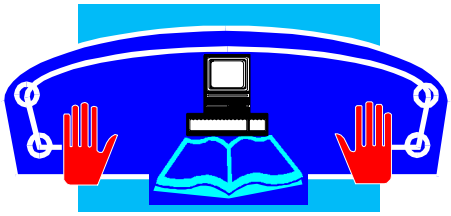

The Macro Economic Effects Of An Arctic Gas Pipeline On The Canadian Economy - 1976-1985 Mining/oil/energy, Nwt Gas Industry

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1976-1985

by

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University of Toronto
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November, 1974

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This study was commissioned by Canadian Arctic Gas Study Limited which supplied us with the necessary data covering the construction and operations of the Arctic Gas pipeline for the period 1976-1985.

We have benefited greatly from discussion with our colleagues Professors J.E. Pesando and J.E. Floyd and express our appreciation to them. Charles P. Cohen was the senior research assistant responsible for the computations and for developing some computer software necessary for the study. Other research assistants who worked on the project were David Street, André Burgstaller, and Edmund Mak. Miss Lorelle Triolo was project secretary. The additional developmental work on the TRACE model required for this project was done using the facilities of Data Resources, Incorporated. Other computations were done on a fee basis at the University of Toronto Computer Centre.

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1. OBJECTIVE AND FINDINGS OF THE STUDY

The objective of this study is to estimate the medium-term macroeconomic effects of the construction and operation in the early years of a natural gas pipeline from Alaska and the Mackenzie Delta, along the Mackenzie River Valley, and south to the Canadian-United States border. Such a pipeline would bring Mackenzie Delta and Alaskan gas to markets in Canada and the United States. More precisely, the study seeks to determine the impact of the pipeline on the following key macroeconomic variables in Canada during the period 1976-1985:

(1) the level and composition of national output, income and expenditure;

(2) price and wage levels;

(3) interest rates;

(4) imports, exports, international capital flows, and the foreign exchange rate;

(5) the number of persons employed; and,

(6) the level and composition of capital formation and public and private saving.

Throughout the study it is assumed that monetary and fiscal policy are the same whether or not the pipeline is constructed.

As a result, the possibility of a dampening of macroeconomic effects through the application of government monetary and fiscal policies has been ignored. This approach was intentionally adopted in order to estimate the maximum medium-term macroeconomic impacts that would result from the construction and operation of the pipeline.

The study focuses on annual average macroeconomic effects during the period 1976-1985. It is possible that a focus on shorter periods of time, such as a quarter of a year, would result in larger or smaller effects than those estimated on an annual basis. These shorter-run impacts would, however, be smoothed out as changes in various macroeconomic variables took place and the economic system adapted to these shorter-run impacts. Furthermore, since estimates of the magnitude of the macroeconomic impact of the pipeline will be well-documented prior to the beginning of construction, the impact of the pipeline will likely be anticipated and smoother adjustment to its impact may occur than would otherwise be the case.

Our findings are that the construction and operation of the pipeline can be expected to have the following results:

(1) A modest appreciation of the foreign exchange rate with the appreciation during the operations phase being somewhat greater than during the construction period;

(2) Lower price levels as a result of the exchange rate appreciation;

(3) An increase in real personal disposable income and rea[d] personal expenditure on consumer goods and services;

(4) Real location of domestic resources away from producing goods for exports and capital goods in order to release resources to construct the pipeline, to develop the Delta gas fields, and to produce more consumption goods;

(5) A moderate increase in imports;

(6) Increases in employment occur in the construction phase while decreases occur in the early part of the operations phase; and

(7) Negligible changes in interest rates.

Compared with the orders of magnitude of these variables in the economy as a whole, the changes in macroeconomic variables resulting from the construction and operation of the pipeline are small. The small magnitude of these effects reflects the fact that, although it is a large undertaking, the construction is spread over a period of years and its impact in any one year is reduced by the substantial import content and external financing of the pipeline. The net addition to total capital spending in any one year is therefore not large in comparison with the level of capital expenditures in the economy as a whole.

2. SUMMARY OF THE METHODOLOGY

The actual macroeconomic effects of the pipeline in 1976-1985 depend on a number of factors which at the time of writing this report are not known with certainty. Our general approach, therefore, is to make a number of alternative assumptions and to estimate the effects of the pipeline under each set of assumptions. We have tried to choose assumptions which will indicate the sensitivity of the results to various alternative assumptions.

In particular, there are two unknowns with which we deal explicitly in our alternative cases. One is the state of the economy. Since the effects on the economy of a large addition to aggregate demand will be different depending upon the degree of slack in the economy, we have simulated the effects of the pipeline under two alternative assumptions. One is that the unemployment rate is about 4 1/2 per cent of the labour force and the other is that the unemployment rate is near 6 per cent. The first assumption corresponds (given recent history) to a situation of full employment of resources whereas the latter case allows for some slack in the economy.

The second factor which could affect the outcome is the division of sales of Mackenzie Delta gas between exports and domestic markets. The case for which we present the results in greatest detail is the one in which half the Delta gas will flow to domestic markets and half to export markets. The reasons for selecting this case (which we refer to as Case A) as the illustrative one are given in the following statement from Canadian Arctic Gas Study Limited:[1/]

1/ Statement attached to a letter from John R. Yarnell, Vice-President of CAGSL, to J.A. Sawyer, Sept. 4, 1974.

Canadian Arctic Gas Pipeline Limited will be a contract carrier and will not be a purchaser of gas. Accordingly, CAGPL will move gas to whatever markets contract for the purchase and transportation of gas. The company will not be an applicant for export permits but will transport gas to export points for others, if such deliveries are approved by the National Energy Board.

As part of its overall project study work, Arctic Gas has made a detailed examination of future Canadian gas supply and demand. On the basis of those studies, Arctic Gas has concluded that there will be a substantial domestic requirement for Delta gas within the time frame encompassed by the Institute's economic impact assessment.

Therefore, it is the opinion of Arctic Gas that the most realistic presentation of the economic impact cases will be one that gives precedence to the case involving significant volumes of Delta gas moving to domestic markets and displacing energy that would have to be imported in the absence of Delta gas supplies in order to meet domestic requirements.

It should be noted that, at this point, it is impossible to determine precisely the volumes of Delta gas that will flow to domestic as opposed to export markets. That determination ultimately will be made by the National Energy Board. Therefore, the assumption has been made for the purposes of exhibit preparation only, that 50% of the Delta gas will flow to domestic markets in the early years and 50% to export markets. For consistency, the same assumption should be made in the economic impact assessment.

As a limiting case to show the sensitivity of the results to alternative assumptions about the sales of Mackenzie Delta gas, we present as case B the case where all the Delta gas is exported and none is sold domestically in Canada. Because of methodological problems concerning the nature of our experiments (which we explain in detail in Section 5), we present as cases C1 and C2 the cases where the Delta gas is sold domestically but, instead of displacing imported energy, (1) the Delta gas displaces non-Arctic oil and gas in the domestic market which is then diverted to the export market

or (2) the availability of Delta gas displaces domestic investment in the development of alternative energy sources. In presenting these alternative cases B and C, we do not mean to imply that there is a high probability that any of these alternatives will occur. We do so for methodological reasons and do not intend to detract from the position of case A.

To estimate the effects of the pipeline we have used "simulation analysis. " Simulation analysis is a technique that involves setting up a model of a real situation and then performing experiments with the model. The model we used is the TRACE econometric model of the Canadian economy. We used the model to generate a macroeconomic path of the Canadian economy from 1974 to 1985 under two different sets of economic conditions, both of which assume that the pipeline is not built. The first set of economic conditions is one in which there is relatively low unemployment throughout the period. The second set assumes relatively high unemployment. We then superimposedon each of these two alternative projections (which we call "control solutions"), the construction and operation of the pipeline during the period 1976-85. Comparisons were " then made between the results of the simulation experiments which assumed the pipeline was not built with those which assumed it was built in order to estimate the macroeconomic effects of the construction and operation of the pipeline.

An econometric model of an economy is a set of mathematical equations which represent the interrelationships between the various sectors of the economy. These relationships are of two types. The first are definitional equations which give effect to the definitions used in national income accounting. The second are behavioral

equations. The behavioral equations are based on economic theory and analysis of historical relationships; they express in the form of mathematical functions the way in which variables such as consumption expenditures are determined in the model. The coefficients in the behavioral equations express the magnitude of the impact of a change in one variable upon another variable. These coefficients are estimated from historical data using statistical techniques, typically multiple regression analysis.

The variables in an econometric model are of two types: "endogenous" variables whose values are determined by the model, and "exogenous" variables whose values are assumed or provided from outside the model and which become input data for the solution of the model. Among the endogenous variables in the TRACE model are gross national product, consumption expenditures, and the unemployment rate. The key exogenous variables include population growth, tax rates, government employment, and gross national products and price levels in foreign countries.

The exogenous variables drive the model; that is, the endogenous variables repond to changes in the values of the exogenous variables. A change, for example, in the level of government employment (as a result, say, of a winter works program which employs workers previously unemployed) increases the income of those newly-hired workers. This increase in their incomes induces an increase in their consumption expenditures, which leads to changes in other endogenous variables such as production, employment, and imports.

--To project the values of endogenous variables forward into future time, it is thus necessary to establish, from outside the model, future values for the exogenous variables. These exogenous variable projections are then fed into the model as input data and the model generates a future path of values for the endogenous variables. For each alternative set of projections of exogenous variables that is fed into the model, a different projection of values of the endogenous variables will result. Hence, any projection which results from an econometric model is a conditional projection; that is, it is a projection of the values of the endogenous variables which is conditional upon the particular set of values for exogenous variables which is fed into the model as input data. For this study, we present in a later section two conditional projections of the Canadian economy through to 1985 based on two different sets of assumed values for the exogenous variables. These are the low unemployment and high unemployment "control solutions" against which the impact of the pipeline is estimated.

Since the solution values of endogenous variables respond to changes in the values of exogenous variables, econometric models are well-suited to examining the effect on the economy of changes in the values of exogenous variables. The methodology is to generate a control solution with exogenous variables set at some base level. The values of the exogenous variables are then set to a changed level and the model run to generate a second solution. The difference between the values of the endogenous variables in the control solution and the second solution can then be attributed to the change

in the values of the exogenous variables since that is the only difference in input as between the two solutions. To assess the macroeconomic impact of the pipeline we therefore add as exogenous variables, in a manner explained later in this study, the various economic variables which describe the construction and operation of the pipeline. This methodology implies that the pipeline activity is exogenous activity; that is, it is not activity which is included in the values of the endogenous variables generated by the control solution. We shall discuss this point further in a later section.

3. THE TRACE-MODEL OF THE CANADIAN ECONOMY

The TRACE model of the Canadian economy[1] is an econometric model built at the University of Toronto. The first version was constructed from 1966 to 1969 by Professors N.K. Choudhry, Y. Kotowitz, J.A. Sawyer, and J.W.L. Winder[2] and later versions have been used regularly for forecasting the short-term economic outlook for Canada and for making medium-term projections under varying assumptions concerning world trade conditions and domestic economic policy. The model has been revised and improved over the years since 1969 and considerable effort was devoted in 1972 and 1973 by the authors of this report to improving the capital expenditure, balance of payments, and interest rate equations and to improving the mechanism in the model to explain movements in the foreign exchange rate.

The current version of the TRACE model is known as TRACE Mark IIIR and is the one used for the simulation experiments whose results are presented in this report.[3] This version of the model uses 41 behavioral equations and 134 definitional equations so that there are 175 endogenous variables in the model. In addition, there are 119 exogenous variables whose values are obtained or projected from outside the model.[4]

1/ The name is derived from "Toronto annual Canadian econometric" model.

2/ This first version of the model is described in N.K. Choudhry, et. al., The TRACE Econometric Model of the Canadian Economy (Toronto: University of Toronto Press, 1972).

3/ TRACE Mk IIIR is described in J.A. Sawyer, TRACE Mark IIIR: An Econometric Model of the Canadian Economy, Report No. 5, Institute for the Quantitative Analysis of Social and Economic Policy, February, 1974.

4/ Although there are 119 exogenous variables in the model, many of these are minor variables required to account for all the variables contained in the principal tables of the National Income and Expenditure Accounts.

A. An Overview of the Way in Which the Model Works

Although the model is highly interdependent and the various parts of the solution feed back upon one another, it may be helpful to think of the variables and equations of the model being arranged in the following order and the model solved to obtain a projection according to the following steps.[1/] (A more detailed description of the model follows beginning in section B.)

(1) Real output (value added) originating in the personal,[2/] government, and agriculture sectors are specified exogenously. As part of the process of specifying real output in the government sector, government expenditure on goods and services in constant dollars (a component of aggregate demand) is also specified.

(2) Real consumption expenditure, residential construction, business nonagricultural capital formation and inventory change, imports and most exports[3/] are endogenously determined by behavioral equations. These components (along with exogenous components) are summed to obtain real gross national product in constant dollars.

1/ This is not the order in which the equations are arranged in the solution program. See Sawyer (1974), pp. 142-158, for the actual listing of the equations.

2/ In the National Income and Expenditure Accounts published by Statistics Canada, the personal sector includes both households and private non-commercial institutions. Employees of these institutions and of households are regarded as working in the personal sector and output (value added) originates in this sector and is valued at the real labour income of these employees.

3/ Exports of motor vehicles and parts to the United States and of wheat and wheat flour to the rest of the world are determined exogenously.

"(3) Real output in the business non-agriculture sector is obtained by subtracting from real GNP real indirect taxes less subsidies and real output originating in the personal, government, and agriculture sectors.

(4) Prices of real output originating in the personal and agricultural sectors are specified exogenously.

(5) The price of real output originating in the business non-agricultural sector and the wage rate in that sector are endogenous variables whose values are obtained from behavioral equations in the model. Wage rates and prices of purchased goods in the government sector are assumed to move in proportion to wages and prices in the business non-agricultural sector.

(6) The GNP price index is obtained as a weighted average of prices of output originating in the personal, government, agriculture, and business non-agricultural sectors and indirect taxes less subsidies.

(7) Current dollar GNP is obtained by multiplying real GNP by the price index obtained in (6).

(8) Prices of consumer and capital goods are obtained as functions of the GNP price index, or of the price of output in the business non-agricultural sector and the

price of imported goods and services, or of the wage rate in business non-agriculture. An adjustment is made to some prices so that the weighted average of the prices of the expenditure components equals the GNP price index.

(9) National income is obtained by subtracting from GNP capital consumption allowances and indirect taxes less subsidies. Personal income is then obtained by subtracting components of national income which are not distributed to persons (such as undistributed corporation profits) and adding transfer payments received by persons. Personal income taxes are endogenously determined and personal disposable income obtained residually. It is deflated by the implicit price index of personal expenditure on consumer goods and services. Real personal disposable income then enters as an explanatory variable into the behavioral equation for real consumption expenditure.

(10) Corporation profits are endogenously determined as a function of non-wage national income and corporate income taxes and dividends are calculated from behavioral equations.

(11) The primary labour force participation rate (males, 25-54) is determined exogenously but the secondary rate is explained by a behavioral equation. The population in

each labour force group is specified exogenously and the labour force in each of the two categories is then obtained by applying the participation rate to the population estimate and summing. Employment in the non-agricultural business sector is explained by a production function while employment in the other sectors is exogenous. The unemployment rate is then obtained by calculating the number unemployed and expressing this as a percentage of the labour force.

(12) The distinction between actual (nominal) and real interest rates is made in the TRACE model and is based on the assumption that lenders in calculating interest rates do so by adding the expected rate of inflation over the life of the loan to the real rate of return that they desire. Interest rates are therefore explained in the model by three main factors: the rate of change in output in Canada, the deviation of the rate of growth of the money supply about a weighted average of past rates of growth (which is taken as a proxy for the expected rate of growth of the money supply), and a weighted average of current and past rates of change in prices (which is taken as a proxy for expectations regarding price movements).

(13) Capital flows are determined by interest rate differentials between Canada and the U.S.A. and other variables.

The-actual levels of rates are therefore not relevant to the determination of capital flows - only the differentials matter.

(14) A Canadian-U. S. foreign exchange rate is then calculated such that the current and capital accounts of the balance of international payments are brought into balance. The relative prices of exports and imports, and through them the values of virtually all the endogenous variables in the model, are affected by changes in the exchange rate.

(15) The government surplus or deficit is calculated.

(16) The capital formation and saving account is constructed.

B. Personal Expenditure on Consumer Nondurable and Semi-durable Goods and Services

The model distinguishes between personal expenditure on consumer durable goods and expenditure on nondurable and semi-durable goods and services. The latter category of expenditure is related directly to personal disposable income. The nature of the relationship is such that consumption adjusts slowly to a change in income so that it is only after a period of years that consumption levels fully reflect a change in income. Thus consumption expenditures tend to fluctuate less widely than do incomes. This is in accordance with observed consumer expenditure behaviour during business cycles.

C. Residential Construction and Personal Expenditures on Consumer Durable Goods

Expenditures on both of these categories of final demand are explained in a similar way in the TRACE model. In both equations expenditure depends upon the level of real income and upon real interest rates. Real interest rates are calculated by subtracting from the actual rate of interest a weighted average of current and past rates of change in prices (which serves as a proxy for the expected rate of change in prices). As real interest rates rise, expenditure on new housing and on durable goods decreases.

An additional variable which appears in the residential construction equation is the price of new housing relative to the price of consumer goods and services. As the relative price of new housing increases, expenditure decreases.

D. Business Capital Formation (excl. Residential Construction)

Expenditures on new machinery and equipment and on non-residential construction by the business nonagricultural sector respond to changes in the level of real output in this sector, changes in the prices of output in this sector, and to changes in the service price of capital goods. This latter price is related to real interest rates, the rate of taxation of business income, the rate of economic depreciation, tax provisions dealing with capital cost allowances, and the price of capital goods. The adjustment to changes in these variables occurs slowly so that it takes a number of years for the full effect of a change to be reflected in real investment.

Capital expenditures by agriculture and by private non-commercial institutions are treated as exogenous variables in the model.

With respect to inventory change, farm inventories and grain in commercial channels are treated as exogenous variables. Inventory change in the business nonagricultural sector in real terms (that is, in constant dollars) is assumed to adjust to close any gap which develops between the desired and actual stocks of goods. The desired stock is derived by computing an average of the actual

stock/sales ratio for the previous three years. In this way as businesses become more efficient and operate with lower stock/sales ratios, the inventory change equation reflects this. Inventory change in current dollars is derived from the constant dollar change by taking into account the rate of change in the GNP deflator. The inventory valuation adjustment is treated as an exogenous variable.

E. Exports and Imports

(i) Exports of goods

The basic assumption in the TRACE model is that in the aggregate Canada can be regarded as a country selling most of its products on world markets at prices determined on world markets in foreign currencies.[1/] Two markets are treated separately: the United States and the rest of the world. The prices in foreign currencies of Canadian exports are taken as exogenous variables and they are converted to Canadian dollars at the current exchange rate.

The volume of Canada's exports varies with the level of imports of foreign countries. As foreign activity levels go up, so will foreign imports. Canada's share in these foreign markets depends in the model on her willingness to supply goods at the prevailing world prices, given costs of production in Canada.

1/ Motor vehicles and parts, and wheat and wheat flour are exceptions since, as indicated on page 19, these items are exogenous.

These costs are a function of the Canadian price level in the business nonagricultural sector (which in turn is a function of money wage rates, labour productivity, and price of imported goods). The cost of Canadian exports, relative to foreign prices converted to Canadian dollars by the foreign exchange rate, is a major factor in the model in determining variations in the volume of Canadian exports. In the TRACE model, if Canadian prices (and therefore costs) increase in relation to foreign market prices, the volume of Canadian exports would decrease. The same result would follow from an increase in the exchange value of the Canadian dollar which serves to decrease profit margins by reducing the Canadian dollar proceeds of sales at prices quoted in foreign currencies.

There are two exceptions to this general treatment of exports of goods. Exports of motor vehicles and parts to the United States are, because of the U.S.-Canada automobile pact, treated as an exogenous variable as are exports of wheat and wheat flour to the rest of the world.

(ii) Exports of services

In the model there are four components of this item: foreign tourist expenditures in Canada, freight and shipping receipts from abroad by Canadian carriers, income received from abroad, and other receipts on current account. Foreign tourist expenditures are taken to be a function of the level of consumer expenditure in the United States and the price of consumer goods and services in Canada relative to the price in the U.S. (converted to Canadian dollars by the foreign exchange rate). Freight and shipping receipts are a function

of the value of exports of goods and tourist and travel services by Canadians. Income received from abroad is a function of the value of output in the United States. Other receipts (including transfers) are exogenous.

(iii) Imports of goods

The volume of imports into Canada in the model varies directly with the level of economic activity in Canada. Imports of motor vehicles and parts are assumed to grow at the same rate as consumer expenditure on durable goods (an endogenous variable in the model). Other imports are related to real output in the business nonagricultural sector. This relation between the volume of imports and output varies with changes in the. unemployment rate, which serves as a proxy for the degree of utilization of productive capacity in Canada. As the unemployment rate falls, the marginal propensity to import rises. The volume of imports also varies with the price of imported goods (converted to Canadian dollars by the foreign exchange rate) relative to the price of Canadian-produced goods.

(iv) Imports of services

Corresponding to the four categories of exports of services, there are four categories of imports of services. Canadian tourist expenditures abroad depend in the model on the level of consumer expenditure in Canada and the price of consumer goods and services in Canada relative to that in the United States, again converted to Canadian dollars by the foreign exchange rate. Freight and shipping payments are a function of the value of imports of goods

by Canadians. Income paid abroad is a function of the level of dividend and interest payments in Canada. Other payments (including transfers) are exogenous.

E. Prices and Wages

The key price in the TRACE model is the price of output originating in the business nonagricultural sector; in this equation the rate of change of the price of business nonagricultural output moves in response to the rate of change in wage rates in the business nonagricultural sector, the rate of change in labour productivity in this sector, and the rate of change in the price of imported goods. Although a change in the rate of change in one of these variables has some effect-on price of output in the current year, the full impact is spread over a number of years. The rate of change of wage rates in the business nonagricultural sector is explained by an expanded short-run "Phillips curve" equation. In this equation, the rate of change in the wage rate is related to the current rate of change in the price of consumer goods and services (which serves in this equation as a measure of the expected rate of change in prices) and inversely to the unemployment rate.

The prices of output originating in the agriculture and personal sectors and wage rates in these sectors are exogenous in the model.

The implicit price index of gross national product is obtained by computing a weighted average of output in the various sectors of the economy adjusted to include indirect taxes less

subsidies-and to allow for investment income paid to and received from abroad. Prices of consumer goods and services and of capital are related in various ways to the GNP price index, prices of imported goods and services, and domestic wage rates. The prices of exported goods and of imported goods are assumed to be determined exogenously on world markets in U.S. dollars converted to Canadian dollars at the current exchange rate. The price of exports of services is related to domestic wage rates while the price of imported services is assumed to be exogenous in U.S. dollars.[1/]

F. Output, Employment, and the Labour Force

Real output in the agricultural, personal, and government sectors is exogenous in the model. By summing the components of gross national expenditure in constant dollars, the model obtains a value for gross national product in constant dollars. From this an estimate of indirect taxes less subsidies in constant dollars, and output originating in the agricultural, personal, and government sectors are subtracted to arrive. at an estimate of output originating in the business nonagricultural sector.

The relation which economists call a "production function" is then used to convert this estimate of real output in the business non-agricultural sector to an estimate of employment in that sector. The production function relates employment and the stock of capital goods to the level of output. The model assumes that the complete adjustment

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1/ In order to ensure that the GNP price index is also equal to a weighted average of the sum of the price indexes of the various components of gross national expenditure, an adjustment is made to some of prices to ensure that this equality holds.

of employment to a change in output does not occur immediately, but that the effect is distributed over a number of years. Employment in the agricultural, personal, and government sectors is exogenous in the model.

Hours worked in agriculture is exogenous. In the business nonagricultural sector it is assumed that hours move inversely with changes in real wage rates (that is, in money wage rates adjusted for changes in the price of consumer goods and services). Again it is assumed that the adjustment to a change in real wage rates is spread over several years.

The labour force is divided into two groups: (1) the primary labour force, which consists of males in the age group 25 to 54, and (2) the secondary labour force, which consists of females and other males. The participation rate for the primary labour force group has been relatively constant for many years and this rate is treated as an exogenous variable in the model. The secondary participation rate, however, has risen steadily from 36 per cent in 1954 to 45 per cent in 1973. This growth in the secondary labour force participation rate is explained in the model by rising real wage rates. Cyclical variation in the participation rate is explained by changes in job opportunities as measured in the model by the ratio of total employment to total labour force.

In the model the number unemployed is obtained by subtracting the model's estimate of the number employed from the model's estimate of the total labour force. The unemployment rate expresses this number as a percentage of the labour force.

-G. Personal and Corporate Incomes

In the model national income is obtained by taking the constant dollar value of gross national product, multiplying it by the GNP price index, and subtracting capital consumption allowances and indirect taxes less subsidies. Corporate capital consumption allowances are endogenous in the model and are related directly to the price of capital goods and to the stock of capital goods. Other capital consumption allowances are exogenous. Personal income is obtained from national income by subtracting retained earnings in the corporate sector, adding transfer payments to the personal sector, and making a number of other adjustments. Personal disposable income is then obtained by subtracting personal direct taxes from personal income. Real personal disposable income is estimated by dividing it by the price index of personal expenditure on consumer goods and services. It is real personal disposable income that enters into the consumption expenditure equations described above in section B.

The model then divides national income into waaes, salaries, and supplementary labour income; corporate profits before taxes; and other income. Other income is a residual obtained by subtracting estimates of the first two components from national income. The total labour income is arrived at by multiplying the various employment figures by their respective wage rates and hours, where applicable. Corporate profits are estimated as a function of the value of output in the business sector less labour income in that sector and corporate capital consumption allowances. The equation

also includes the unemployment rate in order to capture the cyclical variation in profits. Corporate dividends are related to corporate profits after taxes and it is assumed that dividends adjust over a number of years to a change in profits after taxes.

H. Government Expenditure and Revenue

Employment in the government sector is assumed in the model to be exogenous, as is expenditure by the government on goods and other services in constant dollars. Wage rates in the government sector are assumed to move in the same proportion as wage rates in the business nonagricultural sector and the price of other goods and services purchased by governments is assumed to move in the same proportion as the aggregate of goods and services produced by the economy. Thus government current expenditure on goods and services moves in response to changes in either exogenous real components or in the endogenous wage rates and prices. Government expenditure on capital goods and inventory change are treated as exogenous in both current and constant dollars.

Three categories of transfer payments are treated as endogenous in TRACE Mark IIIR:[1/] (1) unemployment insurance payments, (2) old age security pensions, and (3) workmen's compensation. Unemployment insurance payments are related to number of unemployed, to the weekly unemployment insurance benefit rate, and to the price of consumer goods and services on the assumption that such payments

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1/ In some other versions of the model, the categories of endogenous transfer payments are different.

will be indexed. Old age security payments are related to the population eligible for these benefits, the annual old age pension, and the price of consumer goods and services. Workmen's compensation payments are related to the level of employment and the price of consumer goods and services. Other transfer payments are treated as exogenous variables.

On the revenue side, the endogenous sources of revenue are personal income tax, the corporate income tax, customs import duties, and components of indirect taxes which includes customs import duties, federal excise taxes, an&provincial sales taxes. Other tax revenues are treated as exogenous variables.

Personal-income taxes are related to the number of people employed and the average personal income of employed persons less contributions to the Canada and Quebec pension plans, and the level of the basic personal income tax exemption. An adjustment is made to the tax revenues to allow for the indexing of the personal income tax exemption and rate brackets.

Corporate income taxes are estimated using a relation that involves both the high and low rates of corporate income taxes, corporate profits before taxes, the cutoff point between the high and low rates, and the unemployment rate which serves as a proxy for the phase of the business cycle and which captures the effects of cyclical changes in the distribution of firms by profit categories.

For customs import duties an implicit duty rate is calculated for past periods by dividing total duties by the value of the imports of goods. A similar procedure is followed with the aggregate of excise taxes and duty sales taxes and similar taxes on goods sold or produced in Canada. This is divided by an aggregate sales figure to arrive at an implicit tax rate. Both of these implicit tax rates are treated as exogenous variables for projections.

The government surplus or deficit is then calculated by subtracting total expenditure on goods and services and transfer payments from total revenue.

I.- Interest Rates

Canadian interest rates are determined in TRACE by three main factors: the rate of change in output in Canada, the deviation of the rate of growth of the money supply about a weighted average of past rates of growth (which is taken as a proxy for the expected rate of growth of the money supply), and a weighted average of current and past rates of change in prices (which is taken as a proxy for expectations regarding price movements).

The change in the rate of output is a proxy for a number of factors which would affect the demand for loans in Canada. For example, if investment in machinery and equipment increased, real output would increase and this would put upward pressure on long-term interest rates (since demand for loans will increase due to the need of financing the increased investment in machinery and equipment). The change in real output variable will capture this effect. An increase in the rate of growth of the money supply beyond what is expected, on the other hand, will operate to reduce interest rates.

When the trend of prices is such that lenders and borrowers expect an appreciable price increase, it is anticipated that loans will be repaid in money which will not buy the same amount of goods as the money which was lent; lenders will tend to demand, and borrowers be willing to pay, higher interest rates.

The long-term interest rate equation in TRACE shows the price expectation factor being incorporated fully into interest rates: a rise in the expected rate of price increase by one percentage point causes the long-term interest rate to rise by one percentage point. For the short-term interest rate, a rise in the expected rate of price increase causes short rates to increase by three-quarters of one percentage point.

J. Balance of Payments and the Foreign Exchange Rate

We now describe the relation between foreign trade, capital flows, and the foreign exchange rate. The difference between the value of net imports of goods and services (imports less exports) and the net inflow of capital from abroad can be termed the overall balance of international payments. When imports exceed exports, this deficit on current account can be financed by the inflow of capital. If the current account deficit is not balanced by a net inflow of capital, there will be a net demand for foreign currencies to cover the overall deficit on the balance of payments. Similarly, if there is a surplus in the overall balance of payments, there will be a net demand for Canadian dollars in the foreign exchange market.

If the exchange rate is flexible, with no government intervention in the foreign exchange market, the rate of exchange between foreign currencies and the Canadian dollar adjusts to produce a balance between the current and capital accounts. If there is an excess demand for foreign currency in the foreign exchange market, the value of foreign currency will rise relative to the value of the Canadian dollar; that is, the price of a unit of foreign currency in Canadian dollars will rise.[1/] This is referred to as a depreciation

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1/ The foreign exchange rate can be defined either as the price of a unit of foreign currency in Canadian dollars or as the price of a Canadian dollar in foreign currency. The former definition is used in this study and in the TRACE model.

of the Canadian dollar. Conversely, if there is an excess demand for Canadian dollars in the foreign exchange market (i.e., an excess supply of foreign currency), the price of a unit of foreign currency in Canadian dollars will fall; that is, there will be an appreciation of the value of the Canadian dollar. In the projections and simulations in this report we have taken the exchange rate to be flexible.[1/]

We shall now summarize how capital flows and the foreign exchange market are determined in the simulation experiments.

(i) Short-term capital flows

Short-term capital flows relate to investments in short-term assets (e.g., treasury bills or commercial or financial paper). The TRACE model explains net short-term capital flows (i.e., total short-term inflow-s minus total short-term outflows). Such flows are determined mainly by the "covered" interest differential between Canada and the U.S.. Since most capital flows are between Canada and the U.S., the U.S. interest rate is chosen as the appropriate interest rate to compare to the Canadian rate. The interest rate used for both countries is the interest rate on 91-day treasury bills.

1/ If the exchange rate is being maintained at a fixed value, equilibrium is maintained in the foreign exchange market by intervention in the market by the Government of Canada. When there is excess demand for foreign currencies in the foreign exchange market, the Government will sell foreign currencies from its holdings and when there is excess supply of foreign exchange (i.e., an excess demand for Canadian dollars in the foreign exchange market), the Government will buy foreign exchange. The TRACE model can be used under either a fixed or a flexible (with or without bands) system depending on the assumptions made when the model is run. The behaviour of the economy under different exchange rate regimes is discussed in J.L. Carr, G.V. Jump and J.A. Sawyer, "The Operation of the Canadian Economy under Fixed and Flexible Exchange Rates: Simulation Results from the TRACE Model," Working Paper 7405, Institute for the Quantitative Analysis of Social and Economic Policy, University of Toronto, June, 1974.

The "covered" interest differential is the difference between the Canadian and U.S. rate adjusted for expected changes in the exchange rate.[1/] The covered differential is a differential where there is no exchange rate risk. The greater the covered differential between the Canadian and U.S. interest rate, the more attractive is both borrowing in the U.S. by Canadian residents and investment in Canada by U.S. residents; hence, the greater will be the net inflow of short-term capital funds. TRACE does not determine any U.S. interest rates; these rates are taken as exogenous.

(ii) Long-term capital flows

In the TRACE model there are three types of long-term capital flows: direct investment in Canada, portfolio investment, and other long-term capital flows.

Direct investment in Canada is investment by non-residents in Canadian companies of which they have a controlling interest. There are two main determinants of direct investment. The first is the need for external financing of investment. TRACE constructs a variable which is defined as the sum of investment in non-residential construction in Canada plus investment in machinery and equipment in Canada minus undistributed corporate profits and minus capital consumption allowances. This constructed variable represents the amount Canadian firms have to raise in the Canadian capital market and/or from foreign parent

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1/ The covered differential is equal to the uncovered differential plus the forward premium. The forward premium is the spread between the forward and spot rates of exchange divided by the spot rate of exchange and is exogenous in the model. In the projection period we assumed it was zero.

companies. The greater is this need for financing, the greater will be borrowings from foreign parent companies (and also the greater will be borrowings from the Canadian capital market) and thus the greater will be direct investment in Canada.

The second determinant is the Canada-U.S. long-term interest rate differential. The interest rates used for both countries are the long-term government bond rates. The greater the Canadian interest rate is vis-à-vis the U.S. rate, the more likely will Canadian subsidiaries of foreign companies borrow from their U.S. parent and hence the greater will be foreign direct investment.

Portfolio investment is the investment by foreigners in long-term Canadian securities for portfolio reasons. The prime determinant in the model for portfolio investment in Canadian securities is the differential between the long-term government bond rate in Canada and that same rate in the U.S.. The greater is the Canada rate vis-à-vis the U.S. rate, the more profitable is it for foreigners to lend in Canada or for Canadians to borrow in the U.S., and therefore the greater will be the portfolio inflow of funds.

Other long-term capital flows (mainly outflows, including such items as Canadian direct investment abroad, retirements of bond issues, official new issues, export credits, and government loans and advances) are exogenous.

(iii) Foreign exchange rates

In TRACE Mark IIIR the Canada-United States foreign exchange rate, when it is not fixed, is an endogenous variable[1/] which is determined as the rate which brings the current and capital accounts of the balance of payments into balance. It is established by solving the system of equations comprising the model to find this rate. Thus, the exchange rate is determined by all the factors which affect the balance of international payments. In turn, changes in the exchange rate directly affect foreign trade, tourist expenditures, and freight and shipping receipts and through them the level of real output and prices and interest rates in Canada.

The only other exchange rate which appears in the model is exogenous and is the rate of exchange between the U.S. dollar and a number of overseas foreign currencies. This exchange rate is a weighted index where the weights are proportional to Canada's exports to her principal trading partners. To obtain the rate of exchange between the overseas currencies and the Canadian dollar, the U.S.-overseas rate is converted by the Canada-U.S. rate to yield the Canada-overseas rate.

1/ The TRACE model could also be used for solutions under a system in which the exchange rate is fixed at a precise figure. The difference between the solution procedures is that if the rate is fixed, the rate is an exogenous variable and the change in official international reserves is an endogenous variable. If the rate is flexible, the change in reserves is constrained to be (approximately) zero (or to be not greater than any set amount) and the exchange rate becomes an endogenous variable whose value is determined by simultaneous solution of the equations comprising the model. The solution procedure can also be adapted to the situation in which the rate is flexible within a band but becomes fixed if the solution moves the rate to either the upper or lower limit of the band; at that point, the rate would become, temporarily, an exogenous variable and the change in reserves would become an endogenous variable.

It may be useful to follow through the repercussions resulting from some economic impulse originating either abroad (which increases external demand and/or prices for Canadian exports) or in Canada (e.g., an unusually large wheat crop) which increases Canadian exports. The resultant increase in Canadian incomes and domestic spending and output will induce a number of changes throughout the model. Of prime importance for the international sector is that the increase in Canadian income and expenditure will result in Canada importing more from abroad (these imports are known as ' induced imports'). The increase in Canadian output will also tend to increase borrowing and to put some upward pressure on Canadian interest rates. As Canadian interest rates rise vis-à-vis the U.S. rates, capital will flow into the country. Thus the initial increase in exports (which increased Canada's supply of foreign exchange) induces an increase in imports (which adds to the demand for foreign exchange) and also induces a capital inflow (which adds to the supply of foreign exchange). The net effect of these responses is likely to be that more foreign exchange is supplied than is demanded, and the value of the Canadian dollar is likely to appreciate. The higher price of the Canadian dollar will discourage the volume of exports and encourage the volume of imports. While Canadians will be importing more, imports will be cheaper and because of this one cannot be sure what will happen to the dollar value of imports. However, the induced increase in the volume of imports and the induced decrease in the volume of exports (due to the application of the Canadian dollar) will check the initial rise in real income and output. The fall in the price

of imports will cause a reduction in the general price level in Canada and a reduction in expectations of higher prices. This, together with the effect on output, will counteract the initial increase in Canadian interest rates and capital inflow. The exchange rate will settle at the point where the current and capital accounts of the balance of international payments are in balance again.

L. Capital Formation and Saving

When the model has solved all the equations indicated above, capital formation and saving are then put together. One side of this account shows the total amount of capital formation occurring in both the government and business sectors of the economy. The other side of the account shows the balancing amounts of saving which have taken place in the business, government, personal and non-resident sectors to finance, and thus make possible, this capital formation.

4. THE CONTROL SOLUTIONS

In a previous section we saw that an econometric model does not purport to produce an unconditional forecast of future values for the endogenous variables. Any number of conditional projections are possible, one for each alternative set of values chosen for the exogenous variables. We chose two such projections in each of which the values of the exogenous variables implied the absence of the construction of the natural gas pipeline. Each projection implicitly assumes, however, that energy sources would grow at a rate commensurate with the rate of growth of the economy in the projection. The model does not specify what these sources are but some combination of domestic and imported sources of energy sufficient for the economy to grow at the control solution rate is implicit in the control solution. The projections must be understood therefore to take place in a hypothetical world in which energy sources exist sufficient to sustain the growth rates of the economy assumed in the projections. (This assumption causes a difficulty in our simulation experiments which we discuss in more detail in section 5.) These projections provide two alternative control solutions against which solutions incorporating the pipeline could be compared to estimate the effects of the pipeline on the Canadian economy.

The first control solution is a projection for the period 1976-85 in which relatively low unemployment is assumed throughout the period; that is, unemployment is close to 4 1/2 per cent of the

labour force. The second control solution is one in which unemployment is assumed to be relatively high throughout the period, that is, unemployment is in the neighborhood of 6 per cent of the labour force.

We emphasize again that these projections are not forecasts of the future course of the Canadian economy. They are merely two among many paths that the economy might follow in these years. We have used two control solutions rather than just one in order to provide the analyst with a broader basis for assessing the impact of the pipeline.

Our reason for keying on the unemployment rate as the principal difference between the two control solutions stems from the fact, as we have mentioned before, that the unemployment rate acts as a proxy for the rate of utilization of productive capacity in the TRACE model. In general, one would expect that the impact of the pipeline on real output and other aspects of the economy will vary with the extent to which the resources of the economy are initially being utilized. The marginal propensity to import, for example, increases as the unemployment rate decreases; that is, an increase in aggregate demand in Canada will have a greater induced effect on imports when the unemployment rate is 4 1/2 per cent than when it is 6 per cent. Moreover, the wage rate equation in the model is a modified "Phillips curve" equation in which the rate of change in money wage rates varies inversely with the unemployment rate. Hence wage rate, and therefore price, behaviour will be different in the two situations.

In obtaining these control solutions, in addition to making them conform to a predetermined unemployment rate, we chose values of exogenous variables affecting foreign trade and capital flows such that the foreign exchange rate was approximately parity with the U.S. dollar. This necessitated some changes in values (e.g., foreign prices) in the mid-years of the control solutions. We also tried to keep the share of government expenditure on goods and services relatively constant and to keep the government surplus or deficit from becoming excessively large.

The control solutions contain explicit assumptions about fiscal and monetary policy. The money supply (i.e., current and chartered bank deposits held by the general public) is assumed to grow at the same rate as nominal (current dollar) gross national product. Income tax rates are those stated in the May, 1972 and February, 1973 budgets of the Government of Canada; thus, the basic income tax rates are assumed to decline until 1976 as stated in the 1972 budget. We held the rates constant from 1976 onward. Beginning in 1973 an allowance is made in the personal income tax calculation for the indexing of the exemptions and rate brackets to adjust for changes in the level of prices. Customs import duties and excise and sales tax rates are assumed to be constant. The revenue from withholding taxes is assumed to grow

at the same rate as interest and dividends paid abroad. Government wage rates are assumed to grow at the same rate as wages in the business nonagricultural sector and the deflator for government non-wage expenditure grows at the same rate as the price index of gross domestic product.

An alternative approach to fiscal policy would have been to introduce "reaction functions" (either empirically estimated[1/] or based on rules) so that tax rates or rates of government expenditure respond, for example, to changes in the rate of price increase and in unemployment. This approach was not adopted. Indeed, it would have been inconsistent with our objective of establishing one control solution with a high rate of unemployment. No attempt was made to dispose of any government surplus which might result from increased tax revenues when tax rates are held constant in a growing economy with rising price levels, nor to adjust fiscal policy if a deficit occurred. Since the model solution assumes no direct interaction between a Federal Government surplus or deficit and the rate of growth in the money supply, one interpretation of the solution is that a Government surplus is used to redeem debt or to reduce borrowing that would otherwise take place so that the funds represented by the surplus flow back into the private sector through bond market transactions.

1/ It is difficult to estimate the parameters of empirically-estimated reaction functions from historical data because of the relatively small number of observations and the possibility that policy targets and instruments may have been changing over time. Moreover, the alternating of periods of fixed and flexible exchange rates would complicate the estimation of parameters.

(a) Low unemployment control solution

The "low unemployment" control solution assumes a high rate of growth in international trade over the period 1976-80. Although some moderation in this rate of growth is assumed to occur after 1980, growth still continues at a good pace. The explicit assumptions about world trade and prices of internationally-traded goods are stated in Table 1. The effect of this assumption about world trade and other assumptions which are discussed below was to produce an unemployment rate in Canada in the 1976-85 period of about 4 1/2 per cent.

It is important in understanding the validity of the control solutions for the simulation experiments to recognize the difference between the assumptions which will affect the simulation results and those which will not. To make this distinction we must refer to some of the technical properties of the TRACE model. In describing the model we noted, for example, that both the marginal propensity to import and the rate of increase of money wage rates in the business nonagricultural sector rise as the unemployment rate falls.[1/] Thus, the solution obtained from the model in response to a change in exogenous variables will be different depending upon the unemployment rate, which we use in the model as a proxy for the rate of capacity utilization. The purpose of having two control solutions is to simulate the behaviour of the economy under different assumptions concerning the degree of capacity utilization. It is irrelevant in terms of the objectives of the simulation experiments whether the economy moved to an unemployment rate of 4 1/2 per cent as a result of

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1/ In technical language, these relations are non-linear.

Table 1

LOW UNEMPLOYMENT CONTROL SOLUTION

Percentage Growth Rates for Principal Exogenous Variables for International Trade

(per cent)

	Average Rate 1964-75	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
United States											
Gross national product (constant US$)	4.13	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
Price index of gross national product (US$)	3.68	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Imports of merchandise (constant US$)	9.64	8.00	8.00	8.00	8.00	8.00	8.00	6.00	5.00	5.00	5.00
Price index of merchandise imports (US$)	4.18	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3*50	3.50	3.50
Rest of the World											
Exports of merchandise (constant US$)	8.04	8.00	8.00	8.00	8.00	8.00	"8.00	6.00	5.00	5.00	5.00
Price index of merchandise exports (US$)	3.55	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Canada											
Price index of merchandise imports (US$)	3.23	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Price index of merchandise exports to the U.S. (US$)1/	3.88	3.50	3.50	3.50	3.50	2.50	2.50	2.50	2.50	2.50	2.50
Price index of merchandise exports to the rest of the world 2/	3.22	2.00	2.00	2.00	2.00	2.00	2.00	2.09	2.00	2.00	2.00

1/ Excluding motor vehicles and parts.

2/ Excluding wheat and wheat flour. This index is in units of the value of an verage currency unit (excl. Canada and the U.S.A.) for Canada's principal trading partners (excl. U.S.A.?.

strength in international trade or strong domestic markets. What mattersis the way the economy then responds to a change in exogenous variables given the unemployment rate that exists in the economy (that is, in the control solution) at the time the change takes place.

Before continuing with the assumptions underlying this control solution, an explanation concerning the average figure for the years 1964-75 shown in the table is in order. At the time the control solution was produced, the complete annual national accounts data were only available through 1972. Projections of the values of exogenous variables were made outside the model and the model was then used to project the values of the endogenous variables for 1973 onward. It is the projection values for 1973-75 that enter into the averages for 1964-75 shown in Tables 1-8.

Table 2 shows some of the other assumptions about exogenous variables. Government expenditure on goods and services in constant 'dollars and employment by government were assumed to increase at constant rates as indicated in the Table. The assumptions concerning United States interest rates, agricultural output and prices, and the primary labour participation rate are also shown in Table 2.

Table 2

LOW UNEMPLOYMENT CONTROL SOLUTION

Assumptions Concerning Other Major Exogenous Variables

(percentages)

	Average Rate 1964-75	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Canada		(per cent)									
Primary labour force participation rate 1/	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
		growth rate (per cent)									
Government expenditure on goods and services (constant $)	5.54	4.02	4.04	4.05	4.06	4.06	4.07	4.08	4.08	4.08	4.08
Government employment	5.09	3.17	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.19
Agricultural output	1.26	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
Agricultural prices	2.94	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Population of labour force age	2.46	2.05	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
United States		(per cent)									
Treasury bill rate	5.33	6.50	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.00	5.80
Long-term government bond rate	5.77	8.00	7.60	7.60	7.30	7.30"	7.30	7.30	7.30	7.30	7.30

1/ The primary labour force is defined as males 25-54 years of age.

'-Tables 3-4 show the resulting path of the Canadian economy which forms the "low unemployment" control solution against which the effects of the pipeline will be compared. Table 3 presents growth rates for some of the principal endogenous variables; Table 4 presents interest rates and the balance of international payments.

Table 3

LOW UNEMPLOYMENT CONTROL SOLUTION

The Unemployment Rate and the Growth Rates for Principal Endogenous Variables

(per cent)

	Average Rate 1964-75	1976	1977	1978	1979	1980	1981	1982	1983	1984'	1985
Unemployment Rate	5.00	4.65	4.53	4.55	4.44	4.55	4.61	4.56	4.57	4.55	4.58
Gross national product (current $)	10.03	10.40	10.45	10.36	10.05	10.22	10.20	9.86	9.58	9.49	9.36
Price index of gross national product	4.28	4.72	4.99	4.97	4.72	4.92	4.88	4.80	4.67	4.61	4.54
Gross national product (constant $)	5.51	5.43	5.19	5.14	5.09	5.05	5.07	4.83	4.70	4.67	4.61
Personal expenditure on consumer goods and services (constant $)	5.54	5.89	5.65	5.39	5.59	5.19	5.17	5.33	5.28	5.23	5.16
Business gross fixed capital formation (constant $)	5.60	4.84	4.66	4.11	2.95	3.12	3.28	3.80	4.53	4.15	3.45
Exports of goods and services (constant $)	8.87	6.54	6.37	6.36	6.57	6.40	6.40	5.22	4.40	4.41	4.47
Imports of goods and services (constant $)	8.78	5.98	6.04	5.28	5.66	4.83	4.90	5.14	4.99	4.84	4.57
Labour force	3.10	2.92	2.91	2.77	2.73	2.81	2.71	2.65	2.67	2.59	2.61
Employment	3.17	3.05	3.04	2.75	2.85	2.70	2.64	2.71	2.67	2.61	2.58
Wage rate in business non-agricultural sector	7.92	7.87	8.33	8.30	8.01	8.30	8.23	8.06	7.87	7.82	7.73

Table 4

LOW UNEMPLOYMENT CONTROL SOLUTION

Interest Rates and Balance of International Payments

	Average Rate 1964-75	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Interest Rates						(Percentage Points)					
Treasury bill rate (3 month)	5.35	6.89	6.53	6.42	6.44	6.41	6.41	6.37	6.30	6.22	6.14
Differential between Canadian and U.S. bill rate	-0.04	0.39	0.33	0.22	0.24	0.21	0.21	0.17	0.10	0.22	0*34
Long-term Government of Canada bond yield (10 year and over)	6.94	8.94	8.94	8.76	8.51	8.40	8.44	8.42	8,36	8.29	8.22
Differential between Canadian and U.S. bond rate	1.17	0.94	1.34	1.16	1.21	1.10	1.14	1.12	1.06	0.99	0.92
Balance of Payments						(Billions of Dollars)					
Current account balance	-0.43	-0.88	-0.93	-0.51	-0.07	0.50	1.15	1.03	0.44	-0.13	-0.52
Long-term capital movements	1.10	0.58	0.65	0.29	-0.15	-0.71	-1.37	-1.23	-0.62	-0.08	0.23
Short-term capital movements	-0.17	0.29	0.27	0.22	0.23	0.22	0.22	0.20	0.17	0.22	0.27
Foreign Exchange Rate	1.04	0.998	0.999	0.998	0.999	(Canadian Dollars per U.S. Dollar) 0.998	0.997	0.999	0.998	0.998	0.998

(b) High unemployment control solution

The "high unemployment" control solution was obtained by assuming lower rates of arowth in international trade than did the "low unemployment" control solution. Table 5, which may be compared with Table 1, shows these assumptions. Table 6, which is similar in content to Table 2, gives the values of some of the other exogenous variables used to create the high unemployment control solution. Since the proportion of government expenditure to total GNP is approximately the same in both solutions, government expenditures grow at a slightly lower rate in the high unemployment solution than in the low unemployment solution. Agricultural prices are also assumed to be somewhat lower in the high unemployment solution. Lower rates of growth in imports and prices are assumed in the United States and, in keeping with this assumption, U.S. interest rates are also assumed to be lower. Both solutions assume the same structure of income tax rates but in the high unemployment control solution the implicit tax rate for excise and sales taxes is slightly lower than in the low unemployment control solution in order that there be not too large an " imbalance in the government account.

Tables 7-8 present the solution values of the principal endogenous variables for the high unemployment control solution. It should be remembered that the main difference for the pipeline simulation experiments is, however, the difference in the degree of slack in the economy as indicated by the difference in the unemployment rate in the two control solutions.

Table 5

HIGH UNEMPLOYMENT CONTROL SOLUTION

Percentage Growth Rates for Principal Exogenous Variables for International Trade

(per cent)

	Average Rate 1964-75	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
United States											
Gross national product (constant US$)	3.92	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Price index of gross national product (US$)	3.56	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Imports of merchandise (constant US$)	9.14	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Price index of merchandise imports (US$)	4.06	2.50	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Rest of the World											
Exports of merchandise (constant US$)	7.54	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Price index of merchandise exports (US$)	3.47	2.50	2.50	2.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Canada											
Price index of merchandise imports (US$)	3.14	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Price index of merchandise exports to the U.S. (US$)1/	3.84	3.00	3.00	3.00	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Price index of merchandise exports to the rest of the world2/	3.22	3.00	3.00	3.00	2.50	2.50	2.50	2.50	2-.50	2.50	2.50

1/ Excluding motor vehicles and parts.

2/ Excluding wheat and wheat flour. This index is in units of the value of an average currency unit (excl. Canada and the U.S.A.) for Canada's principal trading partners (excl. U.S.A.).

Table 6

HIGH UNEMPLOYMENT CONTROL SOLUTION

Assumptions Concerning Other Major Exogenous Variables

(percentages)

	Average Rate 1964-75	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Canada					(per cent)						
Primary labour force participation rate[1/]	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
					growth rate (per cent)						
Government expenditure on goods and services (constant $)	5.49	3.94	3.95	3.95	3.95	3.95	3.94	3.93	3.91	3.88	3.85
Government employment	5.09	3.17	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.19
Agricultural output	1.26	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
Agricultural prices	2.82	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Population of labour force age	2.46	2.05	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
United States					(per cent)						
Treasury bill rate	5.37	5.50	5.00	4.00	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Long-term government bond rate	5.77	7.00	6.00	5.50	4.75	4.25	4.00	4.00	4.00	4.00	4.00

1/ The primary labour force is defined as males 25-54 years of age.

Table 7

HIGH UNEMPLOYMENT CONTROL SOLUTION

The Unemployment Rate and the Growth Rates for Principal Endogenous Variables

(per cent)

	Average Rate 1964-75	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Unemployment Rate	5.10	6.01	5.95	6.00	6.00	5.91	6.03	6.23	6.31	6.34	6.41
Gross national product (current $)	9.78	7.44	6.82	6.03	6.38	7.16	6.29	6.07	6.28	6.02	5.99
Price index of gross national product	4.26	1.56	1.54	1.23	1.51	1.78	1.82	1.80	1.61	1.48	1.52
Gross national product (constant $)	5.30	5.79	5.20	4.74	4.79	5.29	4.40	4.20	4.60	4.48	4.39
Personal expenditure on consumer goods and services (constant $)	5.28	6.29	5.44	5.37	5.06	5.27	4.83	4.63	4.75	4.61	4.51
Business gross fixed capital formation (constant $)	5.36	7.56	5.50	4.00	4.44	5.57	4.18	2.21	3.99	4.14	3.91
Exports of goods and services (constant $)	8.52	3.60	4.10	4.35	3.65	3.52	3.51	3.52	3.57	3.60	3.58
Imports of goods and services (constant $)	8.19	5.47	3.74	3,11	3.50	3.98	2.95	2.64	3.03	2.92	2.77
Labour force	3.06	2.69	2.69	2.55	2.44	2.61	2.45	2.29	2.32	2.23	2.22
Employment	3.02	2.67	2.76	2.50	2.43	2.70	2.32	2.08	2.23	2.19	2.15
Wage rate in business non-agricultural sector	7.84	3.72	3.85	3.30	3.94	4.39	4.12	4.13	4.00	3.79	3.87

Table 8

HIGH UNEMPLOYMENT CONTROL SOLUTION

Interest Rates and Balance of International Payments

	Average Rate 1964-75	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Interest Rates					(Percentage Points)						
Treasury bill rate (3 month)	5.32	6.23	4.95	4.00	3.67	3.79	3.80	3.82	3.87	3.79	3.70
Differential between Canadian and U.S. bill rate	-0.06	0.73	-0.05	0.50	0.17	0.49	0.30	0.32	0.37	0.39	0.20
Long-term Government of Canada bond yield (10 year and over)	6.92	8.53	7.79	6.72	5.67	5.09	4.91	4.95	5.03	5.05	4.99
Differential between Canadian and U.S. bond rate	1.16	1.53	1.79	1.22	0.92	0.84	0.91	0.95	1.03	1.05	0.99
Balance of Payments					(Billions of Dollars)						
Current account balance	-0.34	-0.41	-0.30	0.18	0.15	-0.13	0.02	0.37	0.58	0.91	1.34
Long-term capital movements	1.00	-0.02	+0.19	-0.30	-0.35	-0.12	-0.29	-0.64	-0.86	-1.17	-1.56
Short-term capital movements	-0.18	0.44	0.11	0.13	0.20	0.25	0.26	0.27	0.28	0.25	0.21
Foreign Exchange Rate	1.04	(Canadian Dollars per U.S. Dollar) 0.998	1.000	1.001	0.999	1.000	1.000	1.000	1.000	0.999	0.999

5. THE SIMULATION EXPERIMENTS

A. Methodology

The basic methodological approach used to assess the macroeconomic effects of the construction and operation of a Mackenzie Valley pipeline was simulation analysis. Data regarding the construction of the pipeline and various assumptions regarding the markets in which Mackenzie Delta natural gas might be sold were imposed upon the model to obtain a series of solutions simulating the path of the economy under the two alternative assumptions concerning the state of the economy. Comparisons of these solutions with their respective control solutions yielded quantitative estimates of the pipeline's impacts under a variety of conditions.

The methodological approach followed in all of the experiments may be illustrated by considering the example of a specific set of pipeline assumptions taken in conjunction with the assumption of low unemployment. This solution was generated under assumptions identical in all respects save one to the assumptions embodied in the low unemployment control solution. The one difference was, of course, that in the second solution it is assumed that pipeline will be constructed and operated in the 1976-85 period. Comparison of the resultsof this solution with the low unemployment control solution were then made. Differences in the solution values represent estimates of the macroeconomic impact of a pipeline built and operated under conditions of low unemployment and high rates of capacity utilization in the economy.

As we noted on pages 4-6, the outcome may be affected by the division of sales of Mackenzie Delta gas between exports and domestic markets. The methodological differences between simulating a pipeline which will transport Arctic gas to both domestic and export markets (Cases A and C.) and one which will transport gas for export only (Case B) are perhaps best illuminated by consideration of how the control solutions are to be interpreted. As earlier noted, our two control solutions represent hypothetical alternative paths the Canadian economy might follow in the absence of any sort of Arctic gas pipeline. Implicit in these control solutions are assumptions that energy supplies will be forthcoming from somewhere to enable the Canadian economy to grow at the control solution growth rates.

The word "implicit" is emphasized because the TRACE model does not contain an explicit, detailed energy sub-sector (nor does any other macroeconometric model that we know of). In fact, the model contains no energy sub-sector at all. In light of this, the control solutions must be interpreted as being based on the implicit assumption that future energy needs are met through "normal" channels of development; i.e., the growth of energy supplies in the simulation period is generated through the mechanisms that operated to increase energy supplies over the post-war sample period used to estimate the model's parameters. The control solutions depict, in effect, a growing economy fueled by growing energy supplies derived from these traditional domestic or import sources. It is impossible to be more explicit about the energy implications embedded in the control solutions.

--The construction and operation of a Mackenzie Valley pipeline which distributes gas to domestic markets causes a problem in the interpretation of our simulation results. Since the hypothetical world of the control solution already contains sufficient energy sources to support economic growth, we must assume that Mackenzie Delta gas displaces energy sources in the control solution. Because the model does not contain an energy sector, we do not know whether the displaced energy from the control solution was imported or domestically-produced. In the former case imported energy would be reduced whereas in the latter case either Canadian investment in non-Arctic energy sources would be reduced or non-Arctic energy would be released to serve export markets. Since the model cannot tell us the answer, we present results based on the various alternative possibilities inherent in the control solution. In CAGSL's judgment the most likely outcome in the real world of the 1980s will be that Mackenzie Delta gas will displace imported energy.[1/] We therefore give precedence to this case (Case A) in this report.

A pipeline (Case B) in which all Alaskan and Mackenzie Delta gas is exported to the United States represents a case in which the construction of a pipeline through which passes only gas destined for export will have no direct displacement effects on alternative forms of Canadian energy investment. It does not compete in the domestic energy market. The energy sources implicitly assumed to exist in the control solutions are not affected and these sources continue to fuel the domestic economy even after the pipeline comes into

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1/ See footnote 1, page 4.

operation. Case B is therefore a straightforward case since no assumptions need to be made about displacement of energy in domestic markets. In contrast, both Cases A and C require an assumption about the source of the energy which is displaced by Delta gas in domestic markets.

The methodology used in performing the Case B simulations was based on the key assumption that the direct macroeconomic effects of the pipeline can be simply added on to the control solution. That methodology was appropriate for that case. It is not, however, appropriate if the pipeline is to be used to supply domestic needs; for a pipeline which channels Arctic gas into Canadian markets will displace some alternative means of supplying energy. In other words, some of the expansion of traditional energy sources which is implicitly assumed to occur in the control solutions would not occur if a pipeline to supply the domestic market were to be built.

In order to perform the Case A simulation, it was necessary to reduce some of the imported expenditures which (implicitly) represent outlays for energy in the control solutions. In theory, the reduction should be equal in magnitude to the amount of spending that would have been necessary to provide energy in the absence of the pipeline. Since the TRACE model does not contain an energy sub-sector, the model could not by itself generate these offsetting expenditures as part of the induced effects of the pipeline. Instead, the amount of the offset had to be calculated a priori and used as an input in the simulation experiments.

Canadian Arctic Gas Study Limited provided the authors of this report with a set of data, based on the assumption that half of the output (less gas used in the transmission process) of the Mackenzie Delta gas fields will be transported through the pipeline and sold domestically in Canada and that this gas will displace imported energy. The other half is assumed to be exported to the U.S. Throughout the operations phase it is assumed that all Alaskan gas will be transported directly to the U.S. These are the Case A data.

The most straightforward assumption for case A is that every dollar of Mackenzie Delta gas sold domestically displaces one dollar's worth of energy imports. That is, we assume a unit of energy costs the same number of dollars regardless of its source. The direct economic impact of this case would be almost identical with that of the exports-only case (Case B). Relative to Case B, every dollar's worth of gas diverted to the domestic market in Case A represents the loss of one dollar in export revenues. If, in addition, the diversion displaces a dollar's worth of imports, the direct effect on both the level of gross national product and the balance of payments is identical in the two cases. The only difference lies in the levels of exports and imports, which are lower by equal amounts in Case A. An alternative set of simulations based on this case can differ from the Case B simulations only by "second-order" effects attributable to changes in the composition of aggregate gross national product.

Since the model does not indicate what proportion of the energy sources implicit in the control solution are imported or domestic, in order to complete the analysis of the cases possible, given the hypothetical world of the control solution, we also include two other cases (Cases Cl and C2),

(C1) One case is that a pipeline simply displaces some non-Arctic oil and gas in the domestic market and diverts it to the export market. In the absence of detailed cost estimates, we must make the assumption in this case that every dollar of Mackenzie Delta gas shipped to domestic markets generates an additional one dollar of Canadian energy exports. From a macroeconomic point of view, case Cl would look identical to the exports-only case. Exports of Mackenzie Delta gas which occur in Case B would be replaced dollar-for-dollar n Case Cl by exports of other energy supplies. There is, therefore, no need to perform additional simulat on experiments to deal with this case.

(C2) Alternatively, Mackenzie Delta gas might displace higher cost energy, some of which is not competitive with the natural gas a pipeline would introduce. In that case, in our simulation experiment the construction of the pipeline would mean that investment in the pipeline would displace some investment aimed at expanding non-Arctic energy sources.

To test this we have arbitrarily selected an amount equivalent to one quarter of the capital cost of the pipeline as illustrative of the amount of non-Arctic energy that might be displaced.[1/]

Under this assumption (Case C2), the direct impact on the economy of a pipeline would be similar to the impact of an exports-only pipeline except that (a) every dollar spent on pipeline construction would add on to total direct spending only 75 cents--the other 25 cents being offset by displaced investment in non-Arctic energy transportation; and, to be consistent, (b) one-half of the investment in Mackenzie gas field development stimulated by a Case B pipeline would be offset by displaced investment in non-Arctic oil and gas field development. Case C2 represents, in effect, a scaled-down version of the exports-only case with regard to its impacts on the economy. Both its direct and induced effects on macroeconomic variables would be expected to be smaller.

To sum up, we have distinguished three sets of pipeline assumptions (cases A, B, and C) and two alternative states of the economy (low and high unemployment). Thus, we had six possible simulation experiments we could have performed and whose results we could have presented. Tables 10-21 Present the Case A results

1/ The other three quarters represents Alaskan gas and Mackenzie Delta gas shipped to the United States.

in detail for both the low and high unemployment cases while Appendix Table 1 presents summary results for Cases B and C for the low unemployment case.

For most variables the pipeline's total impact can be broken into two parts: a "direct" effect and an "induced" effect. The "direct" effect refers to that part of the total impact arising from expenditures made on labour, equipment, materials and services for the construction and operation of the pipeline. The "induced" effect refers to (a) that part of the impact which results from the spending of the increase in incomes arising from the construction and operation expenditures and (b) that part of the impact which results from price changes, foreign exchange rate changes, and so forth. These induced effects feed back on incomes and expenditure and produce further changes in these variables. The solution of the model takes all these feedbacks into account and calculates an estimate of the total induced effect.

It is possible to sub-divide the total impact into its direct and induced components (for most variables) because of the way in which the assumptions regarding construction and operation of the pipeline were introduced in performing the simulations. A number of detailed changes had to be made to specific equations within the TRACE model in order to facilitate the introduction of these assumptions.[1/] The sole function of the modifications was to permit expenditures made in construction and operation of the pipeline to be added to the solution

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1/ A detailed explanation of equation modifications is contained in the Appendix, "Notifications Made to TRACE Mark IIIR to Facilitate Simulaton of Mackenzie Valley Natural Gas Pipeline."

values of-specific variables within the model. That is, the modifications were made so that, for example, the relationships generating solution values for imports within the model could be incremented by the total of imports purchased for use in building and maintaining the pipeline.

Once the appropriate equations had been modified, a new set of variables pertaining specifically to expenditures on the pipeline became part of the model. These variables are exogenous to the model; i.e., the values taken on by the variables in any simulation are pre-selected by the model-builder and are, therefore, part of the assumptions which underlie the simulation. By assigning to these variables values calculated from estimates of the capital cost of the pipeline's construction and its operating revenues and expenditures, the simulations Were performed.

It should be pointed out that the modifications made to the model's equations in no way affect the behaviour of the model over a period of years. In fact, if the value of each of the new variables introduced by the modifications is set at zero for the 1976 to 1985 interval, the modified model will produce solutions identical in all respects to the control solutions. This is as it should be; a zero value for each of these variables would involve the explicit assumption that the pipeline is not being built.

The critical assumption underlying this methodology is that the direct effects of the pipeline can be added on to the control solution by adding exogenous variables representing the pipeline to the equations of the model. As indicated earlier, this implies that

the pipeline is not part of the "normal" growth of the economy as represented by the values of the endogenous variables generated in the control solutions. Adding the pipeline on in this way does not, however, prejudge the extent to which the pipeline makes a net addition to real output and employment in the Canadian economy. The net addition depends on the amount of the direct effect plus the induced effects (which, in some cases, are negative). Negative induced effects represent the displacement by the pipeline of other types of economic activity. The extent to which net additions are made depends, in part, on the degree of utilization of productive capacity in the economy at the time construction is begun. This is one reason for having two control solutions, i.e., so that the sensitivity of the results to the state of the economy can be seen.

The values of the most important pipeline-specific variables used in the simulations are presented in Table 9. The same values of the pipeline-specific variables are used in both the high and low unemployment Case A solutions. The constant dollar figures are the same and the escalation factors for price increases built into the estimates are also taken to be the same in the two solutions. (The values of the pipeline-specific variables are estimates which are necessarily subject to some margin of error and fine distinctions between the input into the two solutions would not be justified.)

To return briefly to the point raised earlier concerning the distinction between direct and induced effects, it should be noted that the capital expenditure figures in Table 9.

Table 9

Values of Pipeline-Specific Inputs for the Case A Simulations

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
CCGP9 Capital consumption allowances, gas pipeline, billions of dollars	0.0	0.0	0.0	0.052	0.162	0.233	0.268	0.308	0.336	0.334	1.693
CIWGP9 Foreign debt (net of retirements) raised by the pipeline company, billions of dollars	0.0	0.750	1.114	0.994	0.028	-0.165	-0.166	-0.218	-0.233	-0.186	1.918
CPGP9 Corporation profits Plus CCA, gas pipeline, billions of dollars	0.0	0.0	0.0	0.141	0.520	0.781	0.927	1.084	1.110	1.097	5.660
CTGP9 Corporation income taxes, gas pipeline, billions of dollars	0.0	0.0	0.0	0.047	0.186	0.285	0.343	0.404	0.405	0.400	2.070
DIFGP Dividends paid to non-residents by the pipeline company, billions of dollars	0.0	0.0	0.0	0.0	0.0	0.024	).147	0.294	0.172	0.169	0.806
DIVGP9 Total dividends paid, gas pipeline, billions of dollars	0.0	0.0	0.0	0.0	0.0	0.048	0.316	0.633	0.369	0.364	1.730
ECGP Total pipeline employment during construction phase, millions of men	0.002	0.004	0.008	0.006	0.004	0.002	0.001	0.001	0.0	0.0	0.028
EGP6 Total employment required to operate the pipeline, millions of persons	0.0	0.0	0.0	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.005
INCGP Interest paid to residents during operations phase, gas pipeline, billions of dollars	0.0	0.0	0.0	0.018	0.073	0.108	0.100	0.102	0.099	0.087	0.587

Continued.

Table 9 (Cent'd.)

Values of Pipeline-Specific Inputs for the Case A Simulations

		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
INFCGP	Interest during construction paid to non-residents, gas pipeline, billions of dollars	0.0	0.039	0.138	0.212	0.149	0.075	0.054	0.023	0.0	0.0	0.690
INFGP	Interest paid to non-residents, gas pipeline, billions of dollars	0.0	0.039	0.138	0.249	0.304	0.296	0.279	0.259	0.235	0.212	2.011
ITCGP9	Indirect taxes paid on the purchase of pipeline materials, construction phase, billions of dollars	0.086	0.177	0.178	0.107	0.032	0.038	0.028	0.008	0.0	0.0	0.654
ITOGP9	Indirect taxes, including royalties on Mackenzie Delta gas, paid by the pipeline company during the operations phase, billions of dollars	0.0	0.0	0.0	0.016	0.041	0.045	0.055	0.064	0.075	0.074	0.370,
LDWGP9	Foreign equity raised by the pipeline company, billions of dollars	0.250	0.205	0.205	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.660
MEGDIS	Imports of crude petroleum displaced by the introduction of Mackenzie Delta gas to supply domestic energy requirements, billions of dollars	0.0	0.0	0.0	-0.190	-0.373	-0.380	-0.464	-0.551	-0.648	-0.638	-3.244

Continued.

Table 9 (Cent'd.)

Values of Pipeline-Specific Inputs for the Case A Simulations

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
MMGP9 Direct imports of materials used in construction and maintenance of the pipeline, incl. services other than interest and dividends paid to non-residents, billions of dollars	0.224	0.402	0.413	0.275	0.098	0.108	0.078	0.023	0.0	0.0	1.621
NRAG9 Associated non-residential investment in Mackenzie Delta gasfield exploration and development, billions of dollars	0.0	0.380	0.426	0.436	0.180	0.133	0.109	0.099	0.088	0.0	1.851
NRGP9 Total non-residential construction expenditures, gas pipeline, billions of dollars	0.674	1.443	1.974	1.435	0.694	0.453	0.325	0.112	0.0	0.0	7.110
PNRAG Implicit price index for non-residential investment in Mackenzie Delta gasfield exploration, based on 1961 = 1.000.		2.142	2.250	2.362	2.480	2.604	2.734	2.871	3.015	-	
PNRGP Implicit price index for non-residential construction expenditures incurred in constructing the pipeline, based on 1961 = 1.000	1.898	1.972	2.099	2.248	2.541	2.501	2.620	2.829	-	-	
PMMGP Implicit price index for imports of goods used in construction of the pipeline, based on 1961 = 1.000	1.865	1.937	2.060	2.208	2.482	2.457	2.574	2.779	-	-	
PWSCP Deflator for wages and salaries paid to pipeline construction workers, based on 1961 = 1.000 1/	1.343	1.410	1.481	1.554	1.632	1.714	1.800	1.889	1.984	2.083	

Continued.

1/ This deflator is adjusted for productivity change.

Table 9 (Cent'd.)

Values of Pipeline-Specific Inputs for the Case A Simulations

		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
PXGGP2	Implicit wellhead price index for exports of Mackenzie Delta gas to the United States, based on 1961 = 1.000				6.035	6.035	6.035	6.035	6.035	6.035	6.035	
PXSGP2	Implicit price index for exports of pipeline transmission services to the United States, based on 1961 = 1.000	-	-	-	2.927	2.884	2.838	2.964	2.961	2.752	2.671	
RBGP	Interest rate payable on foreign debt issued by the pipeline company	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	0.106	
WSCP	Total wages and salaries plus supplementary labour income paid during the construction phase, billions of dollars	0.041	0.115	0.444	0.363	0.250	0.110	0.076	0.030	0.0	0.0	1.429
WSGP9	Wages, salaries, and supplementary labour income generated in operation phase of pipeline, billions of dollars	0.0	0.0	0.0	0.004	0.011	0.014	0.015	0.016	0.017	0.018	0.095
XGUGP9	Exports of Canadian produced gas to the United States, billions of dollars (valued at wellhead)	0.0	0.0	0.0	0.080	0.160	0.165	0.197	0.234	0.288	0.288	1.412
XSGP9	Exports of pipeline services to the United States (= gross royalties paid for transmission of gas), billions of dollars	0.0	0.0	0.0	0.110	0.599	0.966	1.065	1.191	1.172	1.138	6.241

constitute the direct portion of the pipeline's net impact on non-residential construction outlays. In other words, these figures show the amount added to non-residential construction expenditures as a direct consequence of the pipeline's construction. Any other differences that occur in the simulated values of non-residential construction expenditures between the control solution and the pipeline solution represent induced effects.

These induced effects are generated internally by the many interrelationships within the TRACE model. Because of the complexities of these relationships, the magnitudes of the induced effects can only be determined by solving the model. A project as large as the Arctic gas pipeline will have economic effects which influence construction in other sectors of the economy. Some of these effects will act to stimulate construction; others will tend to restrain construction in other sectors. It is the job of the model to sort out the net result of all such factors' and provide a quantitative estimate of the outcome.

To produce a solution the model necessarily relies on the statistical relationships which have existed in the past. What the TRACE model will produce as an estimate of the induced effects of the pipeline on non-residential construction is essentially an estimate of how this sub-component of gross national product has in the past responded to investments of similar kind and magnitude.

The fact that the Arctic Gas pipeline is an unusually large single project should cause no problems in this regard. Even though it is a large undertaking, the construction is spread over a period

of years and its impact in any one year is reduced by its substantial degree of import content and external financing.

A substantial part of the construction of the pipeline will, of course, take place in the Northwest Territories. It is likely to stimulate appreciable additional regional construction and development, but there will also be a substantial "leakage" out of the region so far as induced effects are concerned. We believe it is reasonable to assume that the statistical relationships within the TRACE model will adequately capture the induced effects on the economy as a whole. Only one modification was made in this respect, relating to the acceleration of gas field development in the Arctic that will accompany the construction of the pipeline. From data provided to us, an additional $1,851 million (in current dollars) was added to non-residential construction expenditures in the pipeline simulation on this account over and above what the model would internally have generated.[1/]

The figures pertaining to imports of pipeline materials and services include not only direct imports made by the pipeline company, but also CAGSL estimates of the import content of goods and services purchased by the pipeline company from domestic Canadian producers; e.g., these figures contain both the value of imported line pipe and estimates of the value of imported components used in producing line pipe purchased from Canadian sources. The values for import

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1/ It is therefore included as a "direct" effect in the tables in order to separate the calculations made by the model from the data fed into it.

content of goods and services purchased from domestic producers could have been left to be generated as part of induced imports in the model simulations. However we chose to enter this portion of induced imports directly into the simulations and over-ride the model's equations because the estimates available were thought to be more accurate than those which the model would internally generate.[1/]

1/ See Appendix I, pp. 113-4, for a description of how the model was altered to produce this effect.

B. Results

Since Case A, the case where half of the Delta gas is sold in domestic markets with the resultant displacement of imported energy, is in the opinion of CAGSL the illustrative case comparable to other preliminary design assumptions, we present in detail in the body of this report the Case A simulation results. The Case B and C results are summarized and compared with Case A in Appendix II.

In Tables 10 to 21 we present the detailed results of the Case A simulation experiments we performed, under two alternative assumptions about the rate of unemployment in the control solution. As we have explained, the figures shown in these tables were obtained by taking the difference between a particular control solution which represents a projection of the economy to 1985 on the assumption the pipeline is not built and a projection of the economy to 1985 which is identical in every respect except that it incorporates the building and operation of the pipeline.

The fact that we have used two separate control solutions in our analysis makes it clear that we do not regard either one as a forecast of economic conditions through 1985; this recognizes the obvious impossibility of accurately forecasting the path of the economy. Providing two measures of impact based on two separate projections which span a range of general economic conditions should, however, assist in the process of assessing what the effect of the pipeline will be.

To understand the difference between the simulation results with the two different unemployment rates, it is essential to distinguish between the construction and operating phases. Although the two phases overlap, we obtain an approximate separation if we take the years 1977-79 as being the years which are mainly affected by construction effects[1/] and the years 1983-85 as the years which are mainly affected by operations effects. (The years 1980-$32 are affected by the adjustment of the economy to the ending of the stimulus of the pipeline construction and are not included in the years we look at to see operating phase effects.)

1/ Although in the simulations construction begins in 1976, the laq structure of the model means that some of the impact is not felt until 1977.

TABLES 10-21

CASE A PIPELINE SIMULATION RESULTS

TABLES 10-15 BASED ON LOW UNEMPLOYMENT CONTROL SOLUTION

TABLES 16-21 BASED ON HIGH UNEMPLOYMENT CONTROL SOLUTION

PIPELINE IMPACT, LOW UNEMPLOYMENT CASE

TABLE 10

CHANGE IN REAL GROSS NATIONAL PRODUCT
RESULTING FROM PIPELINE

PIPELINE IMPACT, LOW UNEMPLOYMENT CASE

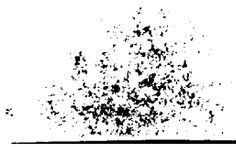
TABLE 10

CHANGE IN REAL GROSS NATIONAL PRODUCT
RESULTING FROM PIPELINE

	1976	1977	978	1979	1980	981	1982	1983	1984	1985	TOTAL
	BILLIONS OF CONSTANT (1961) DOLLARS				BILLIONS OF CONSTANT (961) DOLLARS						
DIRECT EFFECT OF PIPELINE											
PIPELINE CONSTRUCTION	0.355	0.732	0.940	0.638	0.273	0.181	0.124	0.040	0.0	0.0	3.284
LESS: IMPORT CONTENT	-0.120	-0.208	-0.200	-0.125	-0.039	-0.044	-0.030	-0.008	0.0	0.0	-0.775
INTEREST AND DIVIDENDS PAID ABROAD	0.000	-0.025	-0.084	-0.147	-0.174	-0.178	-0.231	-0.294	-0.210	-0.192	-1.534
ASSOCIATED GAS FIELD DEVELOPMENT	0.0	0.177	0.189	0.185	0.073	0.051	0.040	0.034	0.029	0.0	0.778
EXPORTS OF CANADIAN GAS	0.0	0.0	0.0	0.013	0.027	0.027	0.033	0.039	0.048	0.048	0.234
EXPORT REVENUE FROM GAS TRANSMISS ON	0.0	0.0	0.0	0.038	0.208	0.340	0.359	0.402	0.426	0.426	2.199
PLUS: IMPORTS OF ENERGY PRODUCTS DISPLACED BY PIPELINE	0.0	0.0	0.0	0.051	0.100	0.101	0.124	0.147	0.173	0.170	0.866
TOTAL DIRECT EFFECT	0.235	0.677	0.845	0.653	0.466	0.480	0.418	0.360	0.65	0.452	5.052
INDUCED EFFECT OF PIPELINE											
PERSONAL EXPEND ON CONSUMER GOODS & SERVICE	0.095	0.223	0.371	0.330	0.306	0.238	0.284	0.313	0.246	0.272	2.678
GOVERNMENT EXPEND ON GOODS AND SERVICES	0.000	-0.000	-0.001	-0.000	0.000	0.000	-0.001	-0.002	-0.004	-0.004	-0.012
BUSINESS GROSS FIXED CAPITAL FORMATION	-0.037	-0.103	-0.120	-0.102	-0.106	-0.132	-0.123	-0.056	0.056	0.221	-0.504
VALUE OF THE PHYSICAL CHANGE IN INVENTORIES	0.008	0.021	0.016	-0.003	-0.021	-0.027	-0.003	0.010	0.004	0.020	0.025
EXPORTS OF GOODS AND SERVICES	0.005	-0.061	-0.086	-0.101	-0.145	-0.250	-0.272	-0.255	-0.261	-0.188	-1.613
LESS: IMPORTS OF GOODS AND SERVICES 1/	-0.051	-0.254	-0.344	-0.315	-0.250	-0.251	-0.281	-0.316	-0.353	-0.337	-2.752
TOTAL INDUCED EFFECT	0.019	-0.174	-0.162	-0.091	-0.217	-0.422	-0.396	-0.307	-0.312	-0.016	-2.078
GROSS NATIONAL PRODUCT	0.254	0.503	0.683	0.562	0.250	0.058	0.022	0.053	0.154	0.436	2.874
			PER CENT					PER CENT			
CHANGE IN GNP AS % OF CONTROL SOLUTION LEVEL	0.28	0.54	0.69	0.45	0.23	0.05	0.02	0.04	0.12	0.32	
CHANGE IN GNP PRICE INDEX AS % OF CONTROL SOLUTION LEVEL	-0.01	-0.26	-0.44	-0.27	-0.08	-0.07	-0.32	-0.60	-1.02	-1.02	
CHANGE IN WAGE RATE IN BUSINESS NON-AGRICULTURAL SECTOR AS % OF CONTROL SOLUTION LEVEL	0.00	-0.25	-0.38	-0.14	0.03	0.02	-0.24	-0.62	-0.72	-0.91	
			MILLIONS					MILLIONS			
CHANGE IN MAN-YEARS OF EMPLOYMENT	0.012	0.027	0.035	0.031	0.015	-0.002	-0.007	-0.005	-0.006	0.005	0.104

1/ INCLUDES IMPORT CONTENT OF GAS FIELD DEVELOPMENT

NOTE: COMPONENTS MAY NOT ADD TO TOTALS BECAUSE OF ROUNDING.



PIPELINE IMPACT, LOW UNEMPLOYMENT CASE

TABLE 11

CHANGE IN BALANCE OF INTERNATIONAL PAYMENTS
RESULTING FROM PIPELINE

P PE_ NE IMPACT LOW UNEMPLOYMENT CASE

TABLE 1

BALANCE OF INTERNATIONAL PAYMENTS
RESULTING FROM PIPELINE

	1976	1977	1978	1979	1980	198	1982	1983	1984	1985	TOTAL
	BILLIONS OF DOL ARS					BILLIONS OF DOLLARS					
CURREN ACCOUNT:											
EXPORTS OF CANADIAN GAS	0.0	0.0	0.0	0.080	0.160	0.165	0.197	0.234	0.288	0.288	1.412
EXPOR REVENUE FROM GAS TRANSMISSION	0.0	0.0	0.0	0.110	0.599	0.966	1.065	1.191	1.172	1.138	6.241
INDUCED EXPORTS OF GOODS AND SERVICES	0.047	-0.287	-0.463	-0.527	-0.750	-1.275	-1.577	-1.761	-2.168	-1.802	-10.564
LESS: IMPORT CONTENT OF PIPELINE	-0.224	-0.400	-0.409	-0.273	-0.097	-0.106	-0.077	-0.023	0.0	0.0	-1.608
INTEREST AND DIVIDENDS PAID ABROAD	0.000	-0.039	-0.136	-0.246	-0.300	-0.314	-0.420	-0.546	-0.400	-0.375	-2.775
INDUCED IMPORTS	-0.118	-0.196	-0.218	-0.176	0.036	0.347	0.522	0.641	0.943	0.723	2.504
PLUS: WITHHOLDING TAXES	0.001	0.006	0.019	0.032	0.037	0.036	0.044	0.055	0.038	0.035	0.302
PLUS: IMPORTS OF ENERGY PRODUCTS DISPLACED BY PIPELINE	0.0	0.0	0.0	0.190	0.373	0.380	0.464	0.551	0.648	0.638	3.244
CURRENT ACCOUNT BALANCE	-0.294	-0.915	-1.208	-0.810	0.059	0.199	0.2 9	0.342	0.521	0.644	-1.243
CAPITAL ACCOUNT:											
FINANCING OF THE PIPELINE	0.250	0.953	1.315	0.992	0.027	-0.167	-0.167	-0.218	-0.233	-0.186	2.565
INDUCED CAPITAL FLOWS:											
LONG-TERM	0.045	-0.026	-0.090	-0.145	-0.097	-0.058	-0.044	-0.084	-0.228	-0.367	-1.093
SHORT-TERM	0.026	-0.002	-0.032	-0.050	-0.011	0.013	-0.002	-0.044	-0.088	-0.064	-0.252
CAPITAL ACCOUNT BALANCE	0.321	0.925	1.194	0.797	-0.080	-0.2 2	-0.213	-0.346	-0.549	-0.617	1.220
CHANGE IN OFFICIAL INTERNATIONAL RESERVES	0.026	0.009	-0.013	-0.013	-0.022	-0.0 3	0.007	-0.004	-0.028	0.028	-0.023
			DOLLARS					DOLLARS			
CHANGE IN FOREIGN EXCHANGE RATE (CAN.$/US.$)	0.001	-0.005	-0.007	-0.007	-0.009	-0.0 5	-0.017	-0.019	-0.023	-0.018	
INTEREST RATES											
TREASURY BILL RATE	0.061	-0.005	-0.075	-0.118	-0.025	0.030	-0.004	-0.104	-0.210	-0. 52	
LONG-TERM BOND RAT.	0.036	-0.006	-0.063	- .10	-0.067	-0.026	-0.005	-0.032	-0.126	-0.174	

NOTE: COMPONENTS MAY NOT ADD TO TOTALS BECAUSE OF ROUNDING.

PIPELINE IMPACT, LOW UNEMPLOYMENT CASE

TABLE 12

CHANGE IN GROSS NATIONAL PRODUCT
RESULTING FROM PIPELINE

PIPELINE IMPACT: LOW UNEMPLOYMENT CASE

TABLE 12

CHANGE IN GROSS NATIONAL PRODUCT
RESULTING FROM PIPELINE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	TOTAL
	BILLIONS OF CURRENT DOLLARS					BILLIONS OF CURRENT DOLLARS					
DIRECT EFFECT OF PIPELINE											
PIPELINE CONSTRUCTION	0.674	1.440	1.969	1.433	0.693	0.451	0.324	0.112	0.0	0.0	7.094
LESS: IMPORT CONTENT	-0.224	-0.400	-0.409	-0.273	-0.097	-0.061	-0.077	-0.023	0.0	0.0	-1.608
INTEREST AND DIVIDENDS PAID ABROAD	0.000	-0.039	-0.136	-0.246	-0.300	-0.340	-0.420	-0.546	-0.400	-0.349	-2.775
ASSOCIATED GAS FIELD DEVELOPMENT	0.0	0.380	0.247	0.436	0.180	0.133	0.109	0.099	0.088	0.0	1.851
EXPORTS OF CANADIAN GAS	0.0	0.0	0.0	0.080	0.160	0.165	0.197	0.234	0.288	0.288	1.412
PLUS: IMPORTS OF ENERGY PRODUCTS DISPLACED BY PIPELINE	0.0	0.0	0.0	0.160	0.373	0.380	0.464	0.551	0.648	0.638	3.244
EXPORT REVENUE FROM GAS TRANSMISSION	0.0	0.0	0.0	0.110	0.299	0.366	1.065	1.191	1.172	1.138	6.241
TOTAL DIRECT EFFECT	0.450	1.385	1.854	1.732	1.610	1.677	1.664	1.619	1.796	1.689	15.475
INDUCED EFFECT OF PIPELINE											
PERSONAL EXPEND ON CONSUMER GOODS & SERVICE	0.100	-0.111	-0.195	-0.202	-0.061	-0.142	-0.499	-1.022	-2.049	-1.934	-6.115
GOVERNMENT EXPEND ON GOODS AND SERVICES	-0.000	-0.090	-0.155	-0.086	-0.007	-0.009	-0.187	-0.415	-0.757	-0.779	-2.487
BUSINESS GROSS FIXED CAPITAL FORMATION	-0.047	-0.212	-0.324	-0.357	-0.450	-0.605	-0.752	-0.799	-0.833	-0.533	-4.911
VALUE OF THE PHYSICAL CHANGE IN INVENTORIES	0.001	0.016	F10.0	0.001	-0.130	-0.027	-0.008	0.004	-0.004	0.070	0.005
EXPORTS OF GOODS AND SERVICES	0.047	-0.287	-0.463	-0.527	-0.750	-1.275	-1.577	-1.761	-2.168	-1.201	-10.564
LESS: IMPORTS OF GOODS AND SERVICES 1/	-0.118	-0.196	-0.218	-0.176	0.036	0.347	0.522	0.641	0.943	0.723	2.504
STATISTICAL DISCREPANCY	-0.004	-0.012	-0.021	-0.019	-0.017	-0.014	-0.017	-0.023	-0.028	-0.024	-0.178
TOTAL INDUCED EFFECT	-0.014	-0.895	-1.368	-1.369	-1.268	-1.727	-2.520	-3.376	-4.896	-4.328	-21.762
GROSS NATIONAL PRODUCT	0.436	0.490	0.486	0.363	0.341	-0.050	-0.855	-1.757	-3.100	-2.640	-6.286
	PER CENT					PER CENT					
CHANGE IN GNP AS % OF CONTROL SOLUTION LEVEL	0.27	0.28	0.25	0.11	0.14	-0.02	-0.30	-0.56	-0.90	-0.70	

1/ INCLUDES IMPORT CONTENT OF GAS FIELD DEVELOPMENT

NOTE: COMPONENTS MAY NOT ADD TO TOTALS BECAUSE OF ROUNDING

PIPELINE IMPACT, LOW UNEMPLOYMENT CASE

TABLE 13

CHANGE IN NATIONAL INCOME RESULTING FROM PIPELINE

P PELINE IMPACT LOW UNEMPLOYMENT CASE

TABLE 13

CHANGE IN NATIONAL INCOME RESULTING FROM PIPELINE

	976	1977	1978	1979	1980	98	1982	1983	1984	1985	TOTAL
	BILLIONS OF DOLLARS					BILLIONS OF DOLLARS					
GROSS NATIONAL PRODUCT	0.436	0.490	0.486	0.363	0.341	-0.050	-0.855	-1.757	-3.100	-2.640	-6.286
LESS: INDIRECT TAXES PLUS SUBSIDIES	-0.100	-0.195	-0.179	-0.103	0.002	0.054	0.141	0.242	0.407	0.347	0.617
CAPITAL CONSUMPTION ALLOWANCES	-0.003	-0.003	0.001	-0.047	-0.144	-0.183	-0.159	-0.117	-0.042	0.047	-0.650
NATIONAL INCOME	0.333	0.292	0.308	0.213	0.200	-0.178	-0.873	- .632	-2.735	-2.245	-6.318
COMPOSITION OF INCREASE IN NATIONAL INCOME:											
WAGES,SALARIES,AND SUPPL LABOUR INCOME	0.148	0.119	0.387	0.514	0.459	0.087	-0.537	-1.196	-2.162	-1.912	-4.091
CORPORATION PROFITS BEFORE TAXES	0.119	0.177	0.129	0.083	0.122	0.114	0.163	0.233	0.087	0.246	1.472
OTHER INCOME	0.067	-0.004	-0.207	-0.385	-0.382	-0.379	-0.499	-0.670	-0.661	-0.579	-3.700
			PER CENT					PER CENT			
CHANGE IN NATIONAL INCOME AS % OF CONTROL SOLUTION LEVEL	0.27	0.21	0.20	0.13	0.11	-0.09	-0.39	-0.67	-1.03	-0.77	
CHANGE IN PERSONAL DISPOSABLE INCOME AS % OF CONTROL SOLUTION LEVEL	0.14	0.01	0.02	-0.01	-0.01	-0.13	-0.35	-0.57	-1.03	-0.90	
CHANGE IN PRICE INDEX OF PERSONAL EXP ON CONS GOODS AND SERVICES AS % OF CONTROL SOLN LEVEL	-0.06	-0.47	-0.74	-0.64	-0.47	-0.41	-0.65	-0.92	-1.27	-1.15	
CHANGE IN REAL PERSONAL DISPOSABLE INCOME AS % OF CONTROL SOLUTION LEVEL	0.20	0.49	0.77	0.63	0.47	0.28	0.30	0.35	0.25	0.26	

NOTE: COMPONENTS MAY NOT ADD TO TOTALS BECAUSE OF ROUNDING.

PIPELINE IMPACT, LOW UNEMPLOYMENT CASE

TABLE 14

SOURCE OF SAVING REQUIRED TO BALANCE CAPITAL FORMATION
RESULTING FROM PIPELINE

PIPELINE IMPACTS, LOW UNEMPLOYMENT CASE

TABLE 14

SOURCE OF SAVING REQUIRED TO BALANCE CAPITAL FORMATION RESULTING FROM PIPELINE

	1976	977	1978	1979	1980	1981	1982	1983	1984	985	TOTAL
	BILLIONS OF DOLLARS						BILLIONS OF DOLLARS				
CAPITAL FORMATION											
PIPELINE CONSTRUCTION	0.674	1.440	1.969	1.433	0.693	0.451	0.324	0.112	0.0	0.0	7.094
ASSOCIATED GASFIELDDEVELOPMENT	0.0	0.380	0.426	0.436	0.180	0.133	0.109	0.099	0.088	0.0	1.851
INDUCEDBUSINESSFIXED CAPITAL FORMATION	-0.047	-0.212	-0.324	-0.3$)7	-0.450	-0.605	-0.752	-0.799	-0.833	-0.533	-4.911
INDUCEDINVENTORY ACCUMULATION	0.007	0.016	0.013	0.001	-0.018	-().027	-0.008	0.004	-0.004	0.020	0.005
TOTAL CAPITAL FORMATION	0.63S	1.625	2.083	1.512	0.405	-0.048	-0.327	-0.584	-0.749	-0.512	4.040
SAVING											
PERSONAL SAVING	0.046	0.128	0.217	0.185	0.054	-0.082	-0.140	-0.129	-0.218	-0.221	-0.162
Government SURPLUS 1/	0.215	0.472	00575	0.432	0.2.20	0.056	0.103	0.264	0.247	0.589	3.173
UNDISTRIBUTED CORPORATION PROFITS	0.068	0.094	0.060	0.023	0.030	-0.022	-0.249	-0.517	-0.322	-(I.210	-1.045
CAPITAL CONSUMPTION ALLOWANCES	0.003	0.003	-0.001	0.047	0.144	0.183	0.159	0.117	0.042	-0.047	0.650
DEFICIT ON CURRENT ACCT WITHNON-RESIDENTS	0.294	0.915	1.208	0.810	-0.059	-0.199	-0.219	'().342	-0.521	'0.644	1.243
STATISTICAL DISCREPANCY	0.009	0.013	0.024	0.014	0.017	0.017	0.019	0.023	0.023	0.021	0.181
TOTAL SAVING	0.635	1.625	2.083	1.512	0.405	-0.048	-0.327	-0.584	-0.749	'0.512	4.040
			PER CENT						PER CENT		
CHANGE IN SAVING AS % OF CONTROL SOLUTION LEVEL	1.91	4.49	5.33	3.59	0.s9	-0.10	-0.81	-0.99	-1.17	-0.74	

1/ NATIONAL ACCOUNTS BASIS.

PIPELINE IMPACT, LOW UNEMPLOYMENT CASE

TABLE 15

CHANGE IN GOVERNMENT BALANCE
RESULTING FROM PIPELINE

PIPELINE IMPACT, LOW UNEMPLOYMENT CASE

TABLE 15

CHANGE IN GOVERNMENT BALANCE
RESULTING FROM PIPELINE

	197-	1977	978	1979	1980	1981	1982	1983	1984	1985	
		BILLIONS OF DOLLARS					BILLIONS OF DOLLARS				TOTAL
INCREASE IN TAX REVENUES											
PERSONAL INCOME TAX	0.025	-0.005	0.004	0.007	0.010	-0.034	-0.119	-0.213	-0.428	-0.390	-1.143
CORPORATE INCOME TAX	0.040	0.058	0.041	0.042	0.104	0.136	0.172	0.217	0.168	0.220	1.199
INDIRECT TAXES	0.100	0.195	0.179	0.103	-0.002	-0.054	-0.141	-0.242	-0.407	-0.347	-0.617
WITHHOLDING TAXES	0.001	0.006	0.019	0.032	0.037	0.036	0.044	0.055	0.038	0.035	0.302
TOTAL	0.165	0.254	0.243	0.184	0.149	0.084	-0.044	-0.083	-0.630	-0.482	-0.260
INCREASE IN EXPENDITURE											
GOODS AND SERVICES	-0.000	-0.090	-0.155	-0.086	-0.007	-0.009	-0.187	-0.415	-0.757	-0.479	-2.487
TRANSFER PAYMENTS	-0.054	-0.128	-0.181	-0.157	-0.063	0.034	0.038	-0.033	-0.115	-0.291	-0.949
TOTAL	-0.050	-0.217	-0.332	-0.248	-0.071	0.028	-0.147	-0.448	-0.876	-1.072	-3.433
CHANGE IN BALANCE	0.215	0.472	0.575	0.432	0.220	0.056	0.103	0.264	0.247	0.589	3.173

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 16

CHANGE IN REAL GROSS NATIONAL PRODUCT
RESULTING FROM PIPELINE

PIPELINE IMPACTS HIGH UNEMPLOYMENT CASE

TABLE 6

CHANGE IN REAL GROSS NATIONAL PRODUCT
RESULTING FROM PIPELINE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	TOTAL
	BILLIONS OF CONSTANT (196 DOLLARS				BILLIONS OF CONSTANT 1961 DOLLARS						
DIRECT EFFECT OF PIPELINE											
PIPELINE CONSTRUCTION	0.355	0.732	0.940	0.638	0.273	0.181	0.124	0.040	0.0	0.0	3.284
LESS: IMPORT CONTENT	-0.120	-0.208	-0.200	-0.125	-0.039	-0.044	-0.030	-0.008	0.0	0.0	-0.775
INTEREST AND DIVIDENDS PAID ABROAD	0.000	-0.025	-0.086	-0.151	-0.078	-0.182	-0.238	-0.303	-0.218	-0.199	-1.580
ASSOCIATED GAS FIELD DEVELOPMENT	0.0	0.177	0.189	0.185	0.073	0.051	0.040	0.034	0.029	0.0	0.778
EXPORTS OF CANADIAN GAS	0.0	0.0	0.0	0.013	0.027	0.027	0.033	0.039	0.048	0.048	0.234
EXPORT REVENUE FROM GAS TRANSMISSION	0.0	0.0	0.0	0.038	0.208	0.340	0.359	0.402	0.426	0.426	2.199
PLUS: IMPORTS OF ENERGY PRODUCTS DISPLACED BY PIPELINE	0.0	0.0	0.0	0.05	0.100	0.101	0.124	0.147	0.173	0.170	0.866
TOTAL DIRECT EFFECT	0.235	0.677	0.844	0.649	0.462	0.475	0.411	0.351	0.458	0.445	5.006
INDUCED EFFECT OF PIPELINE											
PERSONAL EXPEND ON CONSUMER GOODS & SERVICE	0.101	0.291	0.521	0.541	0.493	0.351	0.311	0.272	0.153	0.184	3.217
GOVERNMENT EXPEND ON GOODS AND SERVICES	0.000	-0.001	-0.002	-0.002	0.001	0.000	0.000	-0.001	-0.005	-0.007	-0.020
BUSINESS GROSS FIXED CAPITAL FORMATION	0.037	-0.084	-0.048	0.055	0.088	-0.026	-0.183	-0.253	-0.197	0.029	-0.655
VALUE OF THE PHYSICAL CHANGE IN INVENTORIES	0.008	0.034	0.036	0.017	-0.019	-0.051	-0.041	-0.021	-0.009	0.026	-0.019
EXPORTS OF GOODS AND SERVICES	0.002	-0.030	-0.008	0.002	-0.065	-0.236	-0.339	-0.377	-0.380	-0.304	-1.733
LESS: IMPORTS OF GOODS AND SERVICES 1/	-0.050	-0.232	-0.325	-0.321	-0.298	-0.326	-0.361	-0.373	-0.370	-0.334	-3.010
TOTAL INDUCED EFFECT	0.024	-0.023	0.175	0.292	0.198	-0.287	-0.614	-0.752	-0.807	-0.457	-2.220
GROSS NATIONAL PRODUCT	0.260	0.654	1.019	0.941	0.660	0.188	-0.202	-0.402	-0.349	0.008	2.786
	PER CENT							PER CENT			
CHANGE IN GNP AS % OF CONTROL SOLUTION LEVEL	0.30	0.71	1.06	0.93	0.62	0.17	-0.18	-0.33	-0.28	0.01	
CHANGE IN GNP PRICE INDEX AS % OF CONTROL SOLUTION LEVEL	-0.13	-0.63	-1.07	-1.02	-0.53	-0.07	-0.09	-0.37	-0.90	-1.14	
CHANGE IN WAGE RATE IN BUSINESS NON-AGRICULTURAL SECTOR AS % OF CONTROL SOLUTION LEVEL	-0.15	-0.72	-1.13	-1.02	-0.45	0.07	0.00	-0.33	-0.90	-1.09	
	MILLIONS							MILLIONS			
CHANGE IN MAN-YEARS OF EMPLOYMENT	0.012	0.034	0.054	0.060	0.043	0.010	-0.018	-0.034	-0.041	-0.027	0.093

1/ INCLUDES IMPORT CONTENT OF GAS FIELD DEVELOPMENT

NOTE: COMPONENTS MAY NOT ADD TO TOTALS BECAUSE OF ROUNDING.

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 17

CHANGE IN BALANCE OF INTERNATIONAL PAYMENTS
RESULTING FROM PIPELINE

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 17

CHANGE IN BALANCE OF INTERNATIONAL PAYMENTS
RESULTING FROM PIPELINE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	TOTAL
	BILLIONS OF DOLLARS						BILLIONS OF DOLLARS				
CURRENT ACCOUNT:											
EXPORTS OF CANADIAN G A S	0.0	0.0	0.0	0.080	0.160	0.165	0.197	0.234	0.288	0.288	1.412
EXPORT REVENUE FROM G A S TRANSMISSION	0.0	0.0	0.0	0.110	0.599	0.966	1.06	1.191	1.172	1.138	6.241
INDUCED EXPORTS OF GOODS AND SERVICES	-0.014	-0.310	-0.399	-0.419	-0.598	-1.176	-1.684	-2.061	-2.440	-2.245	-11.347
LESS: IMPORT CONTENT OF PIPELINE	-0.223	-0.399	-0.409	-0.272	-0.097	-0.106	-0.076	-0.022	0.0	0.0	-1.605
INTEREST AND DIVIDENDS PAID ABROAD	0.000	-0.009	-0.136	-0.245	-0.299	-0.313	-0.418	-0.544	-0.398	-0.373	-2.764
INDUCED IMPORTS	-0.057	-0.091	-0.132	-0.125	-0.048	0.194	0.436	0.685	1.021	0.949	2.833
PLUS: WITHHOLDING TAXES	0.000	0.006	0.019	0.032	0.038	0.037	0.045	0.054	0.037	0.033	0.300
PLUS: IMPORTS OF ENERGY PRODUCTS DISPLACED BY PIPELINE	0.0	11.0	0.0	0.190	0.373	0.380	0.464	0.551	0.648	0.638	3.244
CURRENT ACCOUNT BALANCE	-0.294	-0.832	-1.058	-0.649	0.127	0.147	0.029	0.088	0.329	0.427	-1.686
CAPITAL ACCOUNT:											
FINANCING OF THE PIPELINE	0.249	0.952	1.315	0.991	0.027	-0.167	-0.168	-0.219	-0.233	-0.186	2.562
INDUCED CAPITAL FLOWS:											
LONG-TERM	0.026	-0.090	-0.196	-0.256	-0.134	-0.014	0.078	0.101	-0.130	-0.133	-0.631
SHORT-TERM	0.016	-0.023	-0.075	-0.103	-0.036	0.042	0.061	0.018	-0.059	-0.079	-0.237
CAPITAL ACCOUNT BALANCE	0.292	0.839	1.045	0.632	-0.143	-0.139	-0.029	-0.100	-0.304	-0.398	1.694
CHANGE IN OFFICIAL INTERNATIONAL RESERVES	-0.002	0.007	-0.013	-0.017	-0.016	0.007	-0.000	-0.012	0.024	0.029	0.008
			DOLLARS					DOLLARS			
CHANGE IN FOREIGN EXCHANGE RATE (CAN.$/US.$)	-0.000	-0.007	-0.009	-0.009	-0.011	-0.017	-0.023	-0.027	-0.031	-0.028	
INTEREST RATES											
TREASURY BILL RATE	0.039	-0.055	-0.178	-0.247	-0.085	0.099	0.145	0.043	-0.140	-0.188	
LONG-TERM BOND RATE	0.021	-0.046	-0.155	-0.250	-0.196	-0.068	0.065	0.131	0.058	-0.064	

NOTE: COMPONENTS MAY NOT ADD TO TOTALS BECAUSE OF ROUNDING.

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 18

CHANGE IN GROSS NATIONAL PRODUCT
RESULTING FROM PIPELINE

PIPELINE IMPACT• HIGH UNEMPLOYMENT CASE

TABLE 18

CHANGE IN GROSS NATIONAL PRODUCT
RESULTING FROM PIPELINE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	TOTAL
	BILLIONS OF CURRENT DOLLARS					BILLIONS OF CURRENT DOLLARS					
DIRECT EFFECT OF PIPELINE											
PIPELINE CONSTRUCTION	0.673	1.439	1.968	1.432	0.693	0.451	0.323	0.111	0.0	0.0	ILL. .091
LESS: IMPORT CONTENT	-0.223	-0.399	-0.409	-0.272	-0.097	-0.106	-0.076	-0.022	0.0	0.0	.605
INTEREST AND DIVIDENDS PAID ABROAD	0.000	-0.038	-0.136	-0.245	-0.299	-0.313	-0.418	-0.544	-0.398	-0.373	.764
ASSOCIATED GAS FIELD DEVELOPMENT	0.0	0.380	0.426	0.436	0.180	0.133	0.109	0.099	0.088	0.0	1.851
EXPORTS OF CANADIAN GAS	0.0	0.0	0.0	0.080	0.160	0.165	0.197	0.234	0.288	0.288	1.412
PLUS: IMPORTS OF ENERGY PRODUCTS DISPLACED BY PIPELINE	0.0	0.0	0.0	0.190	0.373	0.380	0.464	0.551	0.648	0.638	3.244
EXPORT REVENUE FROM GAS TRANSMISSION	0.0	0.0	0.0	0.110	0.599	0.966	1.065	1.191	1.172	1.138	6.241
TOTAL DIRECT EFFECT	0.450	1.386	1.855	1.734	1.610	1.678	1.666	1.620	1.798	1.691	15.489
INDUCED EFFECT OF PIPELINE											
PERSONAL EXPEND ON CONSUMER GOODS & SERVICE	-0.018	-0.410	-0.701	-0.822	-0.934	-0.958	-0.138	-0.544	-1.484	-1.690	-6.299
GOVERNMENT EXPEND ON GOODS AND SERVICES	-0.043	-0.223	-0.383	-0.375	-0.386	-0.1	-0.013	-0.164	-0.464	-0.608	-2.448
BUSINESS GROSS FIXED CAPITAL FORMATION	-0.068	-0.233	-0.268	-0.154	-0.030	-0.034	-0.809	-1.147	-1.342	-1.098	-5.632
VALUE OF THE PHYSICAL CHANGE IN INVENTORIES	0.006	0.024	0.028	0.018	-0.009	-0.042	-0.042	-0.026	-0.020	0.021	-0.042
EXPORTS OF GOODS AND SERVICES	-0.014	-0.310	-0.399	-0.419	-0.598	-1.176	-1.684	-2.061	-2.440	-2.245	-11.347
LESS: IMPORTS OF GOODS AND SERVICES 1/	-0.057	-0.091	-0.132	-0.125	-0.048	0.194	0.436	0.685	1.021	0.949	2.833
STATISTICAL DISCREPANCY	-0.004	-0.018	-0.034	-0.035	-0.024	-0.008	-0.001	0.002	0.007	0.010	-0.105
TOTAL INDUCED EFFECT	-0.199	-1.263	-1.895	-1.915	-1.429	-1.465	-2.253	-3.256	-4.721	-4.662	-23.058
GROSS NATIONAL PRODUCT	0.252	0.123	-0.040	-0.181	0.180	0.212	-0.587	-1.635	-2.922	-2.971	-7.569
	PER CENT							PER CENT			
CHANGE IN GNP AS % OF CONTROL SOLUTION LEVEL	0.17	0.08	-0.02	-0.10	0.09	0.10	-0.27	-0.70	-1.18	-.93	

1/ INCLUDES IMPORT CONTENT OF GAS FIELD DEVELOPMENT

NOTE: COMPONENTS MAY NOT ADD TO TOTALS BECAUSE OF ROUNDING.

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 19

CHANGE IN NATIONAL INCOME RESULTING FROM PIPELINE

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 19

CHANGE IN NATIONAL INCOME RESULTING FROM PIPELINE

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	TOTAL
	BILLIONS OF DOLLARS						BILLIONS OF DOLLARS				
GROSS NATIONAL PRODUCT	0.252	0.123	-0.040	-0.181	0.180	0.212	-0.587	-1.635	-2.922	-2.971	-7.569
LESS: INDIRECT TAXES PLUS SUBSIDIES	-0.079	-0.149	-0.119	-0.049	0.001	0.001	0.088	0.214	0.379	0.379	0.665
CAPITAL CONSUMPTION ALLOWANCES	-0.000	0.008	0.021	-0.020	-0.120	-0.172	-0.158	-0.115	-0.030	0.150	-0.506
NATIONAL INCOME	0.173	-0.019	-0.139	-0.251	0.061	0.041	-0.657	-1.536	-2.573	-2.512	-7.410
COMPOSITION OF INCREASE IN NATIONAL INCOME:											
WAGES, SALARIES, AND SUPPL LABOUR INCOME	0.110	-0.271	-0.120	-0.054	0.235	0.298	-0.151	-0.281	-1.743	-1.896	-4.450
CORPORATION PROFITS BEFORE TAXES	0.089	0.291	0.146	0.152	0.220	0.178	0.122	0.110	-0.029	0.086	1.237
OTHER INCOME	0.190	0.033	-0.165	-0.349	-0.394	-0.435	-0.628	-0.825	-0.800	-0.702	-4.198
				PER CENT					PER CENT		
CHANGE IN NATIONAL INCOME AS % OF CONTROL SOLUTION LEVEL	0.15	-0.02	-0.11	-0.18	0.04	0.03	-0.40	-0.87	-1.38	-1.27	
CHANGE IN PERSONAL DISPOSABLE INCOME AS % OF CONTROL SOLUTION LEVEL	0.03	-0.27	-0.42	-0.51	-0.27	-0.11	-0.25	-0.54	-1.16	-1.21	
CHANGE IN PRICE INDEX OF PERSONAL EXP ON CONS GOODS AND SERVICES AS % OF CONTROL SOLN LEVEL	-0.20	-0.92	-1.53	-1.59	-1.09	-0.54	-0.52	-0.74	-1.20	-1.30	
CHANGE IN REAL PERSONAL DISPOSABLE INCOME AS % OF CONTROL SOLUTION LEVEL	0.23	0.66	1.12	1.09	0.83	0.34	0.12	0.20	0.04	0.10	

NOTE : COMPONENTS MAY NOT ADD TO TOTALS BECAUSE OF ROUNDING

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 20

SOURCE OF SAVING REQUIRED TO BALANCE CAPITAL FORMATION
RESULTING FROM PIPELINE

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 20

OF SAVING REQUIRED TO BALANCE CAPITAL FORMATION RESULTING FROM PIPELINE

	1976	1977	1978	1979	1980	198	1982	1983	1984	1985	TOTAL
	BILLIONS OF DOLLARS						BILLIONS OF DOLLARS				
CAPITAL FORMATION											
PIPELINE CONSTRUCTION	0.671	1.439	1.968	1.432	0.693	0.451	0.323	0.111	0.0	0.0	7.091
ASSOCIATED GAS FIELD DEVELOPMENT	0.0	0.380	0.426	0.436	0.180	0.133	0.109	0.099	0.088	0.0	1.851
INDUCED BUSINESS FIXED CAPITAL FORMATION	-0.068	-0.233	-0.268	-0.154	-0.130	-0.384	-0.809	-1.147	-1.342	-1.098	-5.632
INDUCED INVENTORY ACCUMULATION	0.006	0.024	0.028	0.018	-0.009	-0.042	-0.042	-0.026	-0.020	0.021	-0.042
TOTAL CAPITAL FORMATION	0.611	1.611	2.154	1.732	0.734	0.158	-0.419	-0.963	-1.273	-1.077	3.269
SAVING											
PERSONAL SAVING	0.047	0.133	0.237	0.223	0.100	-0.086	-0.216	-0.253	-0.321	-0.291	-0.427
GOVERNMENT SURPLUS 1/	0.216	0.548	0.769	0.741	0.535	0.204	-0.049	-0.141	-0.258	0.026	2.591
UNDISTRIBUTED CORPORATION PROFITS	0.051	0.088	0.072	0.063	0.082	0.007	-0.261	-0.591	-0.383	-0.290	-1.182
CAPITAL CONSUMPTION ALLOWANCES	0.000	-0.008	-0.021	0.020	0.120	0.172	0.158	0.115	0.030	-0.081	0.506
DEFICIT ON CURRENT ACCT WITH NON-RESIDENTS	0.294	0.832	1.058	0.649	-0.127	-0.147	-0.029	-0.088	-0.329	-0.427	1.686
STATISTICAL DISCREPANCY	0.003	0.018	0.039	0.036	0.025	0.007	-0.002	-0.005	-0.012	-0.014	0.095
TOTAL SAVING	0.611	1.611	2.154	1.732	0.734	0.158	-0.419	-0.963	-1.273	-1.077	3.269
	PER CENT						PER CENT				
CHANGE IN SAVING AS % OF CONTROL SOLUTION LEVEL	1.90	4.66	5.95	4.49	1.75	0.36	-0.91	-1.96	-2.45	- .96	

/ NATIONAL ACCOUNTS BASIS.

PIPELINE IMPACT, HIGH UNEMPLOYMENT CASE

TABLE 21

CHANGE IN GOVERNMENT BALANCE
RESULTING FROM PIPELINE

PIPELINE IMPACT• H GH CASE

TABLE 21

CHANGE IN GOVERNMENT BALANCE
RESULTING FROM PIPELINE

	1976	1977	9?8	1979	1980	981	1982	1983	1984	985	TOTAL
					BILLIONS OF DOLLARS			BILLIONS OF DOLLARS			
INCREASE IN TAX REVENUES											
PERSONAL INCOME TAX	0.001	-0.070	-0.108	-0.130	-0.067	-0.024	-0.068	-0.156	-0.362	-0.395	-1.377
CORPORATE INCOME TAX	0.030	0.054	0.047	0.065	0.136	0.157	0.158	0.175	0.129	0.167	1.118
INDIRECT TAXES	0.079	0.149	0.119	0.049	-0.001	-0.001	-0.088	-0.214	-0.379	-0.379	-0.665
WITHHOLDING TAXES	0.000	0.006	0.019	0.032	0.038	0.037	0.045	0.054	0.037	0.033	0.300
TOTAL	0.110	0?139	0.077	0.017	0.106	0.170	0.047	-0.140	-0.576	-0.574	-0.624
INCREASE IN EXPENDITURE											
GOODS AND SERVICES	-0.043	-0.?23	-0.383	-0.375	-0.186	0.01'	-0.013	-0.164	-0.464	-0.6?8	-2.448
TRANSFER PAYMENTS	-0.062	-0.?86	-0.314	-0.350	-0.244	-0.045	0.112	0.168	0.151	0.0?2	-0.757
TOTAL	-0.106	-0.?09	-0.692	-0.724	-0.428	-0.035	0.096	0.002	-0.318	-0.6?0	-3.214
CHANGE IN BALANCE	0.216	0.548	0.769	0.741	0.535	0.204	-0.049	-0.141	-0.258	0.026	z.59

(i) Construction phase effects

Part of the pipe and other materials and equipment necessary to construct the pipeline will be imported either directly by the pipeline contractors or indirectly by their Canadian suppliers as foreign content of materials, equipment and services bought in Canada. Such imports, of course, will have no direct effect on incomes and hence on induced expenditure in Canada. Part of the pipeline is directly financed from abroad, and to the extent that direct foreign financing equals the direct import content of the pipeline, it has no initial effect on the overall balance-of-payments. (The foreign financing will, however, give rise to a future outflow of interest, dividends, and debt repayments which will have a moderate negative effect on the balance of payments at that time.)

The expenditure on Canadian-produced goods and services will lead to increased production and increased incomes in the industries involved. Will this be a net addition to Canadian output? This will depend on the degree of utilization of productive capacity. In an economy in which there is a large amount of slack, unemployed resources will be employed and the additional production will be a net addition. In an economy operating at full capacity, the effect will be to raise prices and wages as resources are bid away from other industries into industries producing pipeline goods and services, and to increase imports and reduce exports. Our two control solutions do not represent either of these extreme cases but a comparison of the 4 1/2 per cent unemployment simulation results with the 6 per cent unemployment results will provide some indication of the sensitivity

of the impact on real output and employment in the construction phase to the degree of resource utilization.

The first set of tables, Tables 10-15, show the result of the simulation experiment which assumes 4 1/2 per cent unemployment in the control solution. The second set, Tables 16-21, show the results of the experiment which assumes 6 per cent unemployment in the control solution. Tables 10 and 16 present the effects of the pipeline simulation experiment in real (constant 1961) dollars on gross national product (GNP) and its components on the expenditure side.[1/] The first eight lines of these tables are the same and show the pipeline data from Table 9 converted to constant (1961) dollars in order to arrive at the direct real effects on the economy. These data were provided to us by Canadian Arctic Gas Study Limited (CAGSL). The second part of the two tables shows the "induced effects" on the components of real GNP as calculated by the TRACE model and are different because of the different control solutions. At the bottom of the tables

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1/ To separate the change in the value of gross national product in Canada current dollars into real (quantity) and price components, national income statisticians follow a procedure of deflating the current dollar figure by a price index with 1961 as the base year in order to arrive at a measure of the change measured in dollars of constant (1961) purchasing power. This is referred to as (real) gross national product in constant (1961) dollars. We have followed this procedure and have converted the pipeline data which we were given to expenditures in (1961) constant dollars so they are compatible with the estimates of gross national product in constant (1961) dollars produced by our control solution. Thus, we can arrive at estimates of the effect of the pipeline construction on real gross national product (in constant 1961 dollars) so that production, employment and price effects can be estimated by the model. This is the procedure followed by Statistics Canada in their National Accounts. They also use 1961 as the base year. We use the same base year to maintain consistency with their Accounts.

are given the changes in the price index of gross national product and in man-years of employment.[1/]

Looking at the years 1977-79 we can see the impacts of the construction phase. Project expenditures and associated gas field development expenditures (less their import content[2/] and interest and dividends paid abroad) result in a direct increase in Canada's real GNP of $2.2 billion during these three years. A further contribution to increasing GNP results from the induced increase in real personal expenditure on consumer goods and services which amounts to $0.9 billion in the low unemployment rate simulation. (The import content of consumption expenditures is included in 'induced imports.)

The induced changes in the components of real GNP result from the changes in real income and expenditure brought about by the pipeline construction and the associated gas field development and from the changes in prices induced by these expenditures. The price changes are in turn affected by the exchange rate appreciation required to restore balance between the current and capital accounts of the balance of international payments. It may help to understand the behaviour of prices and other induced effects ifwe look at the changes in two stages: before and after the exchange rate appreciation occurs.

1/ This calculation is made assuming hours worked per week are the same as in the control solution. If hours worked per week tend to fall, as might be expected, the increase in employment could be slightly higher than indicated in Tables 10 and 16.

2/ We did not have separate data on the import content of gas field development expenditures so the model therefore estimated their import content as part of the total induced increase in imports.

Table 22 presents these two stages for some of the key variables from Tables 10 and 16. The figures shown are the average change over the period 1977-79.

In the model, the full response of prices to an increase in real output takes place with a considerable time lag. The short-run impact effect is an increase in output per man-hour which tends to reduce product prices. As output is increased, however, wage rates and other costs of production tend to rise, especially in an economy which is close to full employment. This increase in costs ultimately leads to increases in prices.[1/] This increase in domestic prices and costs of production, in the face of unchanged world prices for Canada's exports, reduces the profitability of exports and real exports decline.[2/] These price changes also tend to improve the competitive position of imported goods and services and real imports increase. The change in the price level is accompanied by changes in relative prices which affect residential construction expenditures so that they decrease over the control solution level. Other components of business capital formation respond positively, however, to the increase in consumer spending and the increased demand for pipeline materials. At the same time, however, the higher imports and lower exports induced by the

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1/ In the low unemployment simulation, the price level (as measured by the implicit price index of GNP) decreases, in the absence of an exchange rate adjustment, by 0.11 per cent of the control solution level in 1977 and by 0.04 per cent in 1978. In 1979, however, the increasing cost effect takes over and the price level increases by 0.29 per cent. In the high unemployment simulation price increases do not show up until 1980.

2/ This does not necessarily indicate the magnitude of the decline in the output of export industries. Some output of these industries may be diverted to domestic markets in response to the increase in domestic consumption expenditures and pipeline construction expenditures.

Table 22

Average Construction Phase Effects (1977-79) before and after Exchange Rate Appreciation 1/

	Low Unemployment Case		High Unemployment Case	
	before	after	before	after
Change in foreign exchange rate (per cent)	0.0	-0.6	0.0	-0.8
Induced effects on real GNP (millions of constant dollars)				
Personal expenditure on consumer goods and services	333	308	494	451
Business gross fixed capital formation	-125	-108	-27	-26
Exports of goods and services	-44	-83	38	-12
Imports of goods and services	277	304	251	293
Gross national product	-100	-176	292	148
Effects on prices and employment				
Change in GNP price index as per cent of control solution level	0.04	-0.34	-0.43	-0.90
Change in man-years of employment (thousands)	37	31	61	49
Balance of international payments (millions of current dollars)				
Current account	-884	-978	-717	-846
Capital account	1,118	972	1,002	839
Change in international reserves	234	-6	285	-7

1/ The difference between pipeline simulation levels less control solution levels averaged over the three-year period 1977-79.

pipeline's construction will tend to restrain new investment in the non-pipeline sector of the economy. The net effect will depend on the relative strength of these offsetting tendencies. The net induced effect for the economy as a whole is negative in the low unemployment simulation as, in an economy close to full employment, the pipeline construction reduces somewhat the production of goods and services in other sectors of the economy.[1/]

When we turn to the high unemployment simulation results we note a significant difference in the direction of the induced change in real GNP. The closer the economy is to operating at full capacity, the greater will be the tendency for any new project to attract some resources from other sectors. The empirical findings confirm this expectation. In the low unemployment simulation the average induced decrease in real GNP (prior to an exchange rate adjustment occurring) from 1977-79 is $100 million while in the high unemployment simulation there is an induced increase of $292 million.

A perceptible difference between the two cases also shows up in the change in employment. In the low unemployment simulation the direct and induced employment attributable to the pipeline from 1977-79 averages 37 thousand man-years (prior to allowing for the effect of the exchange rate appreciation) whereas in the high unemployment simulation the average is 61 thousand man-years. With the larger increase in employment and the positive induced effect on

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1/ Government expenditure on goods and services is exogenous in constant dollars in the simulation experiments and therefore does not change in response to the pipeline activity.

GNP in the high unemployment simulation, real personal expenditure on consumer goods and services increases on average by $494 million over this period compared with an increase of $333 million in the low unemployment simulation.

What will be the net effect of the pipeline project on the foreign exchange rate? On current account, it is clear that during the construction phase - and before any exchange rate adjustment occurs - the increased imports (both the import content of the pipeline and the import content of the induced increase in consumer expenditure) together with a decrease in exports will lead to a deficit. On capital account, the foreign financing of the pipeline will contribute to a surplus. The net effect on the foreign exchange rate depends on whether the current deficit - calculated at the exchange rate prevailing in the control solution - exceeds the capital inflow calculated on the same basis. If it does, the exchange rate will depreciate, relative to the exchange rate in the control solution, to the point where the current and capital account are brought into balance. If the capital inflow - calculated at the control solution exchange rate - is greater, the rate will appreciate. If the two flows - calculated at the control solution exchange rate - are equal, then the exchange rate will remain unchanged.

If there is a change in the foreign exchange rate, there will be additional effects on the volume and Canadian dollar price of exports and imports of goods and services and through them on all sectors of the economy. An appreciation of the exchange rate will tend to reduce the Canadian dollar proceeds from exports of goods sold at world prices and therefore reduce real exports since their profitability has decreased.

There will, however, be an offsetting tendency as the appreciation will also tend to reduce the rate of inflation in Canada and reduce the rate of increase in costs of production. An appreciation will increase imports of goods as their prices become relatively lower. A depreciation will, of course, have the opposite effects.

A change in the foreign exchange rate will also have effects on the capital account through its influence on the trend of prices and activity in Canada which will result in changes in interest rates In Canada and induce changes in capital flows. For example, an appreciation in response to a surplus in the balance of payments will tend to reduce interest rates and lead to an outflow of capital, and thus to restore balance between the current and capital account.

Turning-to Tables 11 and 17 we see the change in the exchange rate from the control solution level which occurs in the pipeline simulation experiments.[1/] In both the low and high unemployment simulations, the direct and indirect import content and the foreign financing of the pipeline are identical. Over the period 1977-79, the import content of the pipeline (including interest and dividends paid abroad) totalled $1.5 billion while the inflow of capital to finance the pipeline was $3.3 billion. As a result of the differences in price (and wage) behaviour in this period, however, induced exports decrease in the low unemployment simulation (relative to its control solution) whereas in the high unemployment simulation, in the absence

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1/ We remind the reader that the exchange rate is given as the number of Canadian dollars required to buy one U.S. dollar. Hence, a minus sign means an increase in the value of the Canadian dollar.

of an exchange rate change, induced exports increase. Because of the difference in prices, the increase in induced imports is larger in the low unemployment case. Turning to the current account of the balance of international payments, the net effect is that prior to the exchange rate adjustment occurring the current account deficit is larger in the low unemployment case. In both cases the inflow of capital to finance the pipeline is larger than the current account deficit; hence, there is a surplus which is larger (relative to the appropriate control solution) in the case of the high unemployment simulation because of its lower current account deficit. Even though there are some induced outflows of capital in the high unemployment case,[1/] the surplus is still larger than in the low unemployment case. As Table 22 shows, the average increase in international reserves over the three-year period 1977-79 in the low unemployment simulation is $234 million while it is $285 million in the high unemployment simulation. Hence, relative to the level of the exchange rate which balanced the current and capital accounts in the relevant control solution, the exchange rate appreciates more in the high unemployment simulation. In both cases, however, the amount by which the exchange rate appreciates is less than one per cent of the control solution exchange rate and, indeed, there is very little difference in the magnitude of the exchange rate change in the two cases.

The appreciation of the exchange rate has two major effects which work their way through the model and affect all the variables.

1/ As we see from the last two lines of Tables 11 and 17, there is virtually no change in the interest rates; hence, the induced capital flows are very small.

The first is that it changes the prices (in Canadian currency) of internationally-traded goods. Imported goods become less expensive and the revenue from selling exports in world markets decreases. Hence, there is a further decrease in real exports and an increase in imports. This leads to a decrease in real GNP and to a lessening of the tendency to import goods and services. Some changes in relative prices of goods and services also occur. On balance, exports decrease (on average over the three-year period) in the low unemployment simulation by a further $39 million and imports increase by a further $27 million. The induced reduction in real GNP after the exchange rate effects have been taken into account is $176 million - an almost negligible change when compared to the level of GNP in the control solution (almost $100 billion). In the high unemployment simulation, as we observed earlier, there is an induced increase in real GNP. The magnitude of this increase is reduced by the exchange rate appreciation. The increase in real GNP amounts, on average of the three-year construction period, to $148 million.

Mainly because of the resultant appreciation of the foreign exchange rate, the price level (as measured by the implicit price index of gross national product) falls below the control solution level n 1977 and remains below the control solution rate throughout the remainder of the construction period. In 1979 the price level is 0.27 per cent lower than in the control solution in the low unemployment simulation and 1 per cent lower in the high unemployment simulation.

When we look at the current dollar effect of the pipeline on gross national product and its components (Table 12), we see that the decreases in prices have the effect that in both simulations the induced change in current dollar GNP is negative. In the low unemployment simulation the direct effects on GNP are greater than the induced effects in the construction phase so that on balance current dollar GNP increases over the control solution level. In the high unemployment simulation,[1/] however, where the price decreases are larger, the opposite is true in 1978-79 and the net effects on current dollar GNP are negative.

Table 13 shows the components of national income corresponding to the changes in current dollar GNP shown in Table 12. To arrive at the national income figure, indirect taxes plus subsidies and capital consumption allowances are subtracted from GNP. The components of national income are labour income (wages, salaries, and supplementary labour income[2/]), corporation profits before taxes, and other income.[3/] The latter component includes the profits of unincorporated businesses and government business enterprises, various types of investment income, and an inventory valuation adjustment.

In the low unemployment simulation national income increases throughout the construction period. In the high unemployment simulation, however, because of the larger price decreases, national income is lower in 1977-79 than in the control solution.[4/] Because of the price decreases, however, real personal income is higher than in the control solution

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1/ See Table 18.

2/ Including military pay and allowances.

3/ This component is derived residually in the model and its value may reflect errors in estimating the other two components of national income.

4/ See Table 19.

in both simulations. This is reflected in Tables 10 and 16 where real personal expenditure on consumer goods and services and real GNP are both above the control solution level.

With respect to interest rates, we note that once al' the factors affecting interest rates within the model have worked themselves out, the changes in interest rates as measured by the model are so small as to be negligible.[1/]

It is useful to look at where the saving will come from to make possible the net increase in capital formation associated with the pipeline project after taking into account the induced effects on capital expenditures in the business sector. In order to make additions to the stock of capital, an economy must, in the jargon of the national- income statistician, "save". Saving means not using all the income generated in an economy to buy consumption and government goods and services so that some resources can be devoted to the production of capital goods.

There are three major sources of domestic saving: persons, corporations, and governments. Personal saving is the difference between personal disposable income and personal expenditure on consumer goods and services and represents the amount of funds the personal sector can lend to other sectors of the economy. This will increase as personal incomes increase. The retained earnings of

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1/ The printed changes in the Tables are much less than the error that would be associated with estimates from the model and should therefore be regarded as zero. In the model, this demand for funds is transmitted to interest rates through the effect of the increased rate of growth of gross national product on interest rates. The rate of change in the money supply is treated as an exogenous variable in the pipeline simulation experiments and, therefore, did not change from the control solution values.

corporations including capital consumption allowances are the second source of domestic saving. Thirdly, saving will result if there is increased revenue from personal and corporate income taxes and from indirect taxes and if this increase in revenue exceed the increase in government expenditure. Given our assumption that government expenditure on goods and services in constant dollars is unaffected by the pipeline activity, a change in wages and salaries and prices will change nominal dollar government expenditure. (We assumed in the model solution that the government uses any surplus for debt redemption from the private sector of the economy and that the privately-held money supply remained unchanged.)

Domestic saving will be augmented by obtaining a net inflow of goods and services from abroad; that is by importing more than is exported so that the saving of residents of other countries is used to make possible capital formation in Canada. In the construction phase non-resident saving will make a major contribution to providing the physical resources and the financing required for the production of capital goods.

The first half of Table 14 shows the total direct and induced capital formation (including inventory change) attributable to the pipeline, a total of $5.2 billion over the three-year period 1977-79. The sources of saving which make this capital formation possible are shown in the second half of Tables 14 and 20. The principal sources of saving in the construction period are from the non-resident, personal,

and government sectors.[1]

In the low unemployment simulation (see Table 11), the net decrease in the value of exports of goods and services ($1.1 billion) plus the net increase in imports of goods and services ($1.8 billion)[2] gives rise to an increase in the deficit on current account with non-residents of $2.9 billion. This deficit represents a source of additional resources to the Canadian economy during this period and hence is part of the total saving available to finance capital formation. Personal saving accounts for $0.5 billion. The government surplus, amounting to $1.5 billion, we shall explain when we turn to Table 15. These three sectors make somewhat similar contributions to total saving in the high unemployment simulation.

Table 15 shows the changes in government tax revenue and expenditure in the low unemployment simulation giving rise to the net increase in the balance of $1.5 bi lion over the three-year period. We assumed no change in fiscal pol cy in this simulation experiment so that the tax rates prevailing i the control solution remain in effect. In the low unemployment simulation, tax revenues increase during the construction phase. On the expenditure side, real government expenditure (in constant dollars) was assumed to be unchanged from the control solution and wage rates and prices of purchased goods and services were assumed to move in line with movements in prices and wages in the private sector of the economy. As prices and

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1/ The statistical discrepancy in these Tables indicates the extent to which the estimates of saving by the model fall short of the estimated capital formation and indicates small errors in the estimates of the components of saving or of induced capital formation.

2/ After adjustment for withholding taxes.

wages fall relative to the control solution, government expenditure on goods and services falls relative to the control solution. Similarly, there is a net decrease in transfer payments. Since expenditures decline while tax revenues increase, there is an improvement in the government balance over the period. A similar result appears in the high unemployment simulation[1/] where, although tax revenues decrease because of the larger decrease in prices, the decrease in expenditures more than outweighs the tax decreases.

1/ See Table 21.

(ii) Operations phase effects

Turning to the operations phase, we note that there will be substantial export revenues from the transmission of Alaskan and Mackenzie Delta gas and from export sales of Delta gas. In contrast to the construction phase, expenditures on materials and labour and the direct and induced imports resulting therefrom will be relatively small. When the construction phase has ended there will be no further inflows of capital to finance the project. Repayment of debt capital will, however, have begun and the outflow of interest and dividends will be substantial. These outflows will directly offset part of the export revenues. Moreover, the pipeline export revenues will increase incomes which will induce personal consumption expenditures in Canada and in turn lead to imports of goods and services. If the export revenues are substantial relative to the magnitude of the outflows of debt repayment, interest and dividends and the imports of goods and services, the net effect will be for the exchange rate to appreciate to restore equality between the current and capital accounts of the balance of payments. To the extent that the appreciation reduces prices and interest rates, this will reduce capital inflows into Canada (or increase capital outflows) and reduce the amount by which the exchange rate has to appreciate in order to offset the net surplus arising from the increased export revenues.

1/ The construction and operations phases overlap during the years 1979-83. Although we discuss them separately here, when we interpret the simulation results we must bear this overlap in mind.

As we commented earlier, the years 1979-82 are affected by two forces tending to some extent to offset each other. The slowdown in the rate of construction tends to produce a cyclical reaction in the economy as the stimulus provided by the pipeline construction is reduced. On the other hand, the beginning of the operations phase means a flow of revenues from the transmission and sale of gas and a consequent increase in incomes which tends to offset the effects of the slowdown in the rate of construction activity.

To analyze the impact of the operations phase itself, therefore, we look at simulation results for the years 1983-85. To obtain operations phase effects which would not be confounded by the cyclical effects of the ending of the construction phase, we ran a set of simulations which assumed no pipeline construction or operations in the years 1976-82. We "turned the pipeline on" in 1983 and let the model generate "pure" operations phase effects beginning in 1983.[1/] Table 23 presents a set of these sun-n-nary results.

Ifwe look at the impact prior to an adjustment in the exchange rate taking place, we note that, as we would expect, the increases in real output and expenditure are higher in the high unemployment simulation than in the low unemployment simulation. This is partly because the greater amount of slack in the former situation permits a greater expansion in real output before capacity restraints become effective and partly because productivity gains

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1/ That is, all pipeline variables in Table 9 were assumed to have zero values over the period 1976-82. The figures in Table 22 therefore differ from those which would be derived from Tables 10-21 where the figures for 1983-85 reflect both the operations phase effects and the lagged effects of the ending of the construction phase.

Table 23

Average Operations Phase Effects (1983-85)

before and after Exchange Rate Appreciation/

	Low Unemployment Case		High Unemployment Case	
	before	after	before	after
Change in foreign exchange rate (per cent)	0.0	-2.4	0.0	-2.9
Induced effects on real GNP (millions of constant dollars)				
Personal expenditure on consumer goods and services	265	108	487	186
Business gross fixed capital formation	-87	7	-4	-23
Exports of goods and services 2/	80	-69	166	-77
Imports of goods and services	92	208	89	274
Gross national product	175	-167	582	-201
Effects on prices and employment				
Change in GNP price index as per cent of control solution level	-0.22	-1.84	-0.54	-2.04
Change in man-years of employment (thousands)	20	-9	42	-12
Balance of international payments (millions of current dollars)				
Current account	1,552	1,051	1,680	895
Capital account	-288	-1,050	-343	-893
Change in international reserves	1,264	1	1,337	2

1/ The difference between pipeline simulation levels less control solution levels averaged over the three-year period 1983-85. As is explained on page 100, these are "pure" operations phase effects and the figures therefore differ from those which can be derived from Tables 10-21.

2/ Excludes gas exports and transmission revenues.

in-the early years leads to price reductions in those years. In the high unemployment simulation where there is more slack the upward pressure of capacity restraints upon prices is less and therefore the net price decrease is greater. Although in both cases the average increase in real GNP per year is less than one per cent of the control solution level, the increase in the high unemployment case is roughly three times that in the low unemployment case.

The major difference in the balance of payments between the two cases, prior to the adjustment of the foreign exchange rate, is that induced exports increase more in the high unemployment case because of the better price performance. Hence a larger appreciation of the foreign exchange value of the Canadian dollar is required in the high unemployment simulation to restore balance between the current and capital accounts of the balance of payments.

In contrast to the construction phase, in the operating phase the current account surplus (attributable to export revenues and the displacement of energy imports) is substantially greater than the outflows of capital as debt repayment proceeds. There is, therefore, a larger appreciation of the exchange rate in the operating phase than in the construction phase. The range of difference in the high unemployment simulation from the control solution rate over the whole period varies between an appreciation of0.7 per cent (in 1977) and an appreciation of 3.1 per cent (in 1984).

--(iii) Over-all effects

Looking at the total impact over the ten-year period 1976-85 and averaging the low and high unemployment simulation results, we estimate the order of magnitude of the net effect of the construction and operation of the pipeline on real GNP to be an increase of $2.8 billion over the control solution level. The direct effect (after allowing for direct and indirect import content of the pipeline) is an increase in real GNP of $5.0 billion. In addition, the pipeline activity results in an increase in real personal expenditure on consumer goods and services of $2.9 billion. As we remarked above, there are, however, induced decreases in other components of GNP which more than offset the increase in consumption. The higher levels of income and the exchange rate appreciation induce an increase in imports of goods and services of $2.9 billion. An induced decrease in exports of $1.6 billion occurs while capital expenditures (incl. residential construction) in the non-pipeline sector tend to be less thi n in the control solution so that there is an offset in real cap tal formation of $0.5 billion . over the ten-year period.

Real GNP is above the control solution level in all years in the " ow unemployment simulation but the increase shows a cyclical pattern From 1976-78 the increase rises as construction activity is stepped up; then the increase declines until 982 reflecting the reduction in the stimulus to the economy as the evel of pipeline construction activity is reduced. Beginning in 983 the effects of the increased export revenue and report displacement from the

operations phase offset the effects of the end of the construction activity and the increases in real GNP again begin increasing. The change in man-years of employment follows a similar pattern. In the high unemployment simulation the path of the changes in real GNP follows a somewhat similar cycle. In this case, however, because of the greater exchange rate effect, real GNP falls below the control solution levels in the period 1981-84. The larger appreciation of the exchange value of the Canadian dollar in the high unemployment simulation coupled with the larger amount of slack in the economy also has the effect that the decreases in price level over the respective control solution levels are larger in the high unemployment simulation than in the low unemployment case. On the whole, as we commented earlier, the changes in interest rates are so small as to be negligible and little, if any, significance should be attached to the difference in interest rates in the two simulations.

(iv) Summary

Table 24 gives some percentage comparisons which summarize the orders of magnitude of the economic impact of the pipeline under the assumptions of Case A. To sum up, the simulation experiments with the TRACE model give the result that the construction and operation of the pipeline will have the following results:

(1) There will be a modest appreciation of the foreign exchange rate. The effect on the exchange rate is less than one per cent during the construction period and, at the maximum, slightly over three per cent in the operating phase (in the high unemployment case).

(2) The appreciation of the foreign value of the Canadian dollar will lead to slightly lower price levels in Canada than would have existed in the absence of such an appreciation.

(3) Real personal disposable income and real personal expenditure on consumer goods and services will increase by a small amount.

(4) Some domestic resources will be reallocated away from producing goods for exports and capital goods in order to release resources to construct the pipeline, to develop the Delta gas fields, and to produce more consumption goods.

(5) Real imports will increase by a little over one percent over the level that might exist in the absence of the pipeline.

Table 24

Case A

Summary Results

Percentage change from control solution[1/]

	Control Solution Unemployment Rate	1976-85	1977-79	1983-85	1985	Maximum (year)
Real GNP	Low	0.26	0.56	0.16	0.32	0.69 (1978)
	High	0.26	0.90	-0.19	0.01	1.06 (1978)
Employment	Low	0.10	0.31	-0.02	0.04	0.35 (1978)
	High	0.09	0.50	-0.30	-0.23	0.59 (1979)
GNP price index	Low	-0.44	-0.34	-0.86	-1.02	-1.02 (1984)
	High	-0.60	-0.90	-0.81	-1.14	-1.14 (1985)
Exchange rate	Low	-1.19	-0.63	-2.00	-1.82	-2.28 (1984)
	High	-1.62	-0.83	-2.87	-2.83	-3.15 (1984)
Real exports of goods and services	Low	0.24	-0.23	0.57	0.69	0.69 (1985)
	High	0.25	0.02	0.34	0.52	0.61 (1980)
Real imports of goods and services	Low	1.28	1.91	1.05	0.89	2.18 (1978)
	High	1.62	2.11	1.44	1.21	2.39 (1978)
Real personal expenditure on consumer goods and services	Low	0.36	0.48	0.32	0.30	0.58 (1978)
	High	0.46	0.73	0.25	0.21	0.84 (1978)
Real business gross fixed capital formation						
(a) incl. pipeline	Low	2.07	5.38	0.55	1.09	6.41 (1978)
	High	1.93	5.85	-0.52	0.14	6.83 (1978)
(b) excl. pipeline	Low	-0.29	-0.69	0.18	0.93	0.93 (1985)
	High	-0.52	-0.21	-0.97	-0.12	-1.58 (1983)
Real personal disposable income	Low	0.39	0.63	0.28	0.26	0.77 (1978)
	High	0.49	0.96	0.13	0.10	1.12 (1978)
Interest rate on long-term government bonds	Low	-0.67	-0.68	-1.33	-2.11	-2.11 (1985)
	High	-0.86	-2.24	0.83	-1.28	-4.40 (1979)

1/ Includes both direct and induced effects.

(6) Increases in employment occur in the construction phase while decreases occur in the early part of the operations phase.

(7) The net outcome of the various forces affecting interest rates is such that negligible changes occur.

Compared with the orders of magnitude of these variables in the economy as a whole, the changes in macroeconomic variables resulting from the construction and operation of the pipeline are small. The small magnitude of these effects reflects the fact that, although it is a large undertaking, the construction is spread over a period of years and its impact in any one year is reduced by the substantial import content and external financing of the pipeline. The net addition to total spending in any one year is therefore not overly large in comparison with the level of capital expenditures in the economy as a whole.

APPENDIX I

MODIFICATIONS MADE TO TRACE MARK IIIR TO FACILITATE SIMULATION OF MACKENZIE VALLEY NATURAL GAS PIPELINE

In order to perform the simulation experiments described in the main body of this report, a number of additions had to be made to the econometric model, TRACE Mark IIIR.[1/] New variables pertaining to various aspects of the proposed pipeline project were defined and fitted into the model's existing equations. In addition, several entirely new equations were added. Overall some forty-five modifications were made to the model expressly to take account of various features of the pipeline proposal.[2/] These modifications and the reasons for them are described in this Appendix.

It should be stated at the outset that there is no standard way of incorporating the specific attributes of a project as complex as the proposed Mackenzie Valley pipeline into a macroeconomic model. About all that can be said in this regard is that the model user should attempt to modify the specific model used in a manner that incorporates the project's unique attributes. The appropriate modifications will vary with both the nature of the model used and the "richness" of the data provided.

1/ The TRACE model is described in detail in John A. Sawyer, TRACE Mark IIIR: An Annual Econometric Model of the Canadian Economy, Report No. 5, Institute for the Quantitative Analysis of Social and Economic Policy, University of Toronto, February, 1974. The equation numbers given in this Appendix refer to the listing of the model in that publication.

2/ The model modifications were identical for both the Case A and Case B simulations of which cases differ only as regards the values of certain exogenous variables--most notably exports of natural gas--used as inputs in the simulations.

. . Some of the TRACE modifications described below would, therefore, not necessarily have been made had some other econometric model been used for this analysis. Similarly, a lesser or greater degree of disaggregation in the data provided by Canadian Arctic Gas Study Limited would likely also have altered the nature of the model modifications.

The first series of modifications to be described were necessitated by the fact that the Mackenzie valley pipeline will contribute gross additions to aggregate demand for goods and services in both its construction and operational phases. Expenditures on pipeline construction will represent gross additions to the non-residential construction component of gross national product, while sales of transmission services and assumed sales of natural gas to the United States will add to the exports components during the operations phase. To embody these aggregate demand aspects in TRACE Mark IIIR, the following alterations were made:

(1) An exogenous variable, NRGP9, was created. This variable measures total annual expenditures made in constructing the pipeline in billions of dollars at current prices. It is added to the other components determining business investment in non-residential construction in equation (C 14).

(2) A second exogenous variable, NRAG9, measuring annual non-residential investment in Mackenzie Delta gasfield development in billions of dollars at current prices, was also created. Approval to proceed with construction of the pipeline will stimulate gas field development in the Delta area. This will generate

investment that would otherwise not occur; hence, it should be included in the pipeline simulation experiments. The variable NRAG9 was also added to total business non-residential investment in equation (C.14).

(3) Two exogenous variables relating to natural gas exports were created. The first, XSGP9, measures exports of services generated by the transport of both Alaskan gas, and that part of the Mackenzie Delta gas which is exported, in billions of dollars at current prices. This variable was added to the other components generating total exports of services in equation (D.44). The other, XGUGP9, measures export sales (net of transport costs) of Mackenzie Delta gas in billions of dollars at current prices. It was added to the other components generating exports of goods in equation (D.7).

(4) An exogenous variable, MEGDIS, measuring the value of energy imports displaced by the pipeline, was created and subtracted from the equation determining total merchandise imports. This variable assumed a non-zero value only in the Case A simulations. The rationale behind this modification stemmed from the assumption made in the Case A simulations that the introduction of Delta gas into Canadian markets displaces imported energy. (See pp. 52-56 of the main Report for a more complete explanation of the Case A simulations).

(5) The modifications described above all pertain to current dollar components of GNP. Corresponding to each of the four newly created exogenous variables a price deflator (with base 1961 = 1.000) was also created. The deflated value of each of the variables was added to the respective constant dollar analogue of each of the equations cited above; e.g., (XGUGP9/PXGGP2) was added to the other determinants of real exports of goods in equation (D.5). Thus the gross additions of the pipeline to constant dollar GNP were imbedded in the model through these alterations.

Insofar as TRACE Mark IIIR contains endogenous linkages between aggregate demand and other sectors, these modifications would have sufficed by themselves to enable a rather crude simulation exercise of the pipeline's impacts. Estimates of employment, balance of payments, and other macro-economic effects of the pipeline could have been produced by running simulation experiments based on only these changes. Estimates generated by such an exercise would, however, be less than adequate for assessing the overall impact of the pipeline project; they would ignore aspects of the pipeline proposals which are unique to that specific project and for which data was available. For example, such a crude simulation would rely on the TRACE model's import equation to generate estimates of the impacts of pipeline construction on Canadian imports of goods and services. This would produce a reasonable estimate only if the import content (i.e., the ratio of import value to total construction outlays) involved in

constructing the pipeline is similar to the import content of the average non-residential construction project (for it was the "average project" which formed the sample period data from which the TRACE import equation was estimated). The simulation results could be improved upon by making modifications to the TRACE import equation which allows the data provided to us on the specific import content of the pipeline to "over-ride" the equation's results. This change in the equation was therefore made.

Similarly, the simulation results of other variables could be improved by modification to their respective equations, providing that pipeline data are both available and, in some sense, atypical.[1/] A second series of modifications to the TRACE model, motivated by those considerations, were the following:

(1) An exogenous variable, MMGP9, measuring imports of goods and services associated with pipeline construction was created. The variable is expressed in billions of dollars at current prices and includes both the direct purchase of imported goods and services by the pipeline company and also the estimated import content of goods and services purchased from domestic suppliers. Also created was a price deflator (1961 = 1.000), PMMGP. Using information from the TRACE model, it was assumed that 93 per cent of the total constituted goods and the remainder, services.[2/] The deflated value of the goods portion was added to the other determinants of total merchandise imports in constant 1961 dollars in equation (D.68). A further adjustment to this equation was

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1/ It is in this context that appropriate modifications to a model were said to be partially dictated by the "richness" of the data provided.

2/ This split is based on the equation in the TRACE model which generates imports of freight and transportation services by taking 7 per cent (in steady state) of goods imports (equation D. 71 for MSFSV).

'-necessary to prevent the endogenous import effects of the pipeline increment already added to real business investment in non-residential construction from operatinq. This was accomplished by excluding the net difference between real pipeline investment and real pipeline merchandise imports from the real income variable upon which tota" real merchandise imports in TRACE depend.

(2) Another component of services imports, income paid to non-residents, is directly affected by the pipeline project. The variable, IDPGP9, measuring interest and dividends paid to non-residents by the pipeline company in billions of dollars, was created and added to the determinants of income paid to non-residents in equation (D.76).1/ Double-counting in this equation was avoided by excluding direct pipeline dividends from the total dividend variable appearing as an explanatory variable on the right-hand-side of the equation.

(3) The actual construction of the Mackenzie Valley gas pipeline will directly generate an inventory cycle of sorts. Suppliers of pipeline materials will build up inventories of these materials in advance of delivery. Once delivered, this stockpile of materials will be gradually depleted as the pipeline and its associated

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1/ As will be explained later in this Appendix (page 123), it was necessary to make IDPGP9 endogenous to the TRACE model in order to allow the interest component of this variable to fluctuate with variations in the U.S.-Canadian foreign exchange rate.

facilities are put in place. In a National Income and Expenditure Accounts framework, the bulge in non-residential construction expenditures occurring because of the pipeline should be preceded by an increase in investment in business inventories. It should be coincident with a decline in inventory investment equal in size to the preceding buildup. It would have been desirable in modifying the TRACE model to make alterations which reflect this up-and-down movement in inventories but the required data were not obtainable. We had to assume that pipeline materials are both produced and delivered to Canadian Arctic Gas Pipeline Limited within the same year; i.e., that the inventory cycle described above occurs within the space of one calendar year. Since the basic time unit of observation in the TRACE model is one year and, further, since TRACE measures inventory stocks at the end-of-year values, this assumption meant that a business inventory cycle would not show up in the pipeline simulation experiments. Accordingly, the deflated value of NRGP9 was excluded from the real output measure on which desired inventory stocks depend in TRACE.[1/]

1/ Without this exclusion, the injection of pipeline construction expenditures via the variable NRGP9 would have resulted in the model generating an inventory cycle which lagged behind the actual construction process.

(4) One of the most important modifications made was to al low for the unusually high capital intensity of the pipeline project. In order to recognize the special characteristics of the physical capital generated by these expenditures (i. e., the pipeline itself, compressor stations, etc.), we treated this addition to the capital stock as taking place in a distinct sector of the economy rather than mixing it in with the capital stock of the business sector of the economy. Even after the pipeline is completed and transmissions of gas begun, the volume of physical capital per unit of output produced here will greatly exceed the economy-wide average. Since capital stocks in the business nonagriculture sector are important to the internal workings of TRACE (they affect the determination of investment and employment in non-pipeline enterprises), it was essential that the pipeline capital be kept separate from the capital stocks of the business sector. This was accomplished simply by excluding pipeline investment expenditures from the gross capital flows used to accumulate the stock of non-residential capital in the business non-farm sector. In order to maintain internal consistency, value added in the sale and transmission of gas was treated as output originating in a completely new sub-sector of the model created for this purpose. Two new variables were created, YGP9 and YGP9R,

which measure gross domestic product originating in this new sub-sector in current and constant prices, respectively. YGP9 is an endogenous variable computed as the sum of wages and salaries, corporation profits, and interest paid by the pipeline company during the operation phase. YGP9R, also endogenous, is calculated as YGP9 deflated by the previously defined implicit price index for exports of transmission services, PXSGP2.

The alterations described in (4) above involved a careful distinction between the construction phase and the operations phase of the pipeline project. Construction of the pipeline was viewed as an activity undertaken by a sub-sector of the business non-agricultural sector of the economy in response to exogenous demands introduced via NRGP9. The final output of this construction activity was phsycial capital in the form of line pipe, etc. That physical capital was used by an entirely new sub-sector (the pipeline company) as a factor of production in producing gas transmission services during the operations phase of the project. The physical capital was not counted as part of the measured capital stock of the business non-agricultural sector of the economy, although it did constitute part of the total capital stock of the entire economy. Similarly the output (measured by XSGP9) and factor income shares (measured by YGP9) generated in the

operations phase were not included in their business non-agriculture analogues; but they were included as parts of overall GNP and GDP, respectively.

(5) Evaluation of the employment effects of the pipeline project required separate modifications for each phase of the project. Construction of the pipeline is a business non-agricultural activity for which the direct employment requirements could have been generated internally by the model. However data were provided on the direct employment requirements, and it was decided to utilize them in the simulation experiments. The exogenous variable, ECGP, measuring man-years required for the construction activities, was created and added to the other determinants of employment in business non-agriculture in equation (H.5). Double-counting was avoided by excluding from the real output variable appearing on the R.H.S. of (H.5) the deflated value of wages and salaries paid to these construction workers. Data were also provided for the number of man-years of direct employment required during the operations phase of the project. By the convention adopted with regard to nature of activities during the operations phase, persons employed in this phase of the project were not considered to be part of business non-agriculture employment. Hence the modification made to introduce pipeline construct' on workers into equation (H.5) could not be applied to employment in the operations phase.

A separate exogenous variable, EGP9 , measuring man-years of employment in the operation of the pipeline, had to be created This variable was added to the other components of total employment in equation (H.9).

(6) By and large, the modifications necessary to incorporate the direct pipeline effects on income shares were made only for the operations phase of the project. Incomes in the form of taxes, wages and salaries, and profits generated during the construction phase were in most cases left to be determined endogenously during the simulation exercises. The two exceptions to this were wages and salaries paid to workers involved in constructing the pipeline and indirect taxes paid on the purchase of construction materials. Data were provided for both of these series. The exogenous value of construction workers' wages, introduced via the variable, WSCP, was added to the other components, wages and salaries paid to business non-agricultural workers in equation (1.6). Sales and excise taxes, together with customs duties paid on the purchase of pipeline materials, were measured by the exogenous variable, ITCGP9 , and added to the other components of total indirect business taxes in equation (J.7). In both instances additional modifications to the specified equations were required in order to avoid the problem of double-counting. The direct effect of the pipeline's operation on income shares was introduced by

means of exogenous variables added to appropriate equations. Modifications designed to avoid double-counting were unnecessary because of the separation made between pipeline operations and other forms of business non-farm activity. The exogenous income shares variables created were:

CCGP9 capital consumption allowances associated with the pipeline, added to the R.H.S. of equation (1.9), determining total corporate CCA

CPGP9 corporate profits plus CCA of the pipeline company, added to the R.H.S. of equation (I. 10), determining net corporate profits

CTGP9 corporate income taxes paid by the pipeline company, added to the R.H.S. of equation (J. 3) determining total corporate taxes

DIVGP9 total dividends paid by the pipeline, added to the R.H.S. of equation (1.11), determining total dividends

ITOGP9 total indirect taxes paid by the pipeline company during operations plus royalties paid on the sale of Mackenzie Delta gas, added to the R.H.S. of equation (J.7), determining total indirect business taxes.

WSGP9 total wages, salaries and supplementary income paid to employees during the operations phase, added to equation (1.7), determining total wages and salaries plus supplementary labour income.

(7) The last of the modifications made to take account of aspects specific to the pipeline proposal were made in the sub-sector of TRACE dealing with international capital flows and foreign financing. The

exogenous variable **CIWGP9** was created to measure the quantity of foreign debt (net of repayments) issued to finance the construction of the pipeline. The variable was added to other determinants of net portfolio investment in Canada from abroad in equation **(M.4).** To measure the quantity of foreign equity issued, the exogenous variable LDWGP9 was created. This variable was added to the other determinants of foreign direct investment in Canada in equation (M.3), and the net retained earnings of the pipeline company were excluded from those other determinants to avoid double-counting.

The modifications described above were made over a two-year interval of time and were altered progressively as the degree of detail in the data provided and the structure of the model itself evolved over this interval.

It should be noted that the pipeline data were, in most instances, derived from estimates of the costs of constructing and maintaining a large complex of line pipe, compressor stations, etc. All estimates relating to foreign costs and financing were made under the assumption of a Canadian/United States exchange rate of 1.0. By basing their cost estimates on this exchange rate, the producers of these estimates have in effect valued the costs of construction materials purchased outside Canada in U.S. dollars. For simulation exercises with TRACE, it is the value in Canadian, not U.S., dollars

that is relevant.[1] As long as the exchange rate is at 1.0, of course, it makes no difference which currency is used as the measure of value. One of the more important issues which the TRACE simulations seek to illuminate is how the construction and operation of a Mackenzie Valley gas pipeline might affect the foreign exchange rate. It would be inconsistent to attempt to investigate this issue without also taking account of the impacts of induced variations in the foreign exchange rate on the costs of constructing and financing the pipeline itself. To this end, a third and final set of modifications--designed to allow data pertaining to the pipeline to adjust "automatically" to movements in the Canadian/U.S. foreign exchange rate--was undertaken.

To explain in full detail each individual equation modification involved in this final set of alterations would perhaps double the length of this Appendix. It would also require a re-iteration of the basic workings of the TRACE model--duplicating much of what already exists in another document.[2] Only a simple outline of the basic features of these modifications is presented here.

The variable, MMGP9, was earlier defined to measure the nominal value of imports of pipeline construction materials and services. This definition should now be extended to include the proviso that specific values for MMGP9 are based on a value of 1.0 for the

---

1/ Insofar as the purchase of such foreign-produced goods is financed by foreign borrowing, it does make good sense from an accounting point of view to value foreign purchases in terms of the quantity of foreign currency which will be required.

2/ J.A. Sawyer, TRACE MkIIIR: An Annual Econometric Model of the Canadian Economy, Report 5, Institute for the Quantitative Analysis of Social and Economic Policy, University of Toronto, 1974.

Canadian/U.S. foreign exchange rate. Should the exchange rate differ from 1.0, the costs in Canadian dollars of obtaining a fixed real quantity of imported pipeline materials will be higher (in the case of a depreciation) or lower (in the case of an appreciation) than the quantity MMGP9.[1/] A measure of the costs of these imports which is adjusted for variations in the exchange rate is provided by the expression MMGP9 . FXSU, where FXSU is the TRACE model mnemonic for the Canadian$/U.S.$ foreign exchange rate. One way of introducing exchange rate adjustments into the TRACE model is simply to use the expression MMGP9 . FXSU in every instance which calls for the value of pipeline imports in nominal terms. That is precisely what was done. In other words, in all of the equation modifications involving the variable, MMGP9, described earlier in this Appendix, the exchange-adjusted expression MMGP9 .FXSU was actually used in place of the unadjusted variable.

A similar substitution was made in the place of the total pipeline investment variable NRGP9. Since a movement in the exchange rate changes the costs of importing pipeline materials, it will also change total construction costs by an equivalent amount. The corresponding exchange-adjusted expression for total pipeline investment in year t is given by

$$NRGP9_t + MMGP9_t \text{ “ } (FXSU_{t_L} - 1.0)$$

1/ The costs referred to here are nominal costs. The real or constant 1961 dollar value of a given physical quantity of imports is not affected by exchange rate changes.

This expression was used instead of the unadjusted variable NRGP9 in all equation modifications requiring the insertion of total pipeline investment in nominal prices.[1/]

Foreign debt issues used to finance the pipeline are to be denominated in U.S. currency. Hence, variations in the exchange rate will affect not only the Canadian dollar value of proceeds raised from such issues but also the value of interest paid on them. Exchange rate adjustments had also-to be made to pipeline variables relating to foreign borrowing and interest payments. These were both too numerous and complex to describe in detail, but cause the following sorts of mechanisms to operate in the simulation experiments. Suppose the exchange rate appreciates above 1.0 in year t. Then, the pipeline's import costs drop by say X (Canadian) dollars. The amount of foreign financing required to finance year t's imports will also decline by X (Canadian) dollars, and by modifications built into the TRACE model's equations, such a decline is assumed to automatically take place. That action will, however, lower (in U.S. dollars) the amount of interest which must be paid to non-resident holders of debt in years t, t + 1, t + 2, . , . ., Modifications were introduced to automatically make the required adjustments to pipeline interest payments in year t with the appropriate carry-over provisions for future years. Adjustments were also made to automatically adjust profits of the pipeline company during the operations phase of the project.

1/ As with imports, the real or constant 1961 dollar valueof pipeline investment is invariant with respect to exchange rate changes. Only the nominal magnitude is altered.

- In the example at hand, lower interest payments mean higher profits for the company. Higher profits generate higher corporate income taxes, and still further modifications were required. Readers interested in the precise forms of these modifications are urged to carefully examine the complete listing of modified equations appearing at the end of this Appendix and to compare each equation with its unmodified counterpart in the basic TRACE model.1/

1/ The unmodified listing is on pages 142-158 of John A. Sawyer, TRACE Mk IIIR: An Econometric Model of the Canadian Economy Report #5, Institute for the Quantitative Analysis of Social and Economic Policy, University of Toronto, February, 1974.

List of Variables, Data, and Equation Changes

A. Created Pipeline Variables

1.	CCGP9	Capital consumption allowances, gas pipeline, billions of dollars.
2.	†CIWGP9	Foreign debt (net of retirements) raised by the pipeline company, billions of dollars.
3.	CPGP9	Corporation profits plus CCA, gas pipeline, billions of dollars.
4.	CTGP9	Corporation income taxes, gas pipeline, billions of dollars.
5*	DIFGP	Dividends paid to non-residents by the pipeline company, billions of dollars.
6.	DIVGP9	Total dividends paid, gas pipeline, billions of dollars.
7.	ECGP	Total pipeline employment during construction phase, millions of men.
8.	EGP6	Total employment required to operate the pipeline, millions of persons.
9.	*IDPGP9	Interest and dividends paid to non-residents, gas pipeline, billions of dollars.
10.	INCGP	Interest paid to residents during operations phase, gas pipeline, billions of dollars.
11.	INFCGP	Interest during construction paid to non-residents, gas pipeline, billions of dollars.
12.	†INFGP	Interest paid to non-residents, gas pipeline, billions of dollars.
13.	*INTGP9	Total interest paid to non-residents plus interest paid to residents during operations phase, gas pipeline, billions of dollars.
14.	ITCGP9	Indirect taxes paid on the purchase of pipeline materials, construction phase, billions of dollars.

---

† Calculated on the basis of an assumed value of 1.0 for the Canadian/U.S. exchange rate.

* Endogenous variable.

15. ITOGP9 — Indirect taxes, including royalties on Mackenzie Delta gas, paid by the pipeline company during the operations phase, billions of dollars

16. *KMM — Additional net foreign debt issues necessitated by deviations from parity in the Canadian/U.S. exchange rate, billions of U.S. dollars.

17. LDWGP9 — Foreign equity raised by the pipeline company, billions of dollars.

18. **MEGDIS — Imports of crude petroleum displaced by the introduction of Mackenzie Delta gas to supply domestic energy requirements, billions of dollars.

19. †MMGP9 — Direct imports of materials used in construction and maintenance of the pipeline, incl. services other than interest and dividends paid to non-residents, billions of dollars.

20. NRAG9 — Associated non-residential investment in Mackenzie Delta gasfield exploration and development, billions of dollars.

21. †NRGP9 — Total non-residential construction expend tures, gas pipeline, billions of dollars.

22. PNRAG — Implicit price index for non-residential investment in Mackenzie Delta gasfield exploration, based on 1961 = 1.000.

23. PNRGP — Implicit price index for non-residential construction expenditures incurred in constructing the pipeline, based on 1961 = 1.000.

24. PMMGP — Implicit price index for imports of goods used in construction of the pipeline, based on 1961 = 1.000.

25. PWSCP — Deflator for wages and salaries paid to pipeline construction workers, based on 1961 = 1.000.

26. PXGGP2 — Implicit wellhead price index for exports of Mackenzie Delta gas to the United States, based on 1961 = 1.000.

** Used only in the Case A simulations.

27.	PXSGP2	Implicit price index for exports of pipeline transmission services to the United States, based on 1961 = 1.000.
28.	RBGP	Interest rate payable on foreign debt issued by the pipeline-company, expressed as a fraction, e.g., 0.106.
29.	WSCP	Total wages and salaries plus supplementary labour income paid during the construction phase, billions of dollars.
30.	WSGP9	Wages, salaries, and supplementary labour income generated in operation phase of pipeline, billions of dollars.
31.	XGUGP9	Exports of Canadian produced gas to the. United States, billions of dollars (valued at wellhead).
32.	XSGP9	Exports of pipeline services to the United States (= gross royalties paid for transmission of gas), billions of dollars.
33*	*YGP9	Gross domestic product originating in the operation of the pipeline, billions of dollars.
34.	*YGP9R	Real gross domestic product (in 1961 prices) originating in the operation of the pipeline, billions of dollars.
35.	DOPER	Dummy variable, = 1.0 during construction phase, = 0.0 during operations phase.

B. Equation Changes

```
YGI=YGIB+YGIN+YGDV+GIGP9

KMM = KMM1 + ((MMGP9*(FXSU-1.0))/FXSU)

   IFNB=IFNN+(IFNAV+IFNIV)/PIFNN
1  +(NRGP9 / PNRGP) + (NRAG9 / PNRAG)

 IFNBV      = IFNNV + IFNAV + IFNIV+NRGP9+MMGP9*(FXSU-1.0)+NRAG9
1              +(INTGP9 - (INFGP  +INCGP))*  DOPER

 XGU     = EXP(-0.893204) *((PXGRU/PFXSU) /UPMG)**(-1.19619)
                  (8.09)                              (5.21)
1 *(UMG-XGAU) **.695413 *(XGU1-XGUGP0/PXGGP0-XGAU1 )**.182015+XGAU
                         (8.59)             (1.80)
1         +XGUGP9/PXGGP2

          RBSQ=0.99       SDR=0.023 DW=1.63    PD=54-71   OLS

 XGUV=(XGU-XGAU-(XGUGP9/PXGGP2))*QXGRU*PFXSU +XGAUV+XGUGP9

 Xsv= XSSV + XSGV+YIDX + XSGP9

 Xs    = XSS + xSG + YIDXR+XSGP9/PXSGP2

 TEMPY = VAN -(NRGP9/PNRGP - MMGP9/PMMGP)

 MG = EXP(-0.915128) *TEMPY**( 00773859   +0.242516 *(1.0/UR))
           (7.93)                 (23.4)      (6.53)
1          *(QMGR*PFXSU*(1.0 +RTIM)/PVAN) **(-1.378489) +MGAU
                                                  (7.95)
1         +  (100/10073)  * (MMGP9/PMMGP)/ MUL(285) + MEGDIS/3.747

          RBSQ=0.992  SDR=0.022   DW=1.80   PD=55-71      OLS
          REGRESSAND  WAS LN(MG-MGAU)
```

```
MGV=MGAU*QMGAU*PFXSU+ (QMGR*PFXSU) *((MG-MGAU MEGDIS/3.747) -
1       (1.0/1.073) * (MMGP9 / PMMGP)) + (1.0/1.073) *MMGP9*FXSU
2       + MEGDIS


MSFSV  =  .064964 + ,030218 * (MGV - (1.0/1.073) * MMGP9 * FXSU
          (1.81)             (2,89)
1      - MEGDIS)
*       + ( .073/1.073 ) * MMGP9 *  FXSU
1          + .58616 * ( MSFSV1 -(.073/1.073) * MMGP91 * FXSU1 )
              (3033)

          RBSQ = 0.981  SDR = 0.296 DW = 1.89 PD  =  54-70  OLS


MSS  =  (MSSV  (0073/10073) *MMGP9* FXSU) / PMSS
1          + (0073 / 10073) * (MMGP9 / PMMGP)


IDPGP9 = DIFGP  +(INFGP + RBGP*KMM) * FXSU


YIDM   = EXP(-0.722463)*(YCDV + YIPD - DIVGP9)** 0s900945
            (4.87)                  (5.49)
1          *( YIDM1  - IDPGP0)** 0s148377 + IDPGP9
                 .

          RBSQ=0.99      SDR=0.030      DW=2.03        PD=54-70 OLS
          REGRESSAND WAS LN(YIDM)


IF (TIME  ● GT. 72.)
S TYW = ((YIDM-IDPGP9)/(YIDM1-IDPGP0))*(TYW1 ● 125*(INTGP0 - "
1       INCGP1)  ● lO*DIFGP1) + .125*(INTGP9- INCGP) +.10*DIFGP


SALE = C  + IFB  (NRGP9/PNRGP) + CGNWV/PCGNW + XG


SALE1 =  C1 + IFB1  - (NRGP91/PNRGP1) + CGNWV1/PCGNW1 + XG1


SALE2 = C2 + IFB2  -  (NRGP92/PNRGP2) + CGNWV2/PCGNW2 + XG2


SALE3 = C3 + IFB3  -  (NRGP93/PNRGP3) + CGNWV3/PCGNW3 + XG3


INTGP9 = (INFGP+ RBGP*KMM) *  FXSU  +  INCGP


YGP9 =  (WSGP9 + CPGP9  +  INCGP + (INFGP  -  INFCGP)
1       + (INTGP9  -  (INFGP   +   INCGP))*(1.0 DOPER ))
```

```
YGP9R    = YGP9/PXSGP2

TIM = (MGV  MGAUV - MMGP9*FXSU) * RTIM

TIES = (CV+(IHBV+IFNNV)*DI+IFMNV)*RTIES  +  NRAG9 * DI * RTIES

TI = TIES + TIM + TIP + ITCGP9 + ITOGP9

VAN  =  GDP VAA  VAPG  - YGP9R

 PGDP=(PVAN*VAN+PVAA*VAA+PVAPG*VAPG) /GDP +YGP9/GDP

 RDIS=(GNP*PGNP IFGV  -  CGV  -  IFBV + IHBV  -  IIV  -  XV  +  XSSV
1           + MV  DISEV)  /
2       (PCD*CD + PCNDS* CNDS + PIHB*IHB + XSSV)

 LN      = EXP(-0.002222 -0.0143329*TIME+0.00578824*UR)
                 (0907)        (29.0)           (2.75)
1        * ((VAN  (WSCP/PWSCP))/ (KFRB1  +  KFNN1  +  KFMN1)) **
2              .301393  * (( LN1 - ECGP1)/ (VAN - (WSCP/PWSCP))) **
3             .45 * (VAN - (WSCP/PWSCP)) + ECGP

           RBSQ=0.994      SDR=0.010    DW=1.66     PD=54-70    OLS
           REGRESSAND WASLOG(LN/VAN)
           GAMMA WAS CONSTRAINED TO BE BETWEEN ZERO AND UNITY(0.55)
           BETA  WAS  CONSTRAINED  TO  BE 0.646(LABOUR SHAREIN VANV)

   LE=LA+LN+LGC+LP +EGP6

YWN = WRN * (HMN  - (ECGP*HN*.052))+ WSCP

   YW=YWGC+YWFK+YWPK+YWLK+YWHK+YWA+YWN+YWP +WSGP9

 CCAC    = 0.222595* (0.02*PIHB*0.5*(KFRB+KFRB1) + 0.05*PIFNN*0.5*
             (3.38)
1           (KFNN+KFNN1 )+0.143*PIFMN*0 .5*(KFMN+KFMN1))+
2    .724165*(CCAC1  -  CCGP91) + CCGP9
     (6.80)

          RBSO=0.997  SDR=0.075  DW=1.89   PD=48-71    OLS
```

```
 Yc      = EXP(-1.34024 +  0.493703 *(1.0/UR))*(VANV+VAAV-YWA-YWN
                (17s21)     (4.14)
1        -(CCAC - CCGP9))**1.09144 + CPGP9 CCGP9 - (INTGP9    -
2          (INFGP   +   INCGP)) * (1.0 - DOPER )
                      (44.27)

           RBSQ = 0.99    SDR =  0.041 DW =  1.59   Pi)  =  48-70    OLS
           REGRESSAND WAS LOG(YC)


 TYCL=RTCL*(YC-CPGP9+CCGP9)+(RTCH-RTCL)*(2.03134-1 ● 47b*(l.o/uR) +
                                          (4.94) (1.25)
1      0.561595* (YC-CPGP9+CCGP9)-0.0597419*EXCH) +CTGP9
        (7.85)                      (3.68)

           RBSQ = 0.83    SOR =  0.302   DW = 1.24 PD  =  49-7o    OLS
           REGRESSAND  WAS (TYCL-RTCL*YC)/(RTCH-RTCL)


 YCDV    = 0.0413553 + 0.143555 *(YC-CPGP9+CCGP9-TYCL+CTGP9)
             (1.13)       (2065)
1          ● .629831* (ycDvl-DlvGPo )+DIVGP9
             (4,0.6)

           RBSQ = 0.98   SDR = 0.063  DW = 1.25  PD  =  49-70    OLS


 FIX MONEY SUPPLY (EXOGENOUSLY) FOR PIPELINE  SIMULATIONS

 IF(Z(697).LT..01.AND.Z(698).LT..01● ANDe Z(699).LT..01
*     ● ANDo TIME● GT.73.1)
1    MONY = MONY1*GNPV/GNPV1

27 FDIL    = 00367027  + 0.102815 *(IFMNV + IFNNV - YCU - CCAC
               (6.56)      (3.91)
*            +CPGP9 - CTGP9-DIVGP9- (INTGP9-( INFGP+INCGP)) *
&            (1.0 - DOPER  ) )+
1          00123405   * (RLBG-URBG) - 0.253167 * DRWN
             (2.23)                    (4.48)
1            + LDWGP9

           RBSQ = 0.793    SDR =.070  DW = 2.10 PD  =  54-70    OLS


 FLSN = 0.330769+ 1.32539*(RLBG-URBG-RLBG1+URBG1 )
                (3.48)      (4.39)
1          +0.00817593* ( (RLBG1-URBG1 )*(UPGNP*UYPRM-UPGNP1*UYPRM1 ) )
                (4.82)
2          -0,296055   *DDIS + CIWGP9 + ( MMGP9* (FXSU  -  1.0))
                (2.04)

           RBSQ=0.742     SDR=0.223     DW=2.27      PD=54-70     OLS
```

APPENDIX II

THE CASE B AND C RESULTS

1. The Exports Only Case (Case B)

Case B differs from Case A in that all the Mackenzie Delta gas is exported (see pages 54-6). In Case B (relative to Case A) imported gas is assumed to replace exported gas in domestic markets on a dollar-for-dollar basis. There is, therefore, no direct effect on the current account of the balance of payments; that is, both the value of exports and imports increase in the same amount. The only effects on the simulation results arise from price effects as the slight difference in the components of gross national product produce a slightly different price level. The shift in relative prices leads to a very slightly different composition of the induced change in real GNP. Business gross fixed capital formation (which includes residential construction) is less adversely affected in Case B than in Case A . and, hence, the induced decline in real GNP is slightly smaller in Case B than in Case A. In Case B, induced exports (rather than capital formation) bear a slightly larger proportion of the displacement effect. Hence, total real exports are slightly lower and (because of the smaller induced decline in real GNP) induced real imports are slightly larger. Thus, there is a very slightly smaller appreciation of the foreign exchange value of the Canadian dollar in Case B. The orders of magnitude are so small, however, that there is essentially no difference between the simulation results of Cases A and B.

2. The Domestic Markets Case with Displacement of Domestic Energy (Case C)

In Case C (see pages 57-8) there are two possibilities. One (C1) is that Mackenzie Delta gas sold in domestic markets displaces other energy in the domestic market and diverts it to the export market. Under our assumptions, this would give identical results to Case B. The other possibility (C2) is that investment in the pipeline would displace some investment aimed at expanding non-Arctic energy sources. Case C2 represents, therefore, a scaled-down version of Case B in that only half of the total Delta gas would be exported and there would be less direct capital formation. Hence, both the direct and induced effects on macroeconomic variables are therefore smaller in Case C2 than in Cases A and B. The major effect on the balance of payments, in comparison with Case A, results from the fact that there is no import displacement. The appreciation of the foreign exchange value of the Canadian dollar is therefore less than in Cases A and B. Appendix Table 1 gives a few comparisons of the simulation results for Cases A, B, and C, based on simulations against the low employment control solution.

Appendix Table 1

Comparison of Cases A, B, and C
Difference between Pipeline Simulation
and Low Unemployment Control Solution[1/]

	Case	Average 1976-85	Average 1977-79	Average 1983-85	1985	Maximum (year)
Real GNP (billions of constant dollars)	A	0.287	0.549	0.214	0.436	0.683 (1978)
	B	0.312	0.548	0.314	0.568	0.683 (1978)
	C	0.218	0.371	0.222	0.418	0.469 (1978)
Employment (mill ions of man-years)	A	0.010	0.031	-0.002	0.005	0.035 (1978)
	B	0.010	0.031	-0.001	0.007	0.035 (1978)
	C	0.006	0.020	-0.002	0.005	0.023 (1978)
GNP price index (1961 = 1.0)	A	-0.010	-0.007	-0.023	-0.028	-0.028 (1985)
	B	-0.008	-0.006	-0.021	-0.025	-0.025 (1985)
	C	-0.006	-0.005	-0.014	-0.017	-0.017 (1985)
Exchange rate (Cdn. $ per U.S. $)	A	-0.012	-0.006	-0.020	-0.018	-0.023 (1984)
	B	-0.011	-0.006	-0.018	-0.016	-0.021 (1984)
	C	-0.008	-0.003	-0.012	-0.010	-0.014 (1984)
Real exports of goods and services (billions of constant dollars)	A	0.082	-0.066	0.228	0.286	0.286 (1985)
	B	0.156	-0.053	0.389	0.469	0.469 (1985)
	C	0.119	-0.050	0.296	0.355	0.355 (1985)
Real imports of goods and services (billions of constant dollars)	A	0.420	0.550	0.407	0.359	0.628 (1978)
	B	0.510	0.566	0.577	0.542	0.628 (1978)
	C	0.365	0.407	0.403	0.371	0.466 (1978)
Real personal expenditure on consumer goods and services (billions of constant dollars)	A	0.268	0.308	0.277	0.272	0.371 (1978)
	B	0.273	0.305	0.307	0.321	0.371 (1978)
	C	0.180	0.207	0.192	0.203	0.265 (1978)

Continued.

1/ Includes both direct and induced effects.

Appendix Table 1

(Continued)

Comparison of Cases A, B, and C

Difference between Pipeline Simulation and Low Unemployment Control Solution[1]

	Case	Average 1976-85	Average 1977-79	Average 1983-85	1985	Maximum (year)
Real business gross fixed capital formation (billions of constant dollars)						
(a) incl. pipeline	A	0.356	0.846	0.108	0.221	0.806 (1977)
	B	0.389	0.850	0.183	0.302	0.806 (1977)
	C	0.282	0.614	0.127	0.215	0.733 (1978)
(b) excl. pipeline	A	-0.069	-0.113	0.032	0.174	0.174 (1985)
	B	-0.031	-0.106	0.073	0.269	0.269 (1985)
	C	-0.020	-0.074	0.085	0.192	0.192 (1985)
Real personal disposable income (billions of constant dollars)	A	0.306	0.436	0.264	0.252	0.528 (1978)
	B	0.315	0.432	0.310	0.528	0.528 (1978)
	C	0.206	0.293	0.189	0.200	0.374 (1978)
Interest rate on long-term government bonds (percentage points)	A	-0.057	-0.060	-0.111	-0.174	-0.174 (1985)
	B	-0.043	-0.055	-0.103	-0.182	-0.182 (1985)
	C	-0.030	-0.049	-0.065	-0.124	-0.124 (1985)

1/ Includes both direct and induced effects.

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