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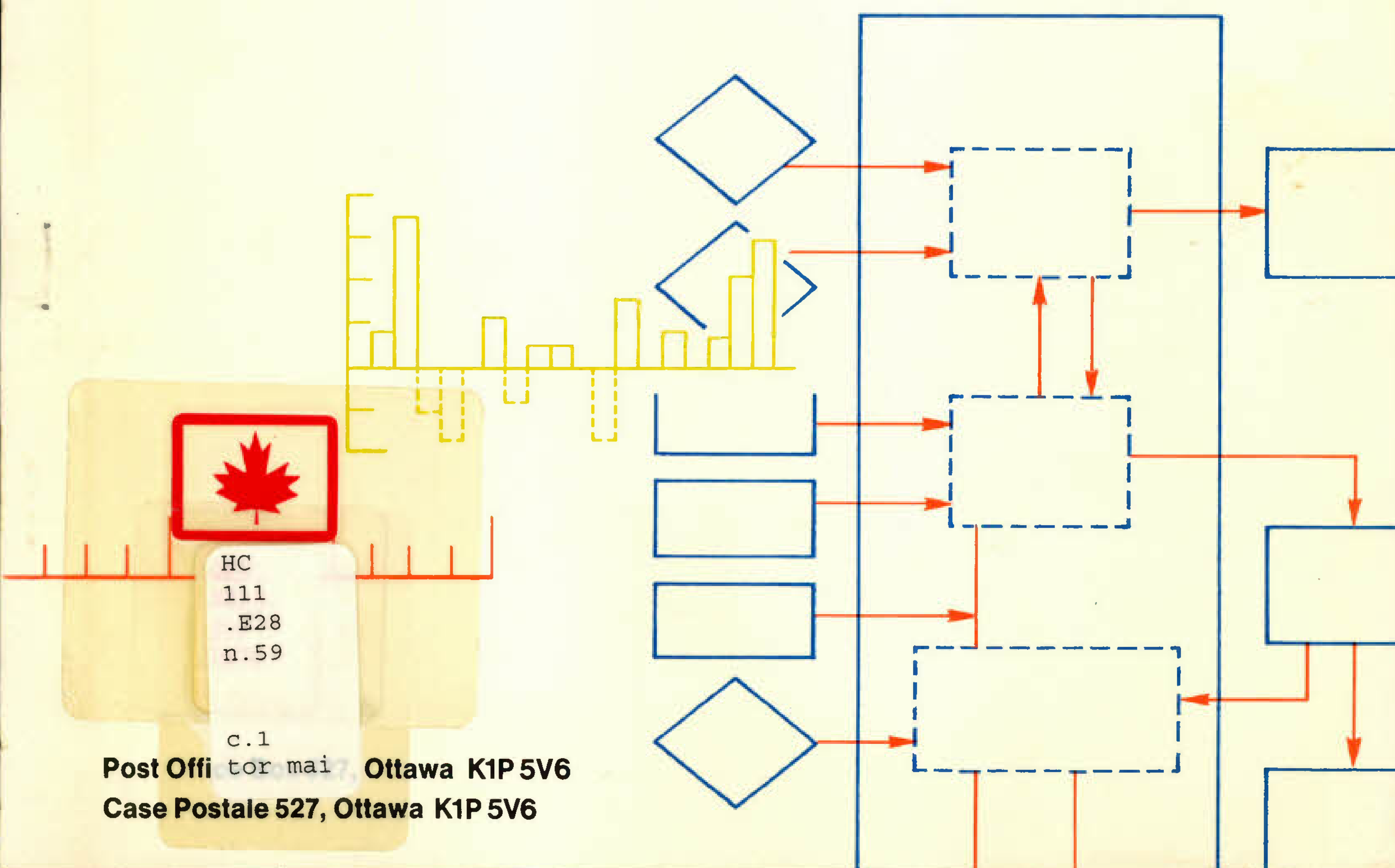

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DISCUSSION PAPER NO. 59

CANDIDE MODEL 1.2M: Summary and Some Simulations

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Abstract

Is the CANDIDE Model too large and complex to be comprehended? This text goes some way towards erasing that myth. In spite of its extensive disaggregation, CANDIDE remains a macro-economic model, which can be "understood", like other such models, by means of analysis of its simulation responses.

Following a succinct description of CANDIDE, the bulk of this paper is devoted to analysis of two simple fiscal policy simulations conducted with the model. Real expenditures, factor markets, savings and investment, and income distribution are considered in turn. The impact of the fiscal policy action on these variables can be understood largely in terms of more or less familiar macro-economic mechanisms.

In CANDIDE, however, these mechanisms are embodied in equations pertaining to disaggregated final demand categories and industrial sectors. The last section of the paper shows how the effects of the fiscal action differ considerably from industry to industry, depending on the degree of "exposedness" to foreign trade, of capital intensity, and so on.

This paper has been produced in the context of a comparative study of the dynamics of Canadian macro models. Besides CANDIDE, three models were involved: RDX2 of the Bank of Canada, and the two models of the University of Toronto. A first set of papers was presented at the CEA meetings in Quebec City, June 1, 1976. This text is a slightly modified version of the paper presented there.

I. Introduction

Macro-economic models are subjected to multiplier studies to reveal their response characteristics. These are the result of the causal relationships and adjustment processes specified in individual equations, and empirically estimated. There is no direct way of revealing the effect of interaction of individual equations in the complex nonlinear models of today. Simulation of the full model is required.

The knowledge of these structural response characteristics is fruitful in several ways. First, if the model is accepted as correct, this knowledge is immediately applicable to forecasting and policy analysis. Multipliers reveal the economic policy control properties of the model.

Second, the longer run structural properties of the economy, as seen through the model, are a subject of interest. The model builder cannot fully foresee how his model will depict the structure of the economy because of its complexity and because this depends on the parameter estimates. Even if the model specification allows for countervailing equilibrating forces, it is not clear a priori that the model will generate stable long-run equilibria.

Finally, the multipliers reflect on the model itself. They may reveal mathematical properties of the model that sometimes suggest needed respecification of structural characteristics (see 4,579). Viewed in this way, multiplier analysis is part of the model validation process.

The trouble with multipliers in any of these various applications is that there is no accepted a priori standard by which they can be judged (1,280). And indeed, real GNP multipliers of U.S. models vary widely in the long-run (3, 70-71).

By lack of an extraneous objective standard, one must have recourse to less absolute benchmarks. It is with the dual purpose of understanding better what determines the size and shape of multipliers and how well they describe the properties of the economy that Canadian model builders have embarked on a comparative study of their models.

The method has been as follows. Each of the participating models[1] was subjected to the same disturbance under the same external and policy conditions, so as to ensure that differences in results are due to differences between the models. The model responses were then analysed in various ways and compared.[2] Since these comparisons do not necessarily do justice to the stronger points of each model - as each model, even though a macro-model, was developed to different specific ends - each participant provides in addition such results as he sees fit to include. This paper does so for CANDIDE.

CANDIDE is unique in its economic growth orientation and extent of disaggregation. The two go hand in hand: in a longer run

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[1] The other models are:
- QFM : Quarterly forecasting model of the University of Toronto (G. Jump)
- RDX2 : The Bank of Canada Model (T. Maxwell and L. de Bever)
- TRACE : Annual model of the University of Toronto (J. Sawyer and D. Foot). J. F. Helliwell acted as co-ordinator and produced comparative charts for the presentation at the CEA meetings in Quebec on June 1 of this year, which he chaired.

[2] No explicit comparison of CANDIDE with the other models is provided here, but the analysis of simulation results benefits from the comparison. Similar papers have been produced for each of the participating models. No comparative text has been written thus far.

perspective, the distributions of spending, production and income assume more interest. However, it is difficult to imagine experiments that would do justice to these features of the model and stay within the usual size of a conference communication. Therefore, no additional simulations have been run. The disaggregation of the model is illustrated with results of the simulations conducted for the comparison.

II. Structure of CANDIDE

The sizeable equation system (2000) of CANDIDE can be described as an elaborate IS framework coupled with a summary LM function. The latter is simply the equation relating the short-term interest rate to real GNP, to the real monetary base, and to an inflation expectation variable. The money supply is exogenous or depends on the federal budget surplus and the balance of payments through policy rules regarding monetization. Long-term interest rates are term structures of the money market rate.

The great bulk of CANDIDE is comprised of equations for supply and demand for real product, i.e., the IS curve. To begin with the demands, final demand categories depend on some activity or income variable, relative prices, sometimes demographic variables and often past accumulation. There are two functions for categories of personal savings, and total consumer spending is obtained by subtracting these savings from disposable income. It is then broken down into some forty components with a Houthakker-Taylor technique. Housing starts depend on the number of households, income per household, the housing stock, the cost of financing and credit availability. Private fixed investment is determined by modifications of the Jorgenson version of the flexible accelerator. A stock adjustment model explains inventory change. Imports and exports depend in the main on activity variables in the receiving country and relative prices[3]. Government expenditures are related to demographic variables, real GNP, and the unemployment rate.

In all, the model distinguishes some 170 categories of final demand. The levels of output in over 60 industries required to produce these effective demands are calculated in a three-step procedure involving input-output methods. In the first step fixed coefficient matrixes, based on observations for the year 1961, are employed to calculate approximations of industry output from final demand. Account is taken of interindustry deliveries. These approximations are subsequently "adjusted" by means of time trends and autoregressive schemes, so as to account for changes in the industry structure. Since these equations are independently estimated, there is no guarantee that the sum of the outputs calculated in step two is consistent with aggregate effective demand. The discrepancy is eliminated by revising all industry outputs proportionately in step three.

These net real outputs are part of a Cobb-Douglas world of supply. The employment equations are inverted Cobb-Douglas functions, and the Jorgenson investment equations are in conformity with this approach. The equations for industry prices of net output or value-added are unit (labour) cost markup equations.[4]

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[3] This summary is necessarily incomplete. For instance, some export items depend on domestic capacity - the diversion-of-supplies-effect that we will encounter later.

[4] For a comparison of supply functions such as present in CANDIDE with equilibrium conditions pertaining to a Cobb-Douglas production structure, see 4, pp. 572-574.

Wage equations complement the IS function and set the stage for nominal magnitudes. Wage changes are related to the rate of labour productivity change in most industries, to labour market tension, and especially to the rate of change of consumer prices.

Final demand deflators are calculated in a three step procedure similar to that for real outputs. Approximations are calculated first from industry prices, import prices and indirect taxes, using the same input-output matrixes with the flow reversed. These approximations are then improved with trends and autoregressive schemes and finally adjusted in such a way that the current dollar identity of national product and expenditure holds. The third element in the identity, aggregate income, is thus known by definition.

Major components of gross income are then derived, as well as capital consumption allowances and indirect taxes. Profits are calculated by subtracting these items from total income - but it is, in fact, the industry price equations and output quantities that determine this seemingly passive residual. An extensive set of tax and transfer equations rounds off the income side of the system.

There are, of course, as many deflators of final demand as there are spending categories. The basic industry disaggregation is the one-digit SIC breakdown into 12 sectors. Employment, manhours, wages, and unit labour cost are calculated for this level of detail. Outputs are obtained for 65 sectors, investment - with structures and machinery & equipment separately treated - for 40 industries and industry prices for some 30 industries.

This detail is completely integrated with the macro model. It is not possible to simulate only the aggregates in CANDIDE, since they are related to each other through their components. Hence the macro results reported below are only a summary of the simulation, as will be illustrated by provision of additional detail.

The detailed treatment of spending and production is not of great interest in short-term forecasting and analysis. Some disaggregation is generally considered useful for catching differences in timeshape and duration of adjustment paths; but CANDIDE far exceeds that level of detail. Rather, it is of interest in longer run analysis which emphasises economic growth, productivity and structure.

In the modeling of economic growth in CANDIDE, an important dual role is played by population growth. It increases the population of working age as well as a number of demands; for housing, schooling, etc. A population calculator in CANDIDE keeps track of the natural evolution of the population by age-sex cohorts, and is used to feed through assumptions about fertility and net immigration. External demand (exports) also acts as a more or less autonomous factor of growth on the demand side, since foreign activity variables dominate their explanation and these as a rule exhibit growth.[5]

All other final demand items evolve over time as a result of the interaction of supply and demand forces. We note that the equations for government expenditures, even if they allow for cyclical factors, are mainly designed with a view to the long term. The idea behind them is that both the demand for and the ability to provide a number of public services depends, over the longer term, on such economic aggregates as GNP.

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[5] Forecasts of U.S. variables from the Wharton Annual and Industry Model are normally used as exogenous inputs into CANDIDE.

Turning now to the supply side, we observe that the tendency for the secondary labour force, especially women, to increase their participation has been captured in equations. Labour productivity depends on the rate of capital accumulation which is determined in the investment equations, and exogenous trend rates of technical progress, estimated separately for each major industry.[6]

III. Simulating the Model

A) The Experiments

Simulation results of the model depend on the control solution, the disturbance applied to it, and the conditions under which the disturbance is applied, especially the policy assumptions.

- The control solution is a solution of the model over the period 1961-73, with the equation residuals added back in as constant adjustments so that the simulated values are identical to the actual historical values. This period is one of modest inflation - by today's standards - and a varying degree of utilization of resources, with a peak in 1965-66.
- The disturbance is a sustained increase from 1961 to 1973 in federal non-wage expenditure of 400 million constant (1961) dollars.[7] More than half of this expenditure is for defence purchases, which makes the experiment unrealistic from a historical point of view. Regarding the

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[6] For a recent and convincing illustration of what the detailed treatment of foreign trade, population and industry structure means to long-term forecasting, see the Twelfth Review of the Economic Council (6), especially the tables to Chapters 1 and 3 in the Appendix.

[7] See Appendix 1 for detail.

economics of the case, there is the question of whether these purchases are made at home. This we have assumed, leaving to the import equations the task of distributing demands over domestic and foreign supplies. The size of the disturbance is substantial in relation to the economy, in particular in the period of high factor utilization, but not excessive.

- We have assumed a fixed exchange rate regime over the whole period, with no deviations from historical values. Net immigration was also kept at historical values even though it is patently dependent on the state of the Canadian economy.

Two simulations were run. They differ in respect of monetary policy. In the first experiment, monetary authorities are assumed to keep the monetary aggregate at control solution values. In the second, they keep interest rates which are directly under their control at control solution (historical) values. In CANDIDE this is equivalent to keeping all interest rates at control values. These admittedly unsophisticated policy assumptions were required to make comparison of results across models possible. The difference in results between the two experiments indicates the influence of monetary policy, which is perhaps more interesting than the result of one, even if more realistic, set of policy assumptions.

B) Format of Presentation of the Results

Tables A through E and Charts A, B and D[8] of Appendix 2 show the differences between the disturbed solution and the control solution for a number of variables. They are designed so as to show the model

[8] Charts A, B and D correspond to Tables A, B and D. There are no charts accompanying Tables C and E.

responses in a meaningful economic way. The top half always depicts the simulation with money supply held at control values, and the bottom half the simulation with interest rates held at control values.

In Charts A are displayed the "real expenditure and supply multipliers"; that is, the changes in major demand and supply components divided by the "real" disturbance of $400 m. The Chart is cumulative, so that the segment between two contiguous lines indicates the contribution of a category. Line 9 is the reverse of line 6 since the total demand and supply responses are identical.[9]

Charts B provide a further analysis of the domestic supply response in terms of the changes in quantities and utilization of production factors. To this end, a synthetic production function with elasticities of .15 for the stocks of plant and machinery & equipment each and .70 for labour inputs was assumed to apply to private nonfarm output. This enables one to relate the percentage change (i.e., percentage deviation from the control value) in output to the percentage change in each of the factors as in the charts. Any change in output unaccounted for by changes in the quantities of factors corresponds to changes in factor utilization. It should be noted, however, that CANDIDE does not contain this production function which is, therefore, only approximately valid.

Savings and investment by functional sector are listed in Table C, expressed as percentages of GNP (all items are measured in deviations from control). This presentation of the results is perhaps the closest thing to the textbook multiplier 1/s, where s is the marginal macro-savings rate which is here decomposed by functional

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[9] Item 7, buffering inventories, present in some of the other models, is missing in CANDIDE which ignores these short-term adjustments.

group. In the textbook case investment is autonomous (exogenous), but this simplification does not hold for CANDIDE and other econometric models. Hence, the multiplier becomes $\frac{1}{s-i}$ where i is the marginal macro-investment rate of GNP; in Table C, the components of i are displayed with a negative sign. Note that column 7 in Table C, the sum of the savings and (negative) investment shares, is equal to the inverse of the nominal GNP multiplier in column 10 (after scaling).[10]

Table C is extremely rich in information about the experiments, as it presents the contribution of each sector, through time, to dampening (S_j) and expansion (I_j). The source of an increase (decrease) in the nominal GNP multiplier can thus be quickly traced.

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[10] These savings and investment shares exclude the initial disturbance. A general formula for the decomposition is:

$$\frac{\Delta GNPC}{D} = \frac{1}{\sum_j \left[\frac{(\Delta S_j - S_j^*)}{\Delta GNPC} - \frac{(\Delta I_j - I_j^*)}{\Delta GNPC} \right]}$$

where S_j : savings group j

I_j : investment of group j

GNPC : current dollar GNP

D : disturbance

* : autonomous change (part of the disturbance).

Derivation of the formula is trivial considering that

$\sum_j (\Delta S_j - \Delta I_j) = 0$ because of the macroeconomic identity of savings and investment, and

$D = \sum_j (S_j^* - I_j^*)$ since a disturbance is always an autonomous change in savings or investment. As indicated in the Appendix, part of the disturbance is in government investment (Table C, Column 6), and part in government current expenditures (Column 9), which is equivalent to an autonomous change in savings.

However this additive decomposition of marginal savings and investment shares is only a first step. Each item can be further broken down so as to yield even more information. As an example, the government savings response of column 2 is broken down into revenues and current expenditures in columns 8 and 9. It is immediately apparent that the perhaps surprisingly low contribution of the public sector to savings is caused, not by a shortfall of revenue, but by increases in current expenditures. One would expect very different results if public spending were exogenous.

Another interesting breakdown would be the following for personal savings:

$$\frac{\Delta SP}{\Delta GNPC} = \frac{\Delta SP}{\Delta YD} * \frac{\Delta YD}{\Delta YP} * \frac{\Delta YP}{\Delta GNPC}$$

where YD : disposable personal income
YP : personal income

The first factor is the personal savings rate. The second factor, the ratio of disposable to personal income, depends mainly on the personal income tax, and the third summarizes the income distribution. It would be possible, of course, to continue by decomposing YP into its components.

Charts D display the distribution of income, and Table E, finally, contains an assortment of variables including some prices and current dollar magnitudes which are of interest but have not been placed in an analytical context.

These tables and charts are intended to overcome as much as possible the impediment to understanding simulation results of macro models, which is that changes in all variables are related and come about through the interaction of all equations. The decompositions serve to isolate the major mechanisms at work.

Differences between models, or results of individual models which do not conform to a priori ideas, can thus be quickly traced to their origin. Many partial results can be understood in terms of the "own" equation of the variable or sector.

Moreover, this way of analysing the results offers the prospect of a more empirical analysis of multiplier responses: the decompositions shown here can be compared with historical (marginal) distributions for plausibility. In spite of the fact that the control conditions of these experiments differ from the historical situation, there is no reason to expect, say, an income distribution in Chart D radically different from the historical (marginal) distribution.[11] Many of the ratios in Table C, especially when further broken down as suggested, can be considered as fairly stable characteristics of the economy. The ratio $\Delta YD/\Delta YP$ for instance, depends, except in case of radical shifts in the sources of personal income, mainly on tax laws. The analysis may thus lead to rejection of certain equations in the model which had been accepted on their individual merits.[12]

C) Results

According to Chart A, line 1, government expenditures increase by more than the 400 m. disturbance introduced in federal spending. Even though there is a slight reduction in some public investment components which are used as counter-cyclical stabilizers, the positive association of public spending and economic activity predominates. Exports decline from control solution values, initially

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[11] If the expenditure increase involved public service wages directly, one would expect more of a difference, at least initially.

[12] See Waslander (8).

because of a diversion-of-supplies-effect governed by the use of the unemployment rate as an indicator of capacity utilization in some of the export functions. Adverse movements in the terms of trade cause exports to remain below control in the longer run.

The response of consumer spending, line 3, is markedly different in the two charts. Since, as we will see below, the personal savings rate is not much influenced by the choice of monetary policy, this difference is due to real income. In the top chart, lines 4 and 5 indicate a much larger negative contribution of private investment than in the bottom chart after the first few years, thereby keeping real income down. Interest rates were allowed to vary in the first simulation, and they react strongly to the change in real activity and the higher rate of inflation. According to Table E, line 4, the long-term government bond rate increases to a maximum of 50 basis points by the end of the simulation period. Other rates, not shown in the tables, increase even more, up to a maximum of 85 points for the short-term rate. The depressing effect of higher interest rates on investment activity is, of course, increasingly reinforced by the relatively lower changes in real output that they thus bring about. As can be easily seen from the charts, residential construction and business fixed investment display similar responses, the latter being more important in line with its larger weight in GNP. By the same token the increase in either expenditure item slows down as stocks build up to the new desired levels. This works both ways of course: In the simulation with money supply held at control values the sustained negative changes in investment have the effect of reducing capital stocks, and this acts as a brake on further declines in investment.

Inventory change is positive initially. CANDIDE ignores the buffer function of inventories, as it emphasizes longer run inventory/sales and goods-in-process/output relationships, which postulate a positive linkage of inventory change and output change. At any rate it is not clear whether an initial decline of inventory stocks on account of unanticipated government purchases would not be compensated by extra output in the first year. In the longer run inventory change turns negative. As will be shown in the next section, the goods producing sectors do not fare well in these simulations, and it is, of course, in these industries that inventories are concentrated.

On the supply side, imports keep on increasing and appear to gradually replace domestic output as a source of supply. This is caused by the price relatives, which deteriorate with the powerful domestic price response in CANDIDE. Imports are much more sensitive to price relatives than exports as they are comprised to a much larger extent of finished and semi-finished products. Exports of minerals and grain are inelastic with respect to relative costs.

Turning now to Charts B, for a display of the factor inputs into the change in real output, we may note the operation of the accelerator mechanism in lines 1 and 2. The Machinery & Equipment accelerator is quicker and stronger - a justification for the breakdown of fixed investment and the capital stock. In the first two or three years, a slight increase in average hours worked adds to the contribution made by additional labour, but it is noteworthy that it takes 7 or 8 years before the degree of factor utilization is back to the level prevailing in the control solution.[13] As output keeps reverting to control values, factor inputs are slow in following the lead, entailing a drop in utilization. The model would seem to agree fairly well with the synthetic production function, considering that the results can be interpreted in terms of short-run adjustments.[14]

The importance of the balance of payments "leakage" for the stability of the Canadian economy is the first striking point to emerge from Table C. Personal savings add to this, but neither the government nor the business sector contribute enough in savings to finance their own additional investment and they exert a destabilizing influence.

Personal savings make a peculiar jump in the second year to about a third of the change in GNP. Usually models depict the savings response as highest in the first year. The personal savings function in CANDIDE contains the change in the unemployment rate as a proxy for consumer confidence. In the first year of the federal expenditure increase, the unemployment rate drops and consumers spend most of their additional income. The next year, the unemployment rate hardly changes and the income effect on savings dominates. The long-run marginal propensity to save is positive, but it is much lower than the initial response.

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[13] It is a peculiarity of CANDIDE that for some industries the employment functions, even though they are specified as Cobb-Douglas functions, in fact, exhibit something close to complementarity. Hence employment does not increase substantially until the capital stocks have caught up to the new output level, and this process takes time.

[14] A shift in the composition of real output towards the "less productive" service producing sectors, as noted in Section IV, is an additional cause of the result that the weighted sum of the factor changes exceeds the output change in the longer run.

The decomposition of government saving into revenues and current expenditures in columns 8 and 9 shows how the substantial revenue response is virtually nullified by increases in current spending over and above the disturbance. To quite an extent the latter reflect wage increases in the public sector. The marginal government revenue share increases over time, reflecting changes in the tax structure - such as the introduction of federal manufacturers sales taxes in the mid-sixties - and the progressivity of the personal income tax. The Benson reform of the personal income tax has entailed a substantially higher progressivity and therefore a higher revenue elasticity of GNP as witness the results for 1972 and 1973.

Business savings (column 3), which include all capital consumption allowances, are very small because a profits squeeze sets in fairly quickly in the exposed sectors of the economy. Business investment (column 5) appears to be very sensitive to monetary policy as explained above. In the simulation with money supply held at control, there is even a temporary decline in the nominal value of business investment (which includes residential construction and inventory change). The price increases generated by the disturbance are not strong enough to offset the decline in real investment outlays illustrated in Chart A, so that the current dollar value drops. After a few more years, outlays become once again higher than in the control run, but this is entirely a result of price increases. Public investment (column 6) initially declines as small adjustments are made in some outlays which are used in stabilization policy.

Nominal GNP multipliers are listed in column 10 of the table. They keep on increasing in spite of the dampened reaction of real national product. This is the result of the price changes induced by the disturbance. The increase in the nominal multiplier appears to be associated mainly with a decline in the balance of payments leakage.[15] As we have seen in Charts A, real imports keep on increasing, and so does the balance of payments deficit. However, import prices are exogenous and do not change as a result of the disturbance, and for this reason the import "leakage", a nominal entity, declines in relative importance.

Turning now to Charts D, we observe a low share of wages during the first several years. The increase in real output is produced, initially, with little additional labour input, while the concurrent temporary increase in labour productivity is not fully and immediately passed on into wages. As the adjustment to a more normal use of factor inputs proceeds, the wage share increases. This goes at the expense of profits which turn negative after 5 years. As explained in more detail below, a profits squeeze occurs in the production sectors of the economy that participate in foreign trade.

We have had occasion several times to allude to differential impacts on industries. Leaving to the reader the analysis of Table E, we now turn to a systematic discussion of results by sector.

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[15] In the sense of the inverse relationship between the nominal GNP multiplier and the sum of columns 1 through 6 of Table C, as specified in footnote 10.

IV. Results for Industry Variables

A selection of the simulation results for industry variables is illustrated in Chart F. For each major industry the chart provides the percentage change from historical values in the first, fifth and final year of the simulation (1961, 65, 73) for output, employment, capital stock and the value-added deflator.

Even a cursory look at this chart will suffice to observe that the impact of the federal fiscal action on real output is far from evenly distributed across industries, especially in the longer run. The model clearly distinguishes between the primary industries and manufacturing on the one hand, and the other, mainly service sectors on the other. The former are exposed to foreign trade, and suffer because of the poor price performance of the economy, whereas the service sectors are "sheltered", and can expand unchecked by external conditions. An exception is the construction industry which bears the brunt of the stringent monetary policy in the first simulation. One would expect to see the same for the machinery producing industry, but the changes in this subindustry are swamped by the relative price effects on the manufacturing industry. Somewhat surprising is the sizeable long-run change in owner occupied housing in the second simulation, and although it is consistent with the direction of change of housing starts and incomes, it seems too large.[16]

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[16] This is an area where data are very poor, or non-existent, which makes it difficult to obtain plausible parameter estimates.

If allowance is made for adjustment lags the changes in employment appear to correspond closely to those in output, with few exceptions. A historical analysis of employment in agriculture would give little weight to output, and CANDIDE explains it very well with a trend and the unemployment rate, the latter representing the capacity of the industrial sector to absorb excess farm labour. This causes the opposite movement of output and employment in this simulation.[17] The increase in employment in utilities by the end of the first simulation is a case of substitution of labour for capital: the capital stock declines because of tightness in financial markets, and the additional output is produced with more labour. The same substitution effects are present to a less striking degree in several other sectors. In the second simulation in which the conditions for capital expansion are much more favourable, a substitution away from labour can be observed. The effects of monetary policy are indeed substantial and pervasive. That total employment still increases by more than real output in the second simulation is due to the shift towards the more labour - intensive service sectors.[18]

A number of prices decline from their control values in the first year of the simulation. The additional output is generated partly by more intensive use of employed labour and capital, which

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[17] A case could be made for keeping both variables exogenous in a simulation of this kind. Agricultural output is endogenous in CANDIDE as it is though to depend on demand in the longer run. Changes from year to year are dominated by weather conditions.

[18] The changes in the capital stock in the forestry sector seem implausible in light of the output changes. They are a direct result of the strong price reaction in this sector - through the operation of relative prices in the investment function - which in turn is caused by excessive wage rate changes. The overall results are not significantly affected in view of the small weight of the industry.

entails lower per unit cost since factor prices do not adjust so quickly.[19] The effect disappears rapidly as factor utilization returns to normal and factor prices begin to increase. The long-run price response is unambiguously strong, except in agriculture and mining where prices are determined by international forces. Manufacturing is a mixture in this regard, but domestic cost pressures are too strong to be absorbed. As for the sheltered industries, price responses differ because of differences in size and speed of the reaction of employment and the wage rate, and in the effects of this on prices. Available space does not allow us to discuss these in detail. But the wage equations, for instance, far from being standard Phillips curves, use a variety of sometimes industry-specific labour market variables, and give different weights to labour productivity and price expectations for each sector. There is, of course, also a variation over time in the importance of these influences. Initially, labour market tightness and short-run productivity gains push wages up; as the economy gets onto a higher inflation trajectory while the real magnitudes swing back to control values, it is the expectation variable - alternatively to be interpreted as a catch-up variable - in the wage equation that keeps the spiral going. Indeed, the coefficient in the wage equations on lagged rates of change of CPI turns out to be approximately .9 for the economy as a whole when all industry equations are weighted together.

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[19] Some economists regard this drop as unreasonable and argue for the use of markups over "normal" or trend unit labour cost in price equations. On the other hand, the view that a fast cyclical upswing reduces price pressures in the short term is widely held.

Before we pass a concluding judgement on these results, we must point at a technical defect of the model which appears to have some effect on the longer run outcome of the experiments. It has to do with export prices and value-added deflators. As we have seen, the value-added deflators in agriculture and mining are determined by export prices. In the manufacturing industry there is some influence of export prices, but many equations are based on a constant mark-up over unit labour cost. If these costs increase, as in our experiments, total factor incomes (including profits) have to increase. Yet this cannot be reflected in export prices as they are exogenous. The third step in the calculation of final demand prices has the effect of diverting cost pressures that would affect export prices to domestic demand deflators.[20] Among these are consumer price deflators, which in turn influence wage demands. Thus the inflation "spiral" gathers too much momentum.

Irrespective of this peculiar mechanism which accounts for only a moderate portion of the price change by the end of the simulation period, the model appears to depict a fairly extreme set of behavioural reactions for the long run. Export prices nor export quantities change appreciably, while nevertheless profit margins in a number of export industries are drastically reduced. Import competing sectors meanwhile loose a large part of their sales to foreign suppliers. As a result, profits of the manufacturing industry are wiped out. Yet investment activity, not dependent on internal financing according to the model, is sustained.

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[20] See (8) for illustrative simulations.

In the real world, such an extreme situation is not likely to occur. Some export prices would increase and cause some reduction in export sales, investment would weaken, and this would prevent price pressures from building up to the same degree. Moreover, in our simulations we have ignored the linkage of balance of payments and federal surplus to the money supply, a linkage which could conceivably have aggravated the balance of payments situation to the point where authorities were forced to act. Under a floating exchange rate regime inflation would have been far less harmful, and some increase in the number of immigrants in the first several years would have attenuated tension in the labour market.

And, finally, during several years of the simulation period the economy was operating at or close to full capacity, and could not have absorbed this increase in demand without strong inflationary pressures. In other words, the design of the experiments, and especially of the policy assumptions, is so stringent as to beg for unrealistic long-run results.

To summarize, CANDIDE's industrial detail is anything but a mechanical breakdown of the aggregate variables. Indeed, the effects of fiscal and monetary policy on industries are so diverse as to challenge the validity of aggregate variables as sole measures of policy impact. This is not to say that these measures are necessarily of poor quality if they are derived without taking industry reactions into account - but they simply do not contain a great deal of information that is of interest. In studies of future economic growth, where the range of scenarios for policy and external influences is so much larger, structure and distribution assume even more importance.

Appendix 1 : The Disturbance

The following variables in CANDIDE were revised by the indicated amounts to implement the increase in federal expenditures of $400 m:

CANDIDE Mnemonic		Description (all variables in constant 1961 dollars)	Amount:
DFCGSK	:	Defence current goods and services	220
DFCAPK	:	Defence capital formation	25
GFCGSK	:	Non-defence federal current goods and services	50
		Federal Current Expenditures	295
GFOENK	:	Federal other engineering construction	30
GFBOSK	:	Federal buildings	35
GFHWYK	:	Federal highway construction	10
GFIMEK	:	Federal investment in Machinery & Equipment	30
		Federal Investment Outlays	105
		TOTAL	400

Appendix 2 : Tables and Charts

Results of the CANDIDE Model

Table A : Decomposition of real demand and supply

Government expenditure increase with money supply held at control values

	1	2	3	4	5	6	8	9	10
	C11M	C12M	C13M	C14M	C15M	C16M	C18M	C19M	C10M
1961	1.03	0.88	1.81	1.87	2.14	2.41	-0.71	-2.41	1.70
1962	1.15	1.03	1.54	1.53	1.86	1.94	-0.60	-1.94	1.33
1963	1.15	1.03	2.01	2.01	2.32	2.36	-0.71	-2.36	1.65
1964	1.20	1.10	2.19	2.14	2.27	2.23	-0.71	-2.23	1.52
1965	1.22	1.14	2.29	2.19	2.17	2.09	-0.72	-2.09	1.38
1966	1.22	1.15	2.39	2.26	2.07	1.97	-0.76	-1.97	1.22
1967	1.22	1.16	2.36	2.20	1.88	1.77	-0.80	-1.77	0.96
1968	1.19	1.13	2.33	2.14	1.74	1.63	-0.88	-1.63	0.75
1969	1.19	1.13	2.38	2.15	1.71	1.62	-0.99	-1.62	0.63
1970	1.19	1.14	2.36	2.12	1.67	1.60	-1.09	-1.60	0.51
1971	1.19	1.14	2.42	2.16	1.72	1.67	-1.20	-1.67	0.47
1972	1.18	1.13	2.09	1.79	1.31	1.25	-1.11	-1.25	0.14
1973	1.14	1.11	2.00	1.68	1.12	1.06	-1.11	-1.06	-0.05

Government expenditure increase with interest rates held at control values

	C11R	C12R	C13R	C14R	C15R	C16R	C18R	C19R	C10R
1961	1.03	0.88	1.81	1.87	2.15	2.41	-0.71	-2.41	1.70
1962	1.15	1.02	1.60	1.63	2.01	2.11	-0.66	-2.11	1.45
1963	1.16	1.01	2.14	2.24	2.68	2.75	-0.83	-2.75	1.92
1964	1.22	1.08	2.51	2.63	3.08	3.11	-0.98	-3.11	2.13
1965	1.27	1.14	2.78	2.92	3.37	3.35	-1.11	-3.35	2.24
1966	1.30	1.18	3.11	3.26	3.62	3.57	-1.28	-3.57	2.29
1967	1.32	1.21	3.31	3.46	3.74	3.64	-1.46	-3.64	2.17
1968	1.30	1.19	3.46	3.62	3.78	3.65	-1.64	-3.65	2.02
1969	1.32	1.23	3.70	3.84	3.91	3.78	-1.84	-3.78	1.94
1970	1.37	1.28	3.77	3.84	3.81	3.68	-1.95	-3.68	1.72
1971	1.38	1.30	3.94	3.93	3.84	3.72	-2.09	-3.72	1.64
1972	1.37	1.30	3.51	3.41	3.24	3.12	-1.93	-3.12	1.19
1973	1.33	1.27	3.48	3.33	3.12	3.03	-1.97	-3.03	1.06

1 : Government Expenditure

2 : 1 + Exports

3 : 2 + Consumer Expenditures

4 : 3 + Residential Construction

5 : 4 + Business Fixed Investment

6 : 5 + Inventory Change

8 : Imports (-)

9 : 8 + Domestic Supply (-)

10 : Real GNP Multiplier

Results of the CANDIDE Model

Table B : Contribution of factor inputs to private business output

Government expenditure increase with money supply held at control values

	1	2	3	4	5
	C21M	C22M	C23M	C24M	C25M
1961	0.014	0.048	0.893	0.971	1.866
1962	0.025	0.102	0.880	0.902	1.367
1963	0.039	0.150	1.041	1.032	1.566
1964	0.040	0.166	0.969	0.913	1.286
1965	0.035	0.158	0.875	0.794	1.040
1966	0.023	0.125	0.734	0.638	0.805
1967	0.006	0.081	0.573	0.466	0.551
1968	-0.012	0.033	0.425	0.320	0.339
1969	-0.031	-0.015	0.308	0.204	0.214
1970	-0.049	-0.059	0.208	0.110	0.114
1971	-0.067	-0.098	0.140	0.049	0.068
1972	-0.085	-0.135	0.020	-0.072	-0.109
1973	-0.104	-0.173	-0.085	-0.170	-0.208

Government expenditure increase with interest rates held at control values

	C21R	C22R	C23R	C24R	C25R
1961	0.014	0.048	0.895	0.972	1.868
1962	0.029	0.111	0.949	0.978	1.492
1963	0.051	0.175	1.200	1.205	1.829
1964	0.073	0.231	1.319	1.290	1.836
1965	0.096	0.278	1.382	1.327	1.761
1966	0.113	0.304	1.353	1.280	1.624
1967	0.126	0.317	1.273	1.175	1.410
1968	0.134	0.316	1.163	1.061	1.155
1969	0.137	0.305	1.063	0.950	0.992
1970	0.134	0.285	0.926	0.801	0.771
1971	0.127	0.259	0.816	0.687	0.640
1972	0.117	0.229	0.642	0.502	0.350
1973	0.107	0.198	0.518	0.390	0.242

1 : Contribution of structures investment

2 : 1 + Contribution of M & E investment

3 : 2 + Contribution of number of employed

4 : 3 + Contribution of hours worked

5 : 4 + Factor utilization = private business output

Results of the CANDIDE Model

Table C : Decomposition of induced savings and investment

Government expenditure increase with money supply held at control values

	1	2	3	4	5	6	7	8	9	10
	C31M	C32M	C33M	C34M	C35M	C36M	C37M	C38M	C39M	C30M
1961	16.7	18.3	14.8	59.4	-40.9	1.2	69.5	22.4	-4.0	1.44
1962	33.8	0.2	9.4	50.5	-30.1	4.0	67.9	20.2	-19.9	1.47
1963	14.4	3.0	8.7	42.7	-21.3	2.3	49.8	21.9	-18.9	2.01
1964	9.2	0.3	5.1	34.8	-8.6	1.0	41.8	23.0	-22.7	2.40
1965	9.5	-1.5	1.7	28.6	-2.5	-0.3	35.5	23.4	-24.8	2.81
1966	9.0	-1.9	-0.8	23.7	1.0	-1.6	29.4	24.3	-26.1	3.40
1967	8.2	-1.4	-2.2	19.9	2.6	-2.7	24.4	26.5	-28.0	4.11
1968	7.1	-1.1	-1.5	17.8	1.3	-3.1	20.5	27.5	-28.6	4.88
1969	6.5	0.2	-1.1	16.5	-1.1	-3.5	17.6	29.0	-28.8	5.69
1970	7.0	-1.1	0.1	15.7	-2.3	-3.6	15.8	29.7	-30.8	6.33
1971	7.1	-0.6	1.5	14.8	-4.8	-4.0	14.1	30.2	-30.8	7.09
1972	4.9	4.2	1.6	12.1	-5.6	-4.1	13.1	35.6	-31.4	7.65
1973	3.6	5.8	1.7	11.4	-6.3	-4.2	12.1	36.7	-30.9	8.27

Government expenditure increase with interest rates held at control values

	C31R	C32R	C33R	C34R	C35R	C36R	C37R	C38R	C39R	C30R
1961	16.7	18.3	14.8	59.4	-41.0	1.2	69.4	22.3	-4.0	1.44
1962	32.5	1.2	9.8	51.1	-35.1	3.7	63.2	19.8	-18.7	1.58
1963	15.0	3.4	9.4	44.0	-30.3	2.2	43.8	21.1	-17.6	2.28
1964	10.6	2.2	7.1	37.6	-25.9	1.0	32.6	22.0	-19.8	3.06
1965	11.8	0.5	4.4	31.9	-23.2	0.1	25.5	22.1	-21.6	3.93
1966	11.6	-0.5	2.1	26.9	-19.4	-1.0	19.7	22.5	-23.0	5.08
1967	10.2	-0.7	0.5	23.2	-15.8	-2.0	15.4	24.4	-25.0	6.47
1968	8.5	-0.9	1.2	20.6	-14.3	-2.5	12.7	25.0	-25.9	7.90
1969	7.0	0.0	1.7	18.8	-14.0	-2.8	10.7	26.6	-26.6	9.36
1970	6.9	-2.0	2.6	17.3	-12.1	-3.1	9.6	27.1	-29.2	10.37
1971	6.6	-2.2	3.9	15.9	-11.9	-3.5	8.7	27.5	-29.7	11.46
1972	4.2	2.0	4.2	13.1	-11.7	-3.6	8.1	32.3	-30.3	12.29
1973	3.1	3.4	4.7	12.6	-12.5	-3.7	7.5	33.2	-29.8	13.28

1 : Personal Savings
2 : Government Savings
3 : Business Savings
4 : Foreign Savings
5 : Business Investment
6 : Government Investment
7 : Total 1-6
8 : Government Revenue
9 : Government Current Expenditure
10 : Nominal GNP Multiplier

Results of the CANDIDE Model

Table D : Induced Incomes as Percentage of the Change in GNP

Government expenditure increase with money supply held at control values

	1	2	3	4	5	6
	C41M	C42M	C43M	C44M	C45M	C46M
1961	57.1	68.8	70.5	82.8	94.4	100.0
1962	66.5	74.4	70.6	82.3	91.9	100.0
1963	66.7	72.4	69.7	80.9	92.2	100.0
1964	71.2	74.1	70.5	81.4	93.0	100.0
1965	76.1	75.4	71.8	82.5	93.7	100.0
1966	79.3	76.8	73.0	83.5	94.6	100.0
1967	81.3	77.9	73.9	84.1	95.3	100.0
1968	81.4	77.3	74.6	84.6	95.6	100.0
1969	81.9	77.3	75.1	85.0	95.6	100.0
1970	81.2	77.6	75.4	85.3	95.5	100.0
1971	80.2	76.8	75.5	85.2	95.2	100.0
1972	81.3	77.6	76.4	85.8	95.0	100.0
1973	81.4	77.4	76.6	85.6	94.8	100.0

Government expenditure increase with interest rates held at control values

	C41R	C42R	C43R	C44R	C45R	C46R
1961	57.1	68.8	70.5	82.7	94.3	100.0
1962	65.7	73.2	69.7	81.7	91.6	100.0
1963	65.6	70.8	68.3	79.8	91.5	100.0
1964	68.2	71.0	67.9	79.1	91.4	100.0
1965	72.3	71.4	68.0	79.0	91.4	100.0
1966	75.5	72.6	68.7	79.5	91.9	100.0
1967	77.9	73.6	69.4	79.9	92.3	100.0
1968	78.1	73.0	69.9	80.4	92.5	100.0
1969	78.4	72.9	70.4	80.8	92.7	100.0
1970	78.1	73.4	71.1	81.4	92.7	100.0
1971	77.4	72.8	71.4	81.6	92.6	100.0
1972	78.2	73.4	72.2	82.4	92.5	100.0
1973	78.0	73.0	72.2	82.3	92.4	100.0

1 : Wages, salaries and MPA

2 : 1 + Corporate Profits

3 : 2 + Inventory valuation Adjustment

4 : 3 + Other Net Income = Net National Income

5 : 4 + Indirect Taxes Minus Subsidies

6 : 5 + Capital Consumption Allowances = Gross National Product at Market Prices

Results of the CANDIDE Model

Table E : Other Variables

Government expenditure increase with money supply held at control values

	1961.00	1962.00	1963.00	1964.00	1965.00	1966.00	1967.00	1968.00	1969.00	1970.00	1971.00	1972.00	1973.00
1 CMSM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 CPGNEM	-0.26	0.12	0.32	0.70	1.08	1.56	2.17	2.66	3.08	3.47	3.80	4.08	4.18
3 CPCPIM	-0.26	0.11	0.29	0.67	1.04	1.50	2.07	2.54	2.96	3.38	3.73	4.03	4.22
4 CRLM	0.00	0.10	0.14	0.20	0.24	0.29	0.36	0.39	0.41	0.43	0.46	0.49	0.56
5 CURM	-0.91	-0.62	-0.71	-0.55	-0.46	-0.36	-0.24	-0.14	-0.09	-0.05	-0.03	0.05	0.11
6 CX$M	-58.54	-49.20	-51.76	-44.73	-40.73	-36.15	-29.91	-26.30	-24.30	-25.03	-25.11	-23.24	-27.10
7 CM$M	284.61	251.86	303.96	304.74	306.34	326.39	350.63	385.16	438.25	488.61	542.70	500.97	540.91
8 CXBAL$M	-343.35	-301.06	-355.71	-349.47	-347.07	-362.54	-380.54	-411.48	-462.54	-513.64	-567.80	-524.13	-568.06
9 CRESM	-215.65	-134.02	-174.74	-153.24	-146.28	-143.07	-135.78	-157.54	-186.60	-212.72	-233.09	-194.50	-228.29
10 CPDIM	372.70	439.35	610.21	768.51	971.94	1256.88	1560.37	1859.67	2195.96	2507.14	2862.15	3007.88	3393.63
11 CFILM	10.61	32.22	50.96	69.28	95.94	133.49	158.95	177.71	209.96	247.27	279.19	321.29	404.97
12 CFISM	117.10	134.82	130.01	126.95	104.85	85.98	85.81	76.24	65.99	53.64	55.52	6.34	-65.27
13 CNEM	61.94	60.50	69.98	66.48	63.04	57.50	49.14	41.44	36.68	32.07	30.05	22.27	15.65
14 CLFM	2.48	20.28	22.89	29.67	31.27	31.84	32.17	31.59	30.79	30.02	29.37	28.66	26.95
15 CGNESM	399.43	402.33	412.33	417.31	429.63	448.83	463.90	473.39	490.01	513.85	537.94	562.52	596.95
16 CYGNEM	40219.39	43519.91	46807.56	51278.90	56570.23	63355.32	68312.94	74894.81	82603.69	88938.00	97115.00	107793.06	123841.06

Government expenditure increase with interest rates held at control values

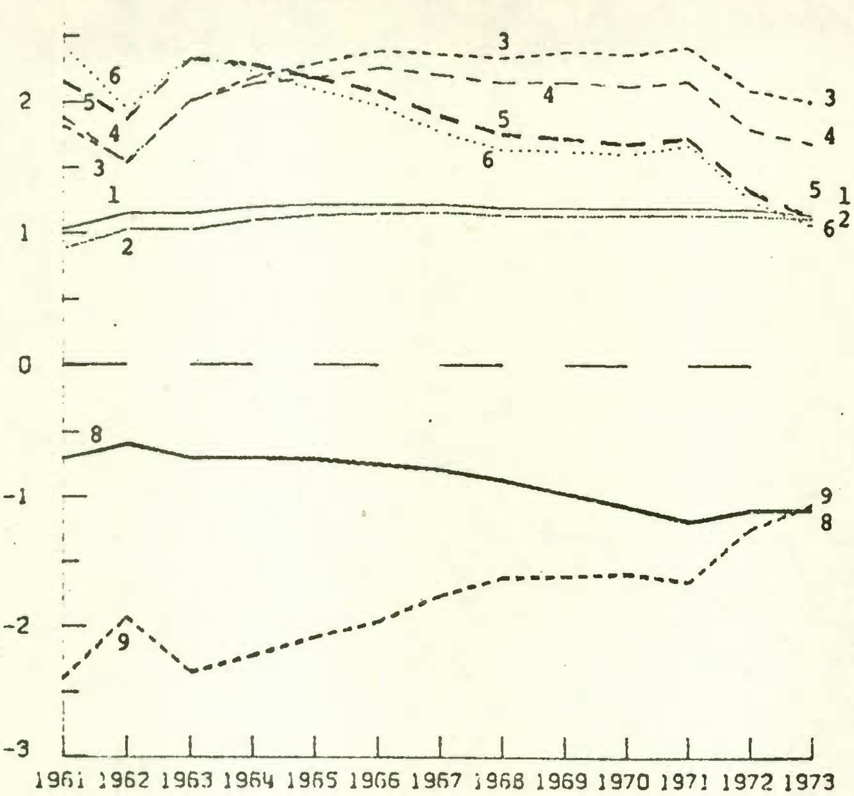
	1961.00	1962.00	1963.00	1964.00	1965.00	1966.00	1967.00	1968.00	1969.00	1970.00	1971.00	1972.00	1973.00
1 CMSR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 CPGNER	-0.26	0.11	0.32	0.74	1.26	1.97	2.95	3.79	4.51	5.17	5.68	6.08	6.19
3 CPCPIR	-0.26	0.09	0.25	0.63	1.07	1.69	2.51	3.21	3.83	4.45	4.90	5.26	5.45
4 CRLR	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	-0.00
5 CURR	-0.92	-0.69	-0.84	-0.82	-0.79	-0.70	-0.55	-0.41	-0.32	-0.19	-0.12	0.01	0.07
6 CX$R	-58.59	-53.25	-60.09	-62.50	-64.92	-62.48	-56.53	-52.26	-48.77	-47.84	-42.01	-37.10	-44.58
7 CM$R	285.05	273.73	356.21	420.11	475.91	554.99	644.09	727.44	823.84	883.90	947.76	879.41	962.62
8 CXBAL$R	-343.64	-326.98	-416.30	-482.62	-540.84	-617.46	-700.62	-779.70	-872.62	-931.74	-989.76	-916.52	-1007.40
9 CRESR	-216.64	-203.18	-259.05	-299.31	-334.80	-383.07	-433.87	-484.84	-542.01	-577.30	-611.88	-562.02	-615.45
10 CPDIR	373.07	466.52	682.57	946.82	1296.29	1804.73	2380.93	2931.45	3514.89	4021.11	4550.39	4743.69	5338.81
11 CFILR	10.36	15.91	20.83	25.70	31.43	34.99	34.64	31.85	38.72	43.22	25.62	16.75	42.43
12 CFISR	312.41	382.46	365.04	408.65	425.16	433.37	436.87	422.05	423.32	435.90	436.73	428.55	406.45
13 CNER	62.00	64.93	80.03	88.70	94.67	95.52	90.59	83.07	78.34	69.77	62.44	49.52	41.76
14 CLFR	2.48	20.27	24.32	33.13	39.42	44.88	49.89	53.03	54.64	55.74	55.38	54.18	51.14
15 CGNESR	399.43	402.32	412.38	417.55	430.34	450.42	466.90	477.87	495.66	521.02	545.93	571.26	606.45
16 CYGNER	40219.96	43563.98	46920.19	51558.74	57052.16	64117.08	69429.56	76361.94	84456.06	91086.50	99557.19	110507.06	126960.13

All values are absolute differences between the disturbed and the control solution, unless otherwise indicated.

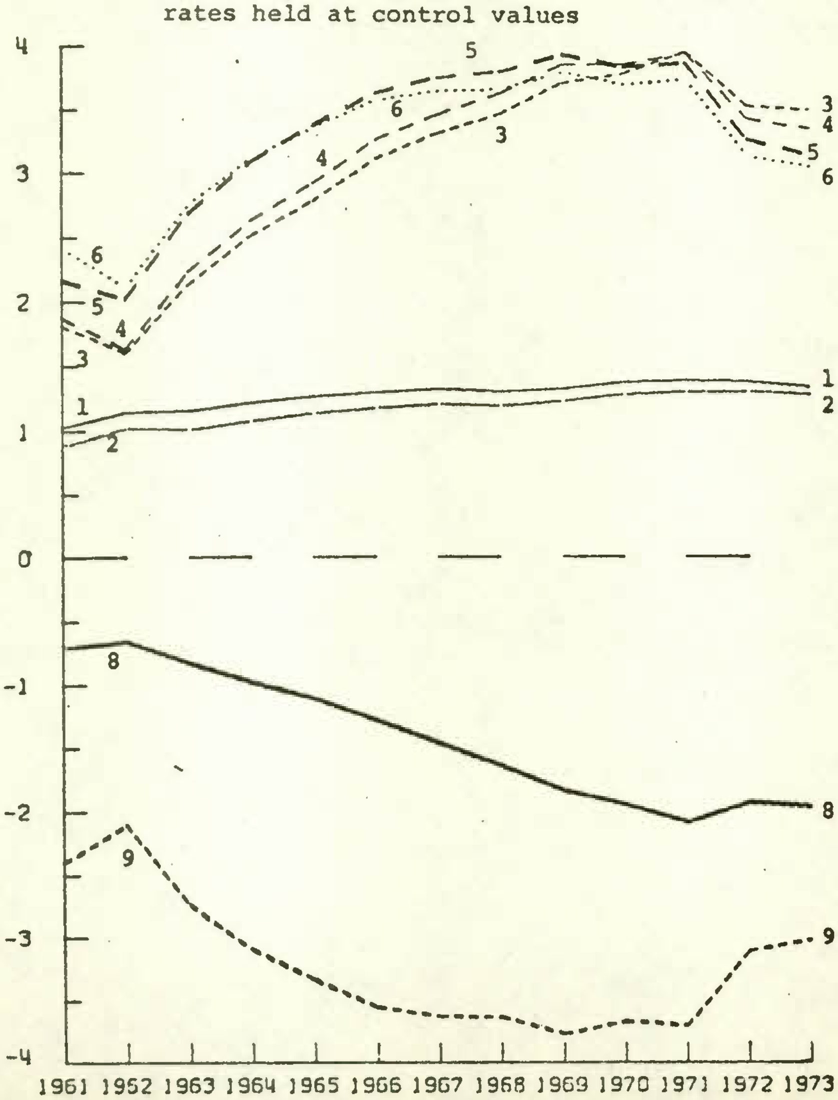
CMS	Money supply, percentage deviations from control values
CPGNE	Implicit deflator of GNE, percentage deviations from control values
CPCPI	Consumer price deflator, percentage deviations from control values
CRL	Long-term government bond rate, basis points
CUR	Unemployment rate
CX$	Exports of goods and services, current dollars
CM$	Imports of goods and services, current dollars
CXBAL$	Current account balance
CRES	Foreign exchange reserves
CPDI	Disposable personal income, current dollars
CFIL	Net long-term capital inflows
CFIS	Net short-term capital inflows
CNE	Employment, in thousands
CLF	Labour force, in thousands
CGNES	Autonomous federal expenditure change, in current dollars (the disturbance)
CYGNE	GNP in the shocked solution, current dollars

Chart A : Decomposition of real demand and supply

Government expenditure increase with money supply held at control values



Government expenditure increase with interest rates held at control values



1 : Government Expenditure

2 : 1 + Exports

3 : 2 + Consumer Expenditures

4 : 3 + Residential Construction

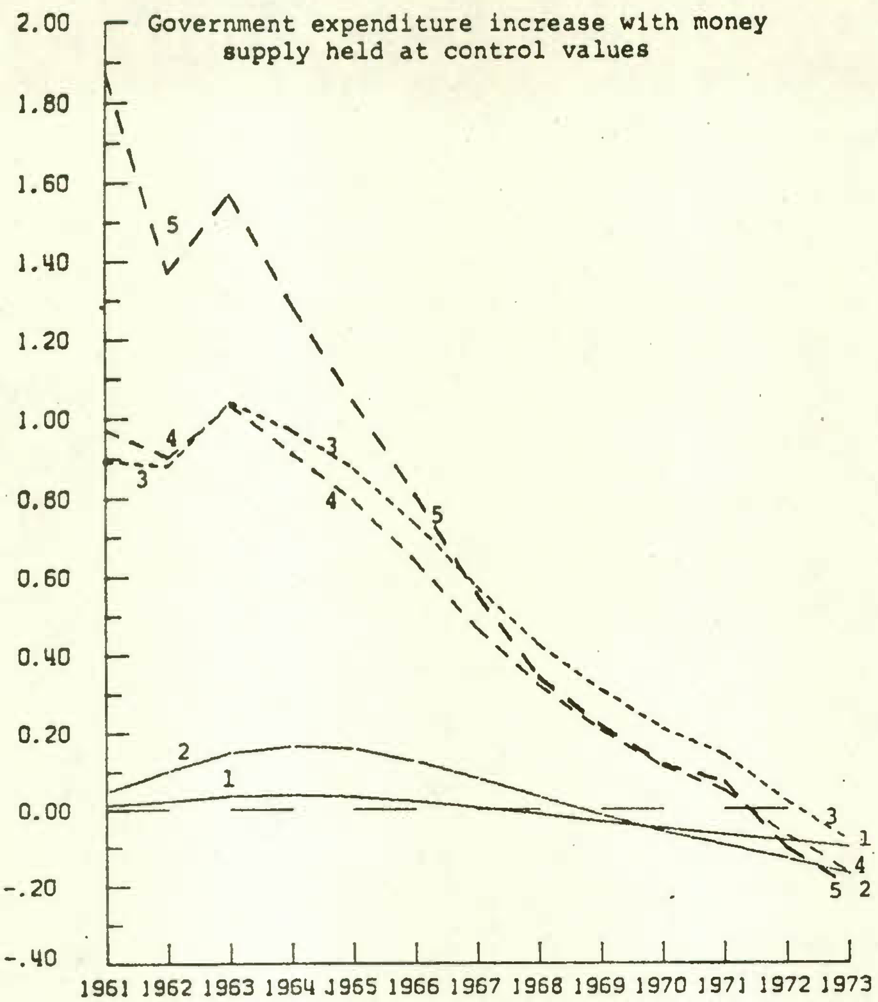
5 : 4 + Business Fixed Investment

6 : 5 + Inventory Change

8 : Imports (-)

9 : 8 + Domestic Supply (-)

Chart B : Contribution of factor inputs to private business output



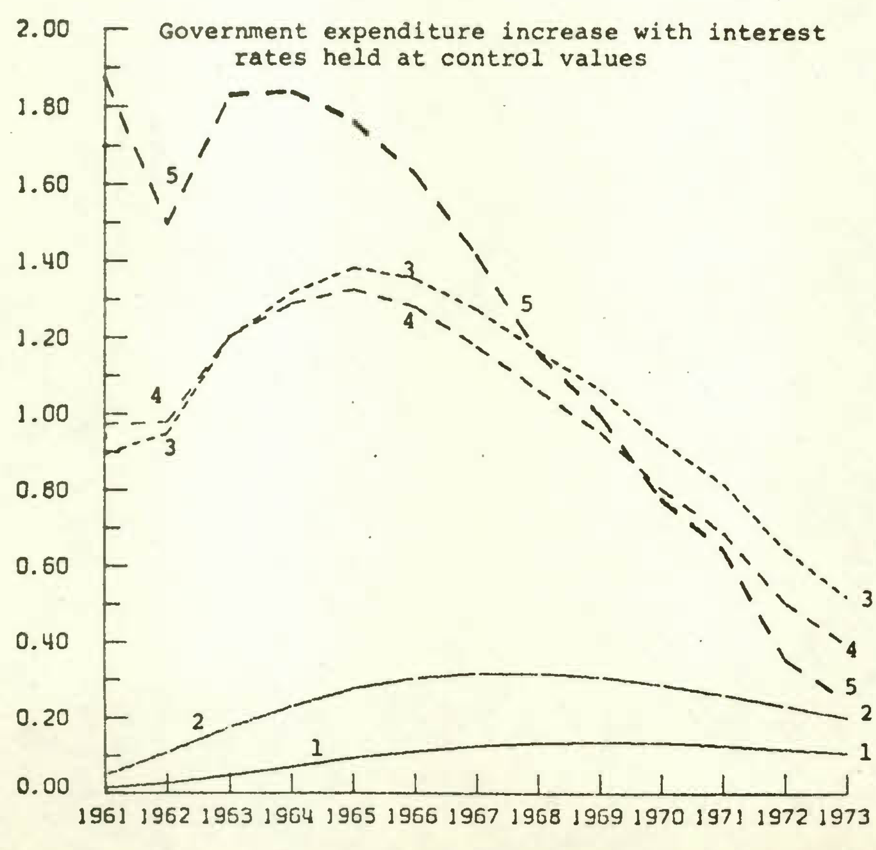
1 : Contribution of structures investment

2 : 1 + Contribution of M & E investment

3 : 2 + Contribution of number of employed

4 : 3 + Contribution of hours worked

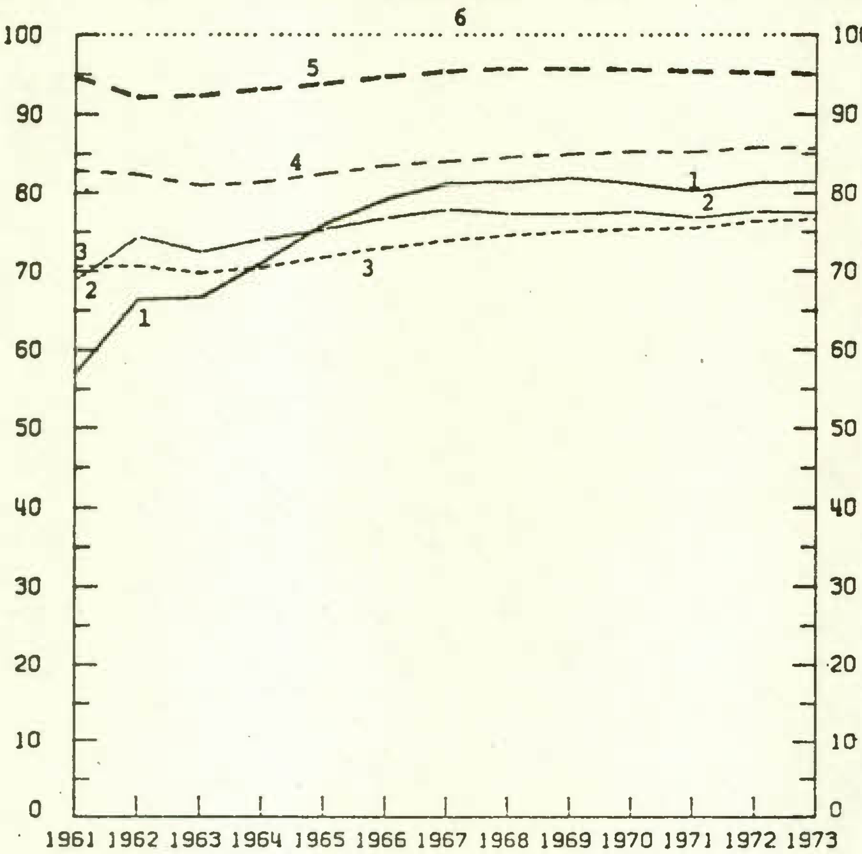
5 : 4 + Factor utilization = private business output



Results of the CANDIDE Model

Chart D : Induced Incomes as Percentage of the Change in GNP

Government expenditure increase with money supply held at control values



1 : Wages, salaries and MPA

2 : 1 + Corporate Profits

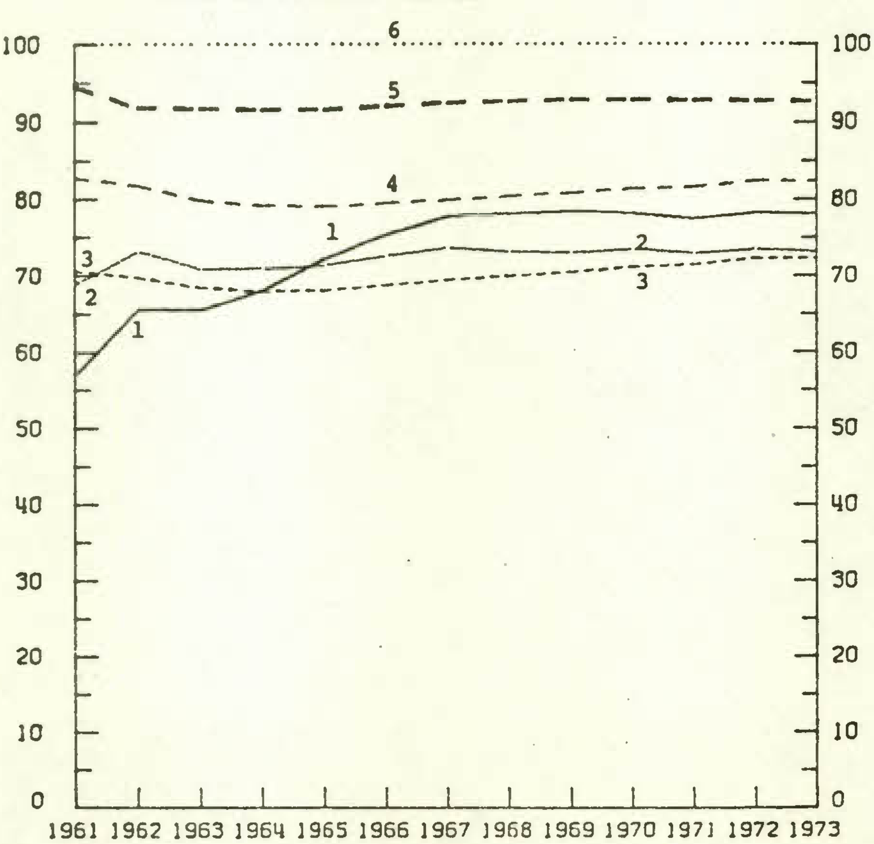
3 : 2 + Inventory valuation adjustment

4 : 3 + Other Net Income = Net National Income

5 : 4 + Indirect Taxes Minus Subsidies

6 : 5 + Capital Consumption Allowances = Gross National Product at Market Prices

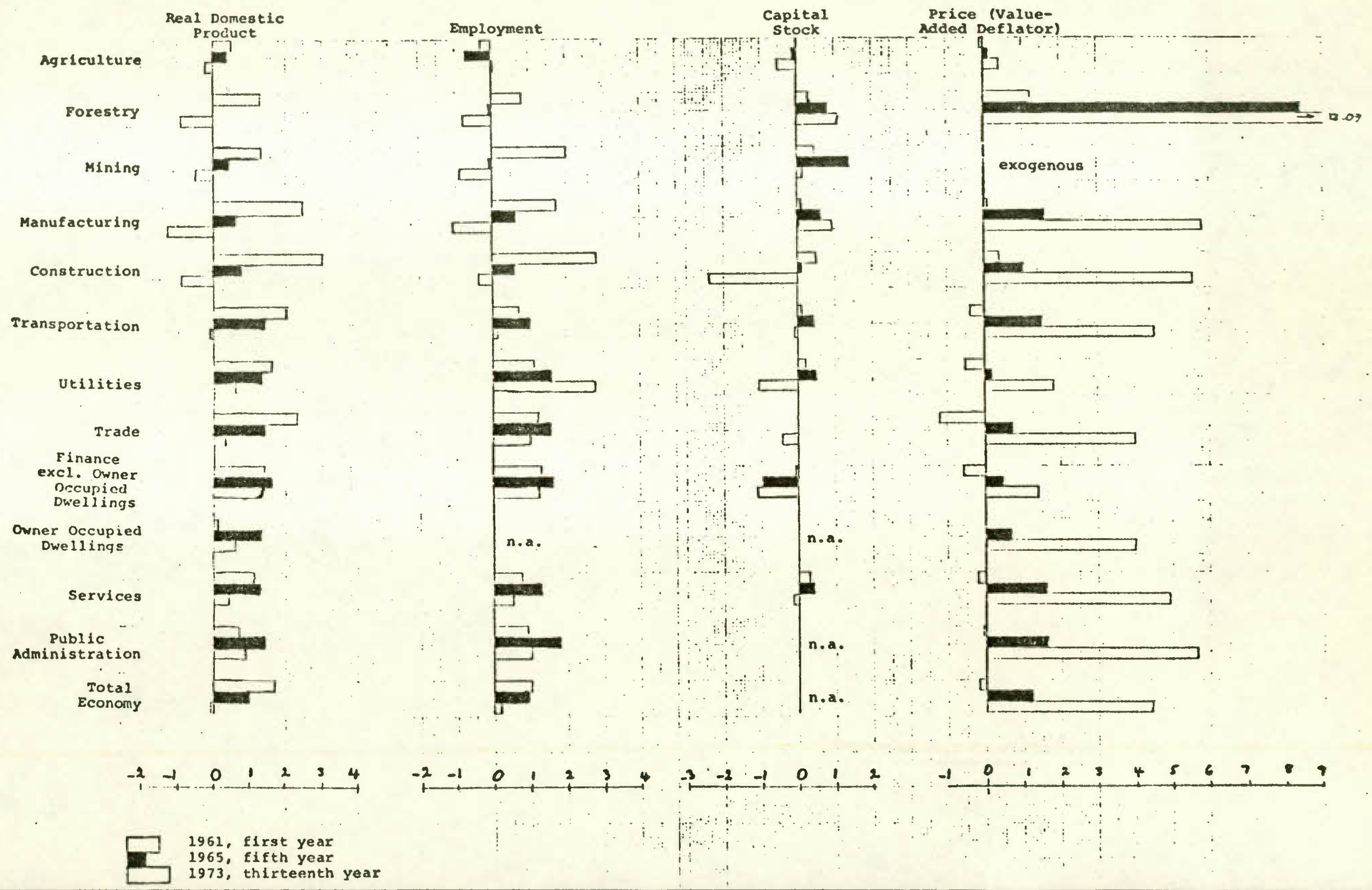
Government expenditure increase with interest rates held at control values



Results of the CANDIDE Model

Chart F : Industry variables, percentage deviations from control values

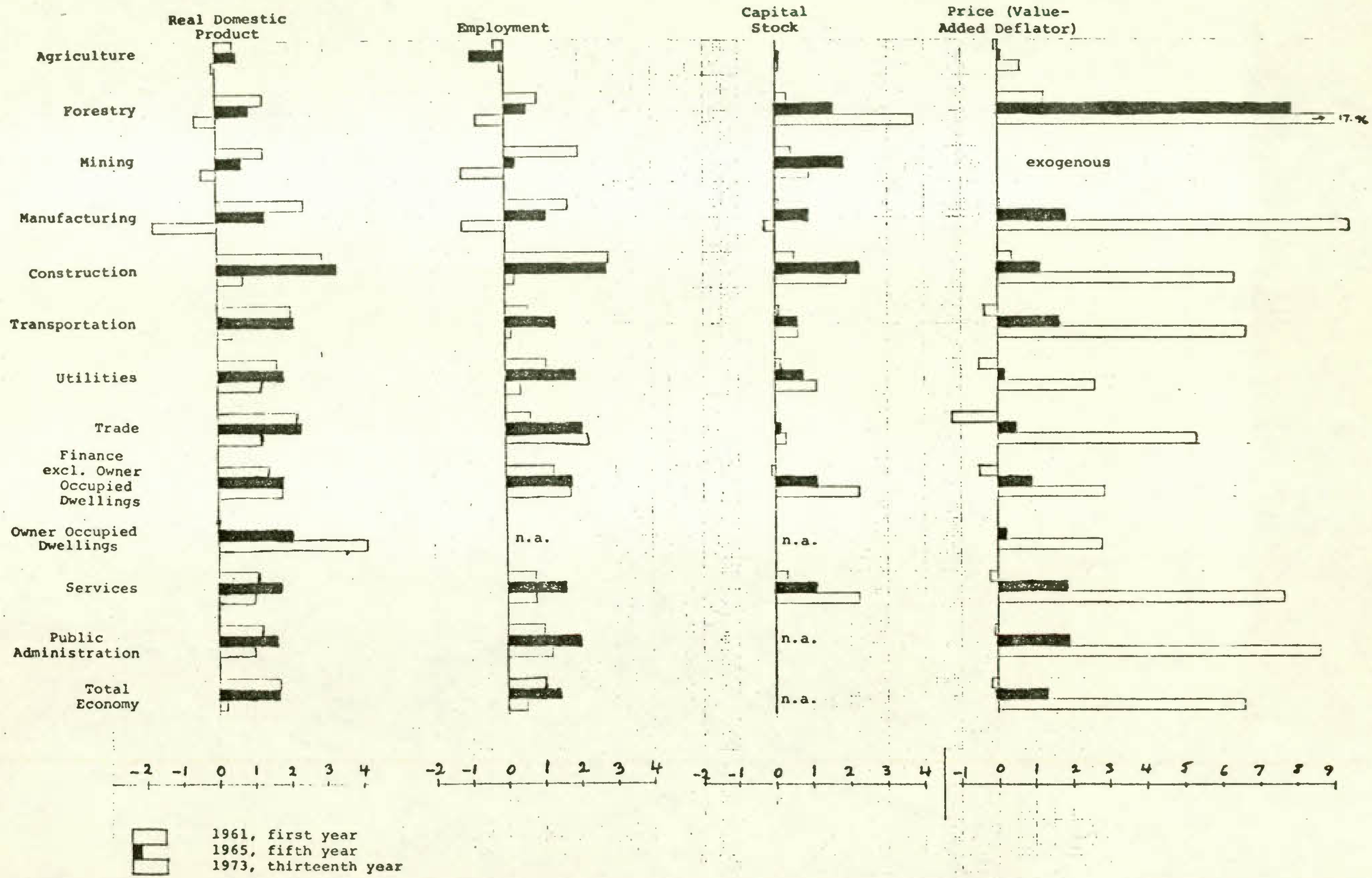
Government expenditure increase with money supply held at control values



Results of the CANDIDE Model

Chart F : Industry variables, percentage deviations from control values

Government expenditure increase with interest rates held at control values



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