simplified neoclassical or the simplified eclectic model provides a better explanation of mining investment.

(3) to determine whether the goodness of fit can be improved using net rather than gross capital stock in the specifications of the models.

(4) to determine if inflation, as measured by the rate of change in the price of capital goods, will improve the results of the neoclassical model.

CHAPTER II

THE NEOCLASSICAL MODEL[1]

The theory of investment is based on the neoclassical theory of optimal capital accumulation.[2] The theory may be expressed in two alternative and

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[1]The neoclassical model described in this chapter is based on that developed by Dale W. Jorgenson and adapted by Derek A. White for use with the Candide 1.0 econometric model.

See Dale W. Jorgenson, "Capital Theory and Investment Behavior", American Economic Review, May 1963, pp. 247-51, which provides the original version of his model; Jorgenson, "The Theory of Investment Behavior", Determinants of Investment Behavior, National Bureau of Economic Research, New York, 1967, pp. 135-55, which provides a more recent and general version of the theory; Robert E. Hall and Jorgenson, "Tax Policy and Investment Behavior", American Economic Review, June 1967, pp. 395-98, which describes the inclusion of taxes in the neoclassical model; and Jorgenson and Calvin D. Siebert, "Optimal Capital Accumulation and Corporate Investment Behavior", Journal of Political Economy, November/December 1968, pp. 1123-28, which in-includes the effects of inflation and taxes in the neoclassical investment theory.

See White, "Les investissements fixes des entreprises dans le modèle 1.0", pp. 13-40.

An excellent summary of the basic assumptions and issues is provided by L.R. Klein, "Issues in Econometric Studies of Investment Behavior", Journal of Economic Literature, March 1974, pp. 43-49.

[2]The theory was described by I. Fisher, Theory of Interest, New York, MacMillan, 1930, and expanded on by J. Hirschleifer, "On the Theory of The Optimal Investment Decision", Journal of Political Economy, August 1958, pp. 329-52, and by M.J. Bailey, "Formal Criteria for Investment Decisions", Journal of Political Economy, October 1959, pp. 476-88. It was given in its present form by Jorgenson, "The Theory of Investment Behavior", pp. 136-41.

The analysis does not distinguish between individuals and firms. Firms are regarded solely as agencies or instruments of individuals.

Reduced to the barest essentials, the theory proposes that an individual or firm carries out investment for the purpose of maximizing the utility over time of a stream of consumption. This basic assumption may be combined with any number of technological possibilities for production from the investment goods and economic possibilities for transformation of the returns from production into a stream of consumption for the individual of firm.

The firm maximizes the utility of its consumption stream subject to a production function which relates the flow of inputs (capital and labour services) to the flow of outputs. The firm obtains the capital services for itself by means of investment. The rate of change in the flow of capital services is proportional(in Jorgenson's neoclassical model, capital stock is assumed to be fully utilized and the constant of proportionality is unity)to the rate of acquisition of investment goods minus the rate of depreciation of previously acquired investment goods in the face of wear and tear, obsolescence or destruction by fire, flood or other equivalent ways:[3] (a) the firm acquires assets in order to provide capital services to itself with the objective of maximizing its present value subject to its technology; or (b) the firm rents its own assets or those from another firm in order to obtain capital services with the objective, in this case, of maximizing current profits, defined as gross revenue less the cost of current inputs and less the rental value of capital inputs.

For simplicity, the following analysis is limited to a production process with a single labour input, a single capital input and a single output.

The rental cost of a capital good can be calculated from the equality, in profit maximizing equilibrium, between the price of the new capital asset and the discounted value of all the future services derived from it. Assuming that the capital asset is fully utilized, so that the flow of services is proportional to the capital good and in the absence of direct taxation:

$$q(t) = \int_t^{\infty} e^{-r(s-t)} v(s)\; e^{-\delta(s-t)} ds \qquad [2\text{-}1]$$

where q(t) is the price of the new capital good at time t, r is the discount rate, s is the time at which capital services are provided, t

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catastrophe. The output of the production process is transformed into a stream of consumption under a known set of prices, both in the present and in the future, for investment goods, labour services, output and consumption goods and the interest rate.

The problem of maximizing utility may be solved in two steps: (1) the enterprise chooses a production plan so as to maximize its present value; and (2) consumption is allocated over time so as to maximize utility subject to the present value of the firm. Given the assumption of known prices, the choice of the production plan is independent of the subsequent allocation of consumption over time. Because of our concern with the theory of business fixed investment, we will consider only the first step which may be expressed in two alternative and equivalent ways, as described above.

[3] See Hall and Jorgenson, "Tax Policy and Investment Behaviour", p. 392.

is the time of acquisition of the capital good, $v(s)$ is the value flow of capital services from the good at time s, and δ is the depreciation rate of the capital asset.

It is assumed that the capital good depreciates exponentially at the constant proportional rate δ, and that the decreasing flow of services over time can be discounted back to its value at time t by the discount rate r. Equation [2-1] can be rewritten:

$$q(t) = e^{(r + \delta)t}\int_t^\infty e^{-(r + \delta)s} v(s)ds \qquad [2\text{-}2]$$

Differentiating [2-2] with respect to time, gives:

$$\frac{dq(t)}{dt} = (r + \delta)e^{(r + \delta)t}\int_t^\infty e^{-(r + \delta)s} v(s)ds + e^{(r + \delta)t}(-e^{-(r + \delta)t} v(t))$$

Combining with [2-2]:

$$\frac{dq(t)}{dt} = (r + \delta)\ q(t) - v(t)$$

Rearranging terms:

$$v(t) = q(t)\ (r + \delta) - \dot{q} \qquad [2\text{-}3]$$

where $\dot{q} = \frac{dq(t)}{dt}$

If it is assumed that there is no change over time in the price of capital goods, then [2-3] reduces to:

$$v(t) = q(t)(r + \delta) \qquad [2\text{-}4]$$

The expressions on the right hand side of equations [2-3] and [2-4] define the implicit rental cost of capital supplied by the firm to itself at time t, in the first case where the capital gains on investment goods are taken into account and, in the second case, where it is assumed that there is no change over time in the price of capital goods. One can therefore write that c(t) = v(t) as the profit-maximizing condition, giving respectively: [4]

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[4] The above line of reasoning follows White, "Les investissements fixes des entreprises dans le modèle 1.0", p. 15. A more mathematical justification is given by Jorgenson, "The Theory of Investment Behavior", pp. 143-44, as follows:

The flow of capital services over an interval of length ds beginning at time s from a unit of investment goods acquired at time t is:

$$e^{-\delta(s-t)}ds$$

If c(s) is the price of capital services at time s, then the discounted price of capital services is $e^{-rs}c(s)$, so that the value of the stream of capital services on the interval ds is:

$$e^{-rs}c(s)\ e^{-\delta(s-t)}ds$$

Similarly, if q(t) is the price of capital goods at time t, then the discounted price of capital goods is $e^{-rt}q(t)$, so that the value of a unit of investment goods acquired at time t is: $e^{-rt}q(t)$

But the value of investment goods acquired at time t is equal to the integral of the discounted value of all future capital services derived from these investment goods:

$$e^{-rt}q(t) = \int_t^\infty e^{-rs}c(s)\ e^{-\delta(s-t)}ds$$

$$= e^{\delta t}\int_t^\infty e^{-(r+\delta)s}c(s)ds$$

Solving for the price of capital goods, we obtain:

$$q(t) = e^{(r+\delta)t}\int_t^\infty e^{-(r+\delta)s}c(s)ds$$

$$= \int_t^\infty e^{-(r+\delta)(s-t)}c(s)ds$$

To obtain the price of capital services implicit in this expression, we differentiate with respect to time: $\dot{q}(t) = [r + \delta]q(t) - c(t)$

so that: $c(t) = q(t)(r+\delta) - \dot{q}$

and where $\dot{q}$ is assumed to be zero: $c(t) = q(t)(r+\delta)$

$$c(t) = q(t)(r + \delta) - \dot{q} \qquad [2\text{-}3a]$$

and where $\dot{q}$ is assumed to be zero:

$$c(t) = q(t)(r + \delta) \qquad [2\text{-}4a]$$

The profits of a firm can be expressed as:

$$\pi = PQ - wL - cK$$

where P is the price of a unit of output, w the price of a unit of labour, c the rental cost of a unit of capital and Q, L and K are the respective quantities.

Differentiation with respect to labour and to capital, gives:

$$\frac{\partial \pi}{\partial L} = P\frac{\partial Q}{\partial L} - w$$

$$\frac{\partial \pi}{\partial K} = P\frac{\partial Q}{\partial K} - c$$

The maximization of profits requires that the two partial derivatives be equal to zero. Thus:

$$\frac{\partial Q}{\partial L} = \frac{w}{P} \qquad [2\text{-}5]$$

$$\frac{\partial Q}{\partial K} = \frac{c}{P} \qquad [2\text{-}6]$$

If we assume that the firm has a Cobb-Douglas production function, of the form:

$$Q = K^{\alpha} L^{B}$$

then, differentiating with respect to labour and capital, gives:

$$\frac{\partial Q}{\partial L} = B\frac{Q}{L} \qquad \text{and} \qquad \frac{\partial Q}{\partial K} = \alpha\frac{Q}{K}$$

Combining the results with equations [2-5] and [2-6] gives the conditions necessary for the maximization of profits; i.e.,

$$B\frac{Q}{L} = \frac{w}{P} \qquad \text{and} \qquad \alpha\frac{Q}{K} = \frac{c}{P}$$

If we know Q, c, w and P, the desired amount of labour and capital necessary for the firm to maximize profits is:

$$L_t* = B\left(\frac{PQ}{w}\right)_t \qquad \text{and} \qquad K_t^* = \alpha\left(\frac{PQ}{c}\right)_t \qquad [2\text{-}7]$$

The desired change in the amount of capital stock in period t is:

$$K_t^* - K_{t-1}^* = \alpha\left[\left(\frac{PQ}{c}\right)_t - \left(\frac{PQ}{c}\right)_{t-1}\right] \qquad [2\text{-}8]$$

The desired increase in capital stock cannot be obtained immediately. For technical, institutional and economic reasons, changes in the quantity of capital stock require time. During any time period, that part of current investment which represents a change in the stock of capital is assumed to be the weighted sum of the effects of desired changes in the current period and in a number of earlier periods:

$$K_t - K_{t-1} = \Sigma_{i=0}^{m} W_i \, [K^*_{t-i} - K^*_{t-i-1}]^5 \qquad [2\text{-}9]$$
$$= \Sigma_{i=0}^{m} W_i \alpha \, [(\frac{PQ}{c})_{t-i} - (\frac{PQ}{c})_{t-i-1}]$$

Gross investment in period t can be considered as the sum of two items: net additions to the capital stock and the replacement of that part of the capital stock which has depreciated:

$$I_t = K_t - K_{t-1} + D_t \qquad [2\text{-}10]$$

If one assumes that the depreciation in period t, D_t, is a constant fraction, δ, of the stock of capital[6], at the end of the preceding period (i.e., $D_t = \delta K_{t-1}$), then [2-10] can be rewritten using [2-9] as:

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[5]The reasoning underlying this assumption is given by Jorgenson, "Capital Theory and Investment Behavior", pp. 249-50. It is summarized as follows: It is supposed that the distribution of times to completion of new investment projects is fixed. Let the proportion of projects completed in time T be W_T. If investment in new projects is I^E_t and the level of starts of new projects is I^N_t , investment is a weighted average of past starts:

$$I^E_t = \sum_{T=o}^{\infty} W_T \, I^N_{t-T} = W(L) \, I^N_t$$

where W(L) is a power series in the lag operator L. We assume that in each period new projects are initiated until the backlog of uncompleted projects is equal to the difference between desired capital stock, K^*_t and actual capital stock, K_t:

$$I^N_t = K^*_t - [K_t + (1 - Wo) \, I^N_{t-1} + \text{-------}]$$

which implies that:

$$I^E_t = W(L) \quad [K_t^* - K^*_{t-1}]$$

[6]The assumption is called the proportionality hypothesis for replacement investment. For further details, see Jorgenson, "Anticipation and Investment Behavior", <u>The Brookings Quarterly Econometric Model of the United States</u>, Rand McNally & Co., 1965, pp. 41-43. For a more mathematical critique, see J.C.R. Rowley and P.K. Trivedi, <u>Econometrics of Investment</u>, John Wiley & Sons, 1975, pp. 12-17. The same assumption is used in the eclectic model.

$$I_t = \Sigma_{i=0}^{m} W_i \alpha \left[\left(\frac{PQ}{c}\right)_{t-i} - \left(\frac{PQ}{c}\right)_{t-i-1} \right] + \delta K_{t-1} \qquad [2\text{-}11]$$

The neoclassical theory attributes considerable importance to the rate of change of the price of investment goods.[7] Changes in this price result in capital gains and losses which should be included in the calculation of economic profit or loss associated with alternative production plans. Jorgenson proposes that positive capital gains influence investment behaviour through two interrelated channels. First, increases in the price of investment goods (i.e. positive $\dot{q}$), holding other determinants of the price of capital services, c, constant, lowers the price of capital services which raises desired capital and has a positive effect on investment. Second, if the price of capital goods increases, holders of corresponding assets receive capital gains which raises the cost of capital and, hence, the price of capital services. Where the capital gains are received on depreciable assets alone, the net effect will be to reduce the price of capital services and to stimulate investment expenditures.

To assess the effects of variations in the rate of change of the price of investment goods (i.e., inflation) on the level of investment, we consider two alternative versions of the neoclassical theory. First, we assume that capital gains are taken into account in investment decisions, so that the price of capital services is given in

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[7] See Jorgenson and Siebert, "Optimal Capital Accumulation and Corporate Investment Behavior", pp. 1124, 1142.

[2-3a] above. Second, we assume that capital gains are regarded as transitory in both the price of capital services and the cost of capital, equation [2-4a], thus having no direct effect on investment behaviour.

Modifications to the Neoclassical Model [8]

The neoclassical model of business fixed investment is based on certain theoretical assumptions which may not be completely valid in the real world. Some of these, with proposed modifications, are outlined below.

(A) Equation [2-7], which is listed again below, implies that desired capital stock, K^*_t, changes whenever $\frac{P_t}{c_t}$ changes over time, t, even if the output, Q_t, remains constant. This, in turn, implies a flexible production function, where the proportion of the factors of production can be modified even after the capacity required to produce a given level of output is already in place.

$$L^*_t = B \frac{P_t}{w_t} Q_t \qquad \text{and} \qquad K^*_t = \propto \frac{P_t}{c_t} Q_t \qquad [2\text{-}7]$$

[8] See White, "Les investissements fixes des entreprises dans le modèle 1.0", pp. 17-23. The modifications were not widely used in the business fixed investment equations of Candide 1.0.

In reality, firms find it more difficult to change factor proportions with respect to already ordered or installed productive capacity than with regard to new additions to capacity. To take account of the difference, equation [2-7] is rewritten:

$$K_t^* = \propto \frac{P_t}{c_t} (Q_t - Q_{t-1} + Q_{t-1}) = \propto \frac{P_t}{c_t} (\Delta Q_t + Q_{t-1}) \qquad [2\text{-}7a]$$

Then:

$$K_t^* - K_{t-1}^* = \propto \frac{P_t}{c_t} (\Delta Q_t + Q_{t-1}) - \propto \frac{P_{t-1}}{c_{t-1}} Q_{t-1}$$

$$= \propto \frac{P_t}{c_t} \Delta Q_t + \propto \Delta (\frac{P}{c})_t Q_{t-1} \qquad [2\text{-}12]$$

The second term in [2-12] is multiplied by some fraction γ^1 to take account of the firm's more limited ability to carry out factor substitution, as relative prices (i.e., $\frac{P_t}{c_t}$) change, with respect to already ordered or installed productive capacity:

$$K_t^* - K_{t-1}^* = \propto \frac{P_t}{c_t} \Delta Q_t + \gamma \Delta (\frac{P}{c})_t Q_{t-1} \qquad \text{Where } \gamma = \gamma^1 \propto \text{ and } \gamma^1 < 1 \qquad [2\text{-}12a]$$

and [2-9] becomes:

$$K_t - K_{t-1} = \Sigma_{i=0}^{m} \alpha^1_i \left(\frac{P_{t-i}}{c_{t-i}}\right) \Delta Q_{t-i} + \Sigma_{j=0}^{n} \gamma_j^{11} [\Delta(\frac{P}{c})_{t-j} Q_{t-j-1}]^9 \qquad [2\text{-}9a]$$

(B) A further assumption of the neoclassical model that may not hold in reality is that desired capital stock is readily adjustable, both up and down. Thus, in equation [2-11] listed again below, any or all of the bracketed terms in the summation could be negative and, in theory, investment, I_t, could also be negative:

$$I_t = \Sigma_{i=0}^{m} \alpha^1_i \left[\left(\frac{PQ}{c}\right)_{t-i} - \left(\frac{PQ}{c}\right)_{t-i-1}\right] + \delta K_{t-1} \qquad [2\text{-}11]$$

Possibly more realistic assumptions are that:

(a) firms will wish to add to productive capacity when expected output is above expected capacity, but will not wish to add to nor decrease capital stock when expected output is below expected capacity;

(b) during economic expansion, firms must decide to add to productive capacity in advance of the time when the capacity is required to produce output;

(c) the rate of initiating additions to future capacity is related to the extent to which current output exceeds previous peak levels. Therefore, when output falls below previous peak levels, firms will be deterred from adding to capacity, but will probably not divest themselves of excess capacity in relation to expected output.

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[9] It is not known *a priori* whether the effects of relative prices and output on investment for new additions to productive capacity will take longer or shorter time than those for already ordered and/or installed productive capacity. Thus, the time lag m may be different from n.

The above assumptions can be incorporated in equations [2-12a] and [2-9a] as follows:

$$K^*_t - K^*_{t-1} = \propto \frac{P_t}{c_t} \Delta Q_t{}^{o} + \gamma \Delta (\frac{P}{c})_t \; Q^{o}_{t-1} \qquad [2\text{-}12b]$$

$$K_t - K_{t-1} = \Sigma^{m}_{i=0} \propto^{1}{}_{i} [(\frac{P}{c})_{t-i} \Delta Q^{o}_{t-1}] + \Sigma^{n}_{j=0} \gamma^{11}_{j} [\Delta (\frac{P}{c})_{t-j} Q^{o}_{t-j-1}] \qquad [2\text{-}9b]$$

where $\Delta Q_t{}^{o} = Q_t - Q^{o}_{t-1}$ when $Q_t - Q^{o}_{t-1} > 0$

and $\Delta Q_t{}^{o} = 0$ when $Q_t - Q^{o}_{t-1} < 0$

and $Q^{o}_{t-1} = \text{Max } Q_{t-i}$ $(i = 1, 2 \ldots\ldots v)$

where v is considerably shorter than the predicted life of the capital goods.

(C) Another problem with the neoclassical model is that the production function does not change over time. In reality, changes in the composition of the products comprising the output or technological developments can cause changes in the parameters of the production function. [10]

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[10] For more details, see White, "Les investissements fixes des entreprises dans le modèle 1.0", pp. 20-23.

Where the composition of the products comprising the output vary over time and each of the products has a Cobb-Douglas production function, the desired level of capital stock, for any given output, can vary according to the changes in the composition of output. The effect can be approximated by replacing the fixed coefficients of the aggregate production function by coefficients that vary over time:

$$Q = K^{\alpha_0 + \alpha_1 t} L^{B_0 + B_1 t}$$

Differentiating with respect to K gives: $\frac{\partial Q}{\partial K} = (\alpha_0 + \alpha_1 t)\frac{Q}{K}$

Profit maximization implies:

$$\frac{\partial Q}{\partial K} = (\alpha_0 + \alpha_1 t) \quad \frac{Q}{K} = \frac{c}{P}$$

$$K^* = (\alpha_0 + \alpha_1 t) \frac{PQ}{c}$$

Combining with the equations developed in (A) above, gives:

$$K^*_t - K^*_{t-1} = \alpha_0 (\frac{P}{c})_t \Delta Q_t + \alpha_1 (\frac{tP}{c})_t \Delta Q_t + \alpha_2 \Delta (\frac{P}{c})_t Q_{t-1} + \alpha_3 \Delta (\frac{tP}{c})_t Q_{t-1} \qquad [2\text{-}12c]$$

$$K_t - K_{t-1} = \Sigma^m_{i=0} \alpha_{0i} (\frac{P_{t-i}}{c_{t-i}} \Delta Q_{t-i}) + \Sigma^n_{j=0} \alpha_{1j} (\frac{tP}{c})_{t-j} \Delta Q_{t-j}$$

$$+ \Sigma^p_{k=0} \alpha_{2k} \Delta (\frac{P}{c})_{t-k} Q_{t-1-k} + \Sigma^q_{\iota=0} \alpha_{3\iota} \Delta (\frac{tP}{c})_{t-\iota} Q_{t-1-\iota} \qquad [2\text{-}9c]$$

Combining with the equations developed in (B) above, gives:

$$K_t - K_{t-1} = \Sigma_{i=0}^{m} \propto 0_i \left(\frac{P_{t-i}}{c_{t-i}} \Delta Q^o_{t-i}\right) + \Sigma_{j=0}^{n} \propto 1_j \left(\frac{tP}{c}\right)_{t-j} \Delta Q^o_{t-j}$$

$$+ \Sigma_{k=0}^{r} \propto 2_k \Delta\left(\frac{P}{c}\right)_{t-k} Q^o_{t-1-k} + \Sigma_{\iota=0}^{s} \propto 3_\iota \Delta\left(\frac{tP}{c}\right)_{t-\iota} Q^o_{t-1-\iota} \qquad [2\text{-}9d]$$

CHAPTER III

THE ECLECTIC MODEL[1]

Summary

Gross investment (I) is explained by an eclectic stock adjustment model.[2]

Net investment, in period t, is by definition equal to the change in the net stock of capital (K) between the end of period t and the end of period t-1 (i.e., $K_t - K_{t-1}$).

Gross investment is equal to net investment plus depreciation (D):

$$I_t = K_t - K_{t-1} + D_t \qquad [3\text{-}1]$$

Assuming that depreciation in period t is a constant proportion δ (the depreciation rate) of the capital stock in existence at the end of the previous period:

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[1] The eclectic model described herein follows that developed by F.C. Braithwaite, An Econometric Analysis of the Determinants of Investment in Canadian Manufacturing, an unpublished PhD Thesis, Queen's University, 1971

The eclectic model used in our study is a simplified version to the extent that it was impossible to include business tax rates, tax credits and the cost of internal finance (availability of internal funds).

See Rowley and Trivedi, Econometrics of Investment, p. 30, for a general summary of the eclectic framework.

Variables are given in real terms, where applicable, with the exception of the rate of interest, which is in %.

[2] The Stock Adjustment model has its basis in acceleration theory and is also known as the flexible accelerator model. The origins of the stock adjustment model and Jorgenson's neoclassical model are therefore the same. For more details, see Klein, "Issues in Econometric Studies of Investment Behaviour", p. 43 and Michael E. Evans, Macroeconomic Activity, Harper & Row, 1969, pp. 84-85.

$$D_t = \delta K_{t-1} \quad [3\text{-}2]$$

Assume that the firm's investment decisions are designed to achieve the desired stock of capital, but that they only fill a proportion λ of the gap between the desired capital stock (K*) and the actual stock of capital, within a single period:

$$I_t = \lambda(K^*_t - K_{t-1}) + \delta K_{t-1} \quad [3\text{-}3]$$

It is further assumed that desired capital stock is a function of expected output (Q^e), expected relative prices (RP^e), the cost of internal finance (IF) and the cost of external finance (EF):

$$K^* = f(Q^e, RP^e, IF, EF) \quad [3\text{-}4]$$

And we assume that proxy measures for the above explanatory variables in year t are:

$$Q^e_t : \Sigma^m_{i=0} d_i Q_{t-i}$$

$$RP^e_t : \Sigma^n_{j=0} b_j \left(\frac{P}{c}\right)_{t-j} \quad \text{or} \quad \Sigma^P_{j=0} w_j \left(\frac{w}{c}\right)_{t-j}$$

where $c = q(\delta + r) \simeq q(\delta + R)$; as developed by the neoclassical model

$$IF_t : (A_{t-1} - L_{t-1} + GRE^e) = F_t$$

where $GRE^e_t = \Sigma^q_{k=0} \alpha_k (GRE)_{t-k}$ [3]

[3] The calculation of GRE^e was considered unnecessary and following W.H. Locke Anderson, "Business Fixed Investment: A Marriage of Fact & Fancy," Determinants of Investment Behavior, National Bureau of Economic Research, New York, 1967, pp. 413-25, the specification of F was simplified to the difference between short term assets and short term assets lagged one year, plus a half of the flow of gross retained earnings in year t and year t-1, which is an approximate measure of the expected flow of gross retained earnings in year t.

$$EF_t : DP^e_t = \Sigma^s_{\iota=0} g_\iota (DP)_{t-\iota} \qquad \text{and} \qquad R^e_t = \Sigma^z_{m=0} w_m (R)_{t-m}$$

where Q is output; $\frac{P}{c}$ is the price of output (P) relative to the price of capital services (c), (q is the implicit price of capital goods, δ is the depreciation rate and R is the rate of interest); $\frac{w}{c}$ is the wage rate relative to the price of capital services; F_t is the potential net financial position at the end of period t, if no investment is undertaken or no shares are issued during period t; A and L are short-term assets and liabilities, respectively, and GRE^e_t is the expected flow of gross retained earnings in period t; DP is the dividend price ratio of shares; and the coefficients are weights which vary with each variable in question.

Assuming that desired capital stock is a linear function of its determinants, equation [3-4] becomes:

$$K^* = a_0 + a_1 Q^e_t + a_2 RP^e_t + a_3 F_t + a_4 DP^e + a_5 R^e_t \qquad [3\text{-}5]$$

Substituting [3-5] into [3-3], and using the relative price variable $\frac{P}{c}$, gross investment is given by:

$$I_t = \lambda[a_0 + a_1 Q^e_t + a_2 RP^e_t + a_3 F_t + a_4 DP^e_t + a_5 R^e_t] - (\lambda - \delta) K_{t-1}$$

$$= b_0 + b_1 Q^e_t + b_2 RP^e_t + b_3 F_t + b_4 DP^e_t + b_5 R^e_t + b_6 K_{t-1}$$

$$= b_0 + b_1 \Sigma^m_{i=0} d_i Q_{t-i} + b_2 \Sigma^n_{j=0} b_j \left(\frac{P}{c}\right)_{t-j} + b_3 F + b_4 \Sigma^s_{\iota=0} g_\iota (DP)_{t-1}$$

$$+ b_5 \Sigma^z_{m=0} W_m R_{t-m} + b_6 K_{t-1} \qquad [3\text{-}6]$$

The signs of d_i, b_j, and b_3 are expected to be positive as business fixed investment is assumed to vary directly with the level of output (Q), the price of output (P), the net financial position of the enterprise (F), and inversely with the rate of interest which is included in the rental cost of capital (c). The signs of g_l and γ_m are expected to be negative as investment is assumed to vary inversely with the dividend price yield (DP) and the rate of interest. The sign of b_6 is expected to be negative since λ, the rate of adjusting the capital stock is, in the typical situation, greater than δ, the rate at which the capital stock is depreciated and both λ and δ are positive.

Departure From Neoclassical Model and Details of Assumptions

Braithwaite's eclectic investment model is based, to a large extent, on the neoclassical model, as developed by Jorgenson. However, the eclectic model makes several significant departures, in order to make the neoclassical theory more realistic. These are outlined below.

First, it is not known whether the Cobb-Douglas production function, which is used in the Jorgenson neoclassical theory, is the appropriate production function for all the industries being studied. For some of these industries, a more general production function, which includes the Cobb-Douglas [4] as a special case, might be more appropriate.

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[4] The Cobb-Douglas production function has unitary elasticity of substitution.

For example, the constant elasticity of substitution (C.E.S.) production function, where Q is output, Xi are the various factor inputs, and σ is the elasticity of substitution:

$$Q = \left(\Sigma_{i=1}^{m} \alpha_i X_i^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \qquad [3\text{-}7]$$

Profits are given by the following equation, where P and c_i are the price of output and of the various inputs:

$$\pi = PQ - \Sigma_{i=1}^{m} c_i Xi \qquad [3\text{-}8]$$

Maximizing profits subject to the production function gives:

$$Xi = \left(\frac{\alpha i P}{c_i}\right)^{\sigma} Q = \beta i \left(P/c_i\right)^{\sigma} Q \qquad [3\text{-}9]$$

However, it is not clear that an aggregate production function, such as the C.E.S. with constant elasticity of substitution between any pair of factors, can be applied. It is therefore assumed that a general production function applies, such as:

$$Q = f(K,L) \qquad [3\text{-}10]$$

and that the desired capital stock, K*, is simply a general function of output and relative prices.[5]

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[5] See Charles W. Bischoff, "Investment Behavior, A Model of Nonresidential Construction in the United States", American Economic Review, May 1970, p. 12.

Second, some firms may be minimizing costs rather than maximizing profits or present value, as is assumed in the neoclassical model outlined in Chapter II. For such firms, the relative price variable could theoretically be $\frac{p}{c}$; Bischoff[6] has derived an expression identical to [3-9], except for a proportionality factor, from a cost minimization model, given the additional assumption that the price of output is set by applying a constant markup to the minimum average cost of production. However, the relative price variable could also be $\frac{w}{c}$[7], where w is the wage rate in constant dollars. The use of the relative price variable $\frac{w}{c}$ has an advantage where firms are not price takers, as required in the perfect competition assumption of the neoclassical model. The above assumptions could be appropriate for certain sections of the mining industry.

Third, the neoclassical model assumes a world of perfect certainty, where desired capital stock is determined by current levels of output and prices (see equation [2-7]) which are assumed to remain at their present level. If we accept that the world includes considerable uncertainty, then desired capital stock, K*, should be determined by the expected values of output and relative prices, rather than the actual

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[6] See Charles W. Bischoff, "Lags in Fiscal and Monetary Impacts on Investment in Producers' Durable Equipment", Cowles Foundation Discussion Paper No. 250 (New Haven, Connecticut), June, 1968.

[7] See Bert G. Hickman, Investment Demand and U.S. Economic Growth, The Brookings Institution, 1965, pp. 28-30, where the assumption of cost minimization is used to justify this variable; and footnote 5 of page 12 of Braithwaite, "An Econometric Analysis of the Determinants of Investment in Canadian Manufacturing", where using Jorgenson's neoclassical theory, desired capital stock is expressed as a function of output and the wage rate relative to the price of capital services.

values. In the absence of a useable theory of expectations,[8] the eclectic model assumes that the expected values of the explanatory variables can be represented by a weighted average of their recent and current values.

Fourth, the Jorgenson neoclassical model implicitly assumes perfect capital markets and certainty[9] so that the discount rate for future earnings equals the interest rate for capital and is independent of the source of funds. The eclectic model attempts to take account of risk and uncertainty and the sources and costs of investment financing. The discount rate r is assumed to be a function of the cost of internal finance, IF, and of the cost of external finance, EF:

$$r = f(IF, EF) \qquad [3\text{-}11]$$

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[8] The relatively recent study by Albert K. Ando, Franco Modigliani, Robert Rasche and Stephen J. Turnovsky, "On the Role of Expectations of Price and Technological Change in an Investment Function", International Economic Review, June 1974, p. 386, experienced this same difficulty.

[9] See Merton H. Miller and Franco Modigliani, "Estimates of the Cost of Capital Relevant for Investment Decisions Under Uncertainty", pp. 180-85, in Determinants of Investment Behaviour, University National Bureau Conference Series No. 18, 1967, edited by R. Ferber.

Also see Klein, "Issues in Econometric Studies of Investment Behaviour", p. 45.

Miller and Modigliani also suggest that perfect capital markets is not an unreasonable assumption for large, well-established firms. Though relatively few in number, such firms account for a disproportionately large share of total investment. Over the relevant range of fund requirements and except for very short intervals of time, the large, established firms have no constraints on investment funds from all sources at the going cost of capital. The above approach was considered but not used by Braithwaite, "An Econometric Analysis of the Determinants of Investment in Canadian Manufacturing", in developing the eclectic model as his study involved both large and small firms in the various manufacturing industries.

The net financial position, F, is used as a measure of the availability of internal funds and therefore of the cost of internal finance, and the rate of interest, R, and the dividend price ratio, DP, are used as measures of the cost of external finance. Hence, an eclectic measure of the rate of discount is:

$$r = g(F, R, DP) \qquad [3\text{-}12]$$

If the functional form of the equation [3-12] above was known, the discount rate r could be calculated directly and used to obtain the price of capital services, c, which in turn could be used to provide the relative price variables RP. The weights applicable to RP would be available from the actual regressions using Almon lags, which would in turn provide a measure of the expected relative prices RP^e. However, the function, g, of equation [3-12] is not known and could be of a complicated non-linear form. And we would also like to study the separate effects of each of the variables concerned on the desired capital stock, K*. Therefore, for simplicity, it is assumed that:

$$r = R + g(F, R, DP) \qquad [3\text{-}13]$$

and the long-term interest rate, R, is used as a proxy for r in the equation for the rental cost of capital services.

$$c = q(\delta + r) \simeq q(\delta + R) \qquad [3\text{-}14]$$

and the explanatory variables, F, R, and DP in the function g are entered separately and linearly as determinants of the desired capital stock K*.

Braithwaite's reason for including R in the user cost of capital and again as a separate determinant of K* is that it could theoretically have an effect on the user cost as well as an independent effect on K* and, secondly, its inclusion as a separate determinant of K* helps to ensure that any success which the relative price variables may have in explaining investment would not be due solely to the use of the rate of interest in the user cost of capital.

The long-term rate of interest, R, is used to measure the market cost of borrowing funds and the dividend price ratio, DP, is used as a measure of the cost to existing shareholders of raising funds through equity issues. The cost to existing shareholders is actually some discounted earnings stream per share divided by the current price per share. However, if a firm has some target dividend pay out ratio which is applied to long-run expected earnings, it is likely to treat fluctuations in current earnings as transitory. Hence, dividends will be a more accurate representation of expected future earnings than the more volatile current earnings. The eclectic model, therefore, uses the dividend price ratio rather than the earnings price ratio.

F is made a function of gross retained earnings, short-term assets and short-term liabilities. Gross retained earnings represent an opportunity cost, as the firm can always lend them to others, but they also involve no internal transaction costs and hence facilitate the ability of the firm to purchase capital goods. Short-term assets and liabilities are included because of the opportunity cost considerations resulting from the risks of illiquidity and indebtedness.

The eclectic model simplifies the specification of F by defining it as the difference between short-term assets and short-term assets lagged one year, plus one-half of the flow of gross retained earnings in year t and year t-1.

Modified Eclectic Model Used in the Study

As discussed in Chapter I, it was impossible to obtain data on the assets (A), liabilities (L), and gross retained earnings (GRE) for the mining industry. As a result, the variable F_t representing the availability of internal funds, had to be omitted from the regressions. The relative price variable $\frac{w}{c}$ is not used as an alternative to $\frac{P}{c}$ because of time constraints and because the mining wage rate is not available in the Candide historical data base. The dividend price yield is not included in the equations developed for use with the Candide econometric model as the data is not included in the Candide data base and the variable is considered difficult to forecast. And the model used in our study also diverges from that developed by Braithwaite (described above) in that the rate of interest R is not included as a separate variable in the final specifications as it is already contained in the rental cost of capital services c, and the double use could cause problems of multicollinearity. The modified specifications, with and without the dividend price yield as an explanatory variable, are:

$$I_t = a + \Sigma_{i=m}^{n} bi\ Q_{t-i} + \Sigma_{j=k}^{l} dj(^P/_c)_{t-j} + g_1 DP_{t-1} + k_1 K_{t-1}$$

$$I_t = a + \Sigma_{i=m}^{n} bi\ Q_{t-i} + \Sigma_{j=k}^{l} dj(^P/_c)_{t-j} + k_1 K_{t-1}$$ [9]

[9] The model used in this study also differs slightly from that of C. Braithwaite in that the time lags m and k are not, *a priori*, assumed to be zero.

CHAPTER IV

DATA SOURCES, DEFINITIONS AND PROBLEMS

The data used in the study is mainly from the historical period 1950 to 1973. Dividend price yields were only available from 1956 onwards. Where possible, data was obtained from the historical data base of the Candide model. The use of Candide data facilitates the combined simulation and use of the aggregated and disaggregated investment equations for the mines, quarries and oil wells industry with the Candide model. The data is provided in Appendix A.

Investment, Capital Stock and the Price of Capital Goods

Data on fixed capital flows (investment) and stocks for the mining industry were obtained from Statistics Canada.[1] The definitions and methods of calculation are summarized in the Statistics Canada annual publication, 'Fixed Capital Flows and Stocks', Catalogue Number 13-211 and are more fully described in 'Fixed Capital Flows and Stocks, Manufacturing, Canada, 1926-1960, Methodology', Catalogue Number 13-522.

In summary, fixed capital stocks are assumed to consist of a homogeneous commodity where the services of capital goods acquired

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[1] The data was provided by P. Koumanakos of the National Wealth and Capital Stock Section of the Construction Division, Statistics Canada. Disaggregated data for the mines, quarries and oil wells industry was not contained in the Statistics Canada publications and was calculated separately.

at different points in time are perfect substitutes in production.

Capital is measured by the perpetual inventory method.[2] Annual investment data is collected by industry (gross fixed capital formation in current dollars). It is deflated by a price deflator (q) for that industry to provide gross fixed capital formation (I) in constant dollars. Based on estimates of the average economic life of capital assets in the various industries (L), the amount of capital assets that would be discarded in that year is subtracted from the investment. Cumulative addition of the gross investment minus the discards for all previous years provides a measurement of gross fixed capital stock (GK) for the year in question. In gross capital stock, assets are therefore included at their full value during the entire time they remain in the capital stock and the deductions from gross investment are due to the fact that the assets in question have ceased to exist.

$$\text{Discards}_t = I_{t-L} \text{ and } GK_t = \Sigma^{t}_{T=-\infty} I_T - I_{T-L} = \Sigma^{t}_{T=t-L+1} I_T \qquad [4\text{-}1]$$

Net capital stock (NK) is obtained by adjusting the value of the assets in existence (gross capital stock, GK) for the depreciation due to wear and tear and obsolescence that they undergo during their service life (L).

Statistics Canada calculates depreciation, alternately called capital consumption allowance, by the straight line method i.e. the value of the asset declines linearly throughout its economic life. The depreciation at any time t (D_t) is assumed to be:

$$D_t = \frac{GK_t}{L} \qquad [4\text{-}2a]$$

[2]During the first L years in which Statistics Canada collected the investment data, there was obviously no information available as to discards so that the measure of capital stock was simply an accumulation of the previous deflated investments. This period is long since past for the data used in the study.

In actual fact, the above stocks relate to the end of each calendar year and the adjustment below is necessary to centre the estimates to the middle of each calendar year:

$$D_t = \frac{GK_t + GK_{t-1}}{2L} \qquad [4\text{-}2b]$$

Net investment at time t is calculated by subtracting D_t from gross investment, I_t:

$$NI_t = I_t - D_t \qquad [4\text{-}3]$$

and net capital stock is the accumulation of NI over the economic life of the assets:

$$NK_t = \sum_{T=t-L+1}^{t} NI_T \qquad [4\text{-}4]$$

The price deflator for gross investment (q) is used as an index measurement of the average price of capital goods for the year in question.[3]

Gross versus Net Capital Stock

Theoretically, both the neoclassical and the eclectic models require net capital stock as an explanatory variable for gross investment. However Candide, uses gross capital stock. The justification for using gross rather than net capital stock is given in D.A. White, op. cit. The argument is summarized below.

The objective of the investment model is to explain gross fixed capital formation as given in the National Accounts. By definition, as in the neoclassical model, gross investment consists of the sum of net investment (new investments; i.e., additions to the stock of real capital) and replacement investments (which is designed to maintain the

[3]For more details, see White, "Les investissements fixes des entreprises dans le modèle 1.0", p. 32.

existing stock of capital intact in the face of wear and tear, aging, obsolescence and destruction by fire, flood or other catastrophy). However, repair and maintenance expenditures are excluded from the National Accounts as not representing final demand expenditures. Therefore, replacement investment would probably represent expenditures to replace worn out or obsolete capital assets being discarded from the gross stock. It is assumed that replacement expenditures would be a fixed proportion of gross, rather than net, capital stock.

It is also possible to argue to the contrary. Replacement investment is designed to replace losses in the productive capacity of existing capital goods.[4] Such losses are due to the physical deterioration and obsolescence of the capital goods (i.e., depreciation and discards). Discards are subtracted from gross investment before summation to give gross capital stock. And depreciation can be considered as a proportion of the productive capacity of existing capital goods. Replacement investment can, therefore, be considered as proportional to net capital stock.

This study will first use gross capital stock and second, as an alternative, net capital stock to determine which provides the better explanation of gross investment. However, the mining investment equations with gross capital stock as an explanatory variable will have

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[4] See Robert M. Coen, "Investment Behaviour, The Measurement of Depreciation and Tax Policy", American Economic Review, March 1975, p. 60.

to be used when the equations are simulated in conjunction with Candide.

Economic Depreciation Rate (δ)

In the neoclassical model, δ is the proportional rate of depreciation of the services obtained from capital goods; i.e., capital is assumed to depreciate exponentially at the rate δ. Statistics Canada calculates capital consumption by the straight-line depreciation of gross capital stock (see equation [4-2] above). The distinction is essentially between depreciation being considered as a constant proportion of the depreciated stock versus depreciation being considered as a constant proportion of the original capital stock. The use of Statistics Canada's data for calculating δ for use with the neoclassical model can be a source of error.

In the Candide model, the economic depreciation rate δ is calculated as the average[5] of the capital consumption allowance, CCA_t, (alternately called depreciation and estimated by the straight-line depreciation of gross capital stock) divided by the previous year's gross capital stock, GK_{t-1}.

$$\delta = \frac{\Sigma\ CCA_t}{\Sigma\ GK_{t-1}} \qquad [4\text{-}5]$$

In this study, when regressions are carried out using net capital stock, the denominator in the above equation [4-4] will obviously be net, instead of gross, capital stock.

[5] Arithmetic mean over the historical period being studied.

The Discount Rate (r)

The McLeod, Young and Weir average yield on ten long-term industrial bonds (R) is used as a proxy for the discount rate (r) in calculating the rental cost of capital (c). See equation [2-4].

Output and Output Prices

Measures of output (Q) are obtained from the Candide historical data base. Values of real domestic product (R.D.P.) are used, which are derived by multiplying the industries' base year (1961) value of R.D.P. by the index of R.D.P. provided by Statistics Canada. Details of the concepts, sources and methods concerning the indexes of R.D.P. are provided in Statistics Canada, Catalogues No. 61-502, 61-505, 61-506, 61-510 and 61-213.

In summary, the index of real domestic product is derived by a process of double deflation; by subtracting each industry's intermediate material and service inputs valued at base year prices from the industry's gross output (sales or shipments) valued at base year prices and dividing the result by the industry's base year R.D.P. Aggregation of industries are based on 1961 R.D.P. weights. Shifts in the relative importance of component industries may obviously take place.

The industry output prices in Candide are obtained implicitly, by dividing estimates of current dollar gross domestic product at factor cost by the real domestic product. The implicit G.D.P. deflator, so calculated, is used in this study as the price of output for total mines, quarries and oil wells. However, disaggregated mining industry output prices are not available from the Candide historical data base. They are also not available from Statistics Canada publications. However, a number of mineral export prices are available from the Candide data base. Given the high proportion of exports to total output in the mineral industry, it is assumed that export prices can be used as a suitable proxy for output prices.

The value of exports, X_i, and export prices, P_{xi}, for the various commodities, i = 1,2 etc., were combined to give an industry export price, P_{xI}, for metal mines and mineral fuels, as follows:

$$P_{xI} = \frac{\sum_i X_i \, P_{xi}}{\sum X_i}$$

The export price of asbestos was used as a proxy for the output price of non-metal mines (NM). Asbestos production historically accounts for about 42% of the production of non-metal mines. There were no other reliable output or export prices available, excluding the use of a general price index.

<u>Dividend Price Yield</u>

The monthly dividend price yields were obtained from 1956 onwards from the Toronto Stock Exchange. The end of the year values

(December values) were used to represent the year in question. The January 1956 value was used as a proxy for the December 1955 value.

From 1956 to 1964, only the industrial index is available. From 1965 onwards, a number of other indexes are published. The industrial index is used for the total MQ&O industry and for non-metal mines (NM). For metal mines (MM), the industrial index is used from 1955 to 1964, and the industrial mines index from 1965 onwards. The discontinuity is taken account of by a dummy variable in the regression. Similarly, for mineral fuels (MF), the industrial index serves up to 1964 and the western oil index afterwards.

CHAPTER V

RESULTS, CONCLUSIONS AND RECOMMENDATIONS

General Information

The study uses a simplified neoclassical model and a simplified eclectic model to explain business fixed investment in the mines, quarries and oil wells industry.[1] The aggregate and disaggregated sectors of the mining industry covered by the study are:

Mines, Quarries and Oil Wells (MQ&O), in total

MQ&O, construction (CT)

MQ&O, machinery and equipment (ME)

Metal Mines (MM), in total

MM, CT

MM, ME

Non-Metal Mines (NM), in total

NM, CT

NM, ME

Mineral Fuels (MF), in total

MF, CT

MF, ME

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[1]The components of the mining industry, according to the Standard Industrial Classification, are given in Appendix C. For this study, quarries and sand pits are included with non-metal mines and services incidental to mining are subdivided among metal mines, mineral fuels and non-metal mines, according to where the costs of such services were expended.

The equations for business fixed investment which were applied to the aggregate and disaggregated sectors of the mining industry are given below. The neoclassical model was first regressed with the rate of inflation included in the rental cost of capital services (c) and then without inflation. Inflation (as measured by the time rate of change in the price of investment goods) provided no significant, consistent improvement in the goodness of fit of the equation for the various sectors of the mining industry and was dropped from further investigation.

A wide range of distributed lags were tried for each specification, in order to determine which provided the best explanation of investment. The equations were all regressed twice; first with gross capital stock (GK) among the explanatory variables, and then with net capital stock (NK), so as to determine which provided the best fit. Two investment equations for the eclectic model were used throughout, one with the dividend price yield included as an explanatory variable and the other without. This was necessary not only to determine the contribution of the DPY to the explanation of investment, but also because the econometric model Candide does not contain DPY variables. Our mining industry investment equations will often have to be used in conjunction with Candide, especially for forecasts where some of the predictions provided by Candide will serve as variable inputs to our investment models.

For the neoclassical model:

$$I_t = a + \Sigma_{i=m}^{n} bi[(^{PQ}/_c)_{t-i} - (^{PQ}/_c)_{t-i-1}] + k_1K_{t-1}$$

where capital stock K = first GK and then NK

and $c = q(R + \delta) - \dot{q}$ taking account of inflation;

and $c = q(R + \delta)$ where inflation is not considered.

And for the eclectic model, with and without the dividend price yield as an explanatory variable:

$$I_t = a + \Sigma_{i=m}^{n} bi\ Q_{t-i} + \Sigma_{j=k}^{l} dj(^{P}/_c)_{t-j} + g_1DP_{t-1} + hD + k_1K_{t-1}$$

$$I_t = a + \Sigma_{i=m}^{n} bi\ Q_{t-i} + \Sigma_{j=k}^{l} dj(^{P}/_c)_{t-j} + k_1K_{t-1}$$

where K = first GK and then NK

$c = q(R + \delta)$

D is a dummy variable, used only for metal mines and mineral fuels, to take account of the inconsistency in the DPY data. (D has 1s from 1950 to 1963 and 0s from 1964 to 1974).

The regressions were carried out using ordinary least squares. The Almon distributed lag technique,[2] with a second degree polynomial, was used for the distributed lags, in order to provide the maximum number

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[2]S. Almon, "The Distributed Lag Between Capital Appropriations and Expenditures", Econometrica, Volume 33, January 1965, pp. 178-196.

of degrees of freedom and to reduce problems of multicollinearity. The subsets of better equations were selected on the basis of the usual criteria: acceptable Durbin-Watson statistic, coefficients with correct signs and magnitudes which seem reasonable on the basis of the theory outlined above, significant t values, high coefficient of multiple correlation (R^2), and low coefficient of variation (C.O.V.) or standard error of estimate (S.E.E.).

The following regression results are summarized in Appendix B:

- A typical neoclassical model with inflation included in the rental cost of capital services (page 72);
- The above neoclassical model without inflation (page 71);
- The best regression results for the eclectic model where the dividend price yield (DP) and gross capital stock (GK) are used as explanatory variables (page 66);
- The best regression results for the eclectic model where GK, but not DP, is included among the explanatory variables (page 67);
- The best regression results for the eclectic model where NK, but not DP, is included among the explanatory variables (page 69);
- The best regression results for the neoclassical model where GK is used as an explanatory variable (page 68);
- The best regression results for the neoclassical model where NK is used as an explanatory variable (page 70).

Estimation Results

The results obtained on estimating the specifications of the behaviourial equations for the neoclassical and the eclectic models are, in general, moderately acceptable. The best results for the various models and specifications are given in Appendix B. For the eclectic model, using GK and DPY among the explanatory variables, three subdivisions of the MQ&O industry have a coefficient of multiple correlation (R^2) over 0.90; six between 0.80 and 0.90; one between 0.60 and 0.70; and one with an R^2 of .597. For the eclectic model using GK but not DPY as an explanatory variable, two have an R^2 over 0.90; five between 0.80 and 0.90; three between 0.70 and 0.80; one at .565; and one at 0.491. For the neoclassical model, with GK as an explanatory variable, one has an R^2 over 0.90; five between 0.80 and 0.90; one between 0.70 and 0.80; two between 0.60 and 0.70; two between 0.50 and 0.60; and one with an R^2 of .208.

The models using NK as an explanatory variable provided similar results. None of the models were successful (i.e., R^2 over 0.75, etc.) in estimating investment for metal mines, construction and for mineral fuels, machinery and equipment.

Output, as measured by Real Domestic Product, is generally the most important explanatory variable of investment. This finding is consistent with previous studies of investment using the neoclassical and/or the eclectic model. The magnitude, sign and significance of its coefficients are mainly satisfactory. The coefficients change sign, in some cases, but this is consistent with the accelerator effect of output on investment.

In a number of equations, the coefficients for some of the various lags of the relative price variable ($^P/_c$) have a negative sign.

This could reflect both the use of long-term supply contracts, at more or less fixed prices, which are prevalent for certain minerals such as copper and also the relative importance of the multinational companies which dominate the mining industry. Some of the multinationals are in an oligopolistic position and exercise control over the overall quantity and price of output. Others, which are vertically integrated, use a bookkeeping transfer price for their crude material obtained in Canada as it goes for further processing outside of Canada. And many multinationals can obtain almost unlimited capital finance from a number of sources and geographic locations and the price of capital services used in our study, which is based on the Canadian long-term interest rate, may not be as critical as, say, the U.S. interest rate or the overall international tax advantage obtained from the allocation of such funds.[3] The negative signs could also result from inadequacies in using a weighted index of export prices of the major mineral commodities as a proxy for the output price of metal mines and of mineral fuels and the export price of asbestos as a proxy for that of non-metal mines, even though a high percentage of the mineral production is exported. Also the assumption that the long-term industrial bond rate can serve as a proxy for both the cost of capital and the time discount rate of future income in the rental cost of capital goods (c) could introduce distortions in the relative price variable.

In several equations of the neoclassical model, the magnitude of the coefficient of the lagged capital stock seems high (i.e., the implied rate of replacement is somewhat higher than what is known about the replacement rate of the capital goods in question), and in one instance the coefficient has an incorrect negative sign where, theoretically, it should be positive. In a number of equations for the eclectic model, where the dividend price yield is not included among the explanatory variables, the

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[3]For a more detailed treatment, see Glenn P. Jenkins and Antal Deutsch, "Foreign Tax Credits and the International Interdependence of Corporate Tax Policies", Discussion Paper Number 384, Harvard Institute of Economic Research, Harvard University, October 1974.

coefficient for the lagged capital stock is positive, where theoretically it is normally expected to be negative. The addition of DPY as an explanatory variable provides the correct sign in all but two instances (see p. 66, Appendix B) but in several instances the coefficient is not statistically significant. The inherent difficulties in collecting reliable capital stock data, discussed later in this chapter, could contribute to the above problems.

Following Jorgenson and a number of others, the estimates of the econometric equations for investment are obtained by single equation, least squares methods. Klein[4] suggests that, with notable exceptions, insufficient attention is being paid in such studies to simultaneous equation bias, non-linearity in parameters or serial correlation of error. More refined estimation techniques would probably improve the results of this study, at the cost of some time and expense. Equal attention should also be given to improved data, the possible addition of further explanatory variables and respecification of the relative price variable, particularly the denominator c, which has been drastically simplified in the neoclassical and eclectic models used herein.

With regard to the relative price variable, $\frac{P}{c}$, in the eclectic model, it has already been pointed out in Chapter III that the alternative price variable, $\frac{w}{c}$ (where w is the wage rate in money terms) appears to be more appropriate for the mining industries. Also, in our neoclassical and eclectic models, the specification of the rental cost of capital, c, has been simplified to the extent that it does not incorporate tax rates, tax credits, and the capital consumption allowance. A number of studies[5] have indicated that these factors have considerable influence on investment.

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[4]For further details, see Klein, "Issues in Econometric Studies of Investment Behavior", p. 47.

[5]For example, see Hall and Jorgenson, "Tax Policy and Investment Behavior", pp. 391-414.

Inflation

A comparison of the results from fitting the neoclassical model of corporate investment behaviour, both with and without taking account of inflation, to data for the twelve subdivisions of the mining industry shows that the rate of change in the price of investment goods has no consistent, substantial impact on investment. (See pages 71 and 72, Appendix B.) Inflation improves the goodness of fit to some extent in two sectors, leaves it relatively unchanged in five, and decreases the goodness of fit somewhat in five sectors.

The above results are in contrast with those of Jorgenson and Siebert, "Optimal Capital Accumulation and Corporate Investment Behavior", which uses a neoclassical model, incorporating tax rates, to study investment in fifteen large American manufacturing companies. The inclusion of inflation in the model provided some improvement in the quality of the results.

More recently, Ando, Modigliani, et. al.[6] examined the effect of expectations of price and technological change on investment. They used an investment function developed by Bischoff based on a putty-clay production function; i.e., the equipment in which the investment at any given point of time is embodied permits smooth factor substitution before installation, but is characterized by fixed proportions and a

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[6] Ando, Modigliani, Rasche and Turnovsky, "On the Role of Expectations of Price and Technological Change in an Investment Function," pp. 384-414.

fixed output-labour ratio after installation. (They pointed out that the neoclassical model is based on the assumption of a putty-putty technology, which implies a myopic investment rule, depending only on the current real rate of interest and, hence, only on the expected rate of change of prices for the current period.) For the period 1953-1965, they found that inclusion of the proportional rate of change of output prices in their model worsened the results in every aspect. On further investigation, they found a break in the formation of expectations in the mid 1960's. Before 1965, expectations could be regarded as rather constant, and it was only afterwards that they were closely related to actual price changes. Using data for the period 1953-1968 and taking account of the change in expectations improved the results. However, the results of the statistical tests are not as clear-cut as one might wish.

A recent study, carried out by Craine,[7] which uses the standard neoclassical assumptions except capital is not freely adjustable and the exogenous variables are random, finds that expected factor price changes influence investment to some extent.

Our results may be explained by the fact that large monopolistic and oligopolistic multinational firms comprise much of the mining industry in Canada. Such firms may be able to influence output and factor prices

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[7] Roger Craine, "Investment, Adjustment Costs and Uncertainty", International Economic Review, October 1975, pp. 648-661.

to some extent. The expected rate of change in the price of investment goods may not be one of the factors that they consider important in making their investment decisions. Alternatively, there may be a break in the formation of price expectations around the mid-'60s when the rate of change of inflation started to increase, as suggested by Ando, Modigliani, et. al. This was not taken into account in our model. For any further studies of the effects of inflation on investment in the mining industry, the model should take account of the effects of the rate of change in the price of output and labour as well as that of investment goods. And a model based on the assumption of imperfect competition and a putty-clay technology might provide more clear-cut results.

The Neoclassical and the Eclectic Models

The eclectic model, even without inclusion of the dividend price yield, provides in general a better explanation of investment for the various subdivisions of the mining industry. And inclusion of the dividend price yield improves the predictive ability of the eclectic model. However, in several instances, with the same explanatory variables,the neoclassical model provides somewhat better results. (For example, see the industries marked with the subscript 1 on page 68 of Appendix B.)

The eclectic model might be expected to provide superior results in a number of cases. First, it assumes a generalized production function, $Q = f(K,L)$ and hence the desired stock of capital, K^*, is simply a general function of output and relative prices. The neoclassical model of Jorgenson is based on the Cobb-Douglas production function and it is not known *a priori* whether this is the appropriate function for all of the various subdivisions of the mines, quarries and oil wells industry.

Second, the neoclassical model is basically a perfect certainty model, where the businessman's optimal capital stock is determined by current and future output and prices which are assumed to be known.[8] However, in a world of uncertainty, it can be assumed that the appropriate determinants of desired capital stock would be the expected values of output and relative prices. The eclectic model uses expected values, for which a weighted average of current and past values serves as a proxy. And the dividend price yield is assumed to provide some measure of expectations.

Third, the neoclassical model assumes perfect capital markets where the rate of interest can be used to discount net income from future periods to the date of decision-making and to represent payment for funds utilized. The eclectic model assumes that in a world of uncertainty, risk and imperfect markets that it is necessary to take account of the cost of internal and external methods of financing. Data on internal finance were not available, without considerable research, for the mines, quarries and oil wells industry. The dividend price yield and the rate of interest on long-term bonds were used as proxies for the cost of external finance.

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[8] Perfect foresight is relaxed in the neoclassical model described in this study to the extent that it permits discrepancies between actual and desired levels of capital; see Jorgenson and Siebert, "Optimal Capital Accumulation and Corporate Investment Behavior", p. 1124.

The separation of the relative price and output variables in the eclectic model facilitates the study of their effects on investment, as an aid to developing appropriate fiscal and monetary policies. This will be even more important in future studies when tax rates are incorporated in the rental cost of capital.

Dividend Price Yield

The dividend price yield on mining stocks adds, to some extent, to the predictive ability of the eclectic model and results in more reasonable coefficients for the remainder of the variables in the equations. (See pages 66 and 67 of Appendix B.) As discussed previously, the dividend price yield is assumed to provide a measure of expectations as well as of the cost of external finance.

Gross and Net Capital Stock

The use of net capital stock provides no consistent, significant improvement in the goodness of fit over that of gross capital stock, in either the neoclassical or the eclectic investment models. This result would initially appear to be somewhat surprising as both models theoretically require the use of net capital stock as an explanatory variable. The explanation could stem from one or more of the following reasons. First, there is merit in White's argument that as repair and maintenance expenditures are excluded from investment data in the National Accounts, then replacement investment would serve mainly to replace discards which can be assumed to be proportional to gross capital stock. Second, Statistics Canada calculates net capital stock by the straight-line depreciation of gross capital stock. The actual depreciation could follow a different type of curve.[9] Third, the measurement of capital stock is difficult for reasons that are partly theoretical and partly due to inadequacies of the statistical data.[10] For instance, as industrial equipment wears out, becomes obsolete or is destroyed, it is generally replaced not by the same machinery, but by equipment which incorporates the latest techniques and which is probably more productive. It is almost impossible to distinguish what part represents new investment and what part replacement investment. The Statistics Canada assumptions, that fixed capital stocks consist of a homogenous commodity and that new gross investments in capital goods, in a given industry, have a fixed life after which they are discarded, may be necessary to facilitate compilation but could introduce significant errors. Such errors could be reflected in the regression results.

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[9] The assumption of constant proportionality between depreciation and actual capital stock, used in both the neoclassical and eclectic models, is consistent with the use of capital stock estimates based on diminishing balance (geometric or exponential) depreciation functions, but not straight-line depreciation functions. However, Robert M. Coen, "Investment Behavior, The Measurement of Depreciation and Tax Policy", The American Economic Review, March 1975, p. 72, finds that the geometric decay of productive capacity does not appear to underlie actual capital spending decisions. Equipment generally evidences losses in productive capacity as it ages, though not necessarily at a geometric rate, but structures, in the majority of industries, suffer no loss in productive capacity over their service lives.

[10] For further details concerning inadequacies of the measurement procedures for capital flow and stock estimates, see Statistics Canada, Fixed Capital Flows and Stocks, Manufacturing, Canada, 1926-1960, Methodology, February 1967, pp. 37-53.

Suggested Future Work

An obvious improvement would be to incorporate the corporation tax rates, tax credits and capital consumption allowances in the rental cost of capital services, c, for both the neoclassical and the eclectic models. The additional variables should improve the goodness of fit of the investment equations and delineate the effects of fiscal policy on investment decisions.

The complete eclectic model includes the cost of internal finance for investment expenditures, for which the corporation's net financial position serves as a proxy. (The net financial position is obtained from the short-term assets, liabilities and expected flow of gross retained earnings of the corporations being studied.) The availability of internal funds could be an important determinant of the extent to which a firm carries out investment and as such is recommended for inclusion in future studies. This, despite the fact that the MQ&O industry consists mainly of large foreign-owned companies and several studies[11] indicate that for such firms there is little constraint on the total of funds from all sources that the firm can obtain at the going cost of capital.

A basic assumption underlying the neoclassical and eclectic models is that capital stock is always fully utilized[12] (or, at least, a constant proportion of the capital stock is utilized). The assumption

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[11] See Miller and Modigliani, "Estimates of the Cost of Capital Relevant for Investment Decisions Under Uncertainty", page 181 and Braithwaite, An Econometric Analysis of the Determinants of Investment in Canadian Manufacturing, pp. 119-20.

[12] See Jorgenson, "Theory of Investment Behavior", p. 141.

is employed in the neoclassical model when the present value of the firm is maximized subject to the constraint that the rate of change of the flow of capital services is proportional to the flow of net investment. The constant of proportionality, which represents the number of units of capital service which flow from a unit of capital stock, is assumed to be unity; i.e., the capital stock is fully utilized.

In reality, the rate of capacity utilization of capital stock varies. For example, according to the Bank of Canada Review, September 1974, the rate of capacity utilization of Canadian industry has varied between 79% to 96% in the period 1960 to 1974. A number of models, such as the American Conference Board's Quarterly Forecasting Model, have found capacity utilization to be a significant explanatory variable of investment. This could be a rewarding approach for future Canadian studies using the eclectic model, despite possible problems in obtaining reliable data on capacity utilization rates.

A recent development in the mining industry has been the significant investment in pollution abatement equipment which often bears a different relationship to plant output than investment in goods-producing equipment. Where possible, future studies should take account of the difference, if recent data is used.

The mining industry in Canada consists mainly of U.S. owned companies. Several studies[13] have found that U.S. foreign tax policies can have a significant effect on the financial returns from such investment in Canada. Also, much of their debt financing is obtained from U.S. sources. The effect of U.S. foreign tax policies and interest rates should be considered in future investment studies.

Neither the neoclassical nor the eclectic model take account of the proven reserves of minerals. The proven reserves would obviously be a determining factor in a decision to invest in a particular mineral commodity. It is suggested that when further disaggregated studies of investment are being carried out with respect to individual commodities, that proven reserves be tried as an explanatory variable. Future studies should also take account of structural changes affecting certain commodities in the mineral industry such as administrative groups or cartels exercising some control over the oil, uranium, bauxite, etc. industries; governments such as the European Economic Community giving preferential tariffs to the exports of certain commodities from Less Developed Countries; governments such as the United States deciding to stockpile some commodities, etc. As mentioned previously, much of the mineral industry is composed of large multinational companies who are in a monopolistic or ogelopolistic position with respect to certain mineral commodities. Such imperfect competition should also be taken into consideration in future studies.

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[13] For example, see Glenn P. Jenkins and Antal Deutsch, "Foreign Tax Credits and the Interdependence of Corporate Tax Policies", Harvard Institute of Economic Research, Harvard University, Discussion Paper No. 384, October 1974.

GROSS FIXED CAPITAL FORMATION (Investment, I)

(Millions of Constant 1961 Dollars)

	Mines, Quarries & Oil Wells			Metal Mines			Mineral Fuels			Non-Metal Mines		
	Total	Const.*	M & E**	Total	Const.	M & E	Total	Const.	M & E	Total	Const.	M & E
1950	155.9	89.1	66.9	56.7	26.2	30.5	83.8	57.7	26.2	15.4	5.2	10.2
1951	207.6	119.7	88.0	86.6	39.9	46.7	101.4	73.9	27.5	19.6	5.9	13.8
1952	255.7	148.8	106.9	106.0	51.1	54.9	121.3	86.6	34.7	28.4	11.1	17.3
1953	305.9	176.5	129.5	129.6	62.8	66.9	134.4	97.4	37.0	41.9	16.3	25.6
1954	346.0	209.2	136.9	135.2	73.8	61.5	163.0	121.1	41.9	47.8	14.3	33.5
1955	390.5	271.9	118.8	114.0	62.6	51.5	231.8	190.9	40.9	44.7	18.4	26.4
1956	604.0	398.4	205.7	269.6	148.9	120.7	286.8	229.0	57.9	47.6	20.5	27.1
1957	700.4	467.4	233.2	346.9	197.3	149.7	297.2	241.6	55.7	56.3	28.5	27.8
1958	400.2	288.2	112.1	115.9	63.1	52.7	232.2	203.7	28.6	52.1	21.4	30.8
1959	379.8	277.5	102.5	117.7	71.4	46.4	223.3	191.0	32.4	38.8	15.1	23.7
1960	406.1	302.8	103.2	138.2	88.6	49.5	235.9	202.2	33.7	32.0	12.0	20.0
1961	537.0	443.0	94.0	150.0	108.0	42.0	352.0	320.0	32.0	35.0	15.0	20.0
1962	556.5	416.9	139.6	204.3	137.3	67.0	293.4	254.7	38.7	58.8	24.9	33.9
1963	560.8	418.9	141.9	179.8	114.7	65.1	325.5	285.7	39.8	55.5	18.5	37.0
1964	658.0	500.0	158.0	220.1	141.1	79.0	364.2	323.4	40.8	73.7	35.5	38.2
1965	635.9	526.6	109.3	173.8	111.2	62.6	381.1	362.1	19.0	81.0	53.3	27.7
1966	860.3	666.7	193.6	291.3	182.8	108.5	423.6	391.6	32.0	145.4	92.3	53.1
1967	852.7	624.7	227.9	293.5	188.0	105.5	392.5	336.9	55.6	166.7	99.8	66.8
1968	856.6	636.3	220.3	292.8	209.1	83.7	396.8	356.2	40.7	167.0	71.0	95.9
1969	893.8	688.6	205.3	299.3	223.5	75.8	490.6	422.7	67.9	103.9	42.4	61.6
1970	980.9	740.3	240.6	363.0	247.8	115.2	524.8	456.7	68.1	93.0	35.8	57.3
1971	1246.1	920.1	326.1	597.9	412.3	185.6	574.0	476.2	97.8	74.2	31.6	42.7
1972	1049.6	695.4	354.3	450.5	210.7	239.8	525.4	460.1	65.3	73.7	24.6	49.2
1973	973.4	703.3	270.2	357.0	178.4	178.6	542.7	500.3	42.4	73.7	24.6	49.2
1974	1115.6	779.4	336.2	297.6	191.4	106.2	692.9	554.2	138.7	125.1	33.8	91.3

* Construction
** Machinery and Equipment
Note: data for components may not add exactly to total

END OF YEAR GROSS CAPITAL STOCK (GK)
(Millions of Constant 1961 Dollars)

	Mines, Quarries & Oil Wells			Metal Mines			Mineral Fuels			Non-Metal Mines		
	Total	Const.*	M & E**	Total	Const.	M & E	Total	Const.	M & E	Total	Const.	M & E
1950	1637.6	999.6	637.9	789.9	474.3	315.5	744.6	475.9	268.7	103.1	49.4	53.7
1951	1785.8	1087.6	698.3	845.5	497.6	347.9	820.2	536.1	284.2	120.1	53.9	66.2
1952	1982.1	1204.4	777.6	920.5	532.0	388.4	915.7	608.8	306.9	145.9	63.6	82.3
1953	2228.6	1349.1	879.5	1019.1	578.2	440.9	1024.3	692.4	331.9	185.2	78.5	106.7
1954	2515.4	1526.5	988.9	1123.4	635.4	488.0	1161.6	799.7	361.9	230.4	91.4	139.0
1955	2846.7	1766.6	1080.1	1206.4	681.3	525.1	1367.7	976.9	390.8	272.6	108.4	164.2
1956	3391.3	2133.0	1258.3	1445.0	813.5	631.5	1628.7	1192.0	436.7	317.6	127.5	190.1
1957	4032.5	2568.5	1464.0	1760.9	994.2	766.8	1900.2	1419.7	480.5	371.4	154.6	216.7
1958	4373.5	2824.9	1548.5	1845.8	1040.7	805.2	2106.7	1609.6	497.1	421.0	174.6	246.2
1959	4694.0	3070.5	1623.5	1932.6	1095.4	837.2	2304.2	1786.7	517.5	457.2	188.4	268.8
1960	5040.8	3341.4	1699.4	2039.8	1167.4	872.4	2514.4	1975.1	539.3	486.6	198.9	287.7
1961	5518.4	3752.7	1765.7	2158.8	1258.8	900.0	2840.6	2281.3	559.3	519.0	212.6	306.4
1962	6015.5	4137.8	1877.8	2332.1	1379.5	952.6	3108.2	2522.2	586.0	575.2	236.1	339.2
1963	6517.1	4524.9	1992.4	2480.9	1477.6	1003.4	3408.0	2794.1	613.9	628.2	253.2	375.1
1964	7115.8	4993.0	2122.7	2670.0	1602.0	1068.0	3746.4	3103.7	642.7	699.4	287.3	412.0
1965	7692.5	5487.8	2204.7	2812.9	1696.6	1116.3	4101.8	3452.0	649.8	777.8	339.2	438.6
1966	8493.5	6122.7	2370.6	3073.2	1862.7	1210.4	4499.7	3829.9	669.8	920.6	430.1	490.4
1967	9280.5	6715.8	2564.8	3338.8	2034.1	1304.7	4867.1	4153.0	714.1	1074.6	528.7	546.0
1968	10065.7	7320.3	2745.5	3599.5	2226.6	1372.9	5236.3	4495.4	741.0	1229.9	598.3	631.6
1969	10863.8	7977.1	2886.8	3856.6	2433.5	1423.1	5687.6	4904.3	783.3	1319.6	639.3	680.4
1970	11745.9	8685.5	3060.4	4172.4	2664.6	1507.8	6172.4	5347.2	825.2	1401.1	673.7	727.4
1971	12872.4	9573.9	3298.5	4707.0	3060.4	1646.6	6705.1	5809.5	895.5	1460.3	704.0	756.4
1972	13783.4	10237.3	3546.0	5086.0	3254.4	1831.5	7182.0	6255.8	926.2	1515.4	727.1	788.3
1973	14595.4	10908.9	3686.6	5359.4	3416.2	1943.3	7673.9	6742.3	931.6	1562.1	750.4	811.7
1974	15535.4	11649.2	3886.0	5576.2	3588.1	1988.0	8312.0	7283.5	1028.4	1647.2	777.6	869.6

* Construction
** Machinery and Equipment
... may not add exactly to total

END OF YEAR NET CAPITAL STOCK (NK)

(Millions of Constant 1961 Dollars)

	Mines, Quarries & Oil Wells			Metal Mines			Mineral Fuels			Non-Metal Mines		
	Total	Const.*	M & E**	Total	Const.	M & E	Total	Const.	M & E	Total	Const.	M & E
1950	934.4	591.6	342.8	425.2	263.0	162.2	437.0	295.9	141.1	72.2	32.7	39.5
1951	1069.8	672.6	397.2	477.2	284.9	192.3	505.8	351.1	154.7	86.8	36.6	50.2
1952	1246.2	778.9	467.2	545.7	316.9	228.8	591.1	416.5	174.6	109.4	45.5	63.8
1953	1463.3	908.1	555.2	634.1	359.2	274.9	685.4	489.8	195.6	143.8	59.1	84.7
1954	1709.5	1064.1	645.3	723.6	410.5	313.1	803.5	583.3	220.2	182.4	70.3	112.0
1955	1987.3	1274.9	712.5	787.9	448.6	339.3	983.6	741.3	242.3	215.8	85.0	130.9
1956	2460.7	1601.0	859.6	1000.9	569.8	431.0	1209.6	930.1	279.5	250.2	101.1	149.1
1957	3006.1	1981.2	1024.7	1279.4	733.6	545.7	1435.5	1123.3	312.2	291.2	124.3	166.8
1958	3231.2	2169.7	1061.6	1318.3	759.1	559.2	1587.3	1270.9	316.4	325.6	139.7	186.0
1959	3422.5	2337.9	1084.8	1355.4	790.9	564.5	1722.3	1399.0	323.4	344.8	148.0	196.9
1960	3626.7	2521.9	1105.0	1408.9	837.6	571.3	1862.1	1531.5	330.7	355.7	152.8	203.0
1961	3945.9	2833.6	1112.3	1469.7	900.7	569.0	2107.9	1772.7	335.2	368.3	160.2	208.1
1962	4265.2	3104.3	1160.9	1578.8	989.1	589.7	2283.7	1938.4	345.2	402.7	176.8	226.0
1963	4568.8	3362.7	1206.1	1656.8	1050.9	605.9	2480.7	2125.7	355.0	431.3	186.1	245.2
1964	4947.7	3686.6	1261.2	1768.1	1135.0	633.1	2704.3	2339.9	364.4	475.3	211.7	263.7
1965	5281.4	4019.1	1262.4	1826.2	1185.1	641.1	2931.7	2580.6	351.1	523.5	253.4	270.2
1966	5812.3	4470.7	1341.6	1993.4	1301.9	691.4	3187.5	2837.4	350.1	631.4	331.4	300.1
1967	6303.8	4857.8	1446.1	2151.8	1417.8	734.0	3397.6	3026.5	371.1	754.4	413.5	341.0
1968	6767.8	5234.2	1533.6	2298.8	1548.0	750.8	3597.9	3222.6	375.4	871.1	463.6	407.4
1969	7237.9	5639.5	1598.0	2441.9	1685.2	756.7	3876.4	3471.3	405.1	919.3	483.0	436.2
1970	7761.1	6071.3	1690.0	2637.2	1838.6	798.7	4171.1	3738.1	433.0	952.8	494.6	458.3
1971	8510.1	6653.2	1857.1	3050.2	2144.9	905.4	4495.4	4007.7	487.8	964.5	500.6	463.9
1972	9021.8	6981.6	2040.2	3296.8	2238.6	1058.2	4751.9	4244.3	507.6	973.1	498.7	474.4
1973	9422.8	7293.3	2129.5	3435.9	2293.5	1142.4	5007.4	4503.9	503.5	979.5	495.9	483.6
1974	9931.3	7655.0	2276.4	3505.5	2355.2	1150.4	5391.6	4798.4	593.2	1034.2	501.4	532.8

* Construction
** Machinery and Equipment
[illegible] may not add exactly to total

OUTPUT PRICE INDEX (P)

(Candide 1.1 Historical Data Base, 1961 = 1.0)

	MQ&O Implicit GDP Deflator (MIP*)	Iron Ore Export P (IRORXP)	Other Minerals Export P (OMISXP)	Metal Mines (calculated)	Petroleum & Gas Export P (CPGSXP)	Coal Export P (COBSXP)	Mineral Fuels (calculated)	Asbestos Export P (ASBSXP)
1950	1.0542	0.7270	0.8940	0.8754	No data	0.8947	0.8947	0.7310
1951	1.2002	0.7200	1.1570	1.0897	1.0000	0.8697	0.8883	0.8310
1952	1.1336	0.6980	1.1480	1.0762	1.0290	0.9193	0.9659	0.8970
1953	0.9608	0.7810	0.9840	0.9546	1.0500	0.8667	0.9745	0.9100
1954	1.0762	0.7750	0.9550	0.9250	1.1430	0.8599	1.0304	0.8970
1955	1.1258	0.8200	1.0480	0.9773	1.0340	0.9050	1.0134	0.8980
1956	1.1168	0.8710	1.1380	1.0443	1.0240	0.8683	1.0144	0.9510
1957	1.0347	0.8990	1.0290	0.9904	1.0570	0.9320	1.0538	0.9640
1958	0.9471	0.8890	0.9920	0.9717	0.9440	0.9400	0.9439	0.9910
1959	0.9524	0.8770	0.9970	0.9760	0.9160	0.8321	0.9126	0.9960
1960	0.9959	0.9460	1.0060	0.9916	0.9230	0.8505	0.9186	0.9916
1961	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1962	1.0217	1.0060	1.0087	1.0078	1.0350	1.0116	1.0343	1.0090
1963	1.0507	1.0130	0.9910	0.9990	1.0150	1.0317	1.0155	1.0010
1964	1.0623	1.0040	1.0150	1.0103	1.0435	1.0140	1.0425	0.9960
1965	1.1204	0.9980	1.1870	1.1038	1.0730	1.1393	1.0749	1.0360
1966	1.1734	0.9920	1.3470	1.1887	1.0950	1.1828	1.0974	1.0490
1967	1.2042	0.9800	1.4080	1.2221	1.1320	1.2363	1.1345	1.0820
1968	1.2563	0.9800	1.4800	1.2695	1.1607	1.2385	1.1626	1.1040
1969	1.2457	0.9650	1.6020	1.3530	1.1340	0.7510	1.1268	1.1642
1970	1.2393	1.0180	1.8640	1.4874	1.1067	0.7380	1.0894	1.2090
1971	1.1265	1.0170	1.6780	1.4143	1.1769	0.7500	1.1459	1.2260
1972	1.1510	1.0000	1.6660	1.4343	1.2172	1.3688	1.2272	1.2390
1973	1.4995	1.0750	2.0926	1.7082	1.4928	1.5099	1.4942	1.2700

*Candide 1.1 mnemonics

EXPORTS

(Candide 1.1 Historical Data Base, millions of 1961 $)

	Iron Ore and Concentrates (IRORXK*)	Other Minerals Including Uranium (OMISXK)	Crude Petroleum, Natural Gas and Sulphur (CPGSXK)	Coal and Other Crude Bituminous Substances (COBSXK)
1950	18.30	145.70	No data	4.50
1951	25.80	141.80	0.80	4.80
1952	31.90	168.00	3.40	4.60
1953	39.40	232.30	6.00	4.20
1954	51.20	255.70	5.60	3.70
1955	121.70	270.90	35.20	6.70
1956	165.80	306.50	101.60	6.70
1957	169.40	401.60	135.70	3.60
1958	121.10	493.70	96.60	3.10
1959	179.90	540.80	100.40	4.30
1960	164.40	518.90	124.92	8.00
1961	142.60	508.00	198.00	9.00
1962	219.20	461.00	300.97	9.20
1963	267.40	467.20	316.75	10.50
1964	354.60	482.10	363.30	12.60
1965	361.50	459.40	382.85	11.40
1966	372.00	462.40	423.80	11.70
1967	390.90	509.00	512.60	12.50
1968	452.20	621.80	582.90	14.10
1969	345.20	538.00	674.34	13.00
1970	467.29	582.56	811.43	39.97
1971	406.39	612.34	905.57	70.93
1972	352.68	660.82	1102.85	77.87
1973	429.76	708.14	1258.64	110.72

*Candide 1.1 mnemonics

REAL DOMESTIC PRODUCT (Q)

(Candide 1.1 Historical Data Base, millions of 1961 $)

	Mines, Quarries & Oil Wells (MIY*)	Metal Mines (MI01Y)	Mineral Fuels (MI02Y + MI03Y)	Non-Metal Mines (MI04Y)
1950	702.54	403.74	195.31	103.49
1951	771.59	422.72	231.68	117.19
1952	806.88	435.66	252.97	118.25
1953	859.58	461.54	282.07	115.96
1954	939.73	508.99	305.64	125.10
1955	1091.38	576.28	374.00	141.09
1956	1241.76	627.18	462.94	151.63
1957	1362.26	737.61	473.90	150.75
1958	1401.82	823.88	433.69	144.25
1959	1585.12	948.97	470.64	165.51
1960	1578.70	925.68	487.33	165.69
1961	1590.40	862.70	552.00	175.70
1962	1690.17	881.68	616.94	191.55
1963	1783.21	898.07	672.01	213.12
1964	2004.78	1036.97	719.55	248.27
1965	2098.83	1059.40	771.99	267.45
1966	2135.90	1044.73	801.45	289.72
1967	2261.65	1115.47	856.38	289.79
1968	2425.95	1170.68	934.97	320.30
1969	2444.82	1099.08	1010.39	335.35
1970	2790.63	1312.17	1135.74	342.72
1971	2915.40	1302.68	1254.30	358.42
1972	3061.08	1237.11	1469.24	354.73
1973	3352.50	1366.52	1595.33	390.65

*Candide 1.1 mnemonics

INTEREST RATE, DIVIDEND PRICE YIELD, AND INVESTMENT PRICE DEFLATOR

	Average Yield for 10 Industrial Bonds (R) in % (RINDB*)	Dividend Price Yield (DPY) in % - Toronto Stock Exchange			Investment Price Deflator (q) 1961 = 100		
		Industrial	Indl. Mine	West Oil	MQ&O	Const.	M & E
1950	3.51				73.06	76.3	68.8
1951	3.96				79.95	85.2	72.8
1952	4.29				81.41	90.1	69.2
1953	4.50				83.05	92.4	70.3
1954	4.10				83.18	90.8	71.6
1955	3.99	3.41			87.59	92.7	75.8
1956	4.61	3.58			91.87	97.4	81.2
1957	5.36	4.30			94.08	94.8	86.2
1958	5.00	3.12			96.21	98.2	91.0
1959	5.62	3.28			97.65	99.5	92.7
1960	5.70	3.47			99.01	100.4	94.9
1961	5.48	2.93			100.00	100.0	100.0
1962	5.45	3.50			101.91	100.5	106.0
1963	5.37	3.29			104.82	102.9	110.6
1964	5.50	3.02			107.47	104.2	117.7
1965	5.68	3.18	3.23	1.17	111.93	108.8	126.2
1966	6.50	3.82	3.44	0.97	118.03	114.9	128.1
1967	7.09	3.66	3.08	0.73	121.27	120.2	124.2
1968	7.92	3.22	3.39	0.69	121.55	121.0	123.0
1969	8.75	3.37	3.09	0.80	127.33	127.5	126.7
1970	9.18	3.69	3.92	0.73	132.74	134.0	129.3
1971	8.35	3.33	3.94	0.67	138.82	142.6	128.8
1972	8.30	2.85	3.04	0.63	144.85	152.2	130.1
1973	8.54	3.57	3.39	0.86	163.06	174.9	134.4
1974	—	5.88	7.64	2.59	181.08	195.4	147.7

*Candide 1.1 mnemonics

ECONOMIC DEPRECIATION RATE (δ)
(calculated x 10^2)

		Gross Capital Stock	Net Capital Stock
Mines, Quarries & Oil Wells	- Total	4.26	6.27
	- Construction	3.88	5.44
	- Machinery & Equipment	5.18	8.68
Metal Mines	- Total	4.37	6.70
	- Construction	3.86	5.58
	- Machinery & Equipment	5.18	8.73
Mineral Fuels	- Total	4.10	5.90
	- Construction	3.89	5.39
	- Machinery & Equipment	5.13	9.10
Non-Metal Mines	- Total	4.61	6.66
	- Construction	3.88	5.25
	- Machinery & Equipment	5.24	8.02

RENTAL COST OF GROSS CAPITAL

$c = q(R + \delta)$ in index points

(q in 1961=100)

	Mines, Quarries & Oil Wells			Metal Mines			Mineral Fuels			Non-Metal Mines		
	Total	Const.*	M & E**	Total	Const.	M & E	Total	Const.	M & E	Total	Const.	M & E
1950	5.67	5.64	5.98	5.76	5.62	5.98	5.56	5.64	5.94	5.93	5.64	6.02
1951	6.57	6.68	6.65	6.66	6.66	6.65	6.44	6.69	6.62	6.85	6.68	6.70
1952	6.96	7.36	6.55	7.05	7.35	6.55	6.83	7.37	6.52	7.25	7.36	6.60
1953	7.27	7.74	6.80	7.37	7.72	6.80	7.14	7.75	6.77	7.56	7.74	6.85
1954	6.96	7.25	6.65	7.05	7.23	6.65	6.82	7.26	6.61	7.25	7.25	6.69
1955	7.23	7.30	6.95	7.33	7.28	6.95	7.09	7.31	6.92	7.54	7.30	7.00
1956	8.15	8.27	7.95	8.25	8.25	7.95	8.01	8.28	7.91	8.47	8.27	8.00
1957	9.06	8.76	9.09	9.16	8.75	9.09	8.90	8.77	9.05	9.38	8.76	9.14
1958	8.91	8.72	9.26	9.01	8.70	9.26	8.75	8.73	9.22	9.24	8.72	9.32
1959	9.65	9.45	10.01	9.76	9.43	10.01	9.49	9.46	9.97	9.99	9.45	10.07
1960	9.86	9.62	10.33	9.97	9.60	10.33	9.70	9.63	10.28	10.21	9.62	10.38
1961	9.74	9.36	10.66	9.85	9.34	10.66	9.58	9.37	10.61	10.09	9.36	10.72
1962	9.89	9.37	11.27	10.01	9.35	11.27	9.73	9.38	11.21	10.25	9.37	11.33
1963	10.10	9.52	11.67	10.21	9.50	11.67	9.93	9.53	11.62	10.47	9.52	11.74
1964	10.49	9.77	12.57	10.61	9.75	12.57	10.31	9.78	12.51	10.86	9.77	12.64
1965	11.12	10.40	13.70	11.25	10.38	13.70	10.94	10.41	13.64	11.52	10.40	13.78
1966	12.70	11.92	14.96	12.83	11.90	14.96	12.51	11.94	14.90	13.11	11.92	15.04
1967	13.77	13.19	15.24	13.90	13.16	15.24	13.57	13.20	15.18	14.19	13.19	15.31
1968	14.81	14.28	16.12	14.94	14.26	16.12	14.61	14.29	16.06	15.23	14.28	16.19
1969	16.57	16.10	17.65	16.71	16.08	17.65	16.36	16.12	17.59	17.01	16.10	17.73
1970	17.84	17.50	18.56	17.98	17.47	18.56	17.62	17.51	18.50	18.30	17.50	18.64
1971	17.50	17.43	17.42	17.65	17.41	17.42	17.28	17.45	17.36	17.99	17.43	17.50
1972	18.19	18.54	17.54	18.35	18.51	17.54	17.96	18.56	17.48	18.70	18.54	17.62
1973	20.87	21.72	18.44	21.05	21.69	18.44	20.61	21.74	18.37	21.44	21.72	18.52

* Construction

** Machinery and Equipment

RENTAL COST OF NET CAPITAL

$c = q(R + \delta)$ in index points
(q in 1961=100)

	Mines, Quarries & Oil Wells			Metal Mines			Mineral Fuels			Non-Metal Mines		
	Total	Const.*	M & E**	Total	Const.	M & E	Total	Const.	M & E	Total	Const.	M & E
1950	7.14	6.83	8.38	7.46	6.93	8.42	6.87	6.79	8.67	7.43	6.68	7.93
1951	8.18	8.01	9.20	8.52	8.13	9.24	7.88	7.97	9.51	8.49	7.85	8.72
1952	8.60	8.77	8.98	8.95	8.90	9.01	8.30	8.72	9.27	8.92	8.60	8.52
1953	8.94	9.18	9.26	9.30	9.31	9.30	8.64	9.14	9.56	9.27	9.01	8.80
1954	8.63	8.67	9.15	8.99	8.79	9.19	8.32	8.62	9.45	8.95	8.49	8.68
1955	8.99	8.75	9.61	9.37	8.88	9.64	8.67	8.70	9.93	9.33	8.57	9.11
1956	10.00	9.79	10.79	10.39	9.93	10.84	9.66	9.74	11.14	10.36	9.61	10.26
1957	10.95	10.24	12.11	11.35	10.38	12.15	10.60	10.20	12.47	11.31	10.06	11.54
1958	10.84	10.25	12.45	11.25	10.39	12.49	10.48	10.20	12.83	11.21	10.06	11.85
1959	11.61	11.01	13.26	12.03	11.15	13.30	11.25	10.96	13.65	11.99	10.82	12.65
1960	11.85	11.19	13.65	12.28	11.33	13.70	11.49	11.14	14.05	12.24	11.00	13.02
1961	11.75	10.92	14.16	12.18	11.06	14.21	11.38	10.87	14.58	12.14	10.73	13.50
1962	11.94	10.94	14.98	12.38	11.08	15.03	11.56	10.89	15.42	12.34	10.75	14.28
1963	12.21	11.13	15.54	12.66	11.27	15.60	11.82	11.08	16.01	12.61	10.93	14.81
1964	12.65	11.40	16.69	13.11	11.54	16.75	12.25	11.35	17.18	13.07	11.20	15.91
1965	13.37	12.10	18.12	13.86	12.25	18.18	12.96	12.04	18.65	13.81	11.89	17.29
1966	15.07	13.72	19.44	15.58	13.88	19.51	14.63	13.66	19.98	15.53	13.50	18.60
1967	16.20	15.06	19.59	16.72	15.23	19.65	15.75	15.00	20.11	16.68	14.83	18.77
1968	17.25	16.17	20.42	17.77	16.34	20.48	16.80	16.11	20.94	17.73	15.94	19.61
1969	19.13	18.09	22.08	19.67	18.27	22.15	18.65	18.03	22.62	19.62	17.85	21.25
1970	20.51	19.59	23.09	21.08	19.78	23.15	20.01	19.52	23.63	21.02	19.33	22.24
1971	20.29	19.66	21.93	20.89	19.86	22.00	19.78	19.59	22.47	20.83	19.39	21.08
1972	21.10	20.92	22.10	21.73	21.13	22.16	20.57	20.84	22.64	21.67	20.62	21.24
1973	24.15	24.45	23.14	24.85	24.69	23.21	23.55	24.36	23.71	24.79	24.12	22.26

* Construction
** Machinery and Equipment

ESTIMATION RESULTS

The regression results summarized in Appendix B are:

- The best regression results for the eclectic model, where gross capital stock (GK) and the dividend price yield (DPY) are included among the explanatory variables. (See page 66.)

- The best regression results for the eclectic model, where GK but not DPY is included among the explanatory variables. (See page 67.)

- The best results for the neoclassical model where GK is included as an explanatory variable. (See page 68.)

- The best results for the eclectic model, where net capital stock (NK) but not DPY is included among the explanatory variables. (See page 69.)

- The best results for the neoclassical model, where NK is used as an explanatory variable. (See page 70.)

- A typical neoclassical model without inflation included in the rental cost of capital services. (See page 71.)

- A typical neoclassical model with inflation (as measured by the rate of change over time in the index price of capital goods) included in the rental cost of capital services. (See page 72.)

The general model equation is given at the top of each page. Underneath, for each industry, is given the specification and estimation results which are chosen as the best. The industry specifications may differ as to the lags used with some of the explanatory variables. The subscript of each coefficient indicates the lag of its variable; e.g., $b_2 \, ({}^{P}/_{c})_{t-2}$. A glance at the coefficient subscripts for each industry indicates the overall lags used with the variables in the specification for that industry.

The superscripts used with certain industry equations, i.e., $MF - ME^3$ on the left hand side of page 66, have the following meanings:

1 - industry equations chosen for use with the econometric model Candide (See pages 67 and 68). The equations are chosen from the results of the neoclassical and the eclectic models where GK and not DP are used as explanatory variables.

2 - industries where exactly the same specification, except that one uses GK and the other NK, provide the best results under their general model equation (See pages 67, 68, 69, and 70). This permits a comparison between the effects of GK, as opposed to NK, as an explanatory variable.

3 - industries where exactly the same specification, except using DP, and alternately not using DP, provide the best results under their general model equation. This permits analysis of the effects of DPY as an explanatory variable.

The abbreviations and symbols used are:

I_t - gross fixed capital formation (gross investment) at time t

P - price of output

c - rental cost of capital services; $c = q(R + \delta) - \dot{q}$ where inflation (as measured by the rate of change in the price of investment goods) is included, and $c = q(R + \delta)$ where inflation is not included. q is the price of capital goods, R is the discount rate (the long-term interest rate on industrial bonds serves as a proxy) and δ is the rate of depreciation of capital goods.

Q - value of output, as measured by real domestic product

DP - dividend price yield

D - dummy variable used to take account of the discontinuity of the DPY data series for Metal Mines and Mineral Fuels

GK - gross capital stock

NK - net capital stock

a - the constant intercept in the equation

b, d, q, h, k - coefficients of the variables in the equations

Monetary values in the data are given in constant 1961 dollars

R^2 - coefficient of multiple correlation

DW - Durbin-Watson statistic

C.O.V. - coefficient of variation $(\frac{\sigma e}{\bar{y}} \times 100)$

MQ&O - Mines, Quarries and Oil Wells

MM - Metal Mines

MF - Mineral Fuels

NM - Non-Metal Mines

TT - in total

CT - non-residential construction

ME - machinery and equipment

BEST RESULTS FOR ECLECTIC MODEL - WITH GK AND DPY AS EXPLANATORY VARIABLES
(DUMMY IS ONLY REQUIRED FOR DPY OF METAL MINES AND MINERAL FUELS)

$$I_t = a + \Sigma_{i=m}^{n} bi(^P/_c)_{t-i} + \Sigma_{j=k}^{l} dj\ Q_{t-j} + g_1 DP_{t-1} + hD + k_1 GK_{t-1}$$

	a	b_0	b_1	b_2	d_0	d_1	d_2	d_3	d_4	d_5	g_1	h	k_1	R^2	DW	C.O.V.(%)
MQ&O - TT	-1656	-13932	18346		0.256	0.389	0.391	0.261			83.0		-0.117	.925	1.42	11.5
	(-1.82)	(-2.79)	(4.16)		(0.732)	(1.63)	(1.64)	(1.47)			(1.18)		(-0.88)			
- CT	-1217	-8463	11914		0.174	0.286	0.294	0.199			44.2		-0.113	.873	1.68	14.7
	(-1.44)	(-1.71)	(2.71)		(0.531)	(1.40)	(1.49)	(1.34)			(0.667)		(-0.766)			
- ME	-658	-3703	5861		0.153	0.197	0.186	0.120			40.9		-0.353	.895	1.93	16.4
	(-3.93)	(-2.23)	(3.92)		(1.28)	(2.52)	(2.02)	(1.67)			(1.67)		(-1.69)			
MM - TT	-3606	-2347	21595		0.632	0.514	0.369	0.198			121	59.1	-.00158	.851	1.38	23.4
	(-2.94)	(-.719)	(4.14)		(1.86)	(2.43)	(2.16)	(1.65)			(2.41)	(0.196)	(-.024)			
- CT	-759		8325	-5540	0.380	.0394	-.0872				79.8	-17.2	.0299	.597	1.60	40.0
	(-0.557)		(1.40)	(-1.14)	(1.08)	(0.159)	(-0.406)				(1.48)	(-0.209)	(0.385)			
- ME	-829	-2223	6617		.0612	0.135	0.150	0.105			35.4	-43.4	-.0115	.865	1.53	26.1
	(-3.44)	(-1.27)	(3.68)		(0.529)	(1.73)	(1.95)	(1.84)			(1.82)	(-1.66)	(-.092)			
MF - TT	579	-1913	-411	227	0.587	-0.106	-0.435	-0.400			-0.101	-71.3	-.0454	.936	2.78	9.7
	(1.42)	(-1.07)	(-0.418)	(0.212)	(2.10)	(-0.908)	(-2.55)	(-2.68)			(-.0047)	(-1.35)	(-0.447)			
- CT	319	533	-972		0.282	-.0642	-0.227	-0.205			3.43	-67.6	.0573	.934	2.62	10.2
	(1.28)	(0.287)	(-0.608)		(1.44)	(-.729)	(-1.45)	(-1.52)			(0.179)	(-1.56)	(0.838)			
- ME[3]	539	-2107	-458	244	0.354	.0721	-.0810	-0.105			-4.71	11.9	-0.804	.672	2.39	30.4
	(1.48)	(-2.25)	(-0.799)	(0.485)	(2.32)	(0.874)	(-1.11)	(-1.86)			(-0.599)	(0.849)	(-1.15)			
NM - TT	240	-4253	180		0.325	0.619	0.662	0.456			31.0		-0.490	.874	1.56	23.2
	(1.04)	(-2.23)	(0.115)		(0.956)	(2.94)	(1.73)	(1.43)			(1.61)		(-4.01)			
- CT[3]	320	-2633	-591	287		0.885	0.202	-0.227	-0.404	-0.328	3.39		-0.296	.880	1.98	30.2
	(1.40)	(-2.87)	(-0.917)	(0.513)		(6.22)	(1.71)	(-1.19)	(-1.99)	(-2.34)	(0.937)		(-1.37)			
- ME	64.5	-1788	-209	387		.0304	0.379	0.551	0.545	0.361	9.44		-0.710	.839	1.42	23.1
	(1.30)	(-1.66)	(-0.772)	(0.661)		(0.162)	(3.71)	(3.63)	(3.23)	(3.02)	(1.09)		(-3.79)			

BEST RESULTS FOR ECLECTIC MODEL - WITH GK BUT NOT DPY AS AN EXPLANATORY VARIABLE

$$I = a + \Sigma_{i=m}^{n} bi(^P/_c)_{t-i} + \Sigma_{j=k}^{l} dj\ Q_{t-j} + k_1 GK_{t-1}$$

	a	b_0	b_1	b_2	b_3	d_0	d_1	d_2	d_3	d_4	d_5	k_1	R^2	DW	C.O.V.(%)
MQ&O - TT[1]	-1458 (-1.69)	-3435 (-1.32)	5538 (3.17)	6683 (3.37)			0.500 (0.142)	0.149 (0.819)	0.194 (1.41)	0.184 (1.29)	0.119 (1.14)	.0119 (0.132)	.889	1.86	13.8
- CT[1,2]	-723 (-2.05)		4061 (2.25)			0.446 (2.11)						-.00538 (-0.115)	.871	1.63	15.9
- ME[1]	-714 (-4.58)	-1387 (-1.88)	2265 (4.60)	2727 (4.16)		0.135 (1.24)	0.157 (2.29)	0.160 (2.78)	0.147 (2.46)	0.115 (2.11)	.0664 (1.87)	-0.405 (-1.86)	.867	1.98	17.7
MM - TT[1,2]	-3751 (-2.27)	466 (0.107)	11073 (2.74)	10918 (2.88)		0.533 (1.47)	0.441 (1.79)	0.350 (1.99)	0.261 (1.85)	0.173 (1.52)	.0858 (1.22)	.0156 (0.201)	.728	1.40	29.8
- CT[2]	-292 (-0.833)		1648 (0.844)			.0909 (0.416)	0.125 (0.606)					.0447 (0.962)	.565	1.52	41.4
- ME[1,2]	-1247 (-3.19)	-1214 (-1.01)	3675 (3.68)	4079 (3.42)		0.204 (1.55)	0.206 (2.06)	0.194 (2.35)	0.167 (2.36)	0.126 (2.24)	.0700 (2.09)	-0.163 (-0.927)	.780	1.24	30.8
MF - TT[1,2]	125 (0.750)		47.8 (.0398)			.0446 (0.244)						.0546 (1.21)	.901	1.43	12.4
- CT	78.0 (0.459)		1270 (0.904)	-1007 (-0.876)		-.0649 (-0.303)	.0426 (0.281)	.0642 (0.317)				.0636 (1.30)	.910	1.41	14.5
- ME[1,2,3]	373 (1.90)	-1056 (-2.07)	-338 (-1.13)	14.5 (-.053)		0.258 (2.49)	.0628 (1.58)	-.0451 (-0.823)	-.0660 (-1.35)			-0.616 (-1.76)	.491	1.57	31.9
NM - TT	77.8 (0.503)	-1696 (-1.45)	-535 (-0.872)	30.9 (.0369)		0.125 (0.437)	0.861 (5.35)	1.08 (3.90)	0.798 (3.42)			-0.573 (-5.21)	.830	1.00	25.9
- CT[2]	99.4 (0.467)	-1411 (-1.69)	45.3 (.0701)	516 (0.839)			0.884 (5.72)	0.191 (1.56)	-0.244 (-1.30)	-0.421 (-2.11)	-0.340 (-2.47)	-0.113 (-0.524)	.825	1.46	34.9
- ME[1,2]	5.08 (0.126)	-572 (-0.690)	142 (0.180)			-.0026 (-.013)	0.300 (4.13)	0.401 (2.79)	0.301 (2.37)			-0.351 (-3.71)	.742	1.51	27.3

BEST RESULTS FOR NEOCLASSICAL MODEL - WITH GK AS AN EXPLANATORY VARIABLE

$$I_t = a + \Sigma_{i=m}^{n} bi[(^{PQ}/_c)_{t-i} - (^{PQ}/_c)_{t-i-1}] + k_1 GK_{t-1}$$

	a	b_0	b_1	b_2	b_3	b_4	b_5	k_1	R^2	DW	C.O.V.(%)
MQ&O - TT^2	189 (2.95)		2.52 (1.37)	1.48 (1.38)	0.644 (0.812)			.070 (8.91)	.835	1.40	17.3
- CT^2	154 (3.42)		2.16 (1.76)	1.03 (1.36)	0.312 (0.548)			.0696 (9.10)	.847	1.44	17.3
- ME^2	-0.132 (-.0036)		2.15 (2.50)	2.11 (3.02)	1.88 (2.56)	1.45 (2.11)	0.826 (1.83)	-.0768 (4.85)	.702	1.57	24.4
MM - TT^2	27.0 (0.605)		4.12 (1.64)	0.169 (0.131)				.0843 (5.48)	.643	1.49	33.8
- $CT^{1,2}$	27.9 (0.962)		3.00 (1.87)	-0.544 (-0.637)				.0797 (4.94)	.619	1.59	37.7
- ME^2	-3.00 (-0.120)		2.50 (1.91)	1.54 (2.19)	0.712 (1.31)			.0874 (3.96)	.537	1.27	41.1
MF - TT^2	158 (5.70)	0.435 (0.403)	0.239 (0.289)	.0916 (0.100)	-.0057 (-.006)	-.0534 (-.0609)	-.0515 (-.0929)	.0572 (8.79)	.881	1.56	11.2
- $CT^{1,2}$	123 (6.51)	0.215 (0.193)	0.155 (0.222)	.0995 (0.118)	.0477 (.0709)			.0634 (11.9)	.905	1.42	13.0
- ME	22.8 (1.47)	0.229 (0.474)	0.111 (0.419)	.0331 (.0856)	-.0038 (-.0117)			.0368 (1.41)	.208	1.18	37.4
NM - $TT^{1,2}$	11.8 (0.979)	-2.92 (-0.823)	9.47 (4.14)	16.0 (6.60)	11.2 (6.72)			.0519 (4.49)	.816	1.05	24.9
- $CT^{1,2}$	-4.61 (-0.600)		1.27 (0.672)	6.72 (5.55)	9.32 (7.68)	9.06 (7.57)	5.96 (7.25)	.0638 (4.18)	.822	1.13	32.6
- ME^2	14.7 (1.70)		-2.13 (-0.618)	1.86 (0.827)	4.06 (1.72)	4.48 (1.91)	3.13 (1.94)	.0521 (2.54)	.512	1.01	35.6

BEST RESULTS FOR ECLECTIC MODEL - WITH NK BUT NOT DPY AS AN EXPLANATORY VARIABLE

$$I = a + \Sigma_{i=m}^{n} bi(^{P}/_{c})_{t-i} + \Sigma_{j=k}^{l} dj\ Q_{t-j} + k_1 NK_{t-1}$$

	a	b_0	b_1	b_2	b_3	d_0	d_1	d_2	d_3	d_4	d_5	k_1	R^2	DW	C.O.V. (%)
MQ&O - TT	-2107	-4853	8111	9729		0.174	0.272	0.319	0.315	0.261	0.156	-0.190	.900	1.72	13.1
	(-2.94)	(-1.59)	(4.04)	(3.91)		(0.577)	(1.34)	(1.95)	(2.04)	(1.93)	(1.80)	(-0.867)			
- CT^2	-725		5282				0.362					.0230	.875	1.72	15.7
	(-2.02)		(2.40)				(1.40)					(0.265)			
- ME	-513	-1745	2727	3308		0.173	0.117	.0712	.0367	.0129		-0.287	.869	2.01	17.6
	(-4.11)	(-1.64)	(4.76)	(4.02)		(1.73)	(3.70)	(2.25)	(0.784)	(0.350)		(-1.99)			
MM - TT^2	-5398	2860	19826	18872		0.761	0.633	0.506	0.379	0.252	0.126	-0.110	.805	1.40	25.2
	(-4.13)	(0.585)	(4.55)	(4.37)		(2.76)	(3.45)	(3.82)	(3.41)	(2.71)	(2.14)	(-1.07)			
- CT^2	-359		2500			0.110	0.132					.0572	.565	1.49	41.5
	(-1.01)		(1.02)			(0.500)	(0.640)					(0.776)			
- ME^2	-981	-2049	4416	5099		0.165	0.160	0.146	0.123	.0913	.0502	-0.225	.757	1.16	32.3
	(-4.63)	(-1.12)	(4.09)	(3.26)		(1.67)	(2.82)	(3.63)	(2.99)	(2.31)	(1.88)	(-1.26)			
MF - TT^2	59.5		489			.0693						.0820	.906	1.52	12.1
	(0.312)		(0.309)			(0.516)						(1.51)			
- CT	-23.8		1103			.0363						.0986	.918	1.70	12.0
	(-0.166)		(0.916)			(0.367)						(2.70)			
- ME^2	168	-1253	46.1	464		0.190	.0139	-.0765	-.0811			-0.386	.582	1.79	29.0
	(2.49)	(-2.35)	(0.200)	(1.38)		(2.67)	(1.07)	(-1.61)	(-1.84)			(-2.65)			
NM - TT	159	-3229	317	1394			1.10	0.211	-0.342	-0.562	-0.448	-.0309	.732	1.37	32.5
	(0.561)	(-1.24)	(0.267)	(0.874)			(3.11)	(1.11)	(-1.44)	(-2.15)	(-2.41)	(-0.132)			
- CT^2	132	-1919	131	771			0.885	0.119	-0.352	-0.529	-0.411	.0100	.828	1.56	34.6
	(0.430)	(-1.62)	(0.124)	(0.834)			(5.47)	(1.34)	(-2.45)	(-3.30)	(-3.63)	(.0621)			
- ME^2	43.4	-1118	516			-0.116	0.205	0.332	0.263			-0.397	.694	1.27	29.7
	(0.919)	(-0.768)	(0.379)			(-0.494)	(3.45)	(2.11)	(1.82)			(-3.02)			

BEST RESULTS FOR NEOCLASSICAL MODEL - WITH NK AS AN EXPLANATORY VARIABLE

$$I_t = a + \Sigma_{i=m}^{n} bi[(^{PQ}/_c)_{t-i} - (^{PQ}/_c)_{t-i-1}] + k_1 NK_{t-1}$$

	a	b_0	b_1	b_2	b_3	b_4	b_5	k_1	R^2	DW	C.O.V.(%)
MQ&O - TT^2	155 (2.34)		3.50 (1.47)	2.15 (1.53)	0.983 (0.956)			0.108 (8.76)	.829	1.38	17.6
- CT^2	131 (2.91)		2.76 (1.93)	1.38 (1.55)	0.459 (0.687)			0.102 (9.61)	.860	1.54	16.6
- ME^2	-34.9 (-0.771)		3.39 (2.80)	3.32 (3.39)	2.95 (2.84)	2.27 (2.33)	1.29 (2.00)	0.145 (4.37)	.698	1.75	24.6
MM - TT^2	22.8 (0.474)		5.27 (1.66)	0.374 (0.216)				0.130 (5.17)	.616	1.41	35.1
- CT^2	27.9 (0.960)		3.74 (1.99)	-0.591 (-0.563)				0.113 (4.93)	.619	1.57	37.7
- ME^2	-13.3 (-0.430)		3.16 (1.76)	2.05 (2.04)	1.00 (1.25)			0.161 (3.46)	.472	1.19	44.0
MF - TT^2	139 (4.50)	0.789 (0.587)	0.489 (0.468)	0.256 (0.217)	.0906 (.0712)	-.0072 (-.0063)	-.0374 (-.0520)	.0878 (8.37)	.872	1.51	11.6
- CT^2	108 (5.76)	0.716 (0.581)	0.455 (0.575)	0.249 (0.259)	0.0970 (0.127)			.0926 (12.7)	.915	1.60	12.2
- ME	27.2 (1.96)	0.910 (1.10)	-0.404 (-0.539)					.0493 (1.13)	.222	1.10	37.3
NM - TT^2	3.87 (0.320)		-1.55 (-0.363)	13.8 (5.03)	21.6 (7.40)	21.9 (7.45)	14.7 (7.26)	.0736 (4.43)	.843	1.12	23.0
- CT^2	-9.11 (-1.24)		2.56 (1.22)	8.58 (6.51)	11.3 (8.61)	10.8 (8.27)	7.04 (7.80)	.0882 (4.57)	.853	1.26	29.6
- ME^2	13.8 (1.36)		-0.905 (-0.186)	3.51 (1.12)	5.81 (1.75)	6.00 (1.80)	4.06 (1.77)	.0734 (1.84)	.477	0.954	36.9

TYPICAL NEOCLASSICAL MODEL - WITHOUT INFLATION IN RENTAL COST OF CAPITAL*

$$I_t = a + \Sigma_{i=0}^{5} bi[(^{PQ}/_c)_{t-i} - (^{PQ}/_c)_{t-i-1}] + k_1 GK_{t-1}$$

	a	b_0	b_1	b_2	b_3	b_4	b_5	k_1	R^2	DW	C.O.V.(%)
MQ&O - Total	230 (2.30)	-1.97 (-1.05)	-0.712 (-0.445)	0.176 (.0983)	0.692 (0.368)	0.834 (0.506)	0.604 (0.587)	.067 (6.24)	.773	1.30	17.7
- CT	223 (3.02)	-1.21 (-0.937)	-0.528 (-0.504)	-0.040 (-.036)	0.257 (0.221)	0.363 (0.357)	0.277 (0.437)	.060 (5.57)	.777	1.52	17.2
- ME	0.860 (0.020)	0.047 (.068)	1.13 (1.85)	1.77 (2.43)	1.98 (2.52)	1.76 (2.53)	1.10 (2.51)	.077 (3.79)	.661	1.43	26.0
MM - Total	144 (1.44)	-1.47 (-0.42)	-3.59 (-1.00)	-4.76 (-1.17)	-4.99 (-1.21)	-4.27 (-1.22)	-2.61 (-1.21)	.060 (2.35)	.530	1.39	35.1
- CT	188 (2.63)	-2.24 (-1.05)	-4.03 (-1.94)	-4.96 (-2.20)	-5.02 (-2.24)	-4.21 (-2.22)	-2.54 (-2.20)	.017 (0.570)	.558	1.96	35.4
- ME	-1.39 (.037)	0.958 (0.652)	1.64 (1.54)	1.98 (1.63)	1.99 (1.47)	1.66 (1.36)	1.00 (1.28)	.078 (2.33)	.466	1.18	44.0
MF - Total	158 (5.70)	0.435 (0.403)	0.239 (0.289)	.092 (0.100)	-.0057 (-.006)	-.053 (-.061)	-.052 (-.093)	.057 (8.79)	.881	1.56	11.2
- CT	142 (6.39)	0.619 (0.706)	0.567 (0.828)	0.494 (0.665)	0.401 (0.511)	0.288 (0.414)	0.154 (0.352)	.058 (10.2)	.901	1.88	10.5
- ME	14.2 (0.579)	.0816 (0.169)	.0654 (0.197)	.0503 (0.128)	.0362 (.0810)	.0231 (.0563)	.111 (.0420)	.0505 (1.26)	.201	1.17	40.0
NM - Total	14.0 (0.913)	-6.59 (-1.63)	4.10 (1.47)	10.96 (4.03)	13.98 (4.89)	13.16 (5.12)	8.50 (5.19)	.0522 (3.67)	.729	1.01	30.2
- CT	-2.58 (-0.298)	-3.05 (-1.65)	3.17 (2.47)	7.11 (5.83)	8.76 (6.97)	8.12 (7.25)	5.20 (7.30)	.0612 (3.62)	.804	1.12	34.2
- ME	14.7 (1.55)	-2.12 (-0.550)	0.597 (0.221)	2.37 (0.970)	3.19 (1.316)	3.08 (1.440)	2.01 (1.487)	.0542 (2.08)	.469	1.03	37.2

*for comparison with similar model incorporating inflation, see page 72.

TYPICAL NEOCLASSICAL MODEL - WITH INFLATION INCORPORATED IN RENTAL COST OF CAPITAL*

$$I_t = a + \Sigma_{i=0}^{5} bi[(^{PQ}/_c)_{t-i} - (^{PQ}/_c)_{t-i-1}] + k_1 GK_{t-1}$$

	a	b_0	b_1	b_2	b_3	b_4	b_5	k_1	R^2	DW	C.O.V.(%)
MQ&O - Total	248 (2.56)	-1.90 (-1.02)	-0.938 (-0.585)	-0.234 (-0.132)	0.212 (0.115)	0.399 (0.249)	0.329 (0.329)	.0658 (6.23)	.769	1.26	17.8
- CT	232 (3.28)	-1.20 (-0.941)	-0.625 (-0.603)	-0.202 (-0.185)	.0725 (.0648)	0.197 (0.203)	0.173 (0.285)	.0593 (5.67)	.776	1.49	17.3
- ME	9.13 (0.203)	0.146 (0.207)	1.11 (1.73)	1.69 (2.18)	1.86 (2.25)	1.64 (2.25)	1.02 (2.23)	.0742 (3.53)	.638	1.35	26.9
MM - Total	147 (1.60)	-1.71 (-0.50)	-4.01 (-1.17)	-5.27 (-1.39)	-5.50 (-1.44)	-4.70 (-1.45)	-2.87 (-1.44)	.0601 (2.53)	.548	1.47	34.4
- CT	173 (2.65)	-2.27 (-1.09)	-3.83 (-1.95)	-4.62 (-2.22)	-4.64 (-2.26)	-3.87 (-2.24)	-2.32 (-2.21)	.0235 (0.847)	.560	2.03	35.3
- ME	1.83 (.0496)	1.09 (0.741)	1.63 (1.51)	1.89 (1.51)	1.85 (1.34)	1.53 (1.22)	0.908 (1.14)	.0763 (2.25)	.457	1.18	44.3
MF - Total	159 (5.81)	0.445 (0.419)	0.201 (0.244)	.0248 (.0272)	-.0833 (-.0851)	-0.123 (-0.142)	-.0957 (-0.174)	.0571 (8.81)	.881	1.56	11.2
- CT	143 (6.51)	0.620 (0.714)	0.546 (0.798)	0.459 (0.618)	0.362 (0.461)	0.253 (0.365)	0.132 (0.303)	.0574 (10.2)	.901	1.87	10.5
- ME	14.7 (0.606)	.0969 (0.203)	.0532 (0.160)	.0204 (-.052)	-.00117 (-.0026)	-.0118 (-.0289)	-.0114 (-.0437)	.0500 (1.25)	.201	1.16	40.1
NM - Total	17.4 (1.17)	-6.61 (-1.67)	3.97 (1.45)	10.8 (4.05)	13.8 (4.95)	13.0 (5.20)	8.37 (5.27)	.0496 (3.55)	.734	1.06	29.9
- CT	0.703 (-.0823)	-3.05 (-1.65)	3.00 (2.34)	6.83 (5.68)	8.45 (6.85)	7.85 (7.14)	5.03 (7.19)	.0557 (3.31)	.800	1.13	34.6
- ME	15.2 (1.61)	-2.12 (-0.562)	0.635 (0.233)	2.43 (0.955)	3.26 (1.29)	3.13 (1.42)	2.05 (1.47)	.0532 (2.02)	.469	1.05	37.2

*for comparison with similar model without inflation, see page 71.

MINES (INCLUDING MILLING), QUARRIES & OIL WELLS

Standard Industrial Classification[1] - Division 4
(Items Comparing 3-Digit Classes)

Major Group 1 - Metal Mines

051 *Placer Gold Mines*

Gold bullion production at placer gold mines
Gold mine, alluvial
Gold mine, hydraulic
Gold mine, placer
Hydraulic mine, gold
Placer mine, gold

052 *Gold Quartz Mines*

Gold bullion production at lode mine
Gold mine, lode
Gold quartz mine
Lode mine, gold

057 *Uranium Mines*

Mining radium and uranium
Pitchblende mine
Radium-bearing ore milling
Radium mine
Uranium mine
Uranium ore milling

058 *Iron Mines*

Hematite mining
Iron mine

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[1] Statistics Canada, Standard Industrial Classification Manual, 1960, Catalogue No. 12-501, occasional.

Metal Mines (cont'd)

058 *Iron Mines (concl.)*

Iron ore milling
Iron pellets, mfg.
Magnetite mining
Magnoferrite mining
Manganiferous iron ore mining
Mining iron
Pyrrhotite mining

059 *Miscellaneous Metal Mines*

Antimony
Beryllium mine
Cerium mine
Chalcopyrite ore mining
Chromite mine
Chromite ore milling
Cinnabar mine
Cobalt mine
Cobalt ore dressing and beneficiating
Cobalt ore milling
Columbium mine
Copper mine
Copper ore dressing and beneficiating
Copper ore milling
Copper-gold-silver mine
Copper-gold-zinc mine
Copper-zinc mine
Cuprite ore mining
Galena ore mining
Lead mining
Lead ore milling
Lead-zinc mining
Lead-zinc ore milling
Magnesium mine
Manganese mine
Mercury mine
Molybdenite mine
Nickel mine
Nickel ore dressing and beneficiating
Nickel ore milling
Nickel-copper mine
Quicksilver mine
Rare earths mine
Scheelite ore mine
Silver mine

Metal Mines (cont'd)

059 *Miscellaneous Metal Mines (concl.)*

Silver ore milling
Silver-cobalt mine
Silver-lead mine
Silver-lead-zinc mine
Sphalerite ore mining
Tantalum mine
Titanium mine
Tungsten mine
Tungsten ore dressing and beneficiating
Vanadium mine
Wolframite mine
Zinc and lead mine
Zinc blend ore mining
Zinc mining

Major Group 2 - Mineral Fuels

061 *Coal Mines*

Anthracite mine
Bituminous coal mines
Bituminous coal screening plants
Breaking, washing, grading coal (contract)
Coal and lignite mine
Coal breaking, washing, grading (contract)
Colliery
Lignite and coal mine
Lignite mine
Semianthracite mine
Subbituminous coal mine

064 *Crude Petroleum and Natural Gas Industry*

Bituminous sand and oil shale digging
Bituminous sand mining for oil extraction
Combustion chamber natural gas processing plant
Crude oil production
Crude petroleum production
Helium content from natural gas, recovery of
Liquefied petroleum gases from natural gas, production
Liquid gas plant (from natural gas)

Mineral Fuels (cont'd)

064 *Crude Petroleum and Natural Gas Industry (concl.)*

Mining oil shale, digging
Naphtha content from natural gas, recovery of
Natural gas absorption plant
Natural gas cleaning plant
Natural gas from oil shale or sand
Natural gas well
Natural gasoline plant
Oil sand mining
Oil shale mining
Oil shale or bituminous sand digging
Oil well
Petroleum, from shales or sand, production
Petroleum well
Sulphur, extraction from natural gas
Tar sand mining
Well drilling, petroleum (oil company)

Major Group 3 - Non-Metal Mines Except Coal Mines

071 *Asbestos Mines*

Asbestos fibre, milling
Asbestos mine

072 *Peat Extraction*

Peat bog
Peat cutting
Peat digging
Peat moss digging or harvesting

073 *Gypsum Mines*

Gypsum mine
Plaster mine, pit or quarry

079 *Miscellaneous Non-Metal Mines*

Actinolite mine
Asphalt, natural, mine

Non-Metal Mines Except Coal Mines (cont'd)

079 *Miscellaneous Non-Metal Mines (cont'd)*

Barite mine
Black lead mine
Brine well
Brucite mine
Chalk mine or quarry
Coloured earth mine
Corundum quarry
Diatomaceous earth mine
Diatomite mine
Dolomite mine or quarry
Epsom salts lake
Epsomite lake
Feldspar mine
Fluorspar mine
Fuller's earth mine
Ganister mine
Garnet mine
Gem stone mine
Graphite mine
Grinding pebble pit or quarry
Grindstone mine or quarry
Iron oxide mine
Jade mine
Kyanite mine
Lithia mine
Lithium minerals mine
Magnesitic dolomite mine
Magnesium sulphate mine
Mica mine
Natro-alunite quarry
Natural abrasives mine
Nepheline syenite mine
Ochre mine or quarry
Packers' salt, mfg.
Perlite mine
Phosphate rock mine
Plumbago mine
Potash mine
Pozzolana mine
Processing of salt
Pulpstone quarry
Pumice quarry
Pyrites mine
Pyrophyllite mine
Quartz mine
Quartzite mine
Refining salt

Non-Metal Mines Except Coal Mines (cont'd)

079 *Miscellaneous Non-Metal Mines (concl.)*

Rock salt mine
Rock salt processing
Salt cake lake
Salt mine
Salt processing
Salt refining
Serpentine mining
Silica mine
Soapstone mine
Soda ash lake
Sodium carbonate lake
Sodium sulphate lake
Strontium minerals quarry
Talc mine
Vermiculite mine
Volcanic ash quarry
Whetstone quarry
Whiting mine

Major Group 4 - Quarries and Sand Pits[2]

083 *Stone Quarries*

Basalt mine, pit or quarry
Conglomerate mine or quarry
Granite quarry
Igneous rock quarry
Limestone quarry
Marble quarry
Marl bed or pit
Sandstone quarry
Sedimentary rock quarry
Shale quarry
Slate quarry

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[2] included with Non-Metal Mines, for purposes of this study.

Quarries and Sand Pits (cont'd)

083 *Stone Quarries (concl.)*

Stone crushing quarry
Stone mine, pit or quarry
Traprock mine or quarry

087 *Sand Pits or Quarries*

Gravel and sand grinding and screening
Gravel pit or quarry
Sand and/or gravel pit
Sand pit or quarry

Major Group 5 - Services Incidental to Mining[3]

096 *Contract Drilling for Petroleum*

Contract drilling for petroleum
Contract drilling, oil or gas well
Drilling gas wells, on contract basis
Natural gas wells drilling, contract
Oil field construction
Oil well drilling, contract
Well sinking and drilling, oil contract

098 *Other Contract Drilling*

Contract diamond drilling
Diamond drilling

099 *Miscellaneous Services Incidental to Mining*

Acidizing oil wells, contract
Acidizing wells - oil field
Bailing wells - oil field
Cementing wells - oil field

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[3]included in Metal Mines, Mineral Fuels or Non-Metal Mines according to where the money was spent.

Services Incidental to Mining (cont'd)

099 *Miscellaneous Services Incidental to Mining (concl.)*

Chemically treating wells - oil field
Cleaning out wells - oil field
Cutting casings, tubes and rods - oil field
Drilling water intake wells - oil field
Gas-oil ratio testing
Logging oil wells
Mine development work
Mine exploration
Mining services, nes
Oil well servicing
Perforating well casings - oil field
Prospecting, ex. geophysical, gravimetric and seismographic surveys
Pulling casings, tubes and rods - oil field
Removal of overburden - mining
Running casings, tubes and rods - oil field
Shaft sinking (mining)
Shooting wells - oil field
Sinking of shafts
Swabbing wells - oil field
Treating wells - oil field
Water intake well drilling - oil field

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