A paper prepared for the

Un document préparé pour le

Economic Council of Canada

P.O. Box 527
Ottawa, Ontario
K1P 5V6

Conseil économique du Canada

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DISCUSSION PAPER NO. 253

OPEC and the Value of Canada's Energy Resources: A Long-Range Simulation Model

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The authors gratefully acknowledge the encouragement and advice of Neil Swan and Tom Schweitzer and computing assistance from H. Saiyed, M. Willis, and R. Preston. The report was very efficiently typed by Linda Kemp and Odette McNeely. Comments from participants in seminars at Queen's and Simon Fraser Universities, and the University of British Columbia, were very useful.

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ISSN-0225-8013

March 1984

CAN.
EC25-
no.253
1984

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RÉSUMÉ

Le présent document analyse les répercussions de la substantielle plus-value des ressources énergétiques canadiennes après l'augmentation du prix mondial du pétrole décrétée par l'OPEP au cours des années 70.

Les auteurs utilisent un modèle mathématique comprenant 200 équations pour simuler les effets de diverses hypothèses quant aux politiques publiques et à la conjoncture internationale jusqu'à l'an 2 000.

Leur plus étonnante constatation est que la production ou la conservation d'un baril supplémentaire de pétrole a énormément plus de valeur, pour le Canada, que le prix mondial. Cet avantage est attribuable au fait que les changements dans nos exportations nettes de produits énergétiques ont une incidence sur les termes de l'échange du Canada, c'est-à-dire sur les prix de nos autres importations et exportations.

Les simulations montrent, qu'à long terme, la politique des prix de l'énergie actuellement pratiquée par le gouvernement fédéral et celui de l'Alberta mène à de légères pertes réelles de consommation pour les Canadiens, comparativement à une stratégie radicale qui consisterait à adopter d'emblée le prix mondial. Le maintien des prix canadiens du pétrole à leurs niveaux de 1980 (soit environ 16 $ le baril) contribuerait à réduire la consommation par habitant de plus de 3 000 $ en l'an 2 000, tant en Alberta que dans le reste du Canada.

Les autres scénarios sont les suivants : retenue, par l'Alberta, des parts de ses recettes énergétiques attribuables aux migrants d'après 1980; investissements accrus dans les usines de traitement des sables bitumineux; absence de l'OPEP; plus grande élasticité de la demande d'énergie, et augmentation des réserves de pétrole et de gaz.

ABSTRACT

The paper examines the implications of the dramatic increase in the value of Canada's energy resources that followed when OPEC increased the world oil price in the 1970s.

A 200-equation mathematical model is used to simulate the effects of alternative assumptions about government policies and states of the world up to the year 2000.

The most striking feature of the results is that producing or conserving an additional barrel of oil is worth considerably more to Canada than the world price. This is because of the effect of changes in net energy exports on Canada's terms-of-trade - the prices at which other commodities are imported and exported.

The simulations show that, over the long-run, the current energy pricing policy of the Federal and Alberta governments results in small real consumption losses to Canadians, compared to a 'cold-turkey' strategy of going directly to the world price. Keeping Canadian prices at their 1980 levels (about $16 per barrel of oil) would reduce per capita consumption by more than $3000 in the year 2000, in both Alberta and the rest of Canada.

Other scenarios include: Alberta withholding shares in its energy revenues from post-1980 migrants; increased investment in oilsands plants; No-OPEC; more elastic demand for energy; and higher numbers for oil and gas reserves.

I. INTRODUCTION AND SUMMARY OF RESULTS

This paper is an examination of the implications of the dramatic increase in the value of Canada's energy resources that has followed from the OPEC-induced increases in the world oil price.

This 'resource boom' is studied over a twenty-year period -- 1981 to 2000, for two regions -- Alberta and the rest of Canada, and under a number of alternative assumptions about government policies and exogenous 'states of the world'. Our purpose is to 'add up' or 'account for' the implications of the assumptions and policies. These implications are not intended to be taken as forecasts of what will happen, but rather as what would happen, were the set of assumptions and policies to be undisturbed. The point of the exercise is to uncover surprising and important implications of adding-up, which may stimulate a reassessment of our economic assumptions, or recommendations for changes in policy.

Our quantitative results are generated from a large mathematical model -- THESIS RD1.4.[1] The next two chapters describe this model, and chapters IV and V set out the results.

Chapter II gives an 'overview' of the model, dealing with the general issues raised by theoretical specification, empirical calibration, and solution of large simulation models.

In chapter III, and the accompanying Appendices A and B, THESIS RD1.4 is analyzed in detail. We will not here attempt a summary description of the model. For this, the reader is referred to section 1 of chapter II.

Chapter IV sets out the 'base-case' solution. The base-case is a version of the model built, as far as possible, on non-controversial assumptions about how the economy works, and incorporating the announced policies of governments.

The results of the base-case simulation are of some interest in themselves, but are primarily of use as a reference solution against which to compare the effects of making changes to the model.

These changes, or different 'scenarios', are examined in Chapter V. There are six scenarios introducing different government policies, and five setting-out alternative assumptions about states of the world. The results are summarized below:

1. <u>The Base-Case Scenario</u>

   (a) With the phased movement towards world prices incorporated in the September 1981 agreement between the governments of Alberta and Canada, and subsequent amendments, Canadian total energy output increases over the twenty-year simulation period. The world oil price increases at about 2% per year, in real terms.

   (b) Oil production is about unchanged, but depends more heavily on oilsands and frontier reserves by 2000. Natural Gas production peaks during the simulation period, but remains well above its 1980 level. Electricity output is policy-determined, and assumed to increase by about 25% 'Alternative' energy (renewables plus energy-substitutes) production increases six-fold, and comprises 16 per cent of total Canadian energy output by 2000, despite supply elasticities which are intended to be conservative.

(c) Total energy use, as intermediate input and final consumption, decreases about 2 per cent, as higher prices just slightly more than offset the higher levels of economic activity and income.

(d) Because of dependence on more expensive sources, energy production costs increase more than four-fold. This results in over one half of the 1½ million workers added to the Canadian labour force between 1980 and 2000 being required by the energy sector.

(e) Oil self-sufficiency (non-negative net exports) is achieved early in the simulation. Net exports of gas and electricity stay above their 1980 levels.

(f) Alberta incomes remain above those in the rest of Canada (RoC), but the differential declines, with slower growth in per capita energy rents.

(g) Per capita consumption levels grow in both Alberta and RoC, and finish in year 2000, 25 per cent and 43 per cent higher than 1980 levels in the two regions respectively.

(h) Encouraged by the income differential, interprovincial migration to Alberta continues throughout the simulation period, so that the Alberta population ends up more than 1 million (50%) greater in 2000 than in 1980, mostly due to migration. The migration dilutes the rents available to Albertans, which is partially responsible for the slower per capita consumption growth in this region.

2. The Other Scenarios: Comparison with Base-case in Year 2000

(a) A made-in-Canada policy which keeps all Canadian energy prices at their 1980 levels (about $15-$16 per barrel of oil) results in real per capita consumption in both Alberta and RoC that is more than $3,500 lower (29%) than the base-case. This is due to the diversion of reproducibles output to pay for net imports of energy which are the result of lower supply and higher demand.

Against this, per capita wealth is up by $7,000 -- the value, in year 2000 prices, of oil and gas not depleted under this scenario.

(b) Going immediately to world prices for all energy sources increases total energy output early in the simulation so that with depleted reserves and an appreciated dollar, output is down by about $1.3 billion in 1980 prices by 2000. Per capita real consumption is up by over $200 by the year 2000 in spite of higher cost reserves. Valuation of energy resources at their opportunity cost (world price) would result in a present value per capita gain of $300 for all Canadians over the period 1980-2000.

(c) If Alberta is able to withhold shares in its energy rents from post-1980 migrants, consumption levels of 'original' Albertans are higher by nearly $1,000 per capita in 2000. The Alberta population is over 1.2 million less than in the base-case, as migrants are discouraged.

(d) If there is increased investment in oilsands projects then Albertans are made worse off on a per capita basis because of a reduction in the size of the conventional rent-yielding energy sector. 60,000 individuals who would have migrated to Alberta remain in the rest of Canada, where per capita consumption is higher with the oilsands development because of the terms-of-trade effect of larger energy net exports.

(e) An Alberta province-building strategy of boosting investment in the non-energy sector raises Alberta reproducibles output, increasing net exports, but shows no sign of substantially raising Alberta per capita consumption.

(f) If, in the absence of OPEC, world oil prices were constant at the 1980 domestic Canadian price, per capita real consumption would be reduced by over $150 in Alberta. Canada in general, and Alberta in particular, gain from higher world oil prices, as net exporters of energy.

(g) A falling world oil price would result in per capita real consumption that is $600 lower than in the Base Case for Alberta and $360 lower for RoC. This is partially offset by the increase in per capita wealth of about $3,000, the value in year 2000 of reserves still in the ground.

(h) More elastic energy demand (price elasticity increased from -0.5 to -1.0) has a very beneficial effect, with real per capita consumption levels $500 - $600 higher throughout Canada in the year 2000, thanks to a larger surplus of energy to be exported to pay for non-energy imports.

(i) Higher numbers for oil and gas reserves, so that depletion is, in effect, not significant over the simulation period, would lead to real per capita consumption over $400 higher in Alberta, and $600 higher in the Rest of Canada.

(j) If, contrary to the expectations of the NEB, Canadian consumers do not rapidly adjust energy use from oil to gas implying more slower gas conversion, then per capita consumption is slightly reduced. The reduction in domestic use of gas is entirely made up through exports, with gas exports ($1.35 billion greater than under the Base Case) slightly crowding out reproducible exports.

II. AN OVERVIEW OF THE THESIS RD1.4 MODEL

1. Introduction

THESIS RD1.4 is a mathematical model of the Canadian economy designed to simulate the long-run impact on Canadian incomes of the "resource boom" -- that is, the effect of the rise in world oil prices on the value of Canadian energy resources.

The focus on energy sets the basic parameters of the model. The most striking characteristic of our oil and gas production is that it cannot last. Oil and gas are depleting resources. The 'boom' is temporary.

To be useful, therefore, the model must be long-run, looking far enough ahead to encompass the extraction of all or most of the resources from our presently proven reserves, and their replacement by other energy sources, or with oil and gas from the plentiful but expensive reserves of the oilsands and the 'frontier' regions.

That is, we should see Canada through to the era of the 'backstop technology', when energy is a product like any other, which can be reproduced for ever at a cost which, while non-increasing, is high enough to eliminate all 'rents'.[1] If we get to the backstop era, we can then look back and add-up the income effects of the 'boom' years.[2]

Predictions of extraction paths by the National Energy Board (1981, hereafter this publication is referred to as 'NEB') imply that, by the year 2000, most of

Canada's rent-yielding (low-cost) sources of oil and gas will have been exploited, and this year is chosen as the cut-off for the present model.[3]

The long-run time scale has implications for the scope of the model. Very little of what concerns a typical short- to medium-term macroeconometric forecasting model (such as the Economic Council of Canada's CANDIDE 2.0) can or should appear here. The typical 'macro' model is characterized by:

(a) an underlying 'Keynesian' assumption that output is demand-determined, which implies multiplier effects of changes in spending, and a range of possible output and employment levels in each period;

(b) attempts to predict 'nominal' variables, such as the rate of inflation; in particular, by linking them to 'real' variables (e.g. unemployment rates) through Phillips curves;

(c) some sophistication in modelling the operation of individual markets, often at a quite disaggregated level.

For all their size and complexity, none of these models are able to reliably forecast even a few years into the future. It would therefore be fatuous to even attempt to predict, say, the rate of inflation, or the employment-spinoff effects of a 'megaproject', up to the year 2000. Moreover, it is not even necessary that we should try and do so. Over the long-term, certain economic fundamentals, which may be obscured over periods of a few years, can be expected to assert themselves. A decision to invest in an oilsands plant might result in an identifiable disturbance in the path of employment and inflation for a few quarters, but this should not be viewed as other than a temporary disequilibrium: to assume a permanent increase in the level of activity is to assume a 'pool' of resources (labour, capital) that would otherwise be forever unemployed in the absence of the oilsands project.

The fundamental proposition that we should rely on, as good economists, is that there is elasticity in the system, and that elasticity increases with the length of the period considered, as the range of substitution possibilities increases. Another way of putting this is to propose that all resources have an opportunity cost, which approaches the value of their current use if we look far enough ahead.

What this implies for model-building is a shift from the demand-determined world of year-to-year cyclical fluctuations, to the long-run of trend-growth, on paths that are basically supply-determined by the availability of factors and technology.

The long-run perspective means, too, that it is not necessary to model in detail the operation of actual markets, as is attempted in short-term forecasting models. Over the short-term, imperfections in, for example, the workings of international capital markets, can have significant effects on important variables such as interest rates and the exchange rate.

Over a longer period, though, it is reasonable to cut-through what are essentially adjustment processes and look for the intersection of supply and demand curves; that is, to assume that the necessary market forces exist to restore the economy to equilibrium.[4]

All the above is in support of our position that the theoretical simplicity of the THESIS RD1.4 model is to be defended, not just on the (important) pragmatic ground of inexpensiveness, but as being fundamentally appropriate to the task of long-term forecasting to which we are constrained by the characteristics of the energy producing sectors.

The focus on energy also has implications for the regional dimension of the model. About 85 per cent of Canada's oil and gas production comes, at present, from the province of Alberta. Therefore, the model divides Canada into two regions -- Alberta and the "Rest of Canada" (RoC).

As for the industrial structure of the model, our interests lead to all non-energy production being lumped-together into one, "reproducibles", sector, whereas the energy sector is broken down into six industries -- "old" oil (from reserves proven by 1980), "new" oil, oil sands, natural gas, electricity, and "alternative" energy, which includes solar heating and other small scale energy sources.

Beginning from the actual situation in 1980 (the most recent year for which a satisfactory database can be assembled), the model computes for successive years output, employment, incomes, and consumption in each industry and region, subject to selected "scenarios" of policy choices and values assumed for exogenous variables and parameters, and up to the year 2000.

Thus, to a large extent, THESIS RD1.4 will be complementary to the "UBC" model of Helliwell, McRae, et al. This is built-up from an impressively disaggregated block of equations describing the Canadian energy sector, to which has now been added a set of macroeconomic equations for inflation, unemployment, capital flows, exchange rate and so on.

The UBC model's combination of extremely 'micro', treatment of the energy sector along with a macroeconomic emphasis on cyclical variables makes it more suited to short- to medium-term forecasting than to the long-run simulations on which the RD1.4 model is focused. Nevertheless, some overlap, or substitutability, is inevitable, but, given the undoubted importance of the topic, it is good to have more than one way of looking at it.

An important strength of THESIS RD1.4 is the simplicity with which it is solved, involving only replication of routine arithmetic operations. This means cheapness in computer time and flexibility for users, who can easily experiment with different scenarios and even modify by themselves the structure of the model if they so wish.

In section 2 of this chapter the theoretical structure of the model is outlined. Then, in section 3, issues raised in the calibration of the model to fit what we know, or estimate, about the Canadian economy are brought forward. Finally, section 4 discusses the solution of the model.

2. Theoretical Structure of RD1.4

As noted above, the economics of the model are deliberately simple. There are two sectors -- "energy" and "reproducibles". Energy products are produced at costs which increase with the rate of output, and, in the case of conventional oil and natural gas, with the total 'stock' of accumulated output (the depletion effect). Energy products are homogeneous, and so can be bought and sold on the world market at given prices.

Reproducibles are heterogeneous goods produced at constant unit costs (i.e., they can be 'reproduced' at unchanging cost). Being heterogeneous, reproducible imports and exports are subject to less-than-infinite price elasticities of demand.

Of course, some of the thousands of non-energy products produced in the economy are subject to increasing (or decreasing) costs. Some are not traded at all, and others (especially primary products) probably trade at prices which are close to being exogenously given. Nevertheless, it is proposed that our depiction of the non-energy sector is a good approximation of its characteristics, on average, and allows us to capture the essence of the economics of the differences between the two sectors.

The model is 'driven' by energy prices, which are set exogenously. The 'world' price of oil is given, perhaps by OPEC. Canadian governments react to the world price by establishing, through a complicated system of taxes and subsidies which is summarized in the model, both 'supply' and 'demand' prices (not, in general, equal) for oil and other energy sources.

The energy price structure determines (along with incomes) the Canadian supply and demand for oil, with supply an increasing, and demand a decreasing, function of price.

The difference between supply and demand becomes net energy exports. To keep the balance of payments zero (i.e., to avoid build-ups of balance of payments deficits or surpluses), the net surplus (deficit) on energy trade must be matched by a deficit (surplus) of equal magnitude for the sum of non-energy trade and net capital account flows.

Capital flows are endogenously determined as the gross investment-savings differential. Non-energy (reproducibles) trade is effected by changes in the Canadian exchange rate, which alters the prices paid for exports and imports, and thus the demand for them, subject to the non-infinite price elasticites.

On the input side; the amount of energy supplied determines, through technical constraints, the demand for labour and reproducibles inputs in the energy sector. That part of the total labour force not required by the energy sector is then absorbed into reproducibles production. Along with capital stock in this sector (investment is a function of the domestic marginal physical product of capital), the available labour force determines, through the production function, the output of the reproducibles sector.

Thus economic activity in the model is essentially 'supply-determined' -- in the energy sector by exogenous prices, and in the rest of the economy by the available inputs of labour and capital.

The performance of the economy is measured by the quantities of energy and reproducibles that are available for household consumption, after intermediate demand, exports, and capital formation have been netted out.

Regionalizing the model, for a Canadian economy disaggregated into Alberta and the 'Rest of Canada', involves no analytical complication, since it is assumed that there is perfectly free trade between the two regions. We do, however, need to add a set of equations accounting for the distribution of national income -- that is, specifying where are claimed the factor incomes generated in each region. For example, profits earned in the Alberta oil and gas industry are distributed between private Albertan shareholders, the Alberta government, shareholders in the rest of Canada, the Federal government, and shareholders in other countries.

Such is the essence of RD1.4. Though deliberately simple in its economics, and as simple as possible in its scope (two regions, two sectors, seven industries) it still has more than one hundred and seventy-five endogenous variables and their associated equations, all of which must be empirically calibrated before the model can be solved -- the algebraic symbols implied by the theoretical specification must be replaced by numbers representing as closely as possible the actual condition of the economy over the time period. This we now turn to.

3. Empirical Calibration of THESIS RD1.4

Quantification of an economic model necessarily involves a mixture of theoretical reasoning and empirical investigation -- in statistical terms, a combination of 'prior' and 'posterior' information. The model-builder brings to the job certain preconceived views on how the economy works, and fills in the gaps in her or his knowledge by examining actual data, either directly, or indirectly through the findings of other investigators.

In general, the more theory incorporated into the model, the less the model-builder needs (or can afford!) to look at the data. For example, if one begins with just the theoretical notion of a 'production function' linking output to inputs, one will need to add quite a lot of additional information -- from 'engineering' studies, or from econometric analysis of past behaviour -- in order to quantify the production relationship. If, however, one is prepared to make (implicitly or explicitly) a number of additional theoretical assumptions, such as perfectly competitive markets, and non-troublesome aggregation, then the data for just one year's factor shares (distribution of income between labour, capital, etc.) may be sufficient to empirically calibrate the production function.

A scientifically respectable position to take on the mix of theory and empirics is that, subject to the usual constraint of availability of investigative time and resources, the model-builder should impose as few prior beliefs as possible. That is, wherever the data could settle a point of specification, they should be allowed to do so.

It will be proposed here that the application of this principle to the calibration of the THESIS RD model leads to a relatively heavy reliance on the use of theoretical priors. In essence, this is because, for the long-term simulation problem that we have been set, the theory is better, and the data worse, than is typical for the sort of models that have been developed for use in short- to medium-term economic forecasting and policy analysis.

A majority of the latter are what is called 'macroeconometric models',[5] which can be accurately described as economic models of whole economies in which the coefficients of each equation are 'estimated' to 'fit' as closely as possible (by some statistical criterion such as minimization of squared errors) the actual experience of the economy over some historical period.

We will argue that for our purposes of long-term forecasting macroeconometric modelling is not an appropriate technique.

We can check our requirements against four conditions that should be met if econometric analysis of historical data is to be used in calibrating a model intended for forecasting into the future:

(i) the economic structure should not change
(ii) the future should not be unprecedented
(iii) the underlying theory should be appropriate
(iv) the dimensions of the database should be appropriate.

None of these conditions are likely to be satisfied by our model. In turn:

(i) We wish to run our simulations twenty years into the future. It is unlikely that the behavioural and technical relationships in the economy will 'hold still' for this length of time, so information on the past structure of the economy is likely to become obsolete.[6]

(ii) Even if the structure does not change it is only revealed by historical data when these contain sufficient statistical variability. The slope of a line cannot be ascertained by knowledge of one point on it; nor, reliably, by several observations clustered around a single point. Yet this represents our situation with respect to modelling the energy sector. We need estimates of the supply and demand responses to the energy price changes of the last few years (and those changes still to come); since, however, price changes of this size are unprecedented, extrapolation of our past experience is likely to be unreliable, no matter how well the historical data appear to 'fit' their estimating model.[7]

(iii) Although it need not be so, the 'data-mining' procedure that certainly characterizes macroeconometric model-building leads to models twisted to fit as tightly as possible the particular sample period experience, rather than to trace-out the underlying economic structure with an acceptance that even the most sophisticated model is going to leave some sample period 'noise' unaccounted for.

As a result, macroeconometric models have a tendency to go alarmingly 'off-track' when they are pushed more than a few years beyond the data-base on which they were estimated.

Another way of putting this is that the data-mining bias towards eliminating small within-sample errors leaves models prone to catastrophic error outside the sample period.

(iv) To maintain the number of observations at statistically acceptable levels, macroeconometric models are estimated with annual or even quarterly data.

Fluctuations in these data are dominated by 'cyclical' phenomena -- the movements of economic variables adjusting to disequilibria -- and it is on business cycles that macroeconometric models are most informative.

This is entirely appropriate for short- to medium-term forecasting (say, up to five years hence), but is not useful for our purposes, involving simulations over long periods when, as noted in section 2, it is reasonable to expect business cycles to average-out, and so to ignore them.

A further problem with the macroeconometric method, which reduces its reliability in all uses, is the tension between theory and data that is usually generated somewhere in any large-scale modelling effort, when an estimated coefficient seems flatly to contradict some sensible prior belief. Common examples are (a) production functions with negative marginal productivities of capital (e.g. Rao (1979), and the CANDIDE 2.0, *passim*), and (b) demand curves with positive slopes, or with elasticities that generate unacceptable results (such as negative market shares) in simulations (e.g. Helliwell, McRae, *et at.*, p. 39).

The usual 'solution' is to use theory to constrain the function to a more acceptable form. Thus, Rao uses factor shares and the assumption of perfect competition to infer (positive) marginal productivities, and Helliwell, McRae *et al.*, 'naturally bound these [negative demand] estimates at zero' (*loc. cit.*).

Although, if some such 'correction' is not made to deviant equations the whole model will be rendered useless, the procedure compromises the integrity of the econometric method. It amounts to believing the data up to some arbitrary point, after which the researcher jumps to another source of information. What this does for the statistical properties of both the constrained and the unconstrained parts of the model is unknown, but possibly serious.

Thus, for all the reasons given above, THESIS RD1.4 was not estimated as a macroeconometric model. The empirical methodology adopted instead has two features:

(a) maximal use of basic economic theory;

(b) eclectic use of available sources for necessary data.

In turn:

(a) Short-term forecasting models are largely concerned with disequilibrium situations, in which the model must track adjustment paths. Since our theoretical knowledge of market adjustment, especially under conditions of uncertainty, is relatively weak, these models must rely heavily on data and econometrics.

For our present purpose of building a long-run model, however, questions of adjustment, desequilibrium, expectations and so on are not important, (as noted above). We are in a world of economic fundamentals, at the equilibrium points of the economy, instead of being concerned with the tatonnement processes towards equilibria.

Thus we are on the economist's firmest theoretical ground -- the simple microeconomics of supply and demand -- which makes model specification rather simple and uncontroversial, as outlined in the previous section.

(b) Although our informational requirements are greatly reduced by the absence of multipliers, financial markets and so on, we still need data (i) to 'scale' the model to its 1980 starting point, (ii) on expected values of exogenous variables, (iii) on elasticities of supply and demand.

Data sources are explained in detail in the course of the next two chapters. In outline: scaling data are from Statistics Canada and other sources. Forecasts of exogenous variables (the world oil price and Canadian energy policy) are set to be as 'standard' as possible, using National Energy Board publications, and the announced policies of the Federal and Alberta governments.

Elasticities and other 'behavioural' parameters are specified eclectically. That is, all available sources which appear to be well-informed are drawn on. These may include technical studies, 'guestimates' by experts, and econometric case studies of particular industries or markets.

Note that we do not rule out the use of econometrics as one means of finding out about the world; what we have rejected is the 'macroeconometric' approach to model calibration -- that is, the estimation of an entire model from a single cohesive database.

For example, macroeconometric models, based on time series of Canadian data, will probably underestimate the size of the eventual response to the oil price 'shock' of 1980. However, an econometric study using cross-sectional data on energy demand taken from a sample of economies which had for some time experienced quite different energy prices (due to domestic taxes or subsidies) should give a more reliable estimate of the long-run demand elasticity.

Of course, the eclectic method of calibration is informal -- its reliability cannot be assessed by the 'confidence intervals' of statistical inference. But then, nor, in practice, are macroeconometric models properly subject to statistical inference, for all their profusions of R^2s and t-statistics, given the data-mining and other improper procedures in which model-builders chronically indulge.

The best we can reasonably do is to fully document the sources of our parameter estimates, and then run 'sensitivity tests' on the more important ones, to see what difference it makes if our estimates are wrong.

The documentation is done in chapter III, and different coefficient values are tried-out in the simulation exercises reported in chapter V.

4. Model Solution

As has been noted, RD1.4 is formulated to be recursive -- that is, if there is an equation in which the current year's value of a variable y depends on the current value of x, there will be no equation elsewhere in the model in which x depends on y.

The reason for insisting on recursiveness is computational simplicity and cheapness. Were all the equations linear, then non-recursiveness would not be a problem in principle -- the behavioural equations could be substituted into each other to give reduced forms (all right-hand-side variables exogenous) in an algebraically routine (though time-consuming and error-prone) procedure. This was done, for example, in Hazledine's model for the ECC's Workshop on Political Economy of Confederation.

However, RD1.4 is non-linear (there are some linear and some log-linear equations), and solution of a non-linear simultaneous system requires the use of some expensive, and possible troublesome, algorithm.

A recursive model, in contrast, is solvable simply by specifying the correct sequence of routine arithmetic operations.

Recursiveness is achieved by ensuring that, whenever a variable y is dependent on an x that is also endogenous to the model, x is either determined previously in the model solution as a function not involving y, or x is entered with its lagged (previous year's) value.

What are the likely costs of imposing recursiveness on the model by the use of lagged values of some endogenous variables? In many instances, it can very reasonably be argued that lags are in fact realistic. For example, given the time it takes to "work-up" new plant and equipment, it is probably not significantly inacurrate to assume that current-year additions to the capital stock don't affect current-year output.

Variables with more "short-term" flexibility, such as the exchange rate, are probably misrepresented by the imposition of one-year lags, but given that RD1.4 is a long-run model, errors in year-to-year fluctuations are not necessarily troublesome -- so long as they are fairly small relative to historically observed fluctuations, and are approximately self-cancelling. The adjustment lags and negative feedback built into the model, along with its "backbone" of input supply-determined reproducibles production, should be sufficient to keep it tracking its long-run path with acceptably small year-to-year fluctuations.

In effect, the present model has its "tâtonnement" adjustments towards equilibrium built in as explicit economic processes occurring in real time, whereas the numerical methods used in algorithms for solving "simultaneous" systems carry out imaginary tâtonnements out-of-time -- a sort of instantaneous sequence of Walrasian adjustments. Given that, in reality, all economic activity is recursive over some length of time period, it might even be argued that the fully recursive economics of RD1.4 are <u>preferable</u> to the more expensive simultaneous solution algorithms.

III. THE MODEL IN DETAIL

This chapter contains an explanation of each equation in THESIS RD1.4, as this model is set-up to obtain the 'base case' simulation to be reported in chapter IV. Both the general functional form and the particular coefficient values of each equation are examined. The equations are discussed in the order in which they are solved.

As a companion to this chapter, the reader should make use of Appendix A, which is a facsimile of the computer printout, listing, first, the values of all coefficients in numerical order; and second, the algebraic specification of each equation. The algebraic specifications follow the usual conventions - '*', denotes 'multiplied by', '**' denotes 'raised to the power', and operations are carried out in the order: first, expressions in brackets; second, raising to some power; third, multiplication and division; fourth, addition and subtraction. A dash '-' in front of a variable indicates that it is lagged one year. EXP denotes the exponential function.

The equations are divided into twelve blocks which group variables according to type. Except for the population and labour force variables, which are in millions, all variables are in $ billions, some measured at current prices, and others at 1980 prices.

It is assumed below that the previous chapter, giving an overview of the model, has been read.

Appendix B is an alphabetical listing of all variables in the model.

BLOCK 1: POPULATION, LABOUR FORCE AND WAGE RATES

RELWAGAB: Ratio of Alberta to RoC wage rates

The ratio of Alberta (region 'A') to Rest-of-Canada (region 'B') market wage rates equals relative Alberta/RoC per capita incomes raised to the power 0.25. Relative incomes are lagged to maintain recursiveness, since current-year values for incomes are not computed until Block 12.

The exponent on relative incomes is positive but less than one (0.25), reflecting the assumption that higher incomes do induce some bidding-up of wages, but that in a 'small open economy' like Alberta, the wage share does not stay constant when incomes increase. Some of the higher income (when such derives from higher resource rents) will be capitalized into the value of fixed factors (land). As well, to the extent that the Alberta government captures resource rents and distributes them as lower direct and/or indirect taxes, the market wage acceptable to labour will be lower than in more heavily taxed regions. As Norrie and Percy (1981) note, this effect could be sufficiently strong to generate a negative relationship between income and wage rates.

EMIG: Emigration from Canada

Emigration from Canada is a proportion 0.003 of the total population of Canada at the start of each year (lagged population). The equation is calibrated to match Statistics Canada's forecast of 75,000 emigrants yearly (catalogue no. 91-520).

FMIG: Net Foreign Migration into Canada

Net foreign migration into Canada each year is the difference between immigration (a policy variable) and emigration. The values taken by policy and other exogenous variables are specified in the chapters reporting the scenario simulations.

FMIGA: Net Foreign Migration into Alberta

Alberta's share of net foreign migration to Canada is determined by its population relative to the population of Canada, multiplied by C216; multiplied by Alberta/RoC relative per capita incomes raised to the power C227. Population and income variables are lagged to maintain recursiveness. C216 is set at 1.0, on the assumption that, in the absence of income differentials, Alberta is of average attractiveness to foreign migrants. The income elasticity C227, is set the same as the income elasticity for internal migrants -- see IMIGA, below.

FMIGB: Net Foreign Migration into RoC

The rest of Canada gets the migrants who do not end up in Alberta.

IMIGA: Net Interprovincial Migration into Alberta

Net interprovincial migration flows between RoC and Alberta are a proportion C205 of the difference between lagged relative per capita incomes of 'new' Albertans and RoC and C207, raised to the power C206. C207 is set at 1.0 on the assumption of no net migration flow in the absence of an income differential. C206 is set at 2.0, in line with estimates of migration elasticities by Winer and Gauthier. Foot and Milne, and Schweitzer have also found evidence of income-induced migration. Norrie and Percy assume an elasticity (with respect to real wages) of 2.0.

C205 is set at 0.076 to give a value of 50,000 for net interprovincial migration into Alberta in 1981, given the values of the other variables and coefficients. Actual interprovincial migration in 1980 was 40,000, according to the Alberta government (report in Globe and Mail, 21 Sept. 1981).

'New' Albertans are those arriving in the province after 1980, and their progeny. The specification assumes that new Albertans would turn around and leave the province, should their per capita incomes fall below those in RoC, and that these would account for all the net out-migration in this case.

NMIGA: Total Number of New Albertans

The 'stock' of 'new' Albertans is last year's stock times 1.0 plus the natural rate of population increase, C203; plus the net flow of new migrants from the rest of Canada and abroad. C203 is set at 0.005, which approximates the forecast of Statistics Canada (91-520) who expect a natural rate of population increase declining from 0.008 (0.8%) in 1980, to 0.002 (0.2%) in 2000. The NEB (Appendix C) make similar projections.

POPAO: Total Number of 'Original' Albertans

The population of 'original' Albertans is last year's number times 1.0 plus the natural rate of population increase, C203. The 1980 value of POPAO is set equal to the actual 1980 population of Alberta. That is, original Albertans are defined as the residents of the province in 1980 plus their progeny.

POPA: Total Population of Alberta

The population of Alberta is made up of 'original' and 'new' Albertans.

POPB: Total population of Rest of Canada

The population of RoC equals last year's population times 1.0 plus the natural rate of population increase; less net interprovincial migration to Alberta; and plus the net flow of the foreign migrants to RoC.

POP: Population of Canada

The sum of POPA and POPB.

LATOT: Employed Labour Force in Alberta

The employed labour force in Alberta is a constant proportion, C208, of the Alberta population; times relative Alberta/RoC wage rates raised to the power C226. This coefficient is the (negative) elasticity of demand for labour with respect to deviations in the Alberta wage rate from the RoC wage, and is set at -0.25. Thus, the labour market imperfections that allow a wage differential to result from inter-regional income differentials cause some of the Alberta labour force to be 'priced out of a job'.

C208 is set 0.42, which is the actual 1980 employment rate, and thus is probably above the long-run sustainable rate, given that the unemployment rate in Alberta was only 3.7 per cent in 1980. The use of 0.42 for C208 also assumes (incorrectly) that Alberta and RoC wage rates were equal in 1980.

LBTOT: Employed Labour force in Rest of Canada

The RoC employed labour force is the same proportion of RoC population as it was in 1980 (C209 = 0.37).

UAGAP: The Alberta Unemployment Gap

This variable measures the difference between actual employment in Alberta, LATOT, and the level of employment had there been no difference in wage rates between Alberta and RoC. It thus can be interpreted as the 'gap' between actual Alberta unemployment and the 'natural' amount of unemployment that is embodied in the employment rate coefficients C208 and C209.

BLOCK 2: ENERGY PRICES AND SUPPLY

RPAELEC: Retail Price of Electricity in Alberta

The retail price (to intermediate and final consumption users) of electricity in Alberta may be set fully exogenously or as an exogenous proportion of the world price of oil, PWOIL, converted into $ Canadian by the exchange rate, EXCH (lagged for recursiveness). That is, one of POL11 and POL12 will normally be set equal to zero in each year. This formulation allows us, if we so wish, to have prices rising in steps until they reach a certain proportion of the world oil price, and thereafter maintain the proportional relationship. Values of policy variables are discussed in the scenario simulation chapters.

RPBELEC: Retail Price of Electricity in Rest-of-Canada

For explanation see RPAELEC above.

RPAOIL: Retail Price of Oil in Alberta

For explanation see RPAELEC above.

RPBOIL: Retail Price of Oil in Rest-of-Canada

For explanation see RPAELEC above.

RPAGAS: Retail Price of Gas in Alberta

For explanation see RPAELEC above. 'Gas' includes natural gas and liquid petroleum gases.

RPBGAS: Retail Price of Gas in Rest-of-Canada

For explanation see RPAELEC and RPAGAS above.

SPOOIL: Supply Price of Old Oil

The price received by suppliers of 'old' oil set by policy. For explanation of the formula see RPAELEC above. 'Old' oil has been defined as oil discovered before 1981 in the National Energy Program. This has been complicated in the May 1982 'Update' to the NEP by allowing a special higher price for oil discovered in the 1974-80 period which the Alberta government classifies as 'new oil'. (See NEP Update 1982, p. 74). This 'new/old' oil has been included with oil discovered since 1980 in THESIS RD1.4.

SPNOIL: Supply Price of New Oil

Price received by suppliers of 'new' oil. See SPOOIL and RPAELEC above. 'New' oil here includes; (a) all Alberta oil discovered from 1974 (see SPOOIL above), (b) all oil produced in Rest-of-Canada.

SPGAS: Supply Price of Natural Gas

Price received by suppliers of natural gas and liquified petroleum gas. For explanation see RPAELEC above.

PAALT: Price of Alternative energy in Alberta

'Alternative' energy is the aggregate of energy produced from various non-depleting resources - sun, wind, plants and trees - using a variety of technologies, which vary in their sophistication and current stage of development.

The alternative energy industry is therefore an agglomeration of many processes and markets, similar to the non-energy 'reproducibles' sector. Accordingly, it is assumed (a) that the 'supply' and 'demand' prices of alternative energy are the same -- there is no 'wedge' driven between them by the special taxes and royalties that are important in the oil and gas sector, and (b) that alternative energy prices are set by market forces such that they find a level matching the prices of the substitutes oil, gas, and electricity.

A single representative price (PAALT) for the sector in Alberta is assumed to be the weighted average of oil, gas, and electricity prices, with the weights set as the lagged (for recursiveness) shares of oil and gas and electricity in total Alberta absorption of non-alternative energy.

PBALT: Price of Alternative Energy in Rest-of-Canada

For explanation see PAALT above.

RPAENT: Retail Price of Energy in Alberta

Since PAALT is the average of the prices of other energy sources, weighted by their share of non-alternative energy use, the average of all energy prices, weighted by each energy source's share in total energy use is equal to PAALT.

RPBENT: Retail Price of Energy in Rest-of-Canada

See RPAENT above for explanation.

RPENT: Retail Price of Energy in Canada

All Canada retail price of energy a weighted average of Alberta and Rest-of-Canada prices.

PREP: Price Index of Reproducibles Output

The price index of reproducibles output (1980 = 1.0) changes by a percentage equal to the per cent change in energy prices weighted by the 1980 share of energy in reproducibles costs less the per cent rate of technical progress (see XAREP, XBREP).

PAREP: Price Index of Alberta Reproducibles Output

Although the Alberta wage rate can differ from the RoC wage rate (see Block 1), and although the 1980 share of energy in reproducibles input costs is higher in Alberta than in RoC, PAREP is, for simplicity, set equal to PREP.

PBREP: Price Index of Rest-of-Canada Reproducibles Output

Assumed same as total-Canada reproducibles price index.

RESAOOIL: Alberta Reserves of Old Oil

Alberta reserves of 'old' oil (from reserves 'proven' by 1974) at the start of the year equal reserves at the start of the previous year minus last year's production of oid oil. See XANOIL below for further discussion.

XAOOIL: Alberta Production of Old Oil

Alberta production of old oil equals 1980 production; multiplied by the ratio of remaining to 1980 old oil reserves raised to the power C9. Thus, it is assumed that old oil ouput declines steadily, and is not affected by price or other economic variables. This is consistent with the NEB's forecasts (pp. 117-124).

RESANOIL: Alberta Reserves of New Oil

Alberta reserves of 'new' oil (from reserves added since 1974) at the start of the year equal reserves at the start of the previous year minus last year's production of new oil. See XANOIL below for further discussion.

XANOIL: Alberta Production of New Oil

Alberta production of new oil is determined by the selling price of new oil scaled by C4 and raised to the power C1 -- the price elasticity of supply; all raised to the power C2 -- the adjustment lag coefficient; multiplied by lagged new oil production raised to the power 1.0 minus C2; multiplied by the ratio of remaining to 1980 new oil reserves raised to the power C3.

Thus, the supply function shifts over time as reserves are depleted. C4 is set at 1.0 which implies that 1980 production of new oil was about $1 billion in 1980 prices (SPNOIL = 1.0). This number is arbitrary, in that it is not deduced from any data on the proportion of Alberta's 1980 oil production coming from reserves discovered after 1974.

The price elasticity (C1 = 1.5) summarizes the various ways in which a higher selling price can stimulate a larger flow of oil. These include the effects on exploration activity, on depletion rates, and various 'secondary' and 'tertiary' recovery techniques that can be applied to existing reserves. This, and the other energy supply elasticities in the model, are intended to summarize a number of diverse sources of information. Their plausibility should be assessed by examining the time paths of energy production that they help generate.

Since proven reserves are, with the possible exception of 'old' oil, an economic variable responsive to price, the 'reserves' variables included in our supply function are really scaling parameters, capturing the inexorable upward-shifting effect on supply curves of depletion. More complicated models (e.g. Helliwell, McRae et al.) model separately the various stages in energy supply.

The adjustment coefficient (C2 = 0.2) implies that the response to changes in price is quite slow -- only one fifth of the long-run effect is felt in the first year. It was thought that slow adjustment is consistent with the technological characteristics of the industry.

In the absence of any information on the size of the depletion exponent, C3, it is set at 0.25. Originally, C3 was set at 1.0, but it was found that this lead to production becoming very small when a large fraction of the reserves still remained.

XASOIL: Alberta Production of Synthetic Oil

Alberta oilsands output is policy-determined.

XAOIL: Alberta Total Oil Production

The sum of 'old', 'new' and 'synthetic' oil output.

RESAGAS: Alberta Reserves of Natural Gas

Alberta reserves of natural gas at the start of the year equal reserves at the start of the previous year less last year's production. See XANOIL above for further discussion.

XAGAS: Alberta Production of Natural Gas

The Alberta natural gas supply function is similar in form to the function for 'new' oil, discussed above. The scaling coefficient, C11, equals 7.5 (1980 production). The supply price elasticity, C12, is set at 1.0. It was found that, given the relatively high starting (1980) level of gas production, higher elasticities resulted in implausibly rapid depletion. The adjustment coefficient, C13, is set at 0.3, which implies that gas production responds more quickly than does oil to a change in price.

XAELEC: Alberta Production of Electricity

Alberta production of electricity is adjusted to match the previous year's intermediate, (E)LECAREP, and final consumption, (E)LECACON, demand in the province. Demand is lagged to maintain recursiveness.

Thus it is assumed that Alberta has no rent-yielding 'surpluses' of electricity to export. Since only about 13 per cent of Alberta's electricity is from hydro-electric sources (NEB, p. 189), it is probably reasonable to assume that the province does not have a comparative advantage in the production of electricity.

XAALT: Alberta Production of Alternative Energy

Alberta production of 'alternative' energy is subject to exponential increase at the rate C43 annually; multiplied by the price of alternative energy (PAALT) scaled by C23 and raised to the power C24 -- the price elasticity of supply; all raised to the power C27 — the adjustment lag coefficient; multiplied by lagged alternative energy production raised to the power 1.0 minus C27.

The rate of technical progress, C43 = 0.02 and the price elasticity (C24 = 1.5), are intended to be conservative estimates of the supply potential of alternative energy, which is a relatively new industry, and so should be subject to relatively large improvements in productivity (for the definition of alternative energy, see PAALT, above).

The adjustment coefficient, C27, is set larger (= 0.5) than those for oil and of gas, in the belief that alternative energy technologies will tend to be relatively small scale, and thus more flexible than the technologies used in exploring for an extracting coventional oil and gas.

The scaling coefficient C23 is set at 0.1, implying 1980 value of production in Alberta at $100 million. This figure is not supported by any data.

RESBOIL: Rest-of-Canada Reserves of Oil

Rest-of-Canada reserves of oil at the start of the period equal reserves at the start of the previous year minus last year's production. No distinction is made between 'old' and 'new' oil for RoC, but 'frontier' oil is not included in reserves, so its policy-determined production, POLO2, does not subtract from reserves. See XANOIL and XBOIL for further discussion.

XBOIL: Rest-of-Canada Production of Oil

RoC oil production is the sum of market-determined and policy-determined production. The market-determined component is set by a supply function similar to that for XANOIL, above. The scaling coefficient C8 equals 1.13, which is the value of 1980 production of oil in RoC. The price elasticity of supply, C5, is set at 1.5, the same as the XANOIL. The adjustment coefficient and reserve depletion coefficients (C6, C7) also have the same values as their counterparts in the XANOIL supply function.

Added to this privately-determined oil production is POLO2 -- production undertaken independently of prices as a result of direct government intervention (e.g. through subsidies). Much of the 'frontier' activity in oil and gas exploration and depletion is likely, given its costs and uncertainties, to come about as the result of government initiatives.

RESBGAS: Rest-of-Canada Reserves of Natural Gas

RoC reserves of natural gas at the start of the year equal reserves at the start of the previous year less last year's production. See XANOIL for further discussion.

XBGAS: Rest-of-Canada Production of Natural Gas

Similar to XAGAS. The scaling factor C15, equals actual 1980 production ($1.5 billion); the price elasticity of supply, C16, is set at 2.0 (relatively elastic to capture the relatively larger untapped potential of RoC gas reserves), and adjustment and depletion coefficients are the same as the corresponding Alberta coefficients.

XBELEC: Rest-of-Canada Production of Electricity

Much of RoC's electricity is produced by hydroelectricity (about 62% in 1980 -- see NEB, p. 189), which has resulted in a rent-yielding surplus of generating capacity available to produce electricity for export to the U.S. It is planned to increase capacity further so as to maintain or increase exports. Since there is not a readily discernible economic rationale behind the planned additions to capacity, electricity supply has simply been modelled as exogenous, by POLO4.[1]

XBALT: Rest-of-Canada Production of Alternative Energy

Similar to XAALT, except scaled to a 1980 value of $900 million (C25 = 0.9).

XALT: Canada Production of Alternative Energy

Sum of Alberta and RoC production.

XOILGAS: Canada Production of Oil and Gas

Sum of Alberta and RoC oil and gas production.

XENT: Canada Production of Energy

Sum of Alberta and RoC oil, gas, alternative, and electricity production.

BLOCK 3: ENERGY INPUTS TO REPRODUCIBLES SECTOR

ENTAREP: Total Energy Input to Alberta Reproducibles Sector

Total intermediate energy use in Alberta (excl. energy used in the production of energy) is a proportion C94 of lagged reproducibles output (XAREP) multiplied by the ratio of lagged to twice-lagged reproducibles output, all raised to the power C96 -- the adjustment lag coefficient; multiplied by the lagged relative price of energy to reproducibles output price raised to the power C95 -- the price elasticity of demand; all raised to the power C96; multiplied by lagged intermediate energy use raised to the power 1.0 minus C96.

The term in lagged reproducibles output is a proxy for current year output, which it will equal exactly if the rate of change in reproducibles output is unchanged over the preceding two periods.

C94 is set at 0.100 which is the 1980 ratio of energy input to reproducibles output in Alberta. The price elasticity C95 is set at -0.5. This figure is about consistent with the findings of a number of econometric studies of energy demand.

Most recently Helliwell, McRae, et al. report a total energy elasticity of -0.6, which is the aggregate of own-price elasticities for oil, gas, and electricity which are all within about plus or minus 0.1 of -0.5 (Appendix 2, p. 5).

In RD1.4, C96 is set at 1.0, implying no lagged adjustment. Given the steady and fairly predictable path of (exogenous) energy prices in the model, it seems reasonable to assume that the reproducibles sector will be able to achieve its desired, or equilibrium, level of energy use within each year; at least after the new path of energy prices becomes familiar.

ENTBREP: Total Energy Input to Rest-of-Canada Reproducibles Sector

Similar to ENTAREP, except for scale coefficient, C97, set to 0.64, which is the RoC ratio of energy input to reproducibles output. Thus, the RoC reproducibles sector is less energy-intensive than its Alberta counterpart.

ALTAREP: Alternative Energy Input to Alberta Reproducibles Sector

It is assumed, in the absence of other information, that alternative energy output is divided equally between intermediate and final consumption use. Thus, C104 is set at 0.5.

ALTBREP: Alternative Energy Input to RoC Reproducibles Sector

Same as ALTAREP.

OILAREP: Oil Input to Alberta Reproducibles Sector

Energy demand not met by alternative energy is divided-up in the model between oil, gas, and electricity such that their market shares change over time, but not in response to changes in relative prices.

This specification was adopted because: (a) it is difficult to specify cross-price elasticities of demand that can be relied on not to generate foolish results over a long-run simulation. Helliwell, McRae et al., for example, found that their econometrically estimated demand equations predicted negative oil and gas use under some circumstances: "We naturally bound these estimates at zero" (p. 39); (b) there is so much policy intervention designed to effect desired changes in demand patterns (e.g., NEP 1980, pp. 53-87) that unconstrained price-dependent demand equations would probably be inappropriate for the simulation period.

The market shares of oil, gas, and electricity in RD1.4 change smoothly over time so as to approximately match the forecasts of the NEB (chapter 5: summarized in figure 5-1).

Thus the 1980 share of oil in Alberta total intermediate input demand (49%: C102 = 0.49) falls at an annual rate of 0.5 per cent (C103 = -0.005).

OILBREP: Oil Input to Rest-of-Canada Reproducibles Sector

Similar to OILAREP. 1980 share of oil in RoC is 0.39 (C105), and declines at 0.5 per cent each year (C106).

GASAREP: Gas input to Alberta Reproducibles Sector

Similar to OILAREP. 1980 share of gas in Alberta is 0.29 (C108), and increases at 1 per cent each year (C109).

GASBREP: Gas Input to Rest-of-Canada Reproducibles Sector

Similar to OILAREP. 1980 share of gas in RoC is 0.23 (C111) and increases at 1 per cent each year (C112).

ELECAREP: Electricity Input to Alberta Reproducibles Sector

Electricity use calculated as the residual after oil, gas, and alternative energy contribute their share.

ELECBREP: Electricity Input to Rest-of-Canada Reproducibles Sector

Similar to ELECAREP.

BLOCK 4: ENERGY INPUTS TO HOUSEHOLDS

Note: The specification of the final-consumption demand for energy is similar to the specification of intermediate-use demand (Block 3). That is, total demand in each region is modelled as a function of prices and other variables; and this is then split between the different types of energy according to exogenous market shares. The reader is referred to Block 3 for a justification of this approach.

ENTACON: Total Household Consumption of Energy in Alberta

Total energy consumption by Alberta households (in 1980 prices) equals per capita consumption multiplied by the population of Alberta, POPA. Per capita consumption is a function of: (a) real per capita income, YPAC/PY, proxied (for recursiveness) by lagged real per capita income multiplied by the ratio of lagged to twice lagged real per capita income, with a income elasticity of demand C121; and (b) the price of energy relative to the price of reproducibles, with a price elasticity of demand C122; all subject to an adjustment lag coefficient C123.

The function is scaled by C120, which is set at 0.0248, the all-Canada ratio of energy consumption to GNP in 1980, on the assumption that this ratio is applicable to Alberta. The income elasticity of demand is set at 1.0, in line with NEB forecasts (p. 29).

For justification of the specification (which is to maintain recursiveness) of the proxy for current-year income, and of the price elasticity (-0.5), and the adjustment lag coefficient (1.0), see ENTAREP, in Block 3.

ENTBCON: Total Household Consumption of Energy in Rest-of-Canada

Similar to ENTACON.

ALTACON: Household Consumption of Alternative Energy in Alberta

See ALTAREP, Block 3.

ALTBCON: Household Consumption of Alternative Energy in RoC

See ALTBREP, Block 3.

OILACON: Household Consumption of Oil in Alberta

See OILAREP, Block 3.

OILBCON: Household Consumption of Oil in Rest-of-Canada

See OILBREP, Block 3.

GASACON: Household Consumption of Gas in Alberta

See GASAREP, Block 3.

GASBCON: Household Consumption of Gas in Rest-of-Canada

See GASBREP, Block 3.

ELECACON: Household Consumption of Electricity in Alberta

See ELECAREP, Block 3.

ELECBCON: Household Consumption of Electricity in Rest-of-Canada

See ELECBREP, Block 3.

SHAOIL, SHAGAS, SHAELEC, SHBOIL, SHBGAS, SHBELEC

These identities compute the shares of oil, gas, and electricity in total energy use (excl. alternative energy), in Alberta and RoC. The shares are used, lagged, as weights in the energy price formulas of Block 2.

BLOCK 5: TOTAL COSTS AND INPUTS TO ENERGY SECTOR

COSTANOI: Cost of Producing New Oil in Alberta

The supply function for new oil (XANOIL: Block 2) is the inverse of the marginal cost function. To compute total costs, the marginal cost function (excluding adjustment lags) is integrated from zero to actual output. From this is subtracted an adjustment factor (= -0.7) to calibrate total costs to match their actual 1980 levels.

COSTAOOI: Cost of Producing Old Oil in Alberta

'Old' oil supply is largely determined by exogenous flow rates of the reserves, which are expected to decline. Costs of producing old oil are forecast to increase at an annual rate of 10 per cent (C130 = 0.10) from their 1980 level of 4.3 cents per $1 of output (C19 = 0.043).

COSTASOI: Cost of Producing Synthetic Oil in Alberta

Costs of producing 'synthetic' oil (oilsands) are forecast to remain unchanged (C133 = 0.0) from their 1980 level of $2.2 per $1 of output (C20 = 2.2).

This does not imply that oilsands operated at a loss, since their output is not valued at the price of conventional oil. In fact, oilsands plants received x2.2 this price per barrel in 1980. The coefficient C20 is thus set on the assumption that the two oilsands plants did not made more than a 'normal' return on their capital in 1980.

The lack of any change in the real cost per barrel in the model is counter to the 'casual empiricism' of newspaper and other sources, in which it is generally reported that oilsands costs are expected to rise faster than the rate of inflation. Why this should be so, apart from short-term supply bottlenecks, is somewhat of a mystery. The extraction of oil from oilsands is basically a manufacturing operation, which is still at a rather primitive stage of technology, and would be expected to benefit from the 'learning curve' improvements that new manufacturing industries normally experience. As a compromise, then, the rate of cost change, C133, is assumed zero.

COSTAGAS: Cost of Producing Natural Gas in Alberta

Similar to COSTANOI. $3.5 billion subtracted to calibrate to actual 1980 costs.

CASTAOIL: Total Cost of Producing Oil in Alberta

Sum of 'new', 'old', and 'synthetic' costs of production.

COSTBOIL: Cost of Producing Oil in Rest-of-Canada

Similar to COSTANOI for market-determined portion of output (XBOIL-POLO2). Operating costs of policy-determined output assumed to be one half (C18 = 0.5) of the value of production in 1980 prices; that is, about $8/barrel. $1.0 billion is subtracted from the expression to calibrate it to actual 1980 costs. The cost estimates of policy-determined production are somewhat higher than the range cited by the NEB (p. 143).

COSTBGAS: Cost of Producing Natural Gas in Rest-of-Canada

Similar to COSTANOI. $1.0 billion subtracted to calibrate to actual 1980 costs.

COSTAELE: Cost of Producing Electricity in Alberta

Since electricity supply is not determined by marginal costs total costs cannot be determined by integrating the inverse of a supply function. The NEB (Chapter 13) does not give cost estimates, but it appears likely that the marginal cost of new generating capacity, especially of hydroelectricity, will be higher than average costs of the existing capacity. To capture this, electricity costs are specified as a quadratic (C37 = 2.0) function of output, with the scaling coefficient C36 chosen to calibrate the expression to actual 1980 operating costs.

COSTBELE: Cost of Producing Electricity in Rest-of-Canada

Similar to COSTAELE.

COSTAALT: Cost of Producing Alternative Energy in Alberta

Similar to COSTANOI.

COSTBALT: Cost of Producing Alternative Energy in Rest-of-Canada

Similar to COSTANOI.

CAOILGAS: Total Cost of Alberta Oil and Gas Production

Sum of the oil and gas cost variables.

CBOILGAS: Total Cost of Rest-of-Canada Oil and Gas Production

Sum of the oil and gas cost variables.

LAOILGAS: Labour Employed in the Alberta Oil and Gas Industry

The Statistics Canada publication on the oil and gas industry (26-213) does not distinguish between oil and gas in its cost of production data. For the two combined, the 1980 number of employees (millions) per $billion of total costs was 0.025, and this proportion is assumed to hold throughout the simulation period

(C41 = 0.025). Costs are deflated by the price index of reproducibles output PAREP.

LBOILGAS: Labour Employed in the RoC Oil and Gas Industry

Similar to LAOILGAS.

LAELEC: Labour Employed in Alberta Electricity Production

Similar to LAOILGAS. Slightly higher labour/cost ratio in 1980, so C42 = 0.026.

LAALT: Labour Employed in Alberta Alternative Energy Production

It is assumed, in the absence of any information, that one half of alternative energy costs of production are labour costs, and that the average wage in 1980 is about $18,000, which was approximately the average wage paid in the reproducibles sector. On the assumption that the labour/output ratio is constant, these data imply a value of 0.028 for C59.

LBALT: Labour Employed in RoC Alternative Energy Production

Similar to LAALT.

INAOILGA: Reproducibles Inputs to Alberta Oil and Gas Production

The reproducibles sector supplies materials, plants, and equipment to the energy sector. The 1980 proportion of real total oil and gas costs of production that is reproducibles output (i.e., everything that is not wages and salaries) is assumed to hold through the simulation period (cf. LAOILGAS). This proportion is C74 (= 0.4).

To these costs is added POL05, which is policy-determined capital expenditures on building new oilsands plants.

Thus the model does not explicitly distinguish between current and capital expenditures of the 'conventional' oil and gas industries but does so for oilsands. The rationale for this is that projected oilsands plants are likely to be so large and slow in the building that the time path of expenditures will be sufficiently 'lumpy' to show-through even at the high level of aggregation of the model. Such is probably not true of the conventional oil and gas sectors which are an aggregate of many relatively small projects.

INBOILGA: Reproducibles Inputs to RoC Oil and Gas Production

Similar to INAOILGA. POL06 measures policy-determined capital expenditures on 'mega projects'; mainly in 'frontier' areas (cf. NEB, p. 143).

INAELEC: Reproducibles Inputs to Alberta Electricity Production

The Alberta electricity generating industry is assumed to maintain its 1980 ratio of expenditures on materials, plant, and equipment to electricity production, so C76 = 0.58.

INBELEC: Reproducibles Inputs to RoC Electricity Production

Similar to INAELEC. It is assumed that future electricity-generating projects will not be so large as to force a splitting-up of the time paths of current and capital expenditures. This assumption might not be valid if future projects were of the size of Quebec's James Bay scheme.

INAALT: Reproducibles Inputs to Alberta Alternative Energy Production

As noted above (see LAALT) it is assumed that alternative energy costs divide equally between labour and purchases from the reproducibles sector. Thus C78 = 0.5.

INBALT: Reproducibles Inputs to RoC Alternative Energy Production

Similar to INAALT.

REPINENT: Total Reproducibles Inputs to the Energy Sector

Sum of inputs to oil and gas, electricity, and alternative energy.

BLOCK 6: REPRODUCIBLES SUPPLY

LAREP: Labour Employed in Alberta Reproducibles Sector

As noted in chapter II, it is specified in the model that all labour is employed, up to the 1980 participation rates, subject to the qualification that a wage in Alberta greater than that in RoC will reduce employment in Alberta (see LATOT). The all-employed requirement is consistent with the long-run perspective of the model, and fits with standard neoclassical growth theory. The relative-wage effect qualification is appropriate if we view Alberta as a small open economy operating with a fixed exchange rate in a larger economic region (Canada).

All this means that, since the reproducibles sector is the only non-energy sector, its employment of labour is simply the difference between the total employed labour force and the labour required in the energy sectors.

Thus we do not have energy and reproducibles 'competing' for labour. It is assumed that, in the long-run perspective of the model, it is reasonable to suppose that the relatively small energy sector faces an elastic supply of labour, and that the reproducibles sector adjusts to absorb whatever labour is not required in energy production.

LBREP: Labour Employed in RoC Reproducibles Sector

Similar to LAREP.

XAREP: Alberta Reproducibles Value Added

Net output (value added) in the non-energy sector is determined as a production function of the primary inputs labour, capital and energy.

The functional form is the simplest that would incorporate the desired properties. Output is a CES (constant elasticity of substitution) function of energy input and a composite factor which is a Cobb-Douglas function of labour and capital used in the sector.

Simpler still would be a three-factor Cobb-Douglas function, but this has the property that the cost-minimizing demand for each factor input has a price elasticity of -1. Price elasticities are not of concern for labour and capital, whose input levels are supply-determined in the model, but they do matter for energy, of which the use is demand-determined (see ENTAREP, ENTBREP, above) as a function of price.

Labour and capital are combined to maintain the simplicity of the two-factor CES functional form.

Other specifications are possible. Helliwell, McRae *et al.*, put capital and energy into a CES function, and then combine the output of this with labour in a Cobb-Douglas function. Nordhaus ignores capital and specifies output as a CES function of just labour and energy. No doubt an intelligent debate could be held on the relative advantages of different specifications. It is unlikely, though, that empirical data would be of much use in this debate, since freely-estimated production functions are notoriously prone to show unacceptable properties; in particular, negative productivity of capital (e.g. Rao).

Acceptable specifications are usually obtained by making use of theorems that relate observable factor shares of income to production function parameters, on the assumption that neoclassical distribution theory and perfect competition hold. For example, Helliwell, McRae et al., use factor shares, and some sample averages, to calibrate their production function.

The factor shares approach is taken here. The coefficients C30, C31 and C229 are set at 0.75, 0.25 and 0.07, respectively. 0.07 is the approximate 1980 share of energy in reproducibles value added for Canada. C30 equals the labour share (0.70), divided by (1-0.07), and C31 is capital's share (0.23), also divided by (1-0.07). This specification gives us a production function which exhibits constant returns to scale.

From Nordhaus (pp. 361-2) we note that 1/(1-C220) is the first order approximation of the absolute value of the price elasticity of demand for energy. The latter is taken to be -0.5 in the base case version of the model (see ENTAREP above), which implies a value of -1.0 for C220.

The production function is scaled to match actual 1980 output and input levels in the Alberta reproducibles sector (C28 = 12.6) and is subject to Harrod-neutral technical progress at the rate of 1.0 per cent per year (C29 = 0.010) is a compromise between the close-to-zero total factor productivity growth experienced since 1974, and the much higher rates (2-3%) of the previous two decades.

Helliwell, McRae *et al.*, use a higher rate (0.013), having decided that the 'productivity slowdown', post-1973, was transitory (p. 19).

Note that constant returns to scale and Harrod-neutral technical progress are also properties of the Helliwell, McRae, *et al.* production function.

Apart from the scaling factor, the reproducibles production functions for Alberta and RoC are the same. That is, it is assumed that all regions have access to the same production possibilities in this sector. We may note that the actual energy/output ratio is considerably higher in Alberta than in RoC (cf. ENTAREP, ENTBREP above), but it will be assumed here that such is due to the history of lower energy prices in Alberta, rather than to differences in the production function.

XBREP: Rest of Canada Reproducibles Value Added

See XAREP above.

XREP: Total Canada Reproducibles Value Added

Sum of Alberta and RoC reproducibles value added.

BLOCK 7: OTHER PRICES AND EXCHANGE RATE

CUMBOP: Cumulated Balance-of-Payments Surplus

The cumulated balance of payments surplus (or deficit) at the start of each year equals the cumulated balance at the start of the previous year plus the balance of payments of the previous year. This variable measures accumulated disequilibrium in Canada's transactions with the rest of the world. Its 1980 value is set at zero.

NEXOIL: Net Exports of Oil

Net exports equal Canada production minus total use as intermediate input or in final consumption.

NEXGAS: Net Exports of Natural Gas

Similar to NEXOIL.

NEXAELEC: Net Exports from Alberta of Electricity

'Net exports' are the difference between exports and imports. All quantity variables are in 1980 prices. It is assumed in the model that Alberta electricity supply is basically demand determined. However, the equation in Block 2 for electricity production, XAELEC, sets it equal to lagged intermediate and final consumption demand because current values of the demand variables are not determined until later in the model.

Thus, there will be, in general, a small discrepancy between current-year supply and demand. This residual difference is assumed in the model to be exported or imported depending on its sign.

NEXBELEC: Net Exports from Rest-of-Canada of Electricity

Several of the provincial electricity supply utilities in Canada regularly export electricity in significant amounts and do so willingly. Therefore XBELEC in Block 2 is specified as a policy variable such that there will, in general, be positive net exports (to the United States) of electricity.

NEXENT: Total Net Exports of Energy

Sum of NEXOIL, NEXGAS, NEXAELEC, NEXBELEC.

EXCH: Exchange Rate

The $ Canadian price of foreign exchange, indexed to 1980 = 1.0, changes by a proportion of the 'expected' cumulated balance of payments scaled by the 'quantity' of trade.

This is a price adjustment formula. If, for example, there has been a build-up of foreign reserves (CUMBOP positive), the exchange rate will be revalued to discourage exports and encourage imports. Note that, since the exchange rate is measured in Canadian currency, it falls with a revaluation, and rises with a devaluation.

There is an equilibrium exchange rate which would exactly balance inflows and outflows, but we are not able to compute this in a recursive model. However, all available information is used in a formula which gets as close as possible to equilibrium. To the portion of balance of payments accumulated from previous year's disequilibria (CUMBOP raised to the power C158 = .90), is added the change in the balance of energy trade, which can be calculated at this stage in the solution of the model. This sum is taken as the size (with opposite sign) of the required change in the reproducible trade balance, which can be achieved by an exchange rate adjustment determined by the size of import and export demand elasticities (C152, C147), after scaling by the average of lagged reproducibles exports and imports.

Because other factors shift export and import demand curves, and because capital flows can change, the exchange rate formula does not, in general, exactly generate the equilibrium rate. However, it is successful in keeping the foreign accounts tolerably close to balance, with no persistent buildups of balance of payments surpluses or deficits.

PEXREP: World Market Price of Canadian Exports of Reproducibles

The domestic reproducibles price index is used for the Canadian currency price of reproducibles exports. This is converted into 'world' currency units by multiplication by the reciprocal of the exchange rate index.

The Canadian-currency price of our exports is thus determined by domestic costs (see PREP), rather than by the price of competing products in world markets. This assumes: (a) that Canadian and foreign goods are not perfect substitutes, so that their prices can differ; (b) that Canadian exporters are not sufficiently monopolistic to be able to set prices taking into account the prices of competing products from other countries.

Assumption (a) is supported by the frequently demonstrated evidence that price elasticities of demand for exports are not infinite (e.g. Appelbaum and Kohli), but (b) may be incorrect -- Helliwell, McRae et al. do find a role for world prices in their econometric specification of the Canadian non-energy export price index (Appendix 1, p. 16). The assumption of non-infinite elasticities is consistent with comparative static general equilibrium trade models, such as Boadway and Tredennick (1978).

PWEXREP: World Price of Commodities Competing with Canadian Reproducibles Exports

The world price index of export-competing with goods changes at an annual rate C149. In RD1.4 this rate is set at zero and this price can be interpreted as the numeraire of the model.

PWIMREP: World Price of Reproducibles Imported to Canada

The 'basket' of reproducibles imported to Canada differs from the basket of exports, in that the latter is more heavily weighted with primary products. About 60 per cent of 1980 non-energy exports were primary products (farm, fish, forest, metals, fertilizers), compared with about 20 per cent of imports (calculated from tables 74, 75 in Bank of Canada Review, September 1981). Therefore, a negative rate of change of the import price index, relative to PWEXREP, the numeraire, is forecast on the assumption that world prices of primary products will rise relative to world prices of manufactured goods. The net effect (C154) is assumed to be 1 per cent per annum, which is also the rate of technical progress assumed in Canadian reproducibles production.

However, since Canadian reproducibles production is also required to absorb energy price increases which have, for the most part, been already build-in to the price structure of other OECD economies, we will expect to find the relative price of imported to Canadian-produced reproducibles falling in the simulations.

PIMREP: Canadian Price of Reproducibles Imports

The world price of reproducibles imports is converted into Canadian currency.

PY: Price Deflator for National Income

A price deflator is constructed as the output-weighted average of reproducibles and energy price indexes.

BLOCK 8: REPRODUCIBLES INPUTS TO CAPITAL FORMATION

SAVINGA: Alberta Savings

It is assumed that government policies are able to set the proportion of Alberta income, YA (lagged for recursiveness), that is saved. In the base-case, the savings rate, POLO7, is set at 0.23, to match the actual 1980 rate.

SAVINGB: RoC Savings

Similar to SAVINGA. POLO8 equals 0.23; same as Alberta.

MPKREPA: Marginal Productivity of Capital in Alberta Reproducibles

The marginal productivity of capital in the Alberta reproducibles sector is obtained from the Alberta reproducibles production function using 1981 values of labour and output and lagged (1980) capital stock.

MPKREPB: Marginal Productivity of Capital in RoC Reproducibles

See MPKREPA above

EIRWORLD: Expected World Interest Rate

Set equal to the actual world interest rate, IRWORLD. Not used in the present version of the model.

NIREPA: Net Investment in Alberta Reproducibles Sector

Net investment calibrated to 1980, is a function of the difference between optimal capital stock and the previous year capital stock less investment in oilsands projects. Optimal capital is specified as the stock of capital obtained when domestic marginal physical product of capital (MPKREPA) is equal to the world interest rate (IRWORLD).

This specification is a common approach in econometric models to the difficult problem of investment modelling. The specification of the optimal capital stock should include an exogenous output variable. In our specification we include both XAREP and LAREP and therefore create some simultaniety problems. However, we justify this functional form on the grounds that we are not concerned with the cyclical behaviour of the economy and that this approach at least allows for profit maximizing behaviour on the part of investors.

Net investment is calibrated to 1980 by C66 = .24. The inclusion of policy determined investment in (large) oilsands projects (POL05), assumes that this investment crowds out reproducibles investment, dollar for dollar.

NIREPB: Net Investment in RoC Reproducibles Sector

See NIREPA. POL06 is policy-determined investment in (large) 'frontier' oil projects.

NFCFA: Net Foreign Capital Flows, Alberta

This variable is measured as the difference between gross capital formation (net investment plus depreciation) and savings in Alberta. Thus, for example, a positive value would indicate a shortfall of savings to be made up by borrowing abroad, resulting in a capital inflow. (In fact, the funds, could be borrowed from RoC, but so long as the 'world' interest rate is paid, this will make no difference.) Depreciation equals a proportion C235 = 0.053 of the capital stock, calculated as the 1980 ratio of Capital Consumption Allowance to Mid-year Net Capital Stock, excl. energy and mines industries, from Statistics Canada 13-211.

NFCFB: Net Foreign Capital Flows, RoC

See NFCFA, above.

KAREP: Capital Stock in Alberta Reproducibles Sector

Sum of last year's capital stock and this year's net investment.

KBREP: Capital Stock in RoC Reproducibles Sector

Sum of last year's capital stock and this year's net investment.

BLOCK 9: REALIZED DOMESTIC RENTS

'Realized rents' are the surpluses over cost of production realized by the sale of commodities such as oil and gas, for which there is an upward-sloping marginal cost curve (oil, gas, alternative energy); or of which the price is not set as a function of costs (electricity). No rents are realized in the reproducibles sector which produces at constant returns to scale and sells at a price which just covers the opportunity costs of all factor inputs.

The realized rent concept thus does not include the 'rents' earned implicitly by the consumers of a good sold in Canada at less than its tradable price. The magnitude of these can be calculated in the model by making them realized, or explicit, by running a scenario in which consumers pay world prices, and comparing the results with the results of the low-price scenario.

Nor do realized rents here include the revenues actually raised by exports of resources, when such takes place at a price higher than the supply price received by producers. These surpluses are disposed of in the equations for Alberta and Rest-of-Canada Income, YA and YB.

Finally, note that rents generated in a region are not necessarily captured there. There are equations in this section to direct the redistribution of rents form oil and gas.

RAOIL: Realized Alberta Oil Rents

Oil rents generated in Alberta are the sum of rents from 'old' and 'new' oil. It is assumed that taxation, royalty, etc. arrangements for synthetic oil are such that no rents are earned on its sale.

RBOIL: Realized Rest-of-Canada Oil Rents

Rest-of-Canada oil is assumed all sold at the 'new oil' price.

RAGAS: Realized Alberta Natural Gas Rents

RBGAS: Realized Rest-of-Canada Natural Gas Rents

RAOILGAS: Total Alberta Realized Oil and Gas Rents

RBOILGAS: Total Rest-of-Canada Realized Oil and Gas Rents

RAELEC: Realized Alberta Electricity Rents

RBELEC: Realized Rest-of-Canada Electricity Rents

RAALT: Realized Alberta Alternative Energy Rents

RBALT: Realized Rest-of-Canada Alternative Energy Rents

Sharing Rents: The following equations divide-up the above rents between Alberta, RoC, and foreigners. The 'base case' numbers for the share equation coefficients assume:

(i) Alberta oil and gas rents split 10/50/40 between industry/Alberta government/Federal Government;

(ii) Alberta gets back 10 per cent of Federal share through Federal expenditures and transfers;

(iii) RoC oil and gas rents split 10/30/60 between industry/RoC Provincial governments/Federal Government, which implies a 10/84/6 split between industry/RoC/Alberta under assumption (ii). (The higher Federal share in RoC rents reflects the importance of Northern and off-shore production, which will be on Federal territory.)

RGAAOILG: Realized Alberta Oil and Gas Rents Captured for Alberta by Governments

Includes: (a) Alberta governments royalties and taxes; (b) Alberta's share of Federal government's royalties and taxes; on Alberta oil and gas.

RGABOILG: Realized RoC Oil and Gas Rents Captured for Alberta by Government

Alberta's share of Federal Government's taxes and royalties on Rest of Canada oil and gas.

RGBAOILG: Realized Alberta Oil and Gas Rents Captured for RoC by Government

Rest of Canada's share of Federal Government's taxes and royalties on Alberta oil and gas.

RGBBOILG: Realized RoC Oil and Gas Rents Captured for RoC by Governments

Includes: (a) Rest of Canada provincial government's royalties and taxes; (b) Rest of Canada's share of Federal government's royalties and taxes on Rest of Canada oil and gas.

RIAAOILG: Realized Alberta Oil and Gas Rents Captured by Alberta Industry

Alberta-owned industry's share of Alberta's oil and gas rents. Helliwell and McRae report that Canadian ownership of the oil and gas industry was 33 per cent in 1980. It is assumed here that the post-NEP, post-Alberta/Federal Energy

Agreement shares will be 40 per cent for Alberta oil and gas, and 50 per cent for RoC oil and gas.

It will also be assumed, in the absence of any information, that 20 per cent of the Canadian shares in oil and gas firms are owned by Alberta residents. Thus, C188 = 0.2 * 0.4 * 0.10 = 0.008.

<u>RIABOILG: Realized RoC Oil and Gas Rents Captured by Alberta Industry</u>

C189 = 0.2 * 0.5 * 0.10 = 0.01.

<u>RIBAOILG: Realized Alberta Oil and Gas Rents Captured by RoC Industry</u>

C156 = 0.8 * 0.4 * 0.10 = 0.032.

<u>RIBBOILG: Realized RoC Oil and Gas Rents Captured by RoC Industry</u>

C157 = 0.8 * 0.5 * 0.10 = 0.04.

<u>RFAOILG: Realized Alberta Oil and Gas Rents Captured by Foreigners</u>

All rents not captured domestically go to foreigners.

<u>RFBOILG: Realized RoC Oil and Gas Rents Captured by Foreigners</u>

<u>RATRES: Total Realized Energy Rents Captured by Albertans</u>

Sum of realized rents captured by Albertans. It is assumed that all electricity and alternative energy rents are owned in the province in which they are generated.

RBTRES: Total Realized Energy Rents Captured by Rest-of-Canada

For explanation see RATRES above.

BLOCK 10: BALANCE OF TRADE AND PAYMENTS

EXREP: Exports of Reproducibles

Real (1980 prices) reproducibles exports from Canada are a proportion C146 of the 'size' of the reproducibles sector, measured by lagged total reproducibles value added XREP, multiplied by a price term defined as the price of reproducibles exports relative to the world price of competing goods raised to the power C147 -- the price elasticity of demand; all subject to an adjustment lag coefficient C148.

Thus, in allowing the price of Canadian exports to differ from the world price, we are assuming imperfect substitutability -- that is, that Canada is not a 'price taker' in its export markets. As noted in the discussion of PEXREP in block 8, this assumption is supported by the findings of Appelbaum and Kohli (1979), and is commonly found in general equilibrium trade models (eg. Boadway and Treddenick, (1978)).

The scaling coefficient, C146, is set at 0.307, which is the ratio of reproducibles exports to reproducibles value added in 1980. The price elasticity is set at -2.0. This is larger than most econometric estimates (Helliwell, McRae, et al., for example, find a 3-year elasticity of -0.4. Witte (1981) estimates the long-run elasticity to be -0.9), and larger than the figures used by Boadway and Treddenick (1978) in their general equilibrium trade model of Canada.

Smaller values were found, in earlier versions of the model, to generate unstable exchange rate paths, basically because changes in the exchange rate to correct balance of payments disequilibrium could not generate enough of a quantity response for adjustment to be stable.

It was also found that lagged adjustment of exports to equilibrium levels was unconducive to stable responses, and so C148 is set at 1.0.

IMREP: Imports of Reproducibles

Real (1980 prices) imports of reproducibles demand-determined per capita imports equal a proportion C150 of a proxy for per capita income raised to the power C151 -- the income elasticity of demand; multiplied by the price of imports relative to the price of domestic output raised to the power C152 -- the price elasticity of demand; all subject to an adjustment lag coefficient C153.

Total imports then equal per capita demand multiplied by population.

The scaling coefficient, C150, equals 0.260, which is the 1980 proportion of per capita incomes spent on imports of reproducibles in Canada.

In the absence of strong evidence to the contrary, the income elasticity of demand is set at 1.0 (Helliwell, McRae, et al., have a coefficient on output of

1.2 in their non-energy imports equation, but this is not statistically significant (Appendix A1, p. 11).

The price elasticity of demand (-0.5) is lower than that estimated by Helliwell, McRae, <u>et al.</u> (<u>loc. cit.</u>).

<u>DIVENT: Energy Dividends Remitted to Foreigners</u>

Realized rents to foreigners from oil and gas production are remitted to them.

<u>CUMNFCFA: Cumulated Net Foreign Capital Flows, Alberta</u>

Total net foreign indebtedness is the sum of last years total indebtedness plus this year's net capital flow.

<u>CUMNFCFB: Cumulated Net Foreign Capital Flows, RoC</u>

Similar to CUMNFCFA.

<u>BOP: Balance of Payments</u>

The current year balance of payments in Canadian dollars is the sum of net oil exports, sold or bought at the world price of oil; net natural gas exports, sold at a price which is a proportion C170 of the world price of oil; net electricity exports, sold at a price which is a proportion C171 of the world price of oil; and exports of reproducibles, sold at price PEXREP; minus imports of reproducibles sold at price PIMREP; and interest payments on accumulated foreign debt at the world interest rate, IRWORLD; plus this year's energy sector rents remitted to foreigners, DIVENT; net capital inflows; less \$5.0 billion, which was the approximate net sum of foreign interest, dividend and transfer payments in 1980, assumed to continue through the simulation period.

The values for C170 and C171 (0.9; 0.8) are based on the assumption that gas and electricity are close, but not perfect, substitutes for oil, so that movements in the world oil price are dampened somewhat in their effect on gas and electricity prices.

(Recall from Block 2 that price indexes for each energy type are scaled against the 1980 domestic Canadian prices for each type, which are set at 1.0.)

Gas is assumed to be a better oil substitute than electricity, and so C170 is larger than C171.

BLOCK 11: INCOMES

NEQ: Net Equalization Payments to Rest-of-Canada

Net payments from Alberta to the Rest-of-Canada under the terms of the equalization formulae are modelled as a proportion C200 of lagged National Income, Y —a scaling factor; multiplied by lagged relative Alberta/Rest-of-Canada per capita incomes, raised to the power C201 minus 1.0. Thus net flows will be zero if per capita incomes are equal.

It is assumed, with no empirical justification, that the exponent C201 is 1.0. Then, C200 is set at 0.285 to calibrate the formulae to generate actual 1980 NEQ of $0.8 billion, given actual 1980 relative Alberta/RoC per capital incomes.

YA: Total Alberta Income

Total Alberta income (the provincial equivalent of National Income) is the sum of earned income, rents, and net transfers. It therefore includes total realized energy rents captured in Alberta (RATRES); Alberta's share, given as its population share modified by C175, of receipts from exports of natural gas over and above the price received by producers; the components of energy industry costs that are value added in Alberta; Alberta reproducibles value added adjusted for remittance of profits to the Rest-of-Canada; the negative of net equalization payments; and less net interest payments on Alberta's foreign debt.

C175 is set at 1.0, which implies that Albertans share equally (on a per capita basis) with other Canadians in the surpluses generated from the sale in world markets at prices higher than the domestic supply price. That is, it is assumed that all these surpluses are captured by the Federal government through royalties, export taxes, etc., and are then evenly distributed through normal federal expenditures.

The coefficient C176 is set at 0.5, which is a guess at the proportion of Alberta oil and gas value added (most of which is profit (cf. LAOILGAS; Block 5)) not remitted to RoC shareholders in the industry.

C181 is set at 0.95; a guess at the proportion of Alberta reproducibles value added not remitted to RoC shareholders.

YB: Total Rest-of-Canada Income

See YA above for general explanation. RoC is expected to have significant positive net exports of electricity, so the surplus revenue over domestic electricity price from selling at the world price is included. (Alberta net exports of electricity are assumed to be insignificant in the calculation of YA.)

It is assumed in the model that the relative sizes and histories of the Alberta and RoC economies are such that although RoC gets a significant proportion of the earned income from Alberta's oil and gas and reproducibles production, the converse is not true.

Should net oil exports become positive, and fetch a higher price than the domestic producer price, additional income will be generated which is not included in our formulae for YA and YB. So long as these rents are evenly divided per capita, their omission from YA and YB should not significantly distort comparisons of incomes in the two regions.

Y: Canada National Income

YPC: Canada Per Capita Income

YPCA: Alberta Per Capita Income

YPCAO: Per Capita Income of 'Original' Albertans

'Original' Albertans (those living in Alberta in 1980 and their descendants) get a share of Alberta energy rents which will be greater than their share of Alberta's population if C202 is greater than one. In the base case, C202 is set at 1.0, implying that no distinction is made between 'original' and 'new' Albertans. This assumption will be altered in one of the simulations.

YPCAN: Per Capita Incomes of 'New' Albertans

'New' Albertans take what is left of Alberta Income after the 'original' Albertans have taken their share.

BLOCK 13: REAL CONSUMPTION

GREPCONR: Gross Real Availability of Reproducibles in Canada

Domestic availability of reproducibles equals total output of reproducibles, less net exports, less reproducibles used as inputs to the energy sector, plus the change in the balance of payments (which represents potential reproducibles absorption) deflated by the reproducibles price index.

REPCONRA: Real Consumption of Reproducibles in Alberta

Albertans' shares of Canada's reproducibles consumption is determined by their share of Canada's national income, net of expenditures on final consumption of energy, less Alberta real savings.

REPCONRB: Real Consumption of Reproducibles in Rest-of-Canada

Rest-of-Canada consumes the available reproducibles not consumed in Alberta, net of RoC savings.

CONRA: Real Consumption in Alberta

Sum of reproducibles and energy consumption.

CONRB: Real consumption in Rest-of-Canada

Sum of reproducibles and energy consumption.

CONRPCAO: Per Capita Consumption of Original Albertans

'Original' Albertans' share of Alberta consumption equals their share in Alberta income.

MIGCOST: Costs of Income-induced Migration

The discounted stream of expected income differentials required to persuade a Canadian to migrate from one region to another gives a reasonable estimate of the cost of making the move.

The formulae gives a value for these migration costs for each year's stock of migrants, on the assumptions:

(i) migrants are evenly distributed between the extremes of those who required almost no income differential to spur their move, and the marginal migrant who was just persuaded to move at the actual income differential.

This means that the average cost per migrant is the present value of 0.5 multiplied by the expected income differential.

(ii) the expected income differential is well proxied by the actual current differential.

(iii) the present value is 5.0 multiplied by the average expected income differential (C169 = 5.0). This implies a discount rate of 25 per cent per year, which is well above the rate of return, and reflects: (a) uncertainty about the future income stream, and (b) decay of the 'psychic' costs of moving as migrants get accustomed to their new environment.

(iv) should the present Alberta income advantage be reversed, it will be the cohorts of the 'new' Albertans that yield the migrants back to RoC. To allow for negative NMIGA, its value in MIGCOST is first squared, then its square root taken (to keep costs positive).

Migration costs are divided evenly amongst the total stock of new Albertans, (POPA-POPAO), and so will decline per capita over time, as the stock gets larger relative to the annual flow. Thus we are implicitly treating new Albertans as a homogeneous 'class', sharing all costs.

CONRPCAN: Per Capita Consumption of New Albertans

New Albertan's share of Alberta consumption equals their share of Alberta income, less migration costs.

CONRPCB: Per Capita Consumption in Rest-of-Canada

Total consumption divided by RoC population.

IV. THE BASE-CASE SCENARIO

In this chapter we examine the 'base-case' scenario. This is the solution of the RD1.4 model designed to incorporate 'middle of the road' values for coefficients and exogenous variables, and to represent current government policy on energy, as set out in the National Energy Program of 1980, modified by the Alberta-Federal government agreement of September 1981, and by the Federal NEP Update of May 1982.

Although THESIS RD1.4 is not designed to be used as a model generating forecasts for interesting variables, so that the primary use of the base-case solution is as a reference from which to calculate differences implied by other scenarios, it is probably a worthwhile exercise to examine the base-case scenario in some detail, the better to understand the workings of the model, as well as to get some feel for the size of the numbers generated over two decades of growth and structural change in the economies of Alberta and Canada.

This chapter is in three sections. First we look at the 1980 data, which the model is calibrated to fit. Then we will examine the exogenous policy variables of the base-case scenario. Finally, the results of solving the model for the base-case scenario through to the year 2000 are set out.

1. Canada and Alberta in 1980

Appendix C gives values with data sources of the important economic variables in the year 1980, the last for which a complete dataset could be assembled.

We see (row 1) that the GDP of Canada in 1980 was nearly $300 billion, of which $40 billion, or 13-1/3 per cent, was generated in Alberta. This province's share of Canadian population (row 43), was only 8.7 per cent (2.08/23.92), so we can observe at once its relative wealth.

Of course, this disparity in per capita GDP is not fully reflected in income differentials, since much of the output of Alberta's oil and gas sector is either taxed away by the Federal Government, or paid in dividends to shareholders abroad and in the Rest-of-Canada. The resulting net income flows are examined in section 3 below.

Rows 3 to 16 reveal the concentration, in 1980, of oil and gas production in Alberta. Total shipments were $14.45 billion from Alberta, and $2.63 billion from the Rest-of-Canada (rows 3, 6, 7).

Comparing these figures with rows 8 and 9, we see that only a small proportion of revenues are needed to pay production costs (about 6.5 per cent in Alberta), leaving substantial 'rents' to be divided up between shareholders and governments. The size of these rents, from 1981 onwards will be looked at in section 3 below.

The other major energy source -- electricity -- is produced in the two regions approximately in proportion to their relative population sizes (row 17).

In total, including 'alternative' energy (see row 21) value added in the energy sector was $13.2 billion in Alberta (one third of GDP), and $9.1 billion (3.6 per cent of GDP) in the other regions of Canada. That is, energy value added is almost ten times larger as a proportion of total GDP in Alberta than it is, on average, in the rest of the country.

These figures give us a feel for the order of magnitude of the energy and non-energy sectors in our two regions in 1980. We will not here comment on the other rows of Appendix C, which document the more detailed information needed for the model solution.

2. Exogenous Variables

Exogenous variables are those whose values are determined 'outside' the model. Along with the other 'givens' -- the equation specifications and the values of coefficients in the equations -- exogenous variables determine the values that will be generated for the endogenous variables that will be the output of our simulations.

Different sets of exogenous variables, and/or equation specifications and coefficient values, represent different 'scenarios' which will generate different values for the endogenous variables.

Three sources of exogeneity are distinguished in the model: (a) events outside Canada; (b) 'states of nature' within Canada, and (c) Canadian governments' policy. We deal with each in turn:

(a) The Model needs only one purely exogenous variable from the rest of the world -- the world price of oil -- and two which are, in effect, exogenous -- the world prices of reproducibles; (a) competing with Canadian exports, and

(b) imported into Canada. These two variables are specified by exponential trend equations to change at given annual rates (see Block 7 in Appendix A).

That is, apart from the effects of these world prices, everything in the model is determined by events within Canada. This is in keeping with our long-run focus. Over the twenty-year simulation period, we expect events such as the cyclical condition of the U.S economy to average-out, leaving only the fundamentals of growth --- the effects on prices of depletion of natural resources and technological change -- as factors permanently altering the economic environment within which Canada finds itself.

The base-case forecasts for world reproducibles prices were discussed in the previous chapter. For the world price of oil, we go a little higher than the most recent 'official' forecast of the Federal government, as revealed in the May 1982 Update to the National Energy Program. There it was:

> "assumed that world prices will remain constant in nominal terms until the end of 1983, and then rise 2 per cent a year in real terms" (p. 12).

Of course, as the Update notes, 'a large band of uncertainty must clearly surround any forecast' (loc. cit.).

The series for PWOIL -- the world price of oil -- used in the base-case simulation is listed on the second page of Appendix D. For simplicity, PWOIL is held constant at its 1979 value (which was 2.3 times the 1980 domestic Canadian price to which oil prices are indexed) until 1983, even though this implies a rising nominal price, given some inflation in other prices over this period.

After 1983, PWOIL is increased by 0.05 each year, which is close to a percentage rate of 2 per cent.[1] In our base-case we have the world price of reproducibles competing with Canada's reproducibles exports (our numeraire) constant, and the world price of reproducibles imported into Canada falling at 1 per cent a year. Since a reasonable deflator for the world oil price would probably move somewhere between these two reproducibles price indexes, our 2 per cent per year increase in the oil price index implies a somewhat larger (between 2 and 3 per cent) increase in the real world oil price.

(b) There are 27 explicit policy variables in the model, most concerned with energy prices in Canada. There is not always a significant distinction between these variables and the coefficients in the model, since, as noted in Chapter III, some of the latter are assumed to be accessible to policy intervention.[2]

Base-case values for the explicit policy variables are listed on page one of Appendix D. We discuss them in turn:

POL01 measures immigration into Canada, which is taken to be policy-constrained (i.e., no shortage of willing immigrants). Statistics Canada forecast as a 'reasonable range' for immigration 125,000 - 175,000 each year, so we use here the average of these numbers -- 150,000 or 0.15 million. This variable appears in the FMIG equation in Block 1.

POL02 and POL06 concern 'frontier' oil production, off the East Coast of Canada, and in the Beaufort Sea. As the NEB's figures reveal (p. 142), there is a lot of uncertainty about the potential of the frontier regions. The numbers used in the model assume that it requires five years of annual expenditure of $1 billion to develop the frontier fields to yield five subsequent years of production at an annual rate of $1 billion (in 1980 prices of about $15/barrel). Capital expenditures are assumed to be undertaken (POL06) such that frontier production begins at $1 billion a year in 1986 and is increased thereafter by $1 billion every five years (POL02).

Both capital cost and production forecasts seem pessimistic compared with those offered in submissions to the NEB (pp. 141-4). These variables appear in Block 2 of the model.

POL05 measures investment in Alberta oilsands megaprojects. No such projects are now scheduled, and so POL05 is set to zero throughout. However, production from oilsands is expected to increase, from its 1980 value of $0.77 billion, by about $100 million a year (POL10), as the necessary incentives are offered to effect the expansion of the two existing plants and/or the addition of new, relatively small-scale plants.

As discussed in Chapter III, the path of capital expenditures associated with relatively small scale investments is assumed sufficiently 'smooth' to be added-in with operating costs to the category of energy sector expenditures on the output of the reproducibles sector (see Block 5).

POL04 measures Rest-of-Canada electricity output. The provincial utilities are assumed to add $100 million of real (1980 prices) capacity each year, resulting in a 25 per cent increase in total capacity by the year 2000. These additions to capacity are less than those expected by the NEB, who project a 67 per cent increase (Table 13-4, p. 191). The demand forecasts in the model turn out to be lower than those made by the NEB (cf. section 3 below), and supply additions were therefore reduced from the NEB forecasts to avoid making implausibly heavy demands on the absorptive capacity of the export market in the U.S.

The variables POL07 and POL08 determine the proportion of income that is saved outside the energy sector, in Alberta and RoC. In the base-case, both are set equal to the 1980 savings/income ratio for Canada — 0.23. See the discussion of Block 8, in chapter III, for further detail.

Policy variables 11 through 24 are used in the formulae for retail energy prices in Block 2 of the model. The base-case values embody the following assumptions:

(i) all retail prices are the same in Alberta and RoC;

(ii) electricity retail prices are increased every year, regardless of other prices;

(iii) oil and gas retail prices increase in fixed steps until 1988. Thereafter they follow movements in the world price of oil.

These paths for retail energy prices are consistent with the NEB's forecasts of the implications of the National Energy Policy (Table 4-4, p. 23).

'Supply' prices of energy -- the prices received by producers — differ from retail prices -- the prices paid by customers -- for oil and gas. Under the National Energy Program, the price of 'old' oil (see Chapter III, Block 2, for explanation) rises in steps until it reaches 75 per cent of the world price, whereas 'new' oil receives, in effect, the full world price, under the September

1981 Agreement between the Federal and Albertan governments. Natural gas prices are to be increased by fixed amounts under the Agreement, but presumably will not be allowed to exceed world prices. It is here assumed that the ceiling on gas prices is reached when they reach the same proportion of the world oil price that they were of domestic oil prices in 1980.

Policy variables 25 through 30 reflect these assumptions.

(c) Assumptions about 'states of nature' are needed to set values for recoverable reserves, of oil and gas. As noted, in Chapter III (Block 2), these are specified in the model as fixed numbers, rather than as economic variables. The reserve figures chosen are shown on page 3 of Appendix D. These are estimates of recoverable reserves as at the end of 1980, and are deduced from NEB data. For more information, see the notes on rows 44 to 46 in Appendix C.

3. The Base-Case Simulation

We have now fully described all aspects of the RD1.4 model, and can move on to using it. In this section we will examine in detail the simulation of the base-case scenario.

The simulation is run from 1981 to the year 2000. Results are shown for each variable, in the order in which they are solved, Appendix D. We look in turn at each block of variables.

BLOCK 1: POPULATION, LABOUR FORCE, AND WAGE RATES

The Alberta wage begins higher than the RoC wage and remains so, but the differential is reduced by the year 2000 (see RELWAGAB). This is because the income differential between Alberta and RoC declines over the simulation period, as we shall see (Block 11).

Emigration from Canada (EMIG) is a constant proportion of population, and so increases slowly to 83,000 per year by 2000. Net foreign migration into Canada (FMIG) is the difference between immigration -- a policy variable (= 150,000 p.a.) -- and emigration. Income differentials determine the number of net migrants who go to Alberta (FMIGA); the remainder, of course, end up in RoC (FMIGB).

(Net) interprovincial migration to Alberta (IMIGA) is also determined by income differentials, and declines from about 50,000 to just over 16,000 a year.

The total 'stock' of 'new Albertans', NMIGA, equals nearly 900,000 by 2000. The stock of 'original' (pre-1981) Albertans increases at a more modest rate through natural population growth, from 2.08 to 2.3 million (POPAO), so that the total population of Alberta grows by nearly 50 per cent in twenty years, to 3.1 million (POPA).

In-migration to Alberta is larger in our base case than forecast by Schweitzer from his econometric model (1982, p. 148). The differences are due, not to substantive disagreement in the size of the elasticities determining migration flows, but in the faster depletion rates of low-cost oil and gas sources assumed by Schweitzer, which reduces provincial product in Alberta, and thus discourages economically-induced migration into the province.

As well, Schweitzer forecasts substantial increses in unemployment rate in Alberta, whereas the THESIS RD1.4 model, in keeping with its deliberately long-term, neoclassical structure, has employment rates maintained quite close to 'natural' levels.

Differences in the numbers produced by different models examining similar questions are interesting and useful in the information they yield on the consequences of differences in assumptions about how the economy operates, and about values of exogenous factors. As well, though, differences demonstrate the dangers of taking seriously the output of any model attempting to forecast far into the future.

It is for this reason that we have emphasized that the role of our base case is not as a generator of unconditional forecasts, but as a reference solution against which the consequences of differing assumptions can be set out.

It may also be noted that in his most recent simulation, with a more 'optimistic' oil and gas output scenario, Schweitzer's model gives figures of up to half a million more migrants to Alberta by the year 2000 (see Schweitzer, 1983, Table 7-1); close to our base case scenario.

The population of RoC (POPB) grows much more slowly, by about 13 per cent, so that the total population of Canada (POP) increases from almost 24 million in 1980, to almost 28 million in the year 2000.

The employed labour forces of the two regions (LATOT, LBTOT) grow in proportion with population, with the qualification that higher Alberta wages induce some unemployment (above the 1980 reference level), which declines over the period to 8,000, or about 0.6 per cent of the Alberta labour force.

BLOCK 2: PRICES AND ENERGY SUPPLY

The first nine variables in Block 2 are energy prices determined by exogenous policy variables as described in section 2 of this chapter, and by the exchange rate. Since, as we shall see, the $Canadian appreciates, domestic energy prices do not increase much after 1990. The prices of 'alternative' energy are determined as weighted averages of oil, gas, and electricity prices, with the weights begin (lagged) shares of each energy source in total use. The share variables are listed in Block 4.

Accordingly, alternative energy prices (PAALT, PBALT), and thus the retail price indexes of all energy (RPAENT, RPBENT) increase by about 150 per cent in Alberta, and 160 per cent in RoC by the year 2000. The difference reflects the greater share electricity is of consumption in RoC and the (probably unrealistic) assumption that electricity prices will be increased steadily whatever the prices of other energy sources.

The upward progress of energy prices is broken by a fall between 1987 and 1988, when the pricing formulae switch to parity with the world price. This overshooting of the formulae is the result of the appreciation of the $Canadian (see Block 7, below), which causes the domestic value of imported oil to be less than forecast in the Alberta-Federal agreement. In a more expensive model, we could insert an "IF" statement preventing domestic prices from exceeding the Canadian currency value of the world price.

Reproducibles price indices, for simplicity assumed the same in Alberta and RoC, decline under the influence of the assumed 1 per cent per year rate of technical progress, with this partially countered by increases in the price of the energy input (PREP, PAREP, PBREP).

Turning to energy production, we see that Alberta production of 'old' oil (XAOOIL) declines from $5.2 billion to $0.4 billion over twenty years (in constant 1980 prices); in the Rest of Canada a peak of $4.0 billion is reached in 1990 (XANOIL, XBOIL).

Depletion leaves nearly one half of 1980 reserves still in the ground in Alberta after twenty years (RESANOIL), but almost wipes-out RoC reserves (RESBOIL). Recall that the latter include only non-frontier reserves -- East Coast and Beaufort Sea extraction is specified as policy-determined, and the reserves therein so large (though costly to tap) that depletion is not likely to significantly affect supply by the year 2000.

As noted in section 2 above, oilsands production is increased exogenously over the period (XASOIL). The total of 'old', 'new', and oilsands production in Alberta (XAOIL) peaks in 1986, and thereafter declines quite slowly to about 70 per cent of 1980 levels in 2000.

Combining Alberta and RoC oil production (XAOIL and XBOIL) gives a figure for all-Canada very little changed in the year 2000 from its 1980 value. This falls within the range of the NEB's 'base-case' and 'modified base-case' forecasts (p. 150, figure 10-34).

If we use the ratio of 1980 production to reserves as an index, natural gas is much more plentiful than (non-frontier) oil in Canada. Accordingly, Alberta gas production (including liquified petroleum gases) nearly doubles in response to higher prices, before the depletion effect induces some decline in output, and is about 24 per cent above 1980 production levels in 2000 (XAGAS), with about 43 per cent of 1980 reserves remaining.

Gas production in RoC, which starts from a smaller base, relative to reserves, increases more than three-fold by 1990, before beginning a decline (XBGAS). About 15 per cent of 1980 reserves remain after twenty years (RESBGAS).

Thus, total gas production about doubles at its peak, and remains well above 1980 levels in this base-case simulation. NEB forecasts of supply of gas from conventional areas run at about half these figures (p. 172, figure 11-13); the discrepancy could be made up by 'frontier' gas production, (although the NEB was exceptionally cautious in its assessment of the gas potential of frontier areas (pp. 173-177)).

Alberta electricity production (XAELEC) is about the same at the end of the simulation as in 1980. RoC output (XBELEC) is policy-determined, as discussed in section 2 above.

Under the stimulus of higher prices, and a 2 per cent annual rate of technical progress, alternative energy production increases six-fold by 2000. These large increases demonstrate the power of exponential growth and elastic supply responses, and rather imply that more effort should have been directed towards assembling accurate initial 1980 data (the $1 billion figure for total 1980 production was chosen arbitrarily) since changes in the 1980 number will be proportionately reflected in changes in the figures for the end of the simulation period.

As it stands, total alternative energy production (XALT) is more than one quarter of total oil and gas production (XOILGAS), and about 16 per cent of total energy production (XENT), by the year 2000.

BLOCK 3: INPUTS OF ENERGY

Energy is either exported, used as intermediate input in the reproducibles sector, or consumed by households, in the model.[3] Block 3 deals with intermediate input use. This is related negatively to energy prices, and positively to the size of the reproducibles sector.

For total intermediate energy use (ENTAREP, ENTBREP) we see that the price effect dominates for the first decade, lowering average energy/output ratios, but that, thereafter, the size effect begins to increase total use; eventually to nearly 1980 level, for all-Canada.

This change is less than the NEB's 'middle case' forecast, which is for total intermediate use at around 60 per cent higher levels in 2000 than in 1980, but this is based on forecast real GNP growth of 3.2 per cent a year, whereas reproducibles output in the present model will turn out to grow at an annual rate of 1.8 per cent (cf. NEB, pp. 29, 31).

The sudden increase in consumption between 1988 and 1989 is due to the previous year's fall in energy prices (see Block 2 above). In a model with a shorter-term focus than RD1.4, we would probably wish to smooth-out the consumption path.

The increasing supply of 'alternative' energy, of which one-half is assumed to end up as intermediate input (ALTAREP, ALTBREP), reduces the combined intermediate demand for oil, gas, and electricity below its 1980 level in RoC and in Alberta. The market shares of these energy sources are not constant in the model, and the net result is a fall in the demand for oil and electricity, in Alberta and in RoC, a fall in demand for gas in RoC, and an increase in the demand for gas in Alberta. NEB forecasts an increase in the demand for electricity (p. 28), although their figures are not directly comparable with this model's, since they are built on a considerably higher forecast for total energy demand, as noted above.

BLOCK 4: ENERGY INPUTS TO HOUSEHOLDS

Energy used in Canada is divided between the reproducibles sector (Block 3), and 'household' or 'final' consumption. In both cases, a demand function is used to specify total-energy use, and this is then divided-up between the various energy sources using exogenous market share formulae.

Total energy demand is related negatively to price and positively to income. Price effects dominate until in 1989, when there is a sudden jump, due to the previous year's fall in price (see Block 2); thereafter, increased incomes tend to outweigh higher prices, so that consumption by 2000 is 25 per cent higher in Alberta, and 11 per cent higher in RoC, than in 1980.

The division of total energy demand between energy types is strongly affected by the growth in availability of alternative energy. Although, in 1980, final consumption is only about 30 per cent of total energy use, it is assumed in the model that 50 per cent of alternative energy ends up as final consumption.

This implies that there are relatively more opportunities to substitute alternative for conventional energy in the household sector.

The result is that, by 2000, 37 per cent of household energy requirements are being met by alternative energy supplies, so that there are reductions in the demand for all other energy sources, except electricity and gas in Alberta.

This switch in the composition of energy demand may be too drastic for a 'base case' scenario. However, it should be recalled that the assumptions made about alternative energy supply in the model do not seem particularly extreme -- a price elasticity of supply of 1.5, and 2 per cent per year technical progress.

Adding together intermediate and final energy demand enables us to calculate the shares of total demand, net of alternative energy, taken by oil, gas and electricity.

These shares are used (lagged) in Block 2 of the model, to calculate energy price indices, and are of interest in themselves. As noted in the discussion of intermediate energy demand (Block 3), the base-case scenario turns out to imply decreasing shares of oil and electricity, and increasing shares of gas. The NEB forecasts an increasing share for electricity (p. 28); the difference is due to the NEB's higher estimate for total energy demand (due, in turn, to a higher forecast of GNP growth), along with the assumption that it will be increases in electricity generating capacity -- both coal-fired and hydro -- that meet the extra demand.

BLOCK 5: TOTAL COSTS AND INPUTS TO THE ENERGY SECTOR

Although total oil and gas output are not much higher in 2000 than in 1980, costs of production increase more than four-fold (CAOILGAS,CBOILGAS). The disaggregated cost data in this block reveals the reason: the switch in production from cheap 'old' oil and gas to high-cost synthetic oil, and oil and gas which is only profitable at energy prices higher than those of 1980.

Costs of alternative energy (COSTAALT, COSTBALT) also rise more than proportionately with real output, as higher marginal costs are incurred.

The higher costs are reflected in higher labour requirements for the energy sector, such that, of the 410,000 workers added to the Alberta labour force (cf. LATOT, Block 1), 340,000 - 70 per cent -are absorbed in this sector, leaving only 70,000 available to increase output of reproducibles.

In the Rest-of-Canada economy the energy sector is relatively smaller, so that the increase in its labour requirements does not have such a striking effect, but even so, about 490,000 of the 1 million new workers are required in the energy sector.

Energy sector costs of production are divided between wages and salaries and purchases from the reproducibles sector. In line with the increases in unit costs of producing energy we see that, in total, the quantity of reproducibles absorbed by the energy sector increases nearly four-fold over the simulation period (REPINENT).

These are large numbers, and vividly demonstrate the magnitude of the resource reallocations that would be needed to replace our present relatively low-cost sources of energy supply as these are depleted. The number would be larger still if major oil sands projects were added to the scenario. Some reassessment of energy investment forecasts made by the NEB and others is perhaps called for.

BLOCK 6: REPRODUCIBLES SUPPLY

Despite the relatively larger crowding-out effect of energy in Alberta (noted in Block 5), the growth in that province's population is sufficiently large for the increase of LAREP to be proportionately larger than that of LBREP -- 22 per cent compared to 8.0 per cent.

Reproducibles value added increases with technical progress and with the increased availability of capital and labour.[4] Since the reproducibles labour force increases proportionately more in Alberta than in RoC, so too does reproducibles output. However, the difference in output growth rates is more than the difference in labour input growth, implying that labour productivity (XAREP/LAREP;XBREP/LBREP) grows less in ROC than in Alberta over the period.

BLOCK 7: OTHER PRICES AND EXCHANGE RATE

With domestic energy supply and demand available from earlier blocks of the model, we are able now to calculate trade balances for the various energy types.

The oil deficit (NEXOIL) is eliminated by 1984, and then trade remains in surplus, trailing-off from a peak of more than \$3.5 billion (in domestic 1980 prices) in 1988.

Natural gas exports increase four-fold to a peak of \$15.6 billion in 1988 before depletion and increased domestic demand begin to dominate the effect of higher prices. However, by 2000, gas exports are still well above their initial levels.

RoC electricity exports increase through the simulation period to \$4.42 billion in the year 2000.

The net effect is that the total energy trade balance, in surplus throughout, peaks at \$22.6 billion in 1988, and subsequently remains above \$10 billion.

Our energy export figures are more 'optimistic' than those of the NEB and its submittors. They expected 'self-sufficiency' in oil to not be achieved before the 1990s, if at all (cf. NEB, figure 16-4, p. 208).

Our scenario differs (a) on the demand side, with slightly lower domestic oil requirements in the 1980s due to lower GNP growth forecasts; and (b) on the supply side, with increases in oil output instead of decreases over the first years of the simulation in response to the higher energy prices paid to producers after the September 1981 'Agreement', and the May 1982 National Energy Program 'update'.

Our natural gas net export figure also differs from that of the NEB, who have exports peaking in 1982, and being virtually eliminated by 1990 (p. 218). The significant difference is on the supply side -- the supply elasticities in our model imply gas production, at its 1987 peak, at more than twice the 1980 rate, in response to the higher prices to be paid under the energy pricing agreements.

Electricity exports are larger than forecast by the NEB (p. 223), probably because of their higher domestic demand forecasts, noted above (Blocks 3, 9).

Valued at world prices, this energy trade surplus is big enough to require a substantial appreciation of the Canadian dollar such that, by the year 2000, EXCH is about three quarters of its 1980 value.

Though we are not much concerned with year-to-year fluctuations, we may note that our exchange rate adjustment formulae appears reasonably successful in avoiding large cumulations in balance of payments surpluses or deficits (CUMBOP).

The appreciation of the exchange rate results in the price in world markets of Canadian reproducibles exports (PEXREP) increasing relative to the numeraire PWEXREP (the price of reproducibles competing with Canadian exports). For the same reason, the landed price of reproducibles imports, PIMREP, falls relative to their price in foreign currency (PWIMREP).

The opposing effects of a fall in the domestic reproducibles price index, and an increase in domestic energy prices (PREP, RPENT: Block 2) approximately balance-out in the formulae for the GNP price deflator, PY.

BLOCK 8: REPRODUCIBLES INPUTS TO CAPITAL FORMATION

Savings increase with income (SAVINGA, B), while investment in the reproducibles sectors, after allowance for depreciation, (NIREPA, B), falls off with the nearly two-fold increase in the real capital stock (KAREP, KBREP) which reduces the differential between the marginal product of capital and the world interest rate (IRWORLD). As a result capital outflows (NFCFA, B), the difference between savings and gross investment, increase substantially through the simulation.

The investment specification (see Block 8) performs quite sensibly, with net investment stabilizing in the second half of the simulation after a minimum level marginal product of capital (MPKREPA, B) is attained. Both investment and the marginal product of capital begin a slow increase in the second half of the simulation as growth in reproducibles shows greater gains due to increased labour supply from energy. Consequently, the rate of growth of net capital outflows is reduced substantially from the first half of the simulation.

BLOCK 9: REALIZED DOMESTIC RENTS

This block of the model calculates 'realized rents' -- the difference between producers' revenues and costs of production -- and divides them between governments and industry.

The first ten variables in Block 9 measure rents generated; the remaining twelve establish the distribution of these rents.

Oil, gas, and alternative energy rents generated rise with higher prices, and fall, in the cases of oil and gas, with eventual lowering of production levels due to depletion. Electricity prices increase continuously in the simulation, so that electricity rents increase, too.

Electricity and alternative energy rents are assumed to be captured within the region in which they are generated, but there are, of course, elaborate and contentious procedures for reallocating oil and gas rents. This industry is also substantially foreign-owned, so that some rents flow out of Canada.

The formulae for allocating rents were described in the previous chapter. The net result is that Alberta receives about $10 billion in energy rents in 1981, increasing to $15.7 billion by 2000 (RATRES).

The Rest-of-Canada gets more than $16 billion in 1981, and triples this to $50.0 billion by the year 2000 (RBTRES). The largest single component of RoC rents in 1981 is its share of Alberta oil and gas rents (RGBAOILG, RIBAOILG), but by 2000, this is more than matched by rents generated in RoC's own oil and gas industries (RGBBOILG, RIBBOILG). Most of the increase in RBTRES comes from increases in electricity rents (RBELEC).

The magnitude of these rents will be put into perspective in the next chapter, when one of the alternative scenarios discussed will assume no difference between world and domestic oil prices in 1980 and thereafter.

Recall that 'realized rents' do not include additional revenues earned by the export of energy at prices higher than domestic selling prices. These revenues are included in regional incomes (Block 11, below)

BLOCK 10: BALANCE OF TRADE AND PAYMENTS

The demand-side effect of an appreciating $Canadian tends to reduce reproducibles exports, whereas they are increased by the supply-side effect of an expanding reproducibles sector. After some fluctuations due to fluctuations in the exchange rate, the growth in reproducibles dominates, so that real exports in 2000 are more than $10 billion higher than their 1980 level.

On the other side of the current account, we have price and income effects operating in the same direction, with a combined impact on imports that leaves them at more than double their 1980 level, in 1980 prices.

The result is a large deficit in the balance of reproducibles trade which is made possible, of course, by the surplus in the energy account and the resulting improvement in Canada's terms of trade reflected in the appreciation of its currency.

What has happened is that Canada, by increasing its exportable surplus of the one commodity for which there is a perfectly elastic world demand -- energy, is able to extract monopoly rents from its exports of reproducibles, for which price elasticities are non-infinite. It should be re-emphasized that our reproducibles export price elasticity was conservatively set at -2.0 -- more elastic than the available econometric estimates. Lower elasticity numbers would generate larger monopoly rents. Important terms of trade effects are found in other general equilibrium energy models, such as that of Nordhaus (1980).

The other items in this block are of less importance. As energy rents increase so too do dividend payments to foreign shareholders in the Canadian energy industry (DIVENT). With net capital out-flows growing through the simulation, foreign assets accumulated since 1980 (CUMNFCFA, CUMNFCFB) significantly increase.

The balance of payments (BOP) is kept tolerably close to zero through the simulation, as a consequence of the appreciated exchange rate.

BLOCK 11: INCOMES

In this block, the various sources of income -- wages and salaries, dividends, 'rents' from energy, interprovincial 'equalization' payments -- are aggregated for the residents of each region.

With the increases in both energy and reproducibles output, total income grows in Canada as a whole (Y), and in each region (YA, YB).

Per capita incomes[5] also grow (YPC, YPCA, YPCB), although the increase in Alberta is less than that in the Rest-of-Canada -- 55 per cent compared to 77 per cent over the 1980-2000 period. The difference is due to lower growth in energy rents in Alberta (Block 9).

As a result of the Alberta/RoC income differential declining, but remaining positive, equalization payments in the base-case fall over the simulation period (NEQ).

The base-case scenario assumes that 'new' and 'original' Albertans share equally in energy rents, so that there is no difference in their per capita incomes.

BLOCK 12: REAL CONSUMPTION

Block 12 is the 'bottom line' of the model -- it measures the performance of the regional economies in terms of the energy and reproducibles their inhabitants are able to consume.

The first column, GREPCONR, measures the reproducibles available in Canada for consumption or investment. Thus, it equals reproducibles output less net exports and purchases of reproducibles by the energy sector in constant (1980) prices.

Dividing GREPCONR between the regions according to their incomes, less energy consumption expenditures, and netting-out each region's use of reproducibles for capital formation, we get REPCONRA and REPCONRB -- the quantities of reproducibles absorbed in each region by households (including goods and services provided by government expenditures).

To reproducibles consumption is added final consumption of energy (again, in 1980 prices) to give CONRA and CONRB -- total household consumption of goods and services.

To get indexes of personal welfare, the total available household consumption is divided by the population it is to be shared between.[6] This is quite straightforward for the Rest-of-Canada -- simply divide total consumption by population.

In Alberta, CONRA is divided between 'new' and 'original' Albertans in proportion ot their share in provincial income. As well, the costs incurred by new Albertans in their migration from RoC are subtracted from their share of CONRA.

Thus, we find that per capita consumption of 'original' Albertans, and of RoC inhabitants, rise over the simulation period (CONRPCAO, CONRPCB), approximately in proportion to the increases in per capita incomes (YPCAO, YPCB).

However, for 'new' Albertans, migration costs absorb most of the goods and services available for consumption in 1981, though their per capita effect diminishes over time to a very small fraction of per capita consumption by 2000 (see MIGCOST, CONRPCAN).

The reason for this is that total migration costs are a function of the flow of migrants, which decreases over the period, whereas they are shared between the <u>stock</u> of new Albertans, which, of course, increases over time (see Block 1).

Migration costs are at their largest in the early years, when income differentials and the resulting flows of migrants are largest. For example, the 1981 per capita migration cost of about $7,150 is the result of dividing up total migration costs of $435 million between the 61,000 people who migrated to Alberta from RoC (and from abroad) in 1981. To the extent that migration is subsidized by either sending or receiving region, the distribution of this $435 million should differ from the distribution assumed here; the interesting point, though, is that the size of the costs incurred by income-induced migration is quite significant, representing about 1 per cent of total Alberta income in 1981.[7]

Per capita consumption increases in both regions, and for both 'old' and 'new' Albertans, but at a slower rate in Alberta than in RoC.[8] The reasons are: (a) total energy rents and export revenues grow more in RoC than in Alberta with the depletion of oil and gas and the increased electricity surplus; (b) Alberta's energy rents are spread among substantially increased population due to migration induced by the rents.

Over the long term, the major determinants of increases in real consumption are (a) technical progress in the reproducibles sector, and (b) the increases in reproducibles imports made possible by increases in net energy exports magnified by their terms-of-trade effect on the exchange rate.

Of these determinants, technical progress and terms of trade parameters were chosen cautiously -- technical progress shifts the production function by one per cent a year (below the historical values of most of the post war period), and the demand for reproducible exports is made more elastic than the econometric evidence of Helliwell and McRae, and of Witte, implies.

On the other hand, net energy exports in this base-case scenario are above 'middle-of-the-road' NEB forecasts, due to higher natural gas production and a larger market share of 'alternative' energy sources in our scenario.

We remind the reader that the purpose of this model is not to generate unconditional forecasts, but rather to answer 'what if' questions.

V. THE RESULTS OF OTHER SCENARIOS

1. Introduction

This is the most important chapter of the paper. The assumptions made in the base-case scenario are altered in various ways, and the resulting effects on our simulations to the year 2000 noted.

The scenarios fall into two classes: (a) those modelling the effects of different policy actions; (b) those concerned with the implications of different 'states of the world' -- of the exogenous economic environment differing from the world assumed in the base-case scenario.

Five 'policy' scenarios and five 'state-of-the-world' scenarios were run. The results will be summarized in this chapter on two tables. These contain rows for twenty-nine variables -- first the actual levels in the year 2000 of the base-case solution, and then, for each scenario, the difference between it and the base-case, for each variable in that year.

Clearly it would be impracticable to give results, as was done for the base-case in the previous chapter, for each of the 200 variables in the model, and for each of the 20 years of the simulation period. The 29 variables chosen capture the key features of the results. Where other variables are of interest for particular scenarios, their values are given in the text of the chapter, in which the results of each scenario are discussed in turn. (For a summary of these results, see Chapter I.)

Calling the base-case Scenario 1, the others are:

Scenario 2: 'Made-in-Canada Energy Price' -- Canadian energy prices are held at their 1980 levels throughout the simulation.

Scenario 3: 'Immediate World Price' -- All Canadian energy prices are raised at once (1981) to the world price, and follow the world price thereafter.

Scenario 4: 'No sharing of Rents' -- 'New' Albertans and foreign migrants are not given a share in Alberta's energy rents.

Scenario 5: 'Government Investment in Oil Projects' -- Both Alberta and RoC governments increase investment in oilsands and 'frontier' oil projects.

Scenario 6: 'Province Building' -- Alberta uses its Heritage Fund to accelerate investment in the non-energy ('reproducibles') sector.

Scenario 7: 'No-OPEC' -- It is assumed that the old oil price equals the 1980 domestic Canadian price throughout the period.

Scenario 8: 'Declining World Price' -- The world price of oil falls from its actual 1980 level.

Scenario 9: 'More Elastic Energy Demand' -- The Canadian energy price elasticity of demand is assumed larger than in the base-case.

Scenario 10: 'More Oil and Gas' -- The estimates of Canadian oil and gas reserves are raised substantially.

Scenario 11: 'Pessimistic Gas Conversion' -- It is assumed that Canadians are less responsive than predicted by the NEB to the lower relative price for gas.

Scenarios 2 through 6, model different policies by Canadian governments, and are put together on Table 1 (page 125). Scenarios 7 to 11 capture differences in states of the world, and are on Table 2 (page 126).

There is no particular need to justify these scenarios. Others could, of course, have been chosen, but those shown here do cover an interestingly wide range of policy and environmental alternatives. The results are now discussed in turn.

2. Made-in-Canada Energy Price

In this scenario (shown in column 2 of Table 1), all Canadian energy prices are held constant at their 1980 levels.

Compared with the base-case, under which Canadian prices eventually about triple from 1980, oil and gas reserves are depleted more slowly, leaving more in the ground by 2000. By then, both Alberta and RoC oil and gas output rates are lower than under base-case.

Alternative energy is not subject to depletion, and the effect of the lower price on output is especially marked.

The net effect is that total Canadian energy production, XENT, (which includes a non-price-related electricity production) is about $9.7 billion less, in constant prices, in the year 2000, than under the base-case.

Lower prices stimulate domestic energy demand compared with the base-case. The increase is greater for intermediate demand (ENTAREP, ENTBREP) than for final consumption (ENTACON, ENTBCON). This is because other variables, as we shall see, move in different directions relative to the base-case. Reproducibles output, which affects intermediate demand, is somewhat higher, but personal incomes, which are a factor in the final consumption demand function, are lower.

As a result of the lower prices, energy rents realized in the two regions fall sharply in Alberta (RATRES) to one third of their base-case value; and in RoC to one quarter of their base-case value. The fall is relatively larger in RoC because, electricity rents, which are all generated in RoC, are significantly affected by the scenario, since their prices triple by the year 2000 in the base-case.

Naturally, a fall in supply and an increase in demand entails a reduction in net energy exports. The oil deficit, NEXOIL, falls to nearly $10 billion in domestic 1980 prices (so three times more in world prices), and net exports of natural and liquefied petroleum gases drop from a base-case surplus of $6.6 billion, to a deficit of $4.47 billion again, in 1980 domestic prices. Canada even becomes an importer of electricity (NEXBELEC).

Turning to the reproducibles sector, we see that output increases in both regions (XAREP, XBREP), due (a) to the release of labour and capital from the energy sector, and (b) to the effect on output of higher intermediate energy use encouraged by lower prices.

The total effect is an increase in Canadian reproducibles output of about \$54.7 billion, in 1980 prices, which is partially made up by the sum of the fall in energy output (\$9.7 billion) and the increase in intermediate use (\$12.75 billion), also valued at 1980 prices.

However, national income per capita at market prices is over 9 per cent lower in Alberta (YPCA) and 7 per cent lower in RoC than under the base-case. This is due to the lower energy prices, which lower factor incomes in the energy sector.

Such a fall in market-price incomes does not necessarily imply that Canadians are worse-off, since as well as receiving lower prices for energy as producers, they pay less as consumers. We show these variables because relative Alberta/RoC per capita incomes determine the distribution of real incomes in the model, as they measure the relative spending power of individuals in the two regions.

Thus, the slightly larger percentage fall in Alberta per capita income implies a shift in the distribution of income towards non-Albertans. This, of course, is due to the relatively greater importance played by energy as a source of income in Alberta.

The 'bottom line' of a simulation is its forecast for real per capita consumption -- the final absorption by households of energy and reproducibles measured in 1980 prices.

We see that the 'made-in-Canada' price results in strikingly lower per capita consumption in both regions, compared to the base-case. Per capita annual consumption of both 'new' and 'original' Albertans (CONRPCAO, CONRPCAN) falls to about $9,600 by the year 2000 -- 30 per cent less than base-case consumption in 2000.

RoC per capita consumption (CONRPCB) is about 28 per cent lower then than in the base-case.

The difference in the year 2000 between this simulation and the base-case is explained by differences in trade balances. Under the base-case, Canada is a net energy exporter in 2000, earning a surplus of about $11.7 billion which is used to finance a reproducibles sector trade deficit. With the 'made-in-Canada' prices, Canada has an energy trade deficit of about $17 billion in 1980 prices, which is about $54.4 billion in world market prices in the year 2000. This deficit must be financed by running an offsetting surplus on reproducibles trade -- that is, by exporting reproducibles which otherwise would be available for domestic consumption. The difference between the two scenarios in the real (1980 prices) balance of reproducibles trade in the year 2000 amounts to $156 billion in 1980 prices, or about $128 billion in the prices of the year 2000 (the reproducibles price index falls about 18 per cent over the period due to technological progess at the assumed rate of 0.5 per cent per annum). The discrepancy between differences in energy and reproducibles trade balances is due to a decline in

Canada's terms of trade -- the Canadian dollar must be devalued by about 40 per cent relative to the base-case in order that the large increase needed in reproducibles exports can be sold and imports sufficiently discouraged.

All this is to be blamed on the distortions in the allocation of resources induced by maintaining an internal price structure that doesn't reflect the opportunity cost of energy. Albertan's suffer most, and after twenty years are only a little better-off than residents of the Rest-of-Canada. For Canada as a whole, real consumption levels are over $3500 per head less in the year 2000, compared with the base-case, as a result of the energy pricing policy. Instead of being a period of moderate growth, the two decades from 1980 see Canadian standards of living decline. Against this, remaining reserves of oil and gas are nearly $191 billion in 1980 prices, or around $611 billion in the world prices of 2000, compared with the base-case. The difference in oil and gas production costs between the two scenarios is $280 billion so that total rents 'still in the ground' equal $330 billion -- nearly $12,000 per Canadian, or $1,200 a year at a 10 per cent rate of return.

We look finally at the demographic implications of the scenario. The decline in relative per capita incomes noted above results in about 220,000 people who have migrated to Alberta (or been born to migrants) staying in the Rest-of-Canada.

3. Immediate World Price

Under this scenario (column 3, Table 1) all Canadian energy prices are set immediately (in 1981) at the world price and maintain parity thereafter.

This makes no difference to oil production, since this either declines exogenously (Alberta 'old' oil), or is given the world price in the base-case (Alberta 'new' oil; RoC oil).

Natural gas prices rise more rapidly than in the base-case, encouraging extra production in the earlier years of the simulation; so depleting reserves more rapidly. However, the exchange rate appreciation midway through the period reduces the price effect, reducing this reserve depletion. The net effect by year 2000 is slightly lower gas production in both Alberta and RoC (XAGAS, XBGAS) as compared to the base-case.

Alternative energy output, with no reserves to deplete, is about 11 per cent lower in 2000 than in the base-case (XALT) under the effect of the appreciated exchange rate. Electricity output (not shown) is exogenous and unchanging: in total, Canadian energy output (XENT) is $1.2 billion less than the base-case by 2000 due to reserve depletion from higher production in the early years and due to the price effect of the appreciated exchange rate.

The higher prices initially discourage both intermediate use and final consumption in Alberta and RoC relative to the base-case (ENTAREP, ENTBREP, ENTACON, ENTBCON), with the price-effect reduced by increases in personal incomes.

The net effect of the lower prices from the appreciated dollar on supply and demand in year 2000, compared to the base-case, is lower energy net exports, of oil, gas, and electricity (NEXOIL, NEXGAS, NEXBELEC).

Reproducibles output (XAREP, XBREP) is higher in both Alberta and RoC. The Alberta increase comes about from a larger labour force in that province (see below) and because of the change in the relative reproducibles/energy prices as compared to the early years. The RoC labour force is smaller than in base-case so that the increase in the amount of labour in reproducibles comes completely from the energy sector thanks to the relative price change.

Higher prices paid for electricity and alternative energy initially increase per capital incomes, especially in the Rest-of-Canada (YPCA, YPCB), but the revalued dollar results in incomes slightly below base levels by 2000.

Finally, real per capita consumption is up nearly $300 by the year 2000 as compared to the base case. This gain can be attributed to the valuation of energy resources at their opportunity cost -- the world price of oil. Reducing this consumption gain is the higher costs of energy production from more rapid depletion. No attempt is made here to unravel an efficient depletion path, which will depend on the path of the world oil price. If, for example, this is expected to increase at a rate faster than the real rate of return available in the reproducibles sector, it would probably be efficient to set consumption prices higher, and supply prices lower, than the world price in the early years of the depletion period.

Exploring these matters would be a useful task for further research.

Looking finally at the demographic variables, we note an increase, relative to the base-case, of 67,000 in the 'stock' of new Albertans encouraged to migrate in the early and middle years of the simulation when relative Alberta/RoC per capita incomes were higher than in the base-case.

4. No Sharing of Alberta Rents with Migrants

This scenario has 'new' Albertans (those arriving after 1980) excluded from sharing in Alberta's energy rents. It is assumed that this would result in to net inter-regional migration between Alberta and RoC, and a share of foreign migrants equal to Alberta's share in total Canadian population.

'New' Albertans (all from abroad) are over $3,000 per head worse off (CONRPCAN). This is under the probably unrealistic assumption that these people receive no energy rents at all. Old Albertans having more rents to consume are nearly $1000 per capita better off by year 2000.

Per capita consumption in RoC is slightly lower than under the base-case, with some dilution of RoC energy rents and a lower capital/labour ratio in reproducibles due to the larger population.

This scenario gives an estimate of the loss to 'original'Albertans from making their province's share in energy rents available without discrimination to migrants, as in the base-case.

5. More Investment in Oilsands

In the base-case it is assumed that Alberta oilsands output increases by $100 million each year (in 1980 domestic oil prices of around $16/barrel).

In this scenario, the annual increase is doubled, to $200 million. As in the base-case, the increments to oilsands capacity are assumed to occur 'smoothly' enough for the necessary investment expenditures to be modelled as a constant proportion of total annual costs.

These costs are set on the assumption that, at 1980 World prices, there are no rents from oilsands production. Rents do emerge in later years of the simulation, given our assumption of a slowly increasing World oil price, but they do not become a major component of revenues.

Nevertheless, the additional oilsands output has a substantial effect on real incomes. Per capita consumption in Alberta falls by $200 or more, and in the rest of Canada, increases by $170 by 2000.

Thus, the net effect of the extra oilsands output is an increase in Canadian standards of living - worth about $3 billion in 1980 prices, or one per cent of total real consumption in the year 2000.

This is a large impact for an essentially 'micro' activity and demonstrates again the power of the terms-of-trade effect - of the benefits from producing more of a commodity that can be sold internationally at a given prices and thus being able to move up the demand curve for other exportable goods. Table 1 reveals that the exchange rate appreciates by 3 points - about four per cent of the base-case level - in scenario five. This allows Canada to import $1.8 billion more reproducibles, while exporting $6.5 billion less, and pay for this with only a $1.55 billion income in total energy net exports (all valued at 1980 domestic prices).

The failure of Albertans to benefit, on balance, from this is also due to the terms-of-trade effect. A higher $Canadian means lower energy prices in Canada, which reduces rents accruing to producers of conventional oil and gas. Alberta and RoC producers both lose rents, but the per capita impact is, of course, much larger in Alberta.

6. Province-Building

In this scenario, the Alberta government uses revenues from its Heritage Fund, or from other sources, to induce an increase of 7 per cent of Alberta's income, in the rate of net capital investment in its reproducibles (non-energy) sector. The RoC investment rate is unaffected.

As a result of the higher investment rate, the Alberta reproducibles-sector capital stock is worth $116.0 billion (1980 prices) in the year 2000 -- about 25 per cent more than under the base-case.

The other effects of the scenario are shown in column 6 of Table 1. Oil and gas supply and alternative energy output are not significantly altered, though slightly higher due to the price effect of a slight depreciation of the exchange rate. This is caused by reduced energy exports as a result of a larger demand for intermediate energy in the Alberta reproducibles sector (ENTAREP). Energy rents are virtually unchanged (RATRES, RBTRES). The higher level of activity in the Alberta reproducibles sector (XAREP) increases intermediate energy demand (ENTAREP) by $170 million. RoC intermediate demand (ENTBREP) is reduced, because of lower reproducibles output in RoC (XBREP).

Does the higher investment pay-off? We see that per capita consumption of Albertans is just under $100 a year less by 2000 than under the base-case (CONRPCAO, CONRPCAN). Residents of RoC are better off by about $50 by 2000.

Thus the higher Alberta rate does not deliver higher consumption levels within the time frame of our simulations.

The results of this scenario suggest that it could be worthwhile looking at investment rates <u>lower</u> than that of the base-case.

The latter was chosen to match the actual 1980 investment/output ratio, but this could be inappropriate for the next decades, if the assumption is valid of a rate of technical progress that is lower than those apparently experienced in the 'high-growth' years up to the early 1970s. Some theoretical work on optimal investment rates (integrated with an examination of optimal resource depletion — see scenario 3 above) might be useful here.

7. No OPEC

Assume that the world oil price equalled the 1980 domestic Canadian price throughout the simulation period ($15-$16/barrel). This might correspond to what would have happened had OPEC been unable to enforce its second large price increase following the 1979 Iranian revolution.

Comparing the results of this scenario (Table 2, column 2) with the base-case simulation will give us an idea of the value of the 'resource boom' to Alberta and Canada.

We see (Table 2, column 2) that the lower prices result in a lower time path of energy output, so that, by the end of the simulation period, reserves of oil and gas are higher than under the base-case.

With lower prices and output, energy rents are much smaller than under the base-case (RATRES, RBTRES). Energy demand, of course, is stimulated by the lower prices, and, in total, is 32 per cent higher in 2000 then in the base-case (ENTAREP, ENTBREP, ENTACON, ENTBCON).

With higher demand and lower supply, net energy exports are less by $16.7 billion in 2000. This must be paid for by an increase in the reproducibles trade balance. The additional reproducibles output resulting from diversion of labour from energy production totals \$35.28 billion (XAREP + XBREP).

Of course, remaining reserves of oil and gas are much higher than in the base-case -- \$371 billion against \$201.9 billion, in 1980 prices. But the base-case reserves are worth much more, given the higher world price under this scenario. Valued at the year 2000 price (3.2 x \$16), for example, base-case reserves are worth \$646.14 billion whereas under the No-OPEC scenario the price remains unchanged at the 1980 Canadian price. The difference in value is worth nearly \$10,000 per Canadian, less costs of extraction.

These numbers are our estimates of the value of the OPEC 'resource boom', subject, of course, to the plausibility of our assumptions about the difference in energy prices that is due to OPEC (or to other exogenous events affecting the world oil market).

The next scenario offers another world price path.

8. Declining World Oil Price

In this scenario (Table 2, column 3), the world price of oil falls from its actual 1980 value of 2.3 (the multiple of the 1980 domestic Canadian price) by 0.05 each year; so reaching 1.25 by 2000.

The scenario falls between the base-case and the 'No-OPEC' scenario discussed above, and so, too, do most of the results of the simulation to the year 2000. However one interesting detail is that per capita consumption levels are at least

$360 per capita lower than the NO OPEC and the base-case. This is explained by the higher depletion rates earlier on in the simulation which raise costs relative to the NO OPEC scenario. Per capita consumption is lower than the base-case thanks to the rent reducing effect of the declining world price.

9. Energy Demand More Price Elastic

In the base-case, the price elasticity of demand for total energy is set at -0.5, in both regions, and in intermediate and final consumption use.

It is of interest to examine the implications of more elastic demand, given the surprisingly large savings in energy use that have apparently been realized in Canada and the U.S. following the 1980 oil price shock.

In the present scenario, a figure of -1.0 is used for the price elasticity of demand.

This makes a slight difference to oil and gas production as oil and gas exports do not completely offset the reduction in domestic demand, and little difference to electricity and alternative energy output,[3] but has a striking impact on the rest of the economy.

Total Canadian energy use is reduced to less than 60 per cent of its base-case level in 2000 (ENTAREP, ENTBREP, ENTACON, ENTBCON), which enables increases in net exports of energy.

The increase in exports totals $7.37 billion in 1980 domestic Canadian prices, or nearly $23.6 billion valued at world prices in the year 2000. This pays for an increase in reproducibles net imports of about 48 billion, in Canadian prices. The difference between the changes in energy and non-energy trade balances is attributable to a drastic improvement in the terms of trade over the course of the simulation. The Canadian dollar in 2000 is worth about 19 per cent more in terms of foreign currency under the more-elastic-demand scenario.

The effects of this on consumption are quite substantial — per capita consumption levels of 'old' Albertans, 'new' Albertans, and residents of the Rest-of-Canada, all are at least $500 more at the end of the simulation than under the base-case.

This is despite a fall in reproducibles output that exceeds the fall in energy input to this sector,[4] and which approximately accounts for the falls in per capita national income in the two reions (YPCA, YPCB).

It should be noted that we have run this scenario using the NEP forecast for the world price of oil (PWOIL; see pages 83-84). We have not examined the possibility that if Canada's energy demand is more elastic than implied by the base-case, so too may be the energy demands of other nations. In such a world, we would expect to see the world oil price fall below the NEP estimate, in response to the 'large' reduction in oil demanded.

10. Larger Oil and Gas Reserves

Our figures for remaining oil and gas reserves, as of 1980 are, of course, estimates. In this scenario we uncover the implications of these reserves being much larger than is assumed in the base-case.

Specifically, reserves of 'old' oil, of 'new' oil, and of natural gas in Alberta, and reserves of oil and of natural gas, in RoC are all increased by 60 per cent from their base-case levels in 1980. (The corresponding figures for the base-case are 380, 75, 60, 95 and 37.5, $ billions, respectively.) No particular significance is intended for the numbers chosen, other than that they should be large enough to make depletion an insignificant factor in determining energy production rates over the twenty-year simulation period.

The results are shown in column 5 of Table 2. Not surprisingly, vastly higher reserves are beneficial for all Canadians, raising annual per capita consumption in 2000 by over $500 in Alberta, and in RoC.

Examining in detail the implications of the scenario: year 2000 oil and gas output is, of course, much higher than in the base-case with its stronger depletion effect. Reproducibles output is crowded-out by increased activity in the energy sector (XAREP, XBREP), with the effect being relatively stronger in Alberta, not surprisingly.

The higher consumption levels are paid for, as in the more-elastic demand scenario, by higher net exports of energy, though in this case it is just oil and gas exports that increase (NEXOIL, NEXGAS, NEXBELEC).

National income per capita is higher in RoC and lower in Alberta, because the increased activity in the respective energy sectors decreases Alberta reproducibles output (XAREP) by more than 4 times its effect on RoC reproducibles output (XBREP). Consequently there is a lower rate of inter-provincial migration to Alberta, reflected in the population distribution in the year 2000 (NMIGA, POPA, POPB).

11. Slower Gas Conversion

In the base-case it is assumed, in keeping with NEB predictions, that the share of gas in both intermediate and final use will rise during the period 1980-2000, while oil's share will fall. In this scenario we examine the implications of less optimistic conversion rates. Specifically this scenario supposes that oil's share in total intermediate and final use rises by .5 per cent per year while the shares of gas falls by .5 per cent per year.

This change makes very little difference to energy production; total energy production is down by about $40 million. Intermediate and final consumption is similarly unaffected in total but the composition is quite different. Oil inputs (OILAREP, OILBREP, OILACON, OILBCON) rise by 22 per cent while gas inputs (GASAREP, GASBREP, GASACON, GASBCON) fall nearly 26 per cent. The differences between the unchanged production and the rises and falls in domestic demand are made up entirely through the foreign market. Oil net imports rise by nearly $1.7 billion (NEXOIL) while gas net exports rise by $1.34 billion (NEXGAS). Similarly, the shares of rents from energy production (RATRES, RBTRES) are unchanged given that actual domestic production has not changed from the base-case.

Finally per capita consumption is marginally below base-case levels by 2000 on account of the very slight reduction in total energy production (XENT).

Table 1

Scenarios of Different Policies: Year 2000

	1	Differences From Base-Case Solution				
		2	3	4	5	6
	Solution to Base-Case	'Made in Canada' Price	'Immediate' World Price	No Sharing of Rents	Oilsands Investment	Province Building
RESAOIL	33.36	24.09	1.67	.06	0.35	.1
XAOIL	4.79	-.90	.04	-.02	1.86	.02
RESAGAS	150.16	97.76	-4.45	.33	1.50	.09
XAGAS	9.28	-3.80	-.38	-.05	-0.17	.08
RESBOIL	4.25	15.40	.64	.02	-0.25	.05
XBOIL	3.52	.07	.07	0	0.0	.01
RESBGAS	14.58	53.31	-1.10	.19	-0.13	.03
XBGAS	2.41	-1.24	-.23	-.02	-0.04	.04
XALT	6.04	-4.58	-.82	-.05	-0.16	.05
XENT	36.75	-9.72	-1.30	-.47	1.44	.23
ENTAREP	2.71	2.10	.14	-1.35	-0.31	.16
ENTBREP	14.21	10.64	.51	.73	0.18	-.06
ENTACON	1.08	.62	.09	-.34	-0.04	-.02
ENTBCON	7.06	5.54	.63	.27	+0.00	-.03
RATRES	15.69	-10.57	-1.53	-1.01	-0.73	.27
RBTRES	50.04	-37.62	-10.03	-.27	-1.00	.38
EXCH	.75	.29	-.04	-.01	-0.03	0
NEXOIL	.68	-10.48	-.83	.33	1.86	.03
NEXGAS	6.60	-11.07	-1.13	.20	-0.18	.10
NEXBELEC	4.43	7.06	-.65	-.38	-0.13	.04
EXREP	93.33	142.44	-2.75	-2.25	-6.49	1.46
IMREP	185.02	-13.87	11.77	-.59	1.8	-1.02
XAREP	45.73	7.25	1.61	-22.68	-5.64	3.01
XBREP	379.76	47.52	1.77	18.94	1.94	-.24
CONRPCAO	13.75	-4.13	.21	.90	-0.24	-.07
CONRPCAN	13.66	-4.10	.22	-3.15	-0.20	-.07
CONRPCB	12.51	-3.51	.30	-.08	0.17	.05
POPA	3.19	-.22	.06	-1.23	-0.00	-.01
POPB	24.76	.22	-.06	1.22	0.06	.02

Table 2

Scenarios of Different States of the World: Year 2000

	1	2	3	4	5	6
		Differences From Base-Case Solution				
	Solution to Base-Case	No Opec	Declining World Price	More Elastic Energy Demand	Higher Oil & Gas Reserves	Pessimistic Gas Conversion
RESAOIL	33.36	23.57	10.14	2.57	60.48	-.05
XAOIL	4.79	-.90	-.77	-.24	2.33	0
RESAGAS	150.16	83.88	41.90	10.47	209.92	-.16
XAGAS	9.28	-4.01	-3.47	-1.06	2.19	.02
RESBOIL	4.25	15.07	5.24	1.15	14.40	-.02
XBOIL	3.52	.06	-.09	-.02	.70	0
RESBGAS	14.58	46.62	24.51	6.11	46.13	-.09
XBGAS	2.41	-1.32	-1.14	-.28	1.50	0
XALT	6.04	-2.95	-2.54	-.90	-.46	-.02
XENT	36.75	-8.67	-7.62	-2.75	6.19	-.04
ENTAREP	2.71	1.28	1.12	-.90	-.23	-.01
ENTBREP	14.21	4.01	3.32	-6.09	.32	0
ENTACON	1.08	.32	.28	-.39	.01	0
ENTBCON	7.06	2.40	1.95	-2.76	.20	.02
RATRES	15.69	-8.33	-7.76	-4.03	1.34	-.06
RBTRES	50.04	-16.66	-15.30	-5.95	1.19	.08
EXCH	.75	.09	.11	-.15	-.07	0
NEXOIL	.68	-5.42	-4.70	3.44	.95	-1.71
NEXGAS	6.60	-8.15	-6.97	1.09	4.90	1.34
NEXBELEC	4.43	-3.13	-2.61	2.82	.01	.29
EXREP	93.33	48.20	46.27	-38.04	-16.15	.89
IMREP	185.02	2.91	-.90	10.47	8.81	-.14
XAREP	45.73	7.72	7.29	.29	-4.97	-.03
XBREP	379.76	27.56	21.50	-42.16	-.23	.06
CONRPCAO	13.75	-.18	-.60	.66	.42	-.06
CONRPCAN	13.66	-.16	-.58	.65	.43	-.06
CONRPCB	12.51	.10	-.36	.52	.58	-.04
POPA	3.19	-.18	-.10	.02	-.02	0
POPB	24.76	.18	.10	-.02	.03	0

Appendices:

for

"OPEC and the Value of Canada's Energy Resources"

A: Printout of coefficients and equations of THESIS RD1.4B

B: List of Variables in alphabetical order

C: 1980 Database

D: Base-Case solution of model

Appendix A: Printout of Coefficients and Equations of THESIS RD1.4B

```
1                                              S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

NOTE: THE JOB ECC9IE1 HAS BEEN RUN UNDER RELEASE 79.5 OF SAS AT IST (332921).

1           * WE ARE AT VERSION 1.4B ;                                                        00000010
2           OPTIONS NOSOURCE S=72;                                                            00000100

NOTE: DATA SET WORK.PART1 HAS 22 OBSERVATIONS AND 9 VARIABLES. 250 OBS/TRK.
NOTE: THE DATA STATEMENT USED 0.18 SECONDS AND 215K.

NOTE: DATA SET WORK.PART1 HAS 22 OBSERVATIONS AND 9 VARIABLES. 250 OBS/TRK.
NOTE: THE PROCEDURE SORT USED 1.11 SECONDS AND 324K.

NOTE: DATA SET WORK.PART2 HAS 22 OBSERVATIONS AND 8 VARIABLES. 290 OBS/TRK.
NOTE: THE DATA STATEMENT USED 0.04 SECONDS AND 215K.

NOTE: DATA SET WORK.PART2 HAS 22 OBSERVATIONS AND 8 VARIABLES. 290 OBS/TRK.
NOTE: THE PROCEDURE SORT USED 0.12 SECONDS AND 324K.

NOTE: DATA SET WORK.PART3 HAS 22 OBSERVATIONS AND 3 VARIABLES. 690 OBS/TRK.
NOTE: THE DATA STATEMENT USED 0.03 SECONDS AND 216K.

NOTE: DATA SET WORK.PART3 HAS 22 OBSERVATIONS AND 3 VARIABLES. 530 OBS/TRK.
NOTE: THE PROCEDURE SORT USED 0.11 SECONDS AND 324K.

NOTE: DATA SET WORK.INIT HAS 22 OBSERVATIONS AND 18 VARIABLES. 128 OBS/TRK.
NOTE: THE DATA STATEMENT USED 0.06 SECONDS AND 259K.

NOTE: THE PROCEDURE DELETE USED 0.03 SECONDS AND 216K.

58          DATA RECUR;                                                                       00960000
59            SET INIT;                                                                       00970000
60              RETAIN                                                                        00980000
61                C1      1.5                                                                 00990000
62                C2      0.2                                                                 01000000
63                C3      0.25                                                                01010000
64                C4      1.0                                                                 01020000
65                C5      1.5                                                                 01030000
66                C6      0.2                                                                 01040000
67                C7      0.25                                                                01050000
68                C8      1.13                                                                01060000
69                C9      0.5                                                                 01070000
70                C10     0.0                                                                 01080000
71                C11     7.5                                                                 01090000
72                C12     1.0                                                                 01100000
73                C13     0.3                                                                 01110000
74                C14     [illegible]                                                         01120000
75                C15     1.5                                                                 01130000
76                C16     2.0                                                                 01140000
77                C17     0.3                                                                 01150000
78                C18     0.5                                                                 01160000
79                C19     0.043                                                               01170000
```

```
2                                       S T A T I S T I C A L   A N A L Y S I S   S Y S T E M
880      (20   2.2                                                               01180000
881      (21   .0                                                                01190000
882      (22   .0                                                                01200000
883      (23   0.1                                                               01210000
884      (24   1.5                                                               01220000
885      (25   0.9                                                               01230000
886      (26   1.5                                                               01240000
887      (27   0.5                                                               01250000
888      (28   12.5                                                              01260000
889      (29   0.010                                                             01270000
890      (30   0.75                                                              01280000
891      (31   0.25                                                              01290000
892      (32   0.0                                                               01300000
893      (33   12.5                                                              01310000
894      (34   0.75                                                              01320000
895      (35   0.25                                                              01330000
896      (36   0.66                                                              01340000
897      (37   2.0                                                               01350000
898      (38   1.5                                                               01360000
899      (39   0.052                                                             01370000
900      (40   2.0                                                               01380000
901      (41   0.025                                                             01390000
902      (42   0.026                                                             01400000
903      (43   0.02                                                              01410000
904      (44   .0                                                                01420000
905      (45   .0                                                                01430000
906      (46   .0                                                                01440000
907      (47   .0                                                                01450000
908      (48   .0                                                                01460000
909      (49   .0                                                                01470000
910      (50   1.0                                                               01480000
911      (51   .75                                                               01490000
912      (52   .75                                                               01500000
913      (53   -0.9                                                              01510001
914      (54   -0.9                                                              01520001
915      (55   1.6                                                               01530001
916      (56   -0.5                                                              01540001
917      (57   0.04                                                              01550016
918      (58   0.04                                                              01560016
919      (59   0.029                                                             01570000
920      (60   .0                                                                01580000
921      (61   0.029                                                             01590000
922      (62   .0                                                                01600000
923      (63   103.8                                                             01610000
924      (64   946.3                                                             01620000
925      (65   0.25                                                              01630000
926      (66   0.26                                                              01640036
927      (67   0.26                                                              01650036
928      (68   -0.9                                                              01660001
929      (69   -0.9                                                              01670001
930      (70   1.6                                                               01680001
931      (71   -0.5                                                              01690001
932      (72   0.0                                                               01700036
933      (73   .0                                                                01710000
934      (74   0.4                                                               01720000
935      (75   0.4                                                               01730000
936      (76   0.57                                                              01740000
937      (77   0.53                                                              01750000
```

STATISTICAL ANALYSIS SYSTEM

```
C78   0.5
C79   0.5
C80   .0
C81   .0
C82   .0
C83   0.5
C84   0.6
C85   .0
C86   .0
C87   0.25
C88   .0
C89   .0
C90   .0
C91   .0
C92   .0
C93   0.25
C94   0.100
C95   -0.5
C96   1.0
C97   0.054
C98   -0.5
C99   1.0
C100  0.299
C101  0.270
C102  0.47
C103  -0.005
C104  0.5
C105  0.38
C106  -0.005
C107  0.5
C108  .29
C109  .01
C110  .0
C111  0.23
C112  0.01
C113  .0
C114  .0
C115  .0
C116  .0
C117  .0
C118  .0
C119  .0
C120  0.0258
C121  1.0
C122  -0.5
C123  1.0
C124  0.0232
C125  1.0
C126  -0.5
C127  1.0
C128  0.55
C129  -0.005
C130  0.10
C131  0.5[illegible]
C132  -0.005
C133  0.0
C134  .16
C135  0.01
```

4 STATISTICAL ANALYSIS SYSTEM

996	C135	.0	02340000
997	C137	0.15	02350000
998	C138	0.01	02360000
999	C139	.0	02370000
1000	C140	.0	02380000
1001	C141	.0	02390000
1002	C142	-0.5	02400000
1003	C143	.0	02410000
1004	C144	.0	02420000
1005	C145	0.	02430000
1006	C146	0.307	02440000
1007	C147	-[illegible].0	02450000
1008	C148	1.0	02460000
1009	C149	0.0	02470000
1010	C150	0.250	02480000
1011	C151	1.0	02490000
1012	C152	-0.5	02500000
1013	C153	1.0	02510000
1014	C154	-0.01	02520000
1015	C155	0.5	02530000
1016	C156	0.092	02540000
1017	C157	0.06	02550000
1018	C158	0.90	02560028
1019	C159	.0	02570000
1020	C160	.0	02580000
1021	C161	.0	02590000
1022	C162	.0	02600000
1023	C163	0.0	02610000
1024	C164	0.0	02620000
1025	C165	.0	02630000
1026	C166	0.56	02640000
1027	C167	0.05	02650000
1028	C168	.0	02660000
1029	C169	5.0	02670000
1030	C170	0.9	02680000
1031	C171	1.0	02690000
1032	C172	.0	02700000
1033	C173	.0	02710000
1034	C174	0.5	02720000
1035	C175	1.0	02730000
1036	C176	0.5	02740000
1037	C177	0.35	02750000
1038	C178	0.36	02760000
1039	C179	.0	02770000
1040	C180	.0	02780000
1041	C181	0.95	02790000
1042	C182	.0	02800000
1043	C183	.0	02810000
1044	C184	.0	02820000
1045	C185	.0	02830000
1046	C186	0.0	02840000
1047	C187	1.0	02850000
1048	C188	0.009	02860000
1049	C189	0.01	02870000
1050	C190	.0	02880000
1051	C191	.0	02890000
1052	C192	.0	02900000
1053	C193	.0	02910000

```
5                                        S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

1054        C194    .0                                                          02920000
1055        C195    0.0                                                         02930000
1056        C196    0.0                                                         02940000
1057        C197    .0                                                          02950000
1058        C198    1.0                                                         02960000
1059        C199    0.0                                                         02970000
1060        C200    0.295                                                       02980000
1061        C201    1.0                                                         02990000
1062        C202    1.0                                                         03000000
1063        C203    0.035                                                       03010000
1064        C204    .0                                                          03020000
1065        C205    0.076                                                       03030000
1066        C206    2.0                                                         03040000
1067        C207    1.0                                                         03050000
1068        C208    0.42                                                        03060000
1069        C209    0.37                                                        03070000
1070        C210    0.0                                                         03080000
1071        C211    0.0                                                         03090000
1072        C212    0.5                                                         03100000
1073        C213    0.0                                                         03110000
1074        C214    .0                                                          03120000
1075        C215    .0                                                          03130000
1076        C216    1.0                                                         03140000
1077        C217    .0                                                          03150000
1078        C218    .0                                                          03160000
1079        C219    .0                                                          03170000
1080        C220    -1.0                                                        03180000
1081        C221    -1.0                                                        03190000
1082        C222    0.0                                                         03200000
1083        C223    1.0                                                         03210000
1084        C224    1.0                                                         03220000
1085        C225    1980.0                                                      03230000
1086        C226    -0.25                                                       03240000
1087        C227    2.0                                                         03250000
1088        C228    0.25                                                        03260000
1089        C229    .07                                                         03270000
1090        C230    .07                                                         03280000
1091        C231    .0                                                          03290000
1092        C232    0.033                                                       03300000
1093        C233    .0                                                          03310000
1094        C234    .0                                                          03320000
1095        C235    0.053  ;                                                    03330023
1096      OPTIONS MACROGEN ;                                                    03340000
1097                                                                            03350000
3          +                                                                    00000200 1-INPCOEF
4          +    RETAIN                                                          00000300 1-INPCOEF
5          +   RESAGABO 380.                                                    00000400 1-INPCOEF
6          +   RESANUBO 75.                                                     00000500 1-INPCOEF
7          +   RESADOBO 50.                                                     00000600 1-INPCOEF
8          +   RESBSABO 35.                                                     00000700 1-INPCOEF
9          +   RESBOIBC 37.5 ;                                                  00000800 1-INPCOEF
1097                ;                                                           03350000
1098         POL05 = 0. ; POL12 = 0. ;                                          03360000
1099         POL13 = POL11 ;                                                    03370000
1100         POL14 = POL12 ;                                                    03380000
1101         POL17 = POL15 ; POL21 = POL15 ; POL23 = POL15 ;                    03390000
1102         POL18 = POL16 ; POL22 = POL16 ; POL24 = POL16 ;                    03400000
1103         POL27 = 0. ;                                                       03410000
```

```
6                                              S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

3104          POL29 = 1. ;                                                                    03420000
3105          _PWOIL = LAG(PWOIL) ;                                                           03421000
3106        OPTIONS NOMACROGEN ;                                                              03430000
3107        BEGVAL ;                                                                          03440000
3108        OPTIONS MACROGEN ;                                                                03450000
121         *                                                                                 00009200 1-BLOCK1
122         **                                                                      ;         00009300 1-BLOCK1
123         **      BLOCK 1 POPULATION,LABOUR FORCE,AND WAGE RATES     ;                      00009400 1-BLOCK1
124         **                                                                      ;         00009500 1-BLOCK1
125         *       RELWAGA3 = ( _YPCA / _YPCB ) ** C228 ;                                    00009600 1-BLOCK1
126         *       EMIG     = C232 *     _POP   ;                                            00009800 1-BLOCK1
127         *       FMIG     = POL01 - EMIG ;                                                 00009900 1-BLOCK1
128         *       FMIGA    = C216 * (     _POPA   /     _POP    ) * FMIG *                  00010000 1-BLOCK1
129         *                  (     _YPCA   /     _YPCB   ) ** C227 ;                        00010100 1-BLOCK1
130         *       FMIGB    = FMIG - FMIGA ;                                                 00010200 1-BLOCK1
131         *       IMIGA    = C205 *     ( (   _YPCAN   /     _YPCB   ) ** C205              00010300 1-BLOCK1
132         *                  - C207 )  ;                                                    00010400 1-BLOCK1
133         *       NMIGA    =     _NMIGA   * ( C203 + 1.0 ) + IMIGA + FMIGA ;                00010500 1-BLOCK1
134         *       POPAD    =     _POPAD   * ( C203 + 1.0 ) ;                                00010600 1-BLOCK1
135         *       POPA     = POPAD + NMIGA ;                                                00010700 1-BLOCK1
136         *       POPB     =     _POPB   * ( C203 + 1.0 ) - IMIGA + FMIGB ;                 00010800 1-BLOCK1
137         *       POP      = POPA + POPB ;                                                  00010900 1-BLOCK1
138         *       LATOT    = C208 * POPA * ( RELWAGA3 ) ** C225 ;                           00011000 1-BLOCK1
139         *       LBTOT    = C209 * POPB ;                                                  00011100 1-BLOCK1
140         *       UAGAP    = C208 * POPA - LATOT ;                                          00011200 1-BLOCK1
141         *                                                                                 00011210 1-BLOCK1
3109            ;                                                                             03460000
142         *                                                                                 00011300 1-BLOCK2
143         **                                                                ;               00011400 1-BLOCK2
144         **      BLOCK 2  PRICES AND  ENERGY SUPPLY                        ;               00011500 1-BLOCK2
145         **                                                                ;               00011500 1-BLOCK2
146         *       RPAELEC = POL11 + POL12 * PWOIL * _EXCH ;                                 00011700 1-BLOCK2
147         *       RPBELEC = POL13 + POL14 * PWOIL * _EXCH ;                                 00011800 1-BLOCK2
148         *       RPAOIL  = POL15 + POL16 * PWOIL * _EXCH ;                                 00011900 1-BLOCK2
149         *       RPBOIL  = POL17 + POL18 * PWOIL * _EXCH ;                                 00012000 1-BLOCK2
150         *       RPAGAS  = POL21 + POL22 * PWOIL * _EXCH ;                                 00012100 1-BLOCK2
151         *       RPBGAS  = POL23 + POL24 * PWOIL * _EXCH ;                                 00012200 1-BLOCK2
152         *       SPOOIL  = POL25 + POL26 * PWOIL * _EXCH ;                                 00012300 1-BLOCK2
153         *       SPNOIL  = POL27 + POL28 * PWOIL * _EXCH ;                                 00012400 1-BLOCK2
154         *       SPGAS   = POL29 + POL30 * PWOIL * _EXCH ;                                 00012500 1-BLOCK2
155         *       PAALT   =     _SHAELEC    * RPAELEC                                       00012500 1-BLOCK2
156         *                 +     _SHAOIL     * RPAOIL                                      00012700 1-BLOCK2
157         *                 +     _SHAGAS     * RPAGAS    ;                                 00012800 1-BLOCK2
158         *       PBALT   =     _SHBELEC    * RPBELEC                                       00012900 1-BLOCK2
159         *                 +     _SHBOIL     * RPBOIL                                      00013000 1-BLOCK2
160         *                 +     _SHBGAS     * RPBGAS    ;                                 00013100 1-BLOCK2
161         *       RPAENT  = PAALT ;                                                         00013200 1-BLOCK2
162         *       RPBENT  = PBALT ;                                                         00013300 1-BLOCK2
163         *       RPENT   = RPAENT * (    _ENTACON   +     _ENTAREP )                       00013400 1-BLOCK2
164         *                 /(    _ENTACON   +     _ENTAREP                                 00013500 1-BLOCK2
165         *                 +     _ENTBCON   +     _ENTBREP )                               00013600 1-BLOCK2
166         *                 + RPBENT * (    _ENTBCON   +     _ENTBREP )                     00013700 1-BLOCK2
167         *                 /(    _ENTACON   +     _ENTAREP                                 00013900 1-BLOCK2
168         *                 +     _ENTBCON   +     _ENTBREP ));                             00013900 1-BLOCK2
169         *       PREP    =     _PREP                                                       00013910 1-BLOCK2
170         *                 * (1 + 0.07 * ( RPENT -     _RPENT   )                          00013920 1-BLOCK2
171         *                 / RPENT - C29 ) ;                                               00013930 1-BLOCK2
172         *       PAREP   = PREP ;                                                          00013940 1-BLOCK2
```

```
7                                    S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

173     +     PRREP     = PREP ;                                                        00013950 1-BLOCK2
174     +     RESAJOIL  =      _ESAJOIL   -     _XAJOIL   ;                             00014000 1-BLOCK2
175     +     XAOOIL    =    5.19       * ( RESAJOIL / RESAJOBO ) ** C9 ;               00014100 1-BLOCK2
176     +     RESANOIL  =    _ESANOIL   -     _XANOIL   ;                               00014200 1-BLOCK2
177     +     XANOIL    = ( C4 * SPNOIL ** C1 ) ** C2                                   00014300 1-BLOCK2
178     +                 *     _XANOIL    ** ( 1.0 - C2 )                              00014400 1-BLOCK2
179     +                 * ( RESANOIL / RESANOBO ) ** C3 ;                             00014500 1-BLOCK2
180     +     XASOIL    = POL10 ;                                                       00014600 1-BLOCK2
181     +     XAOIL     = XAOOIL + XANOIL + XASOIL ;                                    00014700 1-BLOCK2
182     +     RESAGAS   =      _RESAGAS   -   _XAGAS   ;                                00014800 1-BLOCK2
183     +     XAGAS     = ( C11 * SPGAS ** C12 ) ** C13                                 00014900 1-BLOCK2
184     +                 *      _XAGAS   ** ( 1 - C13 )                                00015000 1-BLOCK2
185     +                 * ( RESAGAS / RESAGABO ) ** C87 ;                             00015100 1-BLOCK2
186     +     XAELEC    =      _LECAREP   +      _LECACON   ;                           00015200 1-BLOCK2
187     +     XAALT     = ( EXP(C43 * ( YEAR -1980 ) ) * C23                            00015300 1-BLOCK2
188     +                 * PAALT ** C24 ) ** C27                                       00015400 1-BLOCK2
189     +                 *      _XAALT   ** ( 1 - C27 ) ) ;                            00015500 1-BLOCK2
190     +     RESBOIL   =     _RESBOIL   -     _XBOIL   + _POL02 ;                      00015600 1-BLOCK2
191     +     XBOIL     = ( C8 * SPNOIL ** C5 ) ** C5                                   00015700 1-BLOCK2
192     +                 * (     _XBOIL   -     _POL02   ) ** ( 1 - C5 )               00015800 1-BLOCK2
193     +                 * ( RESBOIL / RESBOIBO ) ** C7 + POL02 ;                      00015900 1-BLOCK2
194     +     RESBGAS   =     _RESBGAS   -     _XBGAS   ;                               00015000 1-BLOCK2
195     +     XBGAS     = ( C15 * SPGAS ** C16 ) ** C17                                 00016100 1-BLOCK2
196     +                 *        _XBGAS   ** ( 1 - C17 )                              00016200 1-BLOCK2
197     +                 * ( RESBGAS / RESBGABO ) ** C93 ;                             00016300 1-BLOCK2
198     +     XBELEC    = POL05 ;                                                       00016400 1-BLOCK2
199     +     XBALT     = ( EXP( C43 * ( YEAR - 1980 ) ) * C25                          00016500 1-BLOCK2
200     +                 * PBALT ** C26 ) ** C27                                       00016600 1-BLOCK2
201     +                 *      _XBALT   ** ( 1 - C27) ) ;                             00016700 1-BLOCK2
202     +     XALT      = XAALT + XBALT ;                                               00016800 1-BLOCK2
203     +     XOILGAS   = XAOIL + XBOIL + XAGAS + XBGAS ;                               00016900 1-BLOCK2
204     +     XENT      = XOILGAS + XALT + XAELEC + XBELEC ;                            00017000 1-BLOCK2
205     +                                                                               00017010 1-BLOCK2
1109                   ;                                                                03460000
206     +                                                                               00017100 1-BLOCK3
207     +*                                                                   ;          00017200 1-BLOCK3
208     +*    BLOCK 3 ENERGY INPUTS TO REPRODUCIBLES SECTOR                   ;          00017300 1-BLOCK3
209     +*                                                                   ;          00017400 1-BLOCK3
210     +     ENTAREP   = ( C95 *     _XAREP   ** 2. /     __XAREP   ) ** C96 *         00017500 1-BLOCK3
211     +                 (     _RPAENT   /     _PAREP   ) ** ( C95 * C96 )             00017600 1-BLOCK3
212     +                 *     _ENTAREP   ** ( 1. - C96 ) ;                            00017700 1-BLOCK3
213     +     ENTBREP   = ( C97 *     _XBREP   ** 2. /     __XBREP   ) ** C99 *         00017800 1-BLOCK3
214     +                 (     _RPBENT   /     _PBREP   ) ** ( C98 * C99 )             00017900 1-BLOCK3
215     +                 *     _ENTBREP   ** ( 1. - C99 ) ;                            00018000 1-BLOCK3
216     +     ALTAREP   = C104 * XAALT   ;                                              00018100 1-BLOCK3
217     +     ALTBREP   = C107 * XBALT ;                                                00018200 1-BLOCK3
218     +     OILAREP   = C102 * ( ENTAREP - ALTAREP )                                  00018300 1-BLOCK3
219     +                 * EXP( C103 * ( YEAR - 1990 ) ) ;                             00018400 1-BLOCK3
220     +     OILBREP   = C105 * ( ENTBREP - ALTBREP )                                  00018500 1-BLOCK3
221     +                 * EXP( C105 * ( YEAR - 1990 ) ) ;                             00018600 1-BLOCK3
222     +     GASAREP   = C109 * ( ENTAREP - ALTAREP )                                  00018700 1-BLOCK3
223     +                 * EXP( C109 * ( YEAR - 1990 ) ) ;                             00018800 1-BLOCK3
224     +     GASBREP   = C111 * ( ENTBREP - ALTBREP )                                  00018900 1-BLOCK3
225     +                 * EXP( C112 * ( YEAR - 1980 ) ) ;                             00019000 1-BLOCK3
226     +     ELECAREP  = ENTAREP - ALTAREP - OILAREP - GASAREP ;                       00019100 1-BLOCK3
227     +     ELECBREP  = ENTBREP - ALTBREP - OILBREP - GASBREP ;                       00019200 1-BLOCK3
228     +                                                                               00019210 1-BLOCK3
1109                        ;                                                           03460000
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                              S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

229     *                                                                               00019300 1-BLOCK4
230     **                                                              *               00019400 1-BLOCK4
231     **   BLOCK 4 ENERGY INPUTS TO HOUSEHOLDS                      *               00019410 1-BLOCK4
232     **                                                              *               00019411 1-BLOCK4
233     *    ENTACON  = (  C120 * ( ( _YPCA / _PY ) ** 2 / ( __YPCA / __PY ) ) 00019416 1-BLOCK4
234     *              ** C121 * (     _RPAENT  /     _PAREP   ) ** C122 ) **C12300019417 1-BLOCK4
235     *              * (     _ENTACON  /     _POPA   ) ** ( 1 - C123 ) * POPA ;00019418 1-BLOCK4
236     *    ENTBCON  = (  C124 * ( ( _YPCB / _PY ) ** 2 /  ( __YPCB / __PY ) )00019419 1-BLOCK4
237     *              **C125 * (     _RPBENT  /     _PBREP   ) ** C126 ) ** C12700019420 1-BLOCK4
238     *              * (     _ENTBCON  /     _POPB   ) ** ( 1 - C127 ) * POPB ;00019421 1-BLOCK4
239     *    ALTACON  = ( 1 - C104 ) * XAALT ;                                    00019424 1-BLOCK4
240     *    ALTBCON  = ( 1 - C107 ) * XBALT ;                                    00019425 1-BLOCK4
241     *    OILACON  = C129 * ( ENTACON - ALTACON )                              00019426 1-BLOCK4
242     *              * EXP( C129 * ( YEAR - 1980 ) ) ;                          00019427 1-BLOCK4
243     *    OILBCON  = C131 * ( ENTBCON - ALTBCON )                              00019428 1-BLOCK4
244     *              * EXP( C132 * ( YEAR - 1980 ) ) ;                          00019429 1-BLOCK4
245     *    GASACON  = C134 * ( ENTACON - ALTACON )                              00019430 1-BLOCK4
246     *              * EXP( C135 * ( YEAR - 1980 ) ) ;                          00019431 1-BLOCK4
247     *    GASBCON  = C137 * ( ENTBCON - ALTBCON )                              00019432 1-BLOCK4
248     *              * EXP( C138 * ( YEAR - 1980 ) ) ;                          00019433 1-BLOCK4
249     *    ELECACON = ENTACON - ALTACON - OILACON - GASACON ;                   00019434 1-BLOCK4
250     *    ELECBCON = ENTBCON - ALTBCON - OILBCON - GASBCON ;                   00019435 1-BLOCK4
251     *    SHAOIL   = (OILACON + OILAREP)                                       00019436 1-BLOCK4
252     *              /(ENTACON + ENTAREP - ALTACON - ALTAREP) ;                 00019437 1-BLOCK4
253     *    SHAGAS   = (GASACON + GASAREP)                                       00019438 1-BLOCK4
254     *              /(ENTACON + ENTAREP - ALTACON - ALTAREP) ;                 00019439 1-BLOCK4
255     *    SHAELEC = 1.0 - SHAOIL - SHAGAS ;                                    00019440 1-BLOCK4
256     *    SHBOIL   = (OILBCON + OILBREP)                                       00019441 1-BLOCK4
257     *              /(ENTBCON + ENTBREP - ALTBCON - ALTBREP) ;                 00019442 1-BLOCK4
258     *    SHBGAS   = (GASBCON + GASBREP)                                       00019443 1-BLOCK4
259     *              /(ENTBCON + ENTBREP - ALTBCON - ALTBREP) ;                 00019444 1-BLOCK4
260     *    SHBELEC = 1.0 - SHBOIL - SHBGAS ;                                    00019445 1-BLOCK4
261     *                                                                         00019446 1-BLOCK4
8109                        ;                                                   03460000
262     *                                                                         00019447 1-BLOCK5
263     **                                                              *       00019450 1-BLOCK5
264     **   BLOCK 5 TOTAL COSTS AND INPUTS TO ENERGY SECTOR              *       00019500 1-BLOCK5
265     **                                                              *       00019600 1-BLOCK5
266     *    COSTANOI = ( 1 / C4 * ( RESANO80 / RESANOIL ) ** C3 )                00019700 1-BLOCK5
267     *              ** ( 1 / C1 )                                             00019800 1-BLOCK5
268     *              * C1 / ( 1 + C1 )                                         00019900 1-BLOCK5
269     *              * XANOIL ** ( 1 / C1 + 1 ) - 0.7 ;                        00020000 1-BLOCK5
270     *    COSTAOOI = C19 * EXP( C130 * ( YEAR - 1980 ) ) * XAOOIL ;            00020100 1-BLOCK5
271     *    COSTASOI = C20 * EXP( C133 * ( YEAR - 1980 ) ) * XASOIL ;            00020200 1-BLOCK5
272     *    COSTAGAS = (1 / C11 * ( RESAGA80 / RESAGAS ) ** C87 )                00020300 1-BLOCK5
273     *              ** (1 / C12 )                                             00020400 1-BLOCK5
274     *              * ( C12 / ( 1 + C12 ) )                                   00020500 1-BLOCK5
275     *              * XAGAS ** ( 1 / C12 + 1 ) - 3.5 ;                        00020600 1-BLOCK5
276     *    COSTAOIL = COSTANOI + COSTAOOI + COSTASOI ;                          00020700 1-BLOCK5
277     *    COSTBOIL = ( 1 / C8 * ( RESBOI80 / RESBOIL ) ** C7 )                 00020800 1-BLOCK5
278     *              ** ( 1 / C5 )                                             00020900 1-BLOCK5
279     *              * ( C5 / ( 1 + C5 ) )                                     00021000 1-BLOCK5
280     *              * ( XBOIL - POLO2 ) ** ( 1 / C5 + 1 )                     00021100 1-BLOCK5
281     *              + C19 * POLO2 - 1.0 ;                                     00021200 1-BLOCK5
282     *    COSTBGAS = ( 1 / C15 * ( RESBGA80 / RESBGAS ) ** C93 )               00021300 1-BLOCK5
283     *              ** (1 / C16 )                                             00021400 1-BLOCK5
284     *              * ( C16 / (1 + C16 ) )                                    00021500 1-BLOCK5
285     *              * XBGAS ** ( 1 / C16 + 1 ) - 1.0 ;                        00021600 1-BLOCK5
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S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

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286    *   COSTAELE = C36 * XAELEC ** C37 * PAREP ;                          00021700 1-BLOCK5
287    *   COSTBELE = C39 * XBELEC ** C40 * PBREP ;                          00021800 1-BLOCK5
288    *   COSTAALT = ( 1 / ( EXP( C43 * ( YEAR - 1990 ) ) * C23 ) )         00021900 1-BLOCK5
289    *              ** ( 1 / C24 )                                         00022000 1-BLOCK5
290    *              * ( C24 / ( 1 + C24 ) )                                00022100 1-BLOCK5
291    *              * XAALT ** ( 1 / C24 + 1 ) ;                           00022200 1-BLOCK5
292    *   COSTBALT = ( 1 / ( EXP( C43 * ( YEAR - 1990 ) ) * C25 ) )         00022300 1-BLOCK5
293    *              ** ( 1 / C26 )                                         00022400 1-BLOCK5
294    *              * ( C25 / ( 1 + C26 ) )                                00022500 1-BLOCK5
295    *              * XBALT ** ( 1 / C25 + 1 ) ;                           00022600 1-BLOCK5
296    *   CAOILGAS = COSTAOOI + COSTANOI + COSTASOI + COSTAGAS ;            00022700 1-BLOCK5
297    *   CBOILGAS = COSTBOIL + COSTBGAS ;                                  00022800 1-BLOCK5
298    *   LAOILGAS = C41 * CAOILGAS / PAREP ;                               00022900 1-BLOCK5
299    *   LBOILGAS = C41 * CBOILGAS / PBREP ;                               00023000 1-BLOCK5
300    *   LAELEC   = C42 * COSTAELE / PAREP ;                               00023100 1-BLOCK5
301    *   LBELEC   = C42 * COSTBELE / PBREP ;                               00023200 1-BLOCK5
302    *   LAALT    = C59 * COSTAALT / PAREP ;                               00023300 1-BLOCK5
303    *   LBALT    = C61 * COSTBALT / PBREP ;                               00023400 1-BLOCK5
304    *   INAOILGA = C74 * CAOILGAS / PAREP * POL05 ;                       00023410 1-BLOCK5
305    *   INBOILGA = C75 * CBOILGAS / PBREP * POL06 ;                       00023420 1-BLOCK5
306    *   INAELEC  = C76 * COSTAELE / PAREP ;                               00023430 1-BLOCK5
307    *   INBELEC  = C77 * COSTBELE / PBREP ;                               00023440 1-BLOCK5
308    *   INAALT   = C78 * COSTAALT / PAREP ;                               00023450 1-BLOCK5
309    *   INBALT   = C79 * COSTBALT / PBREP ;                               00023460 1-BLOCK5
310    *   REPINVENT = INAOILGA + INBOILGA + INAELEC                         00023470 1-BLOCK5
311    *              + INBELEC + INAALT + INBALT ;                          00023480 1-BLOCK5
312    *                                                                     00023500 1-BLOCK5
1139                                   ;                                 03460000
313    *                                                                     00023700 1-BLOCK6
314    **                                                    ;               00023800 1-BLOCK6
315    **  BLOCK 6  REPRODUCIBLES SUPPLY                     ;               00023900 1-BLOCK6
316    **                                                    ;               00024000 1-BLOCK6
317    *   LAREP    = LATOT - LAOILGAS - LAALT - LAELEC ;                    00024010 1-BLOCK6
318    *   LBREP    = LBTOT - LBOILGAS - LBALT - LBELEC ;                    00024020 1-BLOCK6
319    *   KAREP    = C28 * EXP( C29 * ( YEAR - 1980 ) ) * ( ( ( 1 - C229 )  00024100 1-BLOCK6
320    *              * ( LAREP ** C30 * _KAREP ** C31 ) ** C220            00024200 1-BLOCK6
321    *              + C229 * ENTAREP ** C220 ) ** ( 1 / C220 ) ;           00024300 1-BLOCK6
322    *   KBREP    = C33 * EXP( C29 * ( YEAR - 1980 ) ) * ( ( ( 1 - C230 )  00024400 1-BLOCK6
323    *              * ( LBREP ** C34 * _KBREP ** C35 ) ** C221            00024500 1-BLOCK6
324    *              + C230 * ENTBREP ** C221 ) ** ( 1 / C221 ) ;           00024600 1-BLOCK6
325    *   KREP     = KAREP + KBREP ;                                        00024700 1-BLOCK6
326    *                                                                     00024710 1-BLOCK6
1109                                         ;                           03460000
327    *                                                                     00024720 1-BLOCK7
328    **                                                         ;          00024730 1-BLOCK7
329    **  BLOCK 7  OTHER PRICES AND EXCHANGE RATE                ;          00024740 1-BLOCK7
330    **                                                         ;          00024750 1-BLOCK7
331    *   CUMBOP   =     _CUMBOP  +     _BOP  ;                             00024760 1-BLOCK7
332    *   NEXOIL   = XAOIL + XBOIL - OILAREP - OILBREP - OILACON - OILBCON ;00024770 1-BLOCK7
333    *   NEXGAS   = XAGAS + XBGAS - GASAREP - GASBREP - GASACON - GASBCON ;00024780 1-BLOCK7
334    *   NEXAELEC = XAELEC - ELECAREP - ELECACON ;                         00024790 1-BLOCK7
335    *   NEXBELEC = XBELEC - ELECBREP - ELECBCON ;                         00024800 1-BLOCK7
336    *   NEXENT   = NEXOIL + NEXGAS + NEXAELEC + NEXBELEC ;                00024900 1-BLOCK7
337    *   T        = ABS( CUMBOP ) ;                                        00024910 1-BLOCK7
338    *   EXCH     = _EXCH * ( 1 + ( ( ( CUMBOP / T ) * T ** C158           00025000 1-BLOCK7
339    *              + ( NEXENT * PWOIL - _NEXENT * _PWOIL )                00025100 1-BLOCK7
340    *              * _EXCH )                                              00025200 1-BLOCK7
341    *              / ( ( _EXREP * _PREP + _IMREP * _PIMREP ) /  2 ) )     00025400 1-BLOCK7
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10                              S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

342      +              / ( 1 + C147 + C152 )                                          00025500 1-BLOCK7
343      +              * ( PREP - _PREP ) / _PREP - C156 ) ;                          00025600 1-BLOCK7
344      +     PEXREP   = PREP / EXCH ;                                                00025700 1-BLOCK7
345      +     PWEXREP  = EXP( C149 * ( YEAR - 1980 ) ) ;                              00025800 1-BLOCK7
346      +     PWIMREP  = EXP( C155 * ( YEAR - 1980 ) ) ;                              00025900 1-BLOCK7
347      +     PIMREP   = PWIMREP *    EXCH ;                                          00025910 1-BLOCK7
348      +     PY       = PREP * ( XREP / ( XREP + XENT ) ) +                          00025920 1-BLOCK7
349      +              RPENT * ( XENT / ( XREP + XENT ) ) ;                           00025930 1-BLOCK7
350      +                                                                             00025940 1-BLOCK7
1109                                                               ;                   03460000
351      +                                                                             00026000 1-BLOCK8
352      +*                                                                  ;         00026100 1-BLOCK8
353      +*    BLOCK 8 REPRODUCIBLES INPUTS TO CAPITAL FORMATION                ;         00026200 1-BLOCK8
354      +*                                                                  ;         00026300 1-BLOCK8
355      +     SAVINGA  = POLO7 * _YA ;                                                00026310 1-BLOCK8
356      +     SAVINGB  = POLO8 * _YB ;                                                00026320 1-BLOCK8
357      +     MPKREPA  = ( 1 / C220 ) * ( C28 * EXP ( C29 * ( YEAR                    00026330 1-BLOCK8
358      +              - 1980.0 ) ) ) ** C220                                         00026340 1-BLOCK8
359      +              * XAREP ** ( 1 - C220 )                                        00026350 1-BLOCK8
360      +              * C220 * C31 * ( 1 - C229 )                                    00026360 1-BLOCK8
361      +              * LAREP ** ( C30 * C220 )                                      00026370 1-BLOCK8
362      +              * _KAREP ** ( C31 * C220 - 1 ) ;                               00026380 1-BLOCK8
363      +     MPKREPB  = ( 1 / C221 ) * ( C33 * EXP ( C29 * ( YEAR                    00026390 1-BLOCK8
364      +              - 1980.0 ) ) ) ** C221                                         00026391 1-BLOCK8
365      +              * XBREP ** ( 1 - C221 )                                        00026392 1-BLOCK8
366      +              * C221 * C35 * ( 1 - C230 )                                    00026393 1-BLOCK8
367      +              * LBREP ** ( C34 * C221 )                                      00026394 1-BLOCK8
368      +              * _KBREP ** ( C35 * C221 - 1 ) ;                               00026395 1-BLOCK8
369      +     EIRWORLD = IRWORLD ;                                                    00026396 1-BLOCK8
370      +     NIREPA   = C56 * ( C57 * ( EXP ( C29 * ( YEAR - 1980 ) ) )              00026397 1-BLOCK8
371      +         ** C68 * IRWORLD ** C69 * XAREP ** C70 * LAREP ** C71               00026398 1-BLOCK8
372      +              - _KAREP ) - POLO5 ;                                           00026399 1-BLOCK8
373      +     NIREPB   = C67 * ( C58 * ( EXP ( C29 * ( YEAR - 1980 ) ) )              00026400 1-BLOCK8
374      +       ** C53 * IRWORLD ** C54 * XBREP ** C55 * LBREP ** C56                 00026401 1-BLOCK8
375      +              - _KBREP ) - POLO6 ;                                           00026402 1-BLOCK8
376      +     NFCFA    = NIREPA * PAREP + C235 * _KAREP                               00026403 1-BLOCK8
377      +              * PAREP + POLO5 * PAREP - SAVINGA ;                            00026404 1-BLOCK8
378      +     NFCFB    = NIREPB * PBREP + C235 * _KBREP                               00026405 1-BLOCK8
379      +              * PBREP + POLO6 * PBREP - SAVINGB ;                            00026406 1-BLOCK8
380      +     KAREP    = _KAREP + NIREPA ;                                            00026407 1-BLOCK8
381      +     KBREP    = _KBREP + NIREPB ;                                            00026408 1-BLOCK8
382      +                                                                             00026409 1-BLOCK8
1109                                                                     ;             03460000
383      +                                                                             00032100 1-BLOCK9
384      +*                                                                ;           00032200 1-BLOCK9
385      +*    BLOCK 9  REALIZED DOMESTIC RENTS                               ;           00032300 1-BLOCK9
386      +*                                                                ;           00032400 1-BLOCK9
387      +     RAOIL    = SPOOIL * XAOOIL + SPNOIL * XANOIL                            00032500 1-BLOCK9
388      +              - COSTANOI - COSTAOOI ;                                        00032600 1-BLOCK9
389      +     RBOIL    = SPNOIL * XBOIL - COSTBOIL ;                                  00032700 1-BLOCK9
390      +     RAGAS    = SPGAS * XAGAS - COSTAGAS ;                                   00032800 1-BLOCK9
391      +     RBGAS    = SPGAS * XBGAS - COSTBGAS ;                                   00032900 1-BLOCK9
392      +     RAOILGAS = RAOIL + RAGAS ;                                              00033000 1-BLOCK9
393      +     RBOILGAS = RBOIL + RBGAS ;                                              00033100 1-BLOCK9
394      +     RAELEC   = RPAELEC * XAELEC - COSTAELE ;                                00033200 1-BLOCK9
395      +     RBELEC   = RPBELEC * XBELEC - COSTBELE ;                                00033300 1-BLOCK9
396      +     RAALT    = PAALT * XAALT - COSTAALT ;                                   00033400 1-BLOCK9
397      +     RBALT    = PBALT * XBALT - COSTBALT ;                                   00033500 1-BLOCK9
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      +      RGAAOILG = C166 * RAOILGAS ;                                     00033600 1-BLOCK9
      +      RGABOILG = C167 * RBOILGAS ;                                     00033700 1-BLOCK9
      +      RGBAOILG = C177 * RAOILGAS ;                                     00033800 1-BLOCK9
      +      RGBBOILG = C179 * RBOILGAS ;                                     00033900 1-BLOCK9
      +      RIAAOILG = C188 * RAOILGAS ;                                     00034000 1-BLOCK9
      +      RIABOILG = C189 * RBOILGAS ;                                     00034100 1-BLOCK9
      +      RIBAOILG = C156 * RAOILGAS ;                                     00034200 1-BLOCK9
      +      RIBBOILG = C157 * RBOILGAS ;                                     00034300 1-BLOCK9
      +RFAOILG = RAOILGAS - RGAAOILG - RGBAOILG - RIAAOILG - RIBAOILG ;        00034400 1-BLOCK9
      +RFBOILG = RBOILGAS - RGABOILG - RGBBOILG - RIABOILG - RIBBOILG ;        00034500 1-BLOCK9
      +RATRES = RGAAOILG + RGABOILG + RIAAOILG + RIABOILG + RAELEC + RAALT;    00034600 1-BLOCK9
      +RBTRES = RGBAOILG + RGBBOILG + RIBAOILG + RIBBOILG + RBELEC + RBALT ;   00034700 1-BLOCK9
      +                                                                       00034900 1-BLOCK9
             ;                                                                03470000
      +                                                                       00034900 1-BLOCK10
      ++                                                         ;            00035000 1-BLOCK10
      ++     BLOCK 10, BALANCE OF TRADE AND PAYMENTS             ;            00035100 1-BLOCK10
      ++                                                         ;            00035200 1-BLOCK10
      +      EXREP    = ( C146 *    _XREP   * ( PEXREP / PWEXREP ) ** C147 )  00035700 1-BLOCK10
      +                 ** C148 *   LEXREP   ** ( 1 - C148 ) ;                00035800 1-BLOCK10
      +      IMREP    = ( C150 * ( ( LYPC / LPY ) ** 2 / ( __YPC / __PY ) )   00035900 1-BLOCK10
      +                 ** C151 * (      PIMREP  /      PREP  ) ** C152 ) ** C153  00035000 1-BLOCK10
      +                 * (      _IMREP  /      LPOP   ) ** ( 1 - C153 ) * POP ;   00036100 1-BLOCK10
      +      DIVENT   = RFAOILG + RFBOILG ;                                   00036400 1-BLOCK10
      +      CUMNFCFA = _CUMFCFA + _NFLFA ;                                   00035410 1-BLOCK10
      +      CUMNFCFB = _CUMFCFB + _NFLFB ;                                   00035420 1-BLOCK10
      +      BOP      = NEXOIL * PWOIL * EXCH                                 00035500 1-BLOCK10
      +                 + NEXGAS * ( C170 * PWOIL ) * EXCH                    00036600 1-BLOCK10
      +                 + ( NEXAELEC + NEXBELEC ) * ( C171 * PWOIL ) * EXCH   00036700 1-BLOCK10
      +                 + EXREP * PEXREP * EXCH                               00036800 1-BLOCK10
      +                 - IMREP * PIMREP                                      00036900 1-BLOCK10
      +                 - DIVENT                                              00037000 1-BLOCK10
      +                 - IRWORLD * ( CUMNFCFA + CUMNFCFB )                   00037100 1-BLOCK10
      +                 + NFCFA + NFCFB - 5.0 ;                               00037110 1-BLOCK10
      +                                                                       00037120 1-BLOCK10
             ;                                                                03470000
      +                                                                       00037200 1-BLOCK11
      ++                                                     ;                00037300 1-BLOCK11
      ++     BLOCK 11, INCOMES                               ;                00037400 1-BLOCK11
      ++                                                     ;                00037500 1-BLOCK11
      +      NEO      = C200 *      _YA   * ( (   _YPCA                       00037600 1-BLOCK11
      +                 /     _YPCB   ) ** C201 - 1 ) ;                       00037700 1-BLOCK11
      +      YA       = RATRES                                                00037800 1-BLOCK11
      +                 + C175 * POPA / POP * NEXGAS * ( C170 * PWOIL - SPGAS )  00037900 1-BLOCK11
      +                   * EXCH                                              00038000 1-BLOCK11
      +                 + C175 * ( CAOILGAS - ( INAOILGA * PAREP )            00038100 1-BLOCK11
      +                 + ( POLOS * PAREP ))                                  00038110 1-BLOCK11
      +                 + COSTAELE - INAELEC * PAREP                          00038200 1-BLOCK11
      +                 + COSTAALT - INAALT  * PAREP                          00038300 1-BLOCK11
      +                 + C191 * KAREP                                        00038400 1-BLOCK11
      +                 - NEO - IRWORLD * CUMNFCFA ;                          00038500 1-BLOCK11
      +      YB       = RBTRES                                                00038600 1-BLOCK11
      +                 + ( 1 - C175 * POPA / POP ) * NEXGAS                  00038700 1-BLOCK11
      +                   * ( C170 *   PWOIL - SPGAS ) * EXCH                 00038800 1-BLOCK11
      +                 + NEXBELEC * ( C171 * PWOIL - RPBELEC ) * EXCH        00038900 1-BLOCK11
      +                 + ( 1 - C175 ) * ( CBOILGAS - ( INBOILGA * PBREP)     00039000 1-BLOCK11
      +                 + ( POLOS * PAREP ) )                                 00039010 1-BLOCK11
      +                 + CBOILGAS - ( INBOILGA * PBREP ) + ( POLO6* PBREP )  00039100 1-BLOCK11
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12                                   S T A T I S T I C A L   A N A L Y S I S   S Y S T E M
454      +              + COSTBELE - ( INBELEC * PBREP ) + COSTBALT                       00339200 1-BLOCK11
455      +              - ( INBALT * PBREP )                                              00339300 1-BLOCK11
456      +              + ( 1 - C181 ) * XAREP + XBREP                                    00339300 1-BLOCK11
457      +              + NEO - IRWORLD * CUMNFCFB ;                                      00039400 1-BLOCK11
458      +       Y        = YA + YB ;                                                     00339500 1-BLOCK11
459      +       YPC      = Y / POP ;                                                     00339600 1-BLOCK11
460      +       YPCA     = YA / POPA ;                                                   00339700 1-BLOCK11
461      +       YPCB     = YB / POPB ;                                                   00039800 1-BLOCK11
462      +       YPCAD    = ( YA - RATRES ) / POPA + RATRES *                             00339900 1-BLOCK11
463      +                ( POPAD / POPA ) ** C202 / POPAD ;                              00340000 1-BLOCK11
464      +       YPCAN    = ( YA - YPCAD * POPAD ) / NAIGA ;                              00340100 1-BLOCK11
1110                           ;                                                          03470000
466      +                                                                                00340200 1-BLOCK12
467      +*                                                    ;                          00340300 1-BLOCK12
468      +*      BLOCK 12, REAL CONSUMPTION                    ;                          00340400 1-BLOCK12
469      +*                                                    ;                          00340500 1-BLOCK12
470      +       GREPCONR = XREP - EXREP + INREP - REPINVENT + CUMBOP / PREP              00340500 1-BLOCK12
471      +                  - _CUMBOP / _PREP ;                                           00040610 1-BLOCK12
472      +       REPCONRA = GREPCONR * ( YA -ENTACON * RPAENT ) / (Y-ENTACON*RPAENT00340700 1-BLOCK12
473      +                  - ENTBCON * RPAENT ) - SAVINGA / PAREP ;                      00340900 1-BLOCK12
474      +       REPCONRB = GREPCONR - REPCONRA  - SAVINGA / PAREP                        00340900 1-BLOCK12
475      +                  - SAVINGB / PBREP ;                                           00040910 1-BLOCK12
476      +       CONRA    = ENTACON + REPCONRA ;                                          00341000 1-BLOCK12
477      +       CONRB    = ENTBCON + REPCONRB ;                                          00341100 1-BLOCK12
478      +       CONRPCAD = CONRA * YPCAD / YA ;                                          00041200 1-BLOCK12
479      +       MIGCOST  = C169 * 0.5 * ( ( IMIGA ** 2 ) ** 0.5 ) * (     _YPCAN    00341300 1-BLOCK12
480      +                  -      _YPCB   ) / ( POPA - POPAD ) ;                        00341400 1-BLOCK12
481      +       CONRPCAN = CONRA * YPCAN / YA - MIGCOST ;                                00341500 1-BLOCK12
482      +       CONRPCB  = CONRB / POPB ;                                                00341600 1-BLOCK12
1110                              ;                                                       03470000
1111          OPTIONS NOMACROGEN ;                                                        03480000
1112          RESETLAG;                                                                   03490000

NOTE: DATA SET WORK.RECUR HAS 22 OBSERVATIONS AND 552 VARIABLES. 4 OBS/TRK.
NOTE: THE DATA STATEMENT USED 1.44 SECONDS AND 289K.

NOTE: THE PROCEDURE PRINT USED 0.46 SECONDS AND 315K AND PRINTED PAGE 1.

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NOTE: THE PROCEDURE PRINT USED 0.44 SECONDS AND 304K AND PRINTED PAGE 7.
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APPENDIX B: LIST OF VARIABLES IN ALPHABETICAL ORDER

Variable	Block	Description
ALTACON	4	Alberta final consumption of alternative energy, $ billions, 1980 prices.
ALTAREP	3	Alberta intermediate use of alternative energy, $ billions, 1980 prices.
ALTBCON	4	RoC final consumtpiton of alternative energy, $ billions, 1980 prices.
ALTBREP	3	RoC intermediate use of alternative energy, $ billions, 1980 prices.
BOP	10	Canada balance of payments surplus, $ billions.
CAOILGAS	5	Alberta total production costs of oil and gas $ billions.
CBOILGAS	5	RoC total production costs of oil and gas, $ billions.
CONRA	12	Alberta total final consumption, $ billions, 1980 prices.
CONRB	12	RoC total final consumption, $ billions, 1980 prices.
CONRPCAN	12	New Albertans total final consumption, $ billions, 1980 prices.
CONRPCAO	12	Original Albertans total final consumption, $ billions, 1980 prices.
CONRPCB	12	RoC total final consumption, $ billions, 1980 prices.
COSTAALT	5	Alberta total production costs of alternative energy, $ billions.
COSTAELE	5	Alberta total production costs of electricity, $ billions.
COSTAGAS	5	Alberta total production costs of natural gas, $ billions.
COSTANOI	5	Alberta total production costs of new oil, $ billions.
COSTAOIL	5	Alberta total production costs of oil, $ billions.

COSTAOOI	5	Alberta total production costs of old oil, $ billions.
COSTASOI	5	Alberta total production of oilsands, $ billions.
COSTBALT	5	RoC total production costs of alternative energy, $ billions.
COSTBELE	5	RoC total production costs of electricity, $ billions.
COSTBGAS	5	RoC total production costs of natural gas, $ billions.
COSTBOIL	5	RoC total production costs of oil, $ billions.
CUMBOP	7	Sum of annual BOPs since 1980, $ billions.
CUMNFCFA	10	Cumulated net foreign debt since 1980, reproducibles Alberta, $ billions.
CUMNFCFB	10	Cumulated net foreign debt since 1980, reproducibles, RoC, $ billions.
DIVENT	10	Oil and gas profits remitted to foreigners, $ billions.
EIRWORLD	8	Expected real world rate of interest.
ELECACON	4	Alberta final consumption of electricity, $ billions, 1980 prices.
ELECAREP	3	Alberta intermediate use of electricity, $ billions, 1980 prices.
ELECBCON	4	RoC final consumption of electricity, $ billions, 1980 prices.
ELECBREP	3	RoC intermediate use of electricity, $ billions, 1980 prices.
EMIG	1	Number of emigrants from Canada, millions.
ENTACON	4	Alberta final consumption of energy, $ billions, 1980 prices.
ENTAREP	3	Alberta intermediate use of energy, $ billions, 1980 prices.
ENTBCON	4	RoC final consumption of energy, $ billions, 1980 prices.
ENTBREP	3	RoC intermediate use of energy, $ billions, 1980 prices.

EXCH	7	Canadian currency price of foreign exchange, 1980 = 1.0.
EXREP	10	Canada exports of reproducibles, $ billions, 1980 prices.
FMIG	1	Net in-migration to Canada, millions.
FMIGA	1	Foreigners migrating to Alberta, millions.
FMIGB	1	Foreigners migrating to RoC, millions.
GASACON	4	Alberta final consumption of natural gas, $ billions, 1980 prices.
GASAREP	3	Alberta intermediate use of natural gas, $ billions, 1980 prices.
GASBCON	4	RoC final consumption of natural gas, $ billions, 1980 prices.
GASBREP	3	RoC intermediate use of natrual gas, $ billions, 1980 prices.
GREPCONR	12	Final absorption of reproducibles in Canada, $ billions, 1980 prices.
IMIGA	1	Net interprovincial migration to Alberta, millions.
IMREP	10	Imports of reproducibles to Canada, $ billion, 1980 prices.
INAALT	5	Reproducibles inputs to Alberta alternative energy sector, $ billions, 1980 prices.
INAELEC	5	Reproducibles inputs to Alberta electricity sector, $ billions, 1980 prices.
INAOILGA	5	Reproducibles inputs to Alberta oil and gas sector, $ billions, 1980 prices.
INBALT	5	Reproducibles inputs to RoC alternative energy sector, $ billions, 1980 prices.
INBELEC	5	Reproducibles inputs to RoC electricity sector, $ billions, 1980 prices.
INBOILGA	5	Reproducibles inputs to RoC oil and gas sector, $ billions, 1980 prices.
IRWORLD	exogenous	World real rate of interest.

KAREP	8	Alberta capital stock in reproducibles sector, $ billions, 1980 prices.
KBREP	8	RoC capital stock in reproducibles sector, $ billions, 1980 prices.
LAALT	5	Alberta employment in alternative energy industry, millions.
LAELEC	5	Alberta employment in electricity industry, millions.
LAOILGAS	5	Alberta employment in oil and gas industry, millions.
LAREP	6	Alberta employment in reproducibles sector, millions.
LATOT	1	Alberta total employment, millions.
LBALT	5	RoC employment in alternative energy industry, millions.
LBELEC	5	RoC employment in electricity industry, millions.
LBOILGAS	5	RoC employment in oil and gas industry, millions.
LBREP	6	RoC employment in reproducibles sector, millions.
LBTOT	1	RoC total employment, millions.
MIGCOST	12	Present value of the migration costs of the year's interprovincial migrants, per new Albertan, $ billions, 1980 prices.
MPKREPA	8	Marginal product of a unit of capital in reproducibles, Alberta.
MPKREPB	8	Marginal product of a unit of capital in reproducibles, RoC.
NEQ	11	Net flow of equalization and other transfer payments from Alberta to RoC, $ billions.
NEXAELEC	7	Alberta net exports of electricity, $ billions, 1980 prices.
NEXBELEC	7	RoC net exports of electricity, $ billions, 1980 prices.
NEXGAS	7	Canada net exports of natural gas, $ billions, 1980 prices.

NEXOIL	7	Canada net exports of oil, $ billions, 1980 prices.
NFCFA	8	Net inflows of capital to Alberta, $ billions.
NFCFB	8	Net inflows of capital to RoC, $ millions.
NIREPA	8	Alberta net investment in reproducibles sector, $ billions, 1980 prices.
NIREPB	8	RoC net investment in reproducibles sector, $ billions, 1980 prices.
NMIGA	1	Stock of new Albertans, millions.
OILACON	4	Alberta final consumption of oil, $ billions, 1980 prices.
OILAREP	3	Alberta intermediate use of oil, $ billions, 1980 prices.
OILBCON	4	RoC final consumption of oil, $ billions, 1980 prices.
OILBREP	3	RoC intermediate use of oil, $ billions, 1980 prices.
PAALT	2	Alberta price of alternative energy, 1980 = 1.0.
PAREP	2	Alberta price of reproducibles output, 1980 = 1.0.
PBALT	2	RoC price of alternative energy, 1980 = 1.0.
PBREP	2	RoC price of reproducibles output, 1980 = 1.0.
PEXREP	7	World currency price of Canadian reproducibles exports, 1980 = 1.0.
PIMREP	7	Canadian currency price of reproducibles improts, 1980 = 1.0.
POL01	exogenous	Foreign immigration into Canada, millions.
POL02	"	Frontier oil production, $ billions, 1980 prices.
POL04	"	RoC electricity production, $ billions, 1980 prices.
POL05	"	Investment in Alberta oilsands megaprojects, $ billions, 1980 prices.
POL06	"	Capital expenditures on frontier oil fields, $ billions, 1980 prices.

POL07	"	Proportion of Alberta income saved.
POL08	"	Proportion of RoC income saved.
POL09	"	Not used in RD1.4.
POL10	"	Alberta oilsands production, $ billions, 1980 prices.
POL11	"	Constant in RPAELEC equation.
POL12	"	Coefficient of PWOIL in RPAELEC equation.
POL13	"	Constant in RPBELEC equation.
POL14	"	Coefficient of PWOIL in RPBELEC equation.
POL15	"	Constant in RPAOIL equation.
POL16	"	Coefficient of PWOIL in RPAOIL equation.
POL17	"	Constant in RPBOIL equation.
POL18	"	Coefficient of PWOIL IN RPBOIL equation.
POL21	"	Constant in RPAGAS equation.
POL22	"	Coefficient of PWOIL in RPAGAS equation.
POL23	"	Constant in RPBGAS equation.
POL24	"	Coefficient of PWOIL in RPBGAS equation.
POL25	"	Constant in SPOOIL equation.
POL26	"	Coefficient of PWOILD in SPOOIL equation.
POL27	"	Constant in SPNOIL equation.
POL28	"	Coefficient of PWOILD in SPNOIL equation.
POL29	"	Constant in SPGAS equation.
POL30	"	Coefficient of PWOILD in SPGAS equation.
POP	1	Population of Canada, millions.
POPA	1	Population of Alberta, millions.
POPAO	1	Number of original Albertans, millions.
POPB	1	Population of Rest-of-Canada, millions.
PREP	2	Canada price of reproducibles output, 1980 = 1.0.

PWEXREP	7	World currency price of reproducibles competing with Canadian exports, 1980 = 1.0.
PWIMREP	7	World currency price of reproducibles imports, 1980 = 1.0.
PY	7	GNP price deflator, 1980 = 1.0.
RAALT	9	Realized rents from Alberta alternative energy, $ billions.
RAELEC	9	Realized rents from Alberta electricity, $ billions.
RAGAS	9	Realized rents from Alberta natural gas, $ billions.
RAOIL	9	Realized rents from Alberta oil, $ billions.
RAOILGAS	9	Realized rents from Alberta oil and gas, $ billions.
RATRES	9	Total energy rents paid to Albertans, $ billions.
RBALT	9	Realized rents from RoC alternative energy, $ billions.
RBELEC	9	Realized rents from RoC electricity, $ billions.
RBGAS	9	Realized rents from RoC natural gas, $ billions.
RBOIL	9	Realized rents from RoC oil, $ billions.
RBOILGAS	9	Realized rents from RoC oil and gas, $ billions.
RBTRES	9	Total energy rents paid to RoC, $ billions.
RELWAGAB	1	Relative Alberta/RoC wage rate.
REPCONRA	12	Final consumption of reproducibles in Alberta net of investment, $ billions, 1980 prices.
REPCONRB	12	Final consumption of reproducibles in Alberta net of investment, $ billions, 1980 prices.
REPINENT	5	Total reproducibles inputs to energy sector, $ billions, 1980 prices.
RESAGAS	2	Remaining reserves of Alberta natural gas at start of year, $ billions, 1980 prices.
RESAGAS80	exogenous	Remaining reserves of Alberta natural gas at start of 1980, $ billions, 1980 prices.

RESANOIL	2	Remaining reserves of Alberta new oil at start of year, $ billions, 1980 prices.
RESANO80	exogenous	Remaining reserves of Alberta new oil at start of 1980, $ billions, 1980 prices.
RESAOOIL	2	Remaining reserves of Alberta old oil at start of year, $ billions, 1980 prices.
RESAOO80	exogenous	Remaining reserves of Alberta old oil at start of 1980, $ billions, 1980 prices.
RESBGAS	2	Remaining reserves of RoC natural gas at start of year, $ billions, 1980 prices.
RESBGAS80	exogenous	Remaining reserves of RoC natural gas at start of 1980, $ billions, 1980 prices.
RESBOIL	2	Remaining reserves of RoC oil at start of year, $ billions, 1980 prices.
RESBOIL80	exogenous	Remaining reserves of RoC oil at start of 1980, $ billions, 1980 prices.
RFAOILG	9	Realized Alberta oil and gas rents to foreigners, $ billions.
RFBOILG	9	Realized RoC oil and gas rents to foreigners, $ billions.
RGAAOILG	9	Realized Alberta oil and gas rents to Alberta government, $ billions.
RGABOILG	9	Realized RoC oil and gas rents to Alberta government, $ billions.
RGAOILG	9	Realized Alberta oil and gas rents to RoC government, $ billions.
RGBBOILG	9	Realized RoC oil and gas rents to RoC government, $ billions.
RIAAOILG	9	Realized Alberta oil and gas rents to Alberta industry, $ billions.
RIABOILG	9	Realized RoC oil and gas rents to Alberta industry, $ billions.
RIBAOILG	9	Realized Alberta oil and gas rents to RoC industry, $ billions.
RIBBOILG	9	Realized RoC oil and gas rents to RoC industry, $ billions.

RPAELEC	2	Alberta retail price of electricity, 1980 = 1.0.
RPAENT	2	Alberta retail price index of all energy, 1980 = 1.0.
RPAGAS	2	Alberta retail price of natural gas, 1980 = 1.0.
RPAOIL	2	Alberta retail price of oil, 1980 = 1.0.
RPBELEC	2	RoC retail price of electricity, 1980 = 1.0.
RPBENT	2	RoC retail price index of all energy, 1980 = 1.0.
RPBGAS	2	RoC retail price of natural gas, 1980 = 1.0.
RPBOIL	2	RoC retail price of oil, 1980 = 1.0.
RPENT	2	Canada retail price index of all energy, 1980 = 1.0.
SAVINGA	8	Alberta savings, $ billions.
SAVINGB	8	RoC savings, $ billions.
SHAELEC	4	Alberta electricity use as a proportion of total Alberta oil + gas + electricity use.
SHAGAS	4	Alberta natural gas use as a proportion of total Alberta oil + gas + electricity use.
SHAOIL	4	Alberta oil use as a proportion of total Alberta oil + gas + electricity use.
SHBELEC	4	RoC electricity use as a proportion of total RoC oil + gas + electricity use.
SHBGAS	4	RoC natural gas use as a proportion of total RoC oil + gas + electricity use.
SHBOIL	4	RoC oil use as a proportion of total RoC oil + gas + electricity use.
SPGAS	2	Selling price of natural gas, 1980 = 1.0.
SPNOIL	2	Selling price of new oil, 1980 = 1.0.
SPOOIL	2	Selling price of old oil, 1980 = 1.0.
UAGAP	1	Alberta number unemployed due to wage rates higher than in RoC, millions.
XAALT	2	Alberta production of alternative energy, $ billions, 1980 prices.

XAELEC	2	Alberta production of electricity, $ billions, 1980 prices.
XAGAS	2	Alberta production of natural gas, $ billions, 1980 prices.
XALT	2	Canada production of alternative energy, $ billion, 1980 prices.
XANOIL	2	Alberta production of new oil, $ billions, 1980 prices.
XAOIL	2	Alberta production of oil, $ billions, 1980 prices.
XAOOIL	2	Alberta production of old oil, $ billions, 1980 prices.
XAREP	6	Alberta reproducibles output, $ billions, 1980 prices.
XASOIL	2	Alberta production from oilsands, $ billions, 1980 prices.
XBALT	2	RoC production of alternative energy, $ billions, 1980 prices.
XBELEC	2	RoC production of electricity, $ billions, 1980 prices.
XBGAS	2	RoC production of natural gas, $ billions, 1980 prices.
XBOIL	2	RoC production of oil, $ billions, 1980 prices.
XBREP	6	RoC reproducibles output, $ billions, 1980 prices.
XENT	2	Total Canada energy production, $ billions, 1980 prices.
XOILGAS	2	Total Canada production of oil and gas, $ billions, 1980 prices.
XREP	6	Total Canada reproducibles output, $ billions, 1980 prices.
Y	11	Canada national income, $ billions.
YA	11	Alberta national income, $ billions.
YB	11	RoC national income, $ billions.
YPC	11	Canada income per capita, $ billions.

YPCA	11	Alberta income per capita, $ billions.
YPCAN	11	Income per capita of new Albertans, $ thousands.
YPCAO	11	Income per capita of original Albertans, $ thousands.
YPCB	11	RoC income per capita, $ thousands.

APPENDIX C: 1980 DATABASE FOR THESIS RD1.4

1. National and Regional Data, $ billions; and Employment, millions

Variable (mnemonic*)	Canada	Alberta	Rest of Canada	Sources, Notes
1. Gross Domestic Product at Market Prices	296.0	40.0	256.0	1979 values for Statistic Canada Provincial Economic Accounts (Experimental Data) grossed-up to 1980 using rate-of-growth figures from Bank of Canada Review, November 1981, Table 1, and Globe and Mail 'Report on Alberta', 21 September, 1981.
2. GDP at 'equivalent' prices	296.0	39.0	257.0	To get equivalence of units for the 1980 base year, Alberta oil sands output is revalued at the price paid for 'conventional' crude oil; and RoC natural gas is revalued at the average Alberta price. See lines 6 and 7, below.
3. Oil, value of shipments (excl. oilsands	7.31	6.18	1.13	Statistics Canada, 26-213, The Crude Petroleum and Natural Gas Industry, 1980.
4. Alberta 'old' oil (XAOIL)		5.18		The National Energy Program (NEP) originally distinguished for pricing purposes between 'old' oil produced from reserves proven before 1981, and 'new' oil from subsequent discoveries. In the May 1982 Update to NEP, however, prices for oil discovered since 1973, were increased to levels close to 'new' oil levels. An estimate of $1 billion
5. 'New' oil (XANOIL, XBOIL)		1.00	1.13	

*mnemonics given only for variables appearing in RD1.4

Variable (mnemonic*)	Canada	Alberta	Rest of Canada	Sources, Notes
				for the 1980 value of production in Alberta of this qusi- 'new' oil seems consistent with the figures given in the Update for the projected financial impact of the changes to the price schedule, for Simplicity, no distinction is attempted in the model between the two categories of 'new' oil, and all of the relatively small RoC 1980 production is assumed subject to the new oil price.
6. Oilsands value of shipments (XASOIL)	0.77	0.77	0.0	Statistics Canadda (op. cit.) report 1980 synthetic crude oil shipments of $1.72 billion. The average value per barrel shipped was $34.0. The value barrel of conventional oil was $15.4. Thus, to get oilsands into the same units as conventional oil, the value of shipments was multiplied by 0.45 (= 15.4/34.0).
7. Gas, value of shipments (XGAS, XAGAS, XBGAS)	9.0	7.5	1.5	'Gas' includes natural gas and liquefied petroleum gases. Statistics Canada (op. cit.) reports RoC 1980 gas shipments totalling $0.43 billion. This represents an average value per 000m^3 of $27.3, compared with value per 000m^3 in Alberta of $94.5. On the assumption that this difference in value is entirely due to a difference in price, RoC shipments werre multiplied by 3.5 (=94.5/27.3).

Variable (mnemonic*)	Canada	Alberta	Rest of Canada	Sources, Notes
8. Oil and Gas cost of materials, supplies, and electricity	0.440	0.320	0.120	loc. cit. Excludes oilsands.
9. Oil and gas salaries and wages	0.671	0.613	0.060	loc. cit. Excludes oilsands.
10. Oil and gas number of employees (000,000)	0.0274	0.0248	0.0026	loc. cit. Excludes oilsands.
11. Oil, cost of materials, etc.	0.196	0.144	0.052	Statistics Canada (op. cit.) does not disaggregate input costs to oil and gas separately.
12. Gas, cost of materials, etc.	0.244	0.176	0.068	Rows 8, 9 above were therefore allocated according to the ratios of value of shipments (rows 3, 7).
13. Oil, Wages and salaries	0.300	0.276	0.026	(excl. oilsands).
14. Gas, wages and salaries	0.371	0.337	0.034	
15. Oilsands, cost of materials, etc.	1.55	1.55	0.0	Statistics Canada does not give data on input costs of the synthetic oil plants.
16. Oilsands, wages and salaries	0.15	0.15	0.0	In a report in the Globe and Mail, March 20, 1982 it was stated that the Syncrude plant produced 4.7 million m^3 in 1981, approximately equal to its 1980 production; and employes 3000-4000 workers. This level of production represents about 60 per cent of total oilsands production. It is assumed that the industry employed 6000 workers. Then, on the assumption of a wage of $25,000 per workers, which is the average for the oil and gas industry as a whole, we get a

Variable (mnemonic*)	Canada	Alberta	Rest of Canada	Sources, Notes
				figure of $0.15 billion for wages and salaries. Then it was assumed that the oilsands industries dis not make a profit above depreciation and the opportunity cost of capital, giving $1.57 billion (=1.72-0.15) as the cost of materials.
17. Electricity, value of production (XAEKEC, XBEKEC)	8.70	0.75	7.95	Data on the electricity generating industry for 1979 are available in Statistics Canada 57-202 (preliminary) grossed up for 1980 on the assumption of a 4 per cent increase in real output and inputs and a 12 per cent increase in input and output prices.
18. Electricity, cost of mateirals, etc.	2.50	0.215	2.285	
19. Electricity wages and salaries	1.80	0.155	1.645	
20. Electricity, number of employees	0.114	0.010	0.104	
21. Alternative energy value of production	1.0	0.1	0.9	'Alternative' energy is the sum of renewable energy (excl. hydro-electricity) and energy substitutes, such as insulation and heat pumps. The value of production figures for 1980 are guesses.
22. Total value added in energy sector	22.3	13.2	9.1	Sum of lines 3, 6, 7, 17, 21; less sum of lines 8, 15, 18. For simplicity, value added is calculated assuming (a) all components of 'materials, etc.' are purchased from the reproducibles sector, and (b) that alternative energy value of production is all value added.

Variable (mnemonic*)	Canada	Alberta	Rest of Canada	Sources, Notes
23. Total value added in reproducibles sector (XREP, XAREP, XBREP)	273.7	26.8	246.9	line 1 minus line 22.
24. Wages and Salaries in reproducibles sector				
25. Number of employees in reproducibles sector				
26. Capital Stock in reproducibles sector	441.6	44.2	397.4	
27. Domestic Absorption of oil and gas	16.28			Total shipments (7.31 + 0.77 + 9.0) less 1980 net exports of oil and gas estimated at 0.8, in domestic 1980 prices.
28. Oil and gas inputs to reproducibles	11.56	2.03	9.53	Domestic absorption of oil and gas is divided between use as inputs to the reproducibles sector and
29. Oil and gas household consumption	4.72	0.57	4.15	use by households (own-use by energy sector is nette-out of the value of shipments data). National Energy Board (1981) data on end-use of energy are used to divide total Canada absorption between reproducibles and households on the assumption that 'transportation' use is split 50/50. This gives a 71/29 split overall. Inputs to reproducibles are split between Alberta and RoC using information on energy/GDP ratios culled from NEB (1981). Household consumption use is split between Alberta and RoC assuming similar

Variable (mnemonic*)	Canada	Alberta	Rest of Canada	Sources, Notes
				consumption/income ratios, and a ratio 12/88 of Alberta/RoC income.
30. Oil inputs to reproducibles (OILAREP, OILBREP)	7.28	1.28	6.00	Data from NEB (1981); especially Appendics G and H, were used to allocate input use between oil and gas.
31. Gas inputs to reproducibles (GASAREP, GASBREP)	4.28	0.75	3.53	
32. Oil household consumption (OILACON, OILBCON)	3.63	0.44	3.19	
33. Gas household consumption (GASACON, GASBCON)	1.09	0.13	0.96	
34. Domestic absorption of electricity	8.3			Total value of production (8.7) less 1980 net exports (0.8).
35. Electricity input to reproducibles ((ELECAREP, ELECBREP)	6.29	0.59	5.7	Electricity absorption split between reproducibles and households in ratio 75/25, from NEB (1981) data.
36. Electricity household consumption (ELECACON, ELECBCON)	2.01	0.24	1.77	Regional split to reproducibles calculated from NEB (1981) data; to households assuming similar consumption/income ratios and a 12/88 ratio of Alberta to RoC income, as for oil and gas (line 27).
37. Alternative energy input to reproducibles (ALTAREP, ALTBREP)	0.5	0.05	0.45	Absent any information to the contrary, 'alternative' energy is assumed to be divided equally between reproducibles and household use.
38. Alternative energy household consumption (ALTACON, ALTBCON)	0.5	0.05	0.45	

Variable (mnemonic*)	Canada	Alberta	Rest of Canada	Sources, Notes
39. Total energy input to reproducibles (ENTAREP, ENTBREP)	18.35	2.67	15.68	Sum of lines 30, 31, 35, 37.
40. Total energy household consumption (ENTACON, ENTBCON)	7.23	.86	6.37	Sum of lines 32, 33, 36, 38.
41. Exports of Reproducibles	81.3			
42. Imports of Reproducibles	80.0			
43. Population	23.92	2.08	21.84	
44. Reserves of 'old' oil	60.0	60.0	-	The NEB (1981) surveyed the major oil companies on their estimates of oil and gas reserves, and also provided their own forecasts, which usually, though not always, fall approximately in the middle of the range of survey responses. The NEB forecasts have been used as the basis for the numbers shown here. This gives us figures of 600 million m^3 of 'old' oil in Alberta, and 125 million m^3 in RoC. Conventional 'new' oil reserves are put at 750 and 250 million m^3 in Alberta and RoC. Valued at the 1980 price of \$100/m^3 (\$15.4/barrel), and lumping together RoC 'old' and 'new' oil as they are in the model, reserve estimates are as shown on lines 42 and 43. In addition to 'conventional' oil, Canada has its Alberta oilsands, and various 'frontier'
45. Reserves of 'new' oil	112.5	75.0	37.5	
46. Reserves of natural gas and LPGs	475.0	380.0	95.0	

Variable (mnemonic*)	Canada	Alberta	Rest of Canada	Sources, Notes
				resources in RoC. Estimates of the size of latter vary from 600 to 12,000 million m^3. Reserve estimates for non-conventional oil are not required in the model, since production is an exogenous policy variable. An apparently reasonable estimate for natural gas reserves in 5.7 trillion m^3, which is disposed between Alberta and RoC in the ratio 4/1. Liquefied petroleum gases reserves are put at about 750 milliom m^3. These are split between Alberta and RoC in the rtio 4/1. Given 1980 prices of $71 per 000^3 for natural gas, and $96 per m^3 for LPG, we get the $ billions figures of line 44.

Appendix D: Base Case Solution of Model

POLICY VARIABLES

YEAR	POL01	POL02	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	POL12	POL13	POL14	POL15	POL16	POL17	POL19	POL21	POL22	POL23	POL24	POL25	POL26	POL27	POL28	POL29	POL30
1979	0.15	0	0.00	0	0	0.00	0.00	0.00	0.00	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0.00	0	1	1.0	0
1980	0.15	0	7.95	0	0	0.23	0.23	1.00	0.77	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0.00	0	1	1.0	0
1981	0.15	0	8.10	0	1	0.23	0.23	1.05	0.80	1.1	0	1.1	0	1.2	0	1.2	0	1.2	0	1.2	0	1.2	0.00	0	1	1.2	0
1982	0.15	0	8.20	0	1	0.23	0.23	1.10	0.90	1.2	0	1.2	0	1.4	0	1.4	0	1.4	0	1.4	0	1.6	0.00	0	1	1.5	0
1983	0.15	0	8.30	0	1	0.23	0.23	1.15	1.00	1.3	0	1.3	0	1.6	0	1.6	0	1.6	0	1.6	0	0.0	0.75	0	1	1.8	0
1984	0.15	0	8.40	0	1	0.23	0.23	1.20	1.10	1.4	0	1.4	0	1.8	0	1.8	0	1.8	0	1.8	0	0.0	0.75	0	1	2.1	0
1985	0.15	0	8.50	0	1	0.23	0.23	1.25	1.20	1.5	0	1.5	0	2.0	0	2.0	0	2.0	0	2.0	0	0.0	0.75	0	1	0.0	1
1986	0.15	1	8.60	0	2	0.23	0.23	1.30	1.30	1.6	0	1.6	0	2.2	0	2.2	0	2.2	0	2.2	0	0.0	0.75	0	1	0.0	1
1987	0.15	1	8.70	0	2	0.23	0.23	1.35	1.40	1.7	0	1.7	0	2.4	0	2.4	0	2.4	0	2.4	0	0.0	0.75	0	1	0.0	1
1988	0.15	1	8.80	0	2	0.23	0.23	1.40	1.50	1.8	0	1.8	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1989	0.15	1	8.90	0	2	0.23	0.23	1.45	1.60	1.9	0	1.9	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1990	0.15	2	9.00	0	2	0.23	0.23	1.50	1.70	2.0	0	2.0	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1991	0.15	2	9.10	0	3	0.23	0.23	1.55	1.80	2.1	0	2.1	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1992	0.15	2	9.20	0	3	0.23	0.23	1.60	1.90	2.2	0	2.2	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1993	0.15	2	9.30	0	3	0.23	0.23	1.65	2.00	2.3	0	2.3	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1994	0.15	2	9.40	0	3	0.23	0.23	1.70	2.10	2.4	0	2.4	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1995	0.15	2	9.50	0	3	0.23	0.23	1.75	2.20	2.5	0	2.5	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1996	0.15	3	9.60	0	4	0.23	0.23	1.80	2.30	2.6	0	2.6	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1997	0.15	3	9.70	0	4	0.23	0.23	1.85	2.40	2.7	0	2.7	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1998	0.15	3	9.80	0	4	0.23	0.23	1.90	2.50	2.8	0	2.8	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
1999	0.15	3	9.90	0	4	0.23	0.23	1.95	2.60	2.9	0	2.9	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1
2000	0.15	3	10.00	0	4	0.23	0.23	2.00	2.70	3.0	0	3.0	0	0.0	1	0.0	1	0.0	1	0.0	1	0.0	0.75	0	1	0.0	1

OTHER EXOGENOUS VARIABLES

YEAR	PMOIL	IRWORLD
1979	2.30	0.1
1980	2.30	0.1
1981	2.30	0.1
1982	2.30	0.1
1983	2.35	0.1
1984	2.40	0.1
1985	2.45	0.1
1986	2.50	0.1
1987	2.55	0.1
1988	2.60	0.1
1989	2.65	0.1
1990	2.70	0.1
1991	2.75	0.1
1992	2.80	0.1
1993	2.85	0.1
1994	2.90	0.1
1995	2.95	0.1
1996	3.00	0.1
1997	3.05	0.1
1998	3.10	0.1
1999	3.15	0.1
2000	3.20	0.1

1990 VALUES USED AS CONSTANTS

YEAR	RESAGA80	RESAVD90	RESADD80	RESBGA80	RESBDI80
1990	390	75	60	95	37.5

__ MEANS DOUBLE LAG, _ MEANS SINGLE LAG

YEAR	__XAREP	_XAREP	__KSREP	_KSREP	__YPCA	_YPCA	__YPCB	_YPCB	__YPC	_YPC
1979	25.0000	.	240.000	.	15.0000	.	12.0000	.	12.3000	.
1980	25.0000	25.8000	240.000	246.900	15.0000	15.8000	12.0000	12.2900	12.3000	12.5000
1981	26.8000	28.3325	246.900	264.587	15.8000	15.7133	12.2900	13.2935	12.5000	13.5953
1982	28.3324	28.8435	264.587	273.500	16.7183	17.9317	13.2935	13.9311	13.5963	14.2050
1983	28.8435	28.8679	273.500	279.011	17.9317	18.5299	13.9311	14.3507	14.2050	14.7414
1984	28.8573	28.4954	279.011	283.812	18.5299	19.1425	14.3507	14.7996	14.7414	15.2153
1985	28.4954	27.3202	283.812	287.778	19.1425	20.0686	14.7996	15.2196	15.2153	15.6947
1986	27.3202	25.5156	287.778	291.080	20.0686	19.2890	15.2196	15.7270	15.6947	16.0947
1987	26.5156	25.7062	291.080	294.995	19.2890	19.1214	15.7270	16.0018	16.0847	16.3203
1988	26.7062	27.3285	294.995	299.553	19.1214	19.1722	16.0018	16.3133	16.3203	16.6392
1989	27.3285	28.2261	299.553	305.920	19.1722	19.4825	16.3133	16.7073	16.6392	16.9980
1990	28.2261	29.2016	305.920	311.864	19.4825	19.8416	16.7073	17.1692	16.9980	17.4522
1991	29.2016	30.5209	311.864	318.153	19.9416	19.9427	17.1692	17.5246	17.4522	17.7832
1992	30.5209	32.0258	318.153	324.978	19.9427	20.3493	17.5246	17.9121	17.7832	18.1751
1993	32.0258	33.4754	324.978	331.643	20.3493	20.7526	17.9121	18.3219	18.1751	18.5864
1994	33.4754	34.9365	331.643	339.099	20.7526	21.1076	18.3219	18.7201	18.5864	18.9923
1995	34.9355	35.5321	339.099	344.733	21.1095	21.5178	18.7201	19.1152	18.9923	19.3598
1996	36.5321	38.2680	344.733	351.333	21.5178	21.7970	19.1152	19.5821	19.3598	19.8287
1997	38.2680	40.1904	351.333	358.417	21.7970	22.0835	19.5821	19.9736	19.8287	20.2101
1998	40.1904	42.0991	358.417	365.813	22.0835	22.5506	19.9736	20.4130	20.2101	20.6514
1999	42.0991	43.9108	365.813	372.881	22.5506	22.9948	20.4130	20.8576	20.6514	21.1000
2000	43.9108	45.7209	372.891	379.760	22.9948	23.3973	20.8576	21.2964	21.1000	21.5353

BLOCK 1 POPULATION, LABOUR FORCE AND WAGE RATES

YEAR	RELWAGAB	EMIG	FMIG	FMIGA	FMIGB	IMIGA	NMIGA	POPAO	POPA	POPB	POP	LATOT	LBTOT	WAGAP
1979	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1980	.	.	.	.	.	.	0.0000000	2.09000	2.09000	21.8400	23.9200	.	.	.
1981	1.06482	0.0717600	0.0792400	0.0112445	0.0659955	0.0496099	0.0603855	2.09040	2.15125	21.9666	24.1178	0.88945	8.12764	0.0140759
1982	1.05904	0.0723535	0.0776465	0.0109590	0.0666875	0.0442567	0.116374	2.10085	2.21723	22.0988	24.3161	0.91799	8.17657	0.0132591
1983	1.06707	0.0729482	0.0770518	0.0118045	0.0652423	0.0517455	0.180511	2.11135	2.29197	22.2228	24.5147	0.94709	8.22245	0.0154951
1984	1.05598	0.0735441	0.0764559	0.0119172	0.0645387	0.0507109	0.244042	2.12191	2.35596	22.3478	24.7137	0.97795	8.26868	0.0157475
1985	1.06644	0.0741412	0.0758588	0.0121500	0.0637089	0.0511497	0.308562	2.13252	2.44108	22.4721	24.9132	1.00890	8.31467	0.0163565
1986	1.07159	0.0747395	0.0752605	0.0128218	0.0624387	0.0551421	0.379069	2.14319	2.52225	22.5907	25.1130	1.04119	8.35857	0.0181543
1987	1.05236	0.0753390	0.0746610	0.0112801	0.0633809	0.0383253	0.430569	2.15390	2.59447	22.7287	25.3132	1.07172	8.40964	0.0137625
1988	1.04553	0.0759397	0.0740603	0.0107913	0.0532531	0.0325219	0.476041	2.16467	2.64071	22.8731	25.5138	1.09692	8.46336	0.0122778
1989	1.04120	0.0765415	0.0734585	0.0105014	0.0629570	0.0299725	0.517895	2.17549	2.69339	23.0215	25.7149	1.11985	8.51795	0.0113596
1990	1.03917	0.0771446	0.0728554	0.0103765	0.0524789	0.0273451	0.558206	2.18637	2.74458	23.1717	25.9163	1.14173	8.57354	0.0110182
1991	1.03682	0.0777489	0.0722511	0.0102186	0.0620325	0.0254977	0.596714	2.19730	2.79402	23.3241	26.1181	1.16293	8.62992	0.0105613
1992	1.03284	0.0783546	0.0716456	0.0099205	0.0517201	0.0226213	0.632044	2.20829	2.84033	23.4800	26.3204	1.18334	8.68761	0.0099989
1993	1.03241	0.0789611	0.0710389	0.0098942	0.0611445	0.0220595	0.667188	2.21933	2.89652	23.6365	26.5230	1.20271	8.74550	0.0096283
1994	1.03163	0.0795690	0.0704310	0.0098338	0.0605972	0.0215031	0.701861	2.23043	2.93229	23.7938	26.7261	1.22201	8.80369	0.0095517
1995	1.03049	0.0801782	0.0698218	0.0097410	0.0600838	0.0206396	0.735751	2.24158	2.97733	23.9522	26.9295	1.24113	8.86231	0.0093536
1996	1.02884	0.0807885	0.0692115	0.0096056	0.0595047	0.0194124	0.759449	2.25279	3.02124	24.1121	27.1336	1.25993	8.92149	0.0089883
1997	1.02715	0.0814001	0.0685999	0.0094641	0.0591359	0.0191545	0.799919	2.26405	3.05397	24.2737	27.3376	1.27828	8.98126	0.0085896
1998	1.02542	0.0820129	0.0679871	0.0093147	0.0586724	0.0169038	0.830139	2.27537	3.10551	24.4360	27.5423	1.29615	9.04162	0.0081602
1999	1.02525	0.0826269	0.0673731	0.0092736	0.0580995	0.0167776	0.860339	2.28675	3.14709	24.6003	27.7474	1.31356	9.10211	0.0082137
2000	1.02469	0.0832422	0.0667578	0.0092029	0.0575550	0.0153735	0.890217	2.29818	3.19840	24.7645	27.9529	1.33099	9.16286	0.0081399

BLOCK 2 PRICES AND ENERGY SUPPLY

YEAR	RPAELEC	RPBELEC	RPAOIL	RPBOIL	RPAGAS	RPBGAS	SPOOIL	SPVOIL	SPGAS	PAALT	PBALT	RPAENT
1979	.	.	.	.	.	.	.	.	.	.	.	.
1980	1.0	1.0	1.00000	1.00000	1.00000	1.00000	1.00000	.	1.00000	1.00000	1.00000	1.00000
1981	1.1	1.1	1.20000	1.20000	1.20000	1.20000	1.20000	2.30000	1.20000	1.17550	1.16400	1.17550
1982	1.2	1.2	1.40000	1.40000	1.40000	1.40000	1.60000	2.33967	1.50000	1.35283	1.32836	1.35283
1983	1.3	1.3	1.60000	1.60000	1.60000	1.60000	1.84574	2.46233	1.80000	1.52925	1.49253	1.52925
1984	1.4	1.4	1.80000	1.80000	1.80000	1.80000	1.90495	2.53993	2.10000	1.70510	1.65655	1.70510
1985	1.5	1.5	2.00000	2.00000	2.00000	2.00000	1.94243	2.58987	2.58987	1.88139	1.82373	1.88139
1986	1.6	1.6	2.20000	2.20000	2.20000	2.20000	1.88339	2.50719	2.50719	2.05728	1.98557	2.05728
1987	1.7	1.7	2.40000	2.40000	2.40000	2.40000	1.74552	2.32736	2.32736	2.23211	2.14956	2.23211
1988	1.8	1.8	2.29039	2.29039	2.29039	2.29039	1.71779	2.29039	2.29039	2.17419	2.11419	2.17419
1989	1.9	1.9	2.31056	2.31056	2.31056	2.31056	1.73292	2.31056	2.31056	2.21358	2.16209	2.21358
1990	2.0	2.0	2.34398	2.34398	2.34398	2.34398	1.75799	2.34398	2.34398	2.26259	2.22063	2.26259
1991	2.1	2.1	2.30045	2.30045	2.30045	2.30045	1.72534	2.30045	2.30045	2.25311	2.22860	2.25311
1992	2.2	2.2	2.31047	2.31047	2.31047	2.31047	1.73285	2.31047	2.31047	2.28443	2.27092	2.28443
1993	2.3	2.3	2.35568	2.35568	2.35568	2.35568	1.76676	2.35568	2.35568	2.34261	2.33578	2.34261
1994	2.4	2.4	2.38578	2.38578	2.38578	2.38578	1.78934	2.38578	2.38578	2.38911	2.39086	2.38911
1995	2.5	2.5	2.38918	2.38918	2.38918	2.38918	1.79188	2.38918	2.38918	2.41505	2.42868	2.41505
1996	2.6	2.6	2.39423	2.39423	2.39423	2.39423	1.78317	2.39423	2.39423	2.43444	2.46133	2.43444
1997	2.7	2.7	2.34400	2.34400	2.34400	2.34400	1.75800	2.34400	2.34400	2.42652	2.47047	2.42652
1998	2.8	2.8	2.36448	2.36448	2.36448	2.36448	1.77336	2.36448	2.36448	2.46505	2.51[illegible]	2.46505
1999	2.9	2.9	2.40515	2.40515	2.40515	2.40515	1.80395	2.40515	2.40515	2.51895	2.58019	2.51895
2000	3.0	3.0	2.42705	2.42705	2.42705	2.42705	1.82029	2.42705	2.42705	2.55835	2.62936	2.55835

BLOCK 2 PRICES AND ENERGY SUPPLY

YEAR	RPMENT	RPEVT	PREP	PAREP	PBREP	RESAJOIL	XAOOIL	RESANOIL	XANOIL	XASOIL	XAOIL	RESAGAS
1979	.	.	.	.	.	.	.	.	.	.	.	.
1980	1.00000	1.00000	1.00000	1.00000	1.00000	60.0000	5.20000	75.0000	1.00000	0.77	7.00000	380.000
1981	1.16400	1.16559	0.99995	0.99996	0.99996	54.9000	4.95045	74.0000	1.27956	0.80	7.03031	372.500
1982	1.32836	1.33184	0.99868	0.99868	0.99868	49.8496	4.72155	72.7204	1.55951	0.90	7.18106	364.618
1983	1.49250	1.49753	0.99643	0.99643	0.99643	45.1280	4.49239	71.1509	1.84540	1.00	7.33778	355.938
1984	1.65655	1.66312	0.99341	0.99341	0.99341	40.6356	4.26292	69.3155	2.11719	1.10	7.48012	346.189
1985	1.82070	1.82876	0.98978	0.98978	0.98978	35.3727	4.03313	67.1983	2.35866	1.20	7.59179	335.190
1986	1.98467	1.99412	0.98562	0.98552	0.98552	32.3336	3.80296	64.8397	2.52397	1.30	7.62692	322.548
1987	2.14856	2.15905	0.98106	0.98104	0.98106	29.5366	3.57236	62.3157	2.57994	1.40	7.55231	308.879
1988	2.11419	2.12132	0.97001	0.97001	0.97001	24.9542	3.34128	59.7358	2.58556	1.50	7.42684	294.912
1989	2.16239	2.16937	0.96180	0.96180	0.96180	21.5230	3.10965	57.1502	2.56931	1.60	7.27796	280.963
1990	2.22063	2.22584	0.95390	0.95390	0.95390	19.5133	2.87737	54.5919	2.53631	1.70	7.11368	267.158
1991	2.22860	2.23169	0.94456	0.94455	0.94455	15.5159	2.64433	52.0455	2.45738	1.80	6.91171	253.557
1992	2.27092	2.27265	0.93629	0.93528	0.93629	12.9916	2.41038	49.5782	2.38757	1.90	6.69795	240.371
1993	2.33578	2.33567	0.92871	0.92871	0.92971	10.5912	2.17531	47.1906	2.31046	2.00	6.48577	227.631
1994	2.39086	2.39352	0.92089	0.92099	0.92019	8.5359	1.93995	44.8302	2.23398	2.10	6.26936	215.217
1995	2.42868	2.42693	0.91265	0.91265	0.91265	6.6571	1.70062	42.6492	2.14281	2.20	6.04353	203.220
1996	2.46103	2.45735	0.90431	0.90431	0.90431	4.7664	1.45999	40.5064	2.04695	2.30	5.80694	191.669
1997	2.47047	2.46629	0.89545	0.89545	0.89545	3.3064	1.21800	38.4594	1.93802	2.40	5.55402	180.537
1998	2.51880	2.51115	0.88766	0.88756	0.88755	2.0734	0.96688	36.5214	1.83603	2.50	5.30291	169.951
1999	2.58019	2.57122	0.88024	0.88024	0.88024	1.1236	0.70885	34.6954	1.74469	2.60	5.05353	159.845
2000	2.62936	2.61976	0.87256	0.87256	0.87256	0.4147	0.43065	32.9407	1.65793	2.70	4.78858	150.161

BLOCK 2 PRICES AND ENERGY SUPPLY

YEAR	XAGAS	XAELEC	KAALT	RESBOIL	K3OIL	RESBGAS	XBGAS	K3ELEC	KBALT	KALT	KOILGAS	RENT
1979	.	.	.	.	.	.	.	.	.	.	.	.
1980	7.5000	0.750000	0.100000	37.5000	1.13000	95.0000	1.50000	7.95	0.90000	1.00000	17.0830	26.7800
1981	7.8823	0.830000	0.114028	36.3700	1.43971	93.5000	1.66676	8.10	1.01871	1.13274	19.0187	28.0815
1982	8.6799	0.860084	0.136554	34.9303	1.73869	91.8332	2.04226	8.20	1.20870	1.34535	19.6419	30.0474
1983	9.7490	0.924387	0.155553	33.1915	2.02742	89.7910	2.61134	8.30	1.45125	1.51691	21.7250	32.4579
1984	10.9986	0.772826	0.199887	31.1642	2.27784	87.1791	3.37826	8.40	1.73688	1.93676	24.1348	35.2444
1985	12.6420	0.709796	0.238763	28.8864	2.45765	83.8039	4.54214	8.50	2.06015	2.29892	27.2436	38.7513
1986	13.5633	0.555407	0.291385	26.4137	3.54782	79.2597	5.40447	8.60	2.41756	2.59950	30.2495	42.2035
1987	13.9670	0.595756	0.328808	23.8709	3.49212	73.8543	5.73903	8.70	2.80756	3.13637	30.7464	43.1786
1988	13.9489	0.517134	0.351713	21.3788	3.37045	69.1192	5.80276	8.80	3.01917	3.37088	30.5490	43.2370
1989	13.8047	0.539065	0.372394	19.0093	3.21730	62.3155	5.75234	8.90	3.21592	3.58922	30.0520	43.0503
1990	13.5916	0.540246	0.393446	16.7910	4.04655	56.5644	5.62834	9.00	3.42075	3.81419	30.3802	43.7346
1991	13.1956	0.552508	0.407195	14.7445	3.34759	50.9361	5.33958	9.10	3.57255	3.97975	29.2946	42.9259
1992	12.7704	0.551562	0.422765	12.8959	3.64969	45.5955	5.01895	9.20	3.74005	4.16282	28.1359	42.0502
1993	12.3635	0.585478	0.443388	11.2481	3.46293	40.5777	4.72238	9.30	3.94769	4.39107	27.0546	41.3311
1994	11.9970	0.609572	0.465447	9.7852	3.29490	35.9553	4.42105	9.40	4.16878	4.63423	25.9757	40.6195
1995	11.5715	0.517746	0.495595	8.4963	3.12477	31.4342	4.08850	9.50	4.37822	4.96382	24.9292	39.8397
1996	11.1116	0.630073	0.503991	7.3715	3.97286	27.3457	3.73356	9.60	4.57715	5.08114	24.6249	39.9361
1997	10.5863	0.549209	0.517344	6.3985	3.33193	23.5122	3.34304	9.70	4.74361	5.25795	23.3152	38.9224
1998	10.1066	0.672463	0.535713	5.5657	3.71069	20.2591	2.99396	9.80	4.94443	5.48014	22.1139	38.3665
1999	9.6840	0.701468	0.559625	4.8561	3.61864	17.2752	2.69035	9.90	5.19319	5.75281	21.0356	37.3912
2000	9.2784	0.721239	0.584491	4.2474	3.52138	14.5848	2.40595	10.00	5.45236	6.03685	19.9943	36.7524

BLOCK 3 ENERGY INPUTS TO REPRODUCIBLES SECTOR

YEAR	ENTAREP	ENTBREP	ALTAREP	ALTBREP	OILAREP	OILBREP	GASAREP	GASBREP	ELECAREP	ELECBREP
1979	.	.	.	.	.	.	.	.	.	.
1980	2.67000	15.6800	0.050000	0.45000	1.29000	6.00000	0.750000	3.53000	0.590000	5.70000
1981	2.97295	16.2559	0.057014	0.50735	1.37293	5.11052	0.824932	3.55810	0.618183	5.97792
1982	2.76254	16.8193	0.068327	0.60435	1.30703	6.26091	0.797107	3.80470	0.590080	6.14927
1983	2.52293	15.6885	0.082926	0.72563	1.17785	5.74866	0.729179	3.54628	0.533072	5.66798
1984	2.33220	14.9843	0.099943	0.96946	1.07214	5.35795	0.673772	3.35521	0.486335	5.30271
1985	2.14696	14.3082	0.119381	1.03008	0.96398	5.05060	0.618145	3.21054	0.440450	5.01695
1986	1.89985	13.7694	0.140923	1.20333	0.93541	4.75383	0.551536	3.06756	0.380897	4.73713
1987	1.78126	13.2788	0.164404	1.40375	0.75501	4.47196	0.502887	2.92929	0.348963	4.47375
1988	1.78323	12.9791	0.175857	1.50959	0.75573	4.27897	0.504961	2.84523	0.345681	4.29528
1989	1.86792	13.1873	0.186197	1.50941	0.79778	4.31707	0.533529	2.91395	0.360310	4.34789
1990	1.92168	13.3332	0.196723	1.71037	0.80401	4.31182	0.552848	2.95439	0.368103	4.35559
1991	1.96159	13.3357	0.203598	1.78628	0.81532	4.26324	0.569099	2.96525	0.373577	4.32096
1992	2.06541	13.5232	0.211383	1.97033	0.85557	4.28007	0.606217	3.02195	0.392239	4.35114
1993	2.15137	13.6412	0.221694	1.97384	0.89504	4.26391	0.637296	3.05606	0.406345	4.34741
1994	2.20315	13.6582	0.232224	2.08439	0.90023	4.20863	0.657292	3.06201	0.412897	4.30319
1995	2.26370	13.5905	0.248797	2.18911	0.91969	4.16147	0.690907	3.07345	0.421305	4.26558
1996	2.34832	13.7901	0.251995	2.28857	0.94923	4.14074	0.713418	3.10436	0.434683	4.25647
1997	2.44319	13.8911	0.258672	2.37030	0.98319	4.12698	0.750902	3.14080	0.450427	4.25302
1998	2.56205	14.0885	0.267455	2.47222	1.02775	4.14057	0.776903	3.19869	0.470428	4.27723
1999	2.54693	14.1850	0.279312	2.59559	1.05477	4.10990	0.830107	3.22306	0.492241	4.25547
2000	2.70745	14.2081	0.292246	2.72619	1.07083	4.05181	0.855481	3.22553	0.488892	4.23457

BLOCK 4 ENERGY INPUTS TO HOUSEHOLDS

YEAR	ENTACON	ENTBCON	ALTACON	ALTBCON	OILACON	OILBCON	GASACON	GASBCON
1979	.	.	.	.	.	.	.	.
1980	0.86000	6.37000	0.050000	0.45000	0.440000	3.19000	0.130000	0.960000
1981	0.83770	6.51465	0.057016	0.50835	0.454711	3.17295	0.134279	0.954343
1982	0.87190	6.63676	0.068327	0.50435	0.437512	3.22509	0.131152	0.904603
1983	0.90022	6.16701	0.082926	0.72563	0.442873	2.99460	0.134766	0.897135
1984	0.85558	5.95148	0.099943	0.85844	0.407427	2.69049	0.125853	0.846478
1985	0.84712	5.71233	0.119391	1.03008	0.390374	2.46599	0.122408	0.787571
1986	0.86591	5.48649	0.140923	1.20883	0.386959	2.24167	0.123171	0.726749
1987	0.73035	5.35017	0.154436	1.40371	0.330433	2.06297	0.097065	0.678921
1988	0.72359	5.13375	0.175357	1.50959	0.239490	1.38031	0.094952	0.628161
1989	0.78772	5.52597	0.196197	1.60841	0.316279	2.02239	0.105307	0.605839
1990	0.81142	5.60336	0.195723	1.71037	0.321592	1.99769	0.108694	0.688386
1991	0.82849	5.70244	0.203599	1.73529	0.325298	2.00156	0.111609	0.699445
1992	0.85203	5.91212	0.211303	1.87003	0.331837	2.05562	0.115573	0.729191
1993	0.89053	6.03231	0.221596	1.97394	0.344659	2.05450	0.121953	0.739450
1994	0.90848	6.11565	0.232724	2.09430	0.346540	2.02971	0.124369	0.741928
1995	0.92998	6.23135	0.242797	2.19911	0.350588	2.02508	0.127724	0.751425
1996	0.95646	6.39602	0.251995	2.29857	0.357665	2.04749	0.132271	0.771221
1997	0.98625	6.57414	0.258672	2.37030	0.367561	2.08509	0.137985	0.797253
1998	1.02473	6.80735	0.267556	2.47222	0.380454	2.13949	0.144984	0.830416
1999	1.05992	6.94439	0.279912	2.59559	0.390175	2.13501	0.150935	0.841201
2000	1.09226	7.05302	0.292245	2.72513	0.393160	2.11904	0.155389	0.847525

YEAR	ELECACON	ELECBCON	SHAOIL	SHAGAS	SHAELEC	SHBOIL	SHBGAS	SHBELEC
1979	.	.	.	.	.	.	.	.
1980	0.240000	1.77000	0.500000	0.255000	0.245000	0.430000	0.210000	0.360000
1981	0.241902	1.77800	0.501159	0.262998	0.235844	0.429762	0.213028	0.359210
1982	0.234907	1.82264	0.498770	0.265392	0.235838	0.426387	0.215282	0.358330
1983	0.239754	1.54955	0.497535	0.255219	0.237245	0.423500	0.217759	0.359532
1984	0.222461	1.54607	0.495172	0.267613	0.237215	0.421408	0.219996	0.358595
1985	0.214957	1.42869	0.493358	0.269772	0.237870	0.418510	0.222608	0.358802
1986	0.214858	1.30925	0.492513	0.267643	0.239844	0.415454	0.225340	0.359206
1987	0.168175	1.21450	0.498162	0.274892	0.236946	0.412783	0.227915	0.359302
1988	0.163384	1.11569	0.485440	0.279357	0.236203	0.409427	0.230888	0.359685
1989	0.179935	1.20932	0.483550	0.279837	0.236613	0.409091	0.232297	0.359612
1990	0.194405	1.20491	0.481097	0.282753	0.236150	0.405780	0.234779	0.358442
1991	0.197795	1.21515	0.479570	0.285655	0.235665	0.405079	0.236959	0.357953
1992	0.193239	1.25728	0.475976	0.289333	0.234692	0.403669	0.238998	0.357333
1993	0.202227	1.26522	0.473633	0.292158	0.234209	0.401730	0.241358	0.356912
1994	0.204949	1.25962	0.471153	0.295392	0.233448	0.399763	0.243762	0.356474
1995	0.208767	1.26572	0.468718	0.299610	0.232672	0.399010	0.246072	0.355918
1996	0.214526	1.28875	0.455253	0.301947	0.231795	0.396552	0.248291	0.355256
1997	0.222036	1.32150	0.453340	0.305239	0.230920	0.395053	0.250439	0.354530
1998	0.231440	1.36525	0.451426	0.308594	0.229980	0.393690	0.252584	0.353726
1999	0.238998	1.37155	0.459117	0.311716	0.229166	0.391870	0.255036	0.353096
2000	0.242468	1.37028	0.456752	0.315070	0.228178	0.390097	0.257483	0.352420

BLOCK 5 TOTAL COSTS AND INPUTS TO ENERGY SECTOR

YEAR	COSTANOI	COSTAJOI	COSTASOI	COSTAGAS	COSTAOIL	COSTBOIL	COSTBGAS	COSTAELE	COSTBELE	COSTAALT	COSTBALT	CAOILGAS	CBOILGAS
1979	.	.	.	.	.	.	.	.	.	.	.	.	.
1980	.	.	.	.	.	.	.	.	.	.	.	.	.
1981	0.20690	0.235257	1.76	0.5527	2.20215	0.02010	0.17356	0.454649	4.05759	0.073685	0.65508	2.9649	0.18436
1982	0.56483	0.247977	1.98	1.5749	2.79251	0.40692	0.59541	0.487589	4.15339	0.098313	0.85955	4.3677	1.00232
1983	0.98049	0.260756	2.20	2.9406	3.44125	0.83304	1.31390	0.447484	4.25592	0.133694	1.15043	6.3019	2.14694
1984	1.42222	0.273460	2.42	4.7547	4.11568	1.24923	2.41639	0.391595	4.35590	0.180425	1.53147	8.3704	3.66562
1985	1.85395	0.285929	2.64	7.4941	4.77930	1.60292	4.35258	0.328180	4.43370	0.239410	2.00849	12.2740	5.35550
1986	2.17625	0.297956	2.86	9.4778	5.33422	2.29555	5.39553	0.279432	4.51957	0.311477	2.59764	14.9120	7.23218
1987	2.30315	0.309336	3.08	10.1955	5.57250	2.23156	5.71699	0.222938	4.61377	0.397353	3.27595	15.9971	8.14553
1988	2.33538	0.319755	3.30	10.3201	5.95513	2.05953	5.93180	0.171208	4.65727	0.438673	3.64875	16.2752	8.97133
1989	2.32393	0.328986	3.52	10.2009	6.17281	1.83519	6.91564	0.164503	4.72342	0.476110	4.00170	16.3737	8.75082
1990	2.28416	0.336325	3.74	9.9494	6.38059	2.08591	6.75499	0.183751	4.79048	0.514898	4.37474	16.3099	8.84090
1991	2.17292	0.341593	3.96	9.3937	6.57451	1.79769	6.26040	0.190303	4.84945	0.538013	4.64077	15.3182	8.35808
1992	2.04182	0.344118	4.18	8.6910	6.55575	1.52123	5.70939	0.194971	4.91331	0.565152	4.94271	15.2570	7.22967
1993	1.91727	0.343221	4.40	8.1211	6.66049	1.27439	5.21275	0.210111	4.99012	0.603735	5.33682	14.7816	6.49712
1994	1.78969	0.338096	4.62	7.5606	6.74778	1.05610	4.71541	0.225101	5.04495	0.645952	5.76681	14.3083	5.77152
1995	1.64774	0.327731	4.84	6.9385	6.91547	0.85157	4.16713	0.229862	5.10572	0.684041	6.17486	13.7540	5.02880
1996	1.49408	0.310950	5.06	6.2675	5.75503	1.12279	3.59930	0.235946	5.15719	0.719135	6.56142	13.1324	4.73109
1997	1.32034	0.286222	5.28	5.4992	6.89657	1.04541	2.95959	0.249089	5.22368	0.740191	6.86445	12.3857	4.03599
1998	1.16224	0.251519	5.50	4.8265	6.91376	0.93016	2.42053	0.264929	5.28558	0.774119	7.26584	11.7403	3.35069
1999	1.02517	0.203788	5.72	4.2632	6.94836	0.83993	1.97245	0.286191	5.34888	0.821533	7.79081	11.2122	2.81233
2000	0.89826	0.136931	5.94	3.7308	6.97539	0.76954	1.56755	0.299568	5.40985	0.871570	8.32694	10.7139	2.33609

YEAR	LAOILGAS	LBOILGAS	LAELEC	LBELEC	LAALT	LBALT	INAOILGA	INBOILGA	INAELEC	INBELEC	INAALT	INBALT	REPINENT
1979	.	.	.	.	.	.	.	.	.	.	.	.	.
1980	.	.	.	.	.	.	.	.	.	.	.	.	.
1981	0.071625	0.034951	0.0118215	0.105753	0.0020533	0.013353	1.15531	1.07752	0.253711	2.35936	0.036844	0.32755	5.2111
1982	0.109336	0.025071	0.0126940	0.104391	0.0027554	0.024099	1.74939	1.40166	0.293176	2.41795	0.049221	0.43034	6.3315
1983	0.160119	0.053966	0.0116763	0.111051	0.0037557	0.032329	2.55190	1.96196	0.260472	2.47728	0.067087	0.57728	7.9059
1984	0.223230	0.072248	0.0102490	0.114743	0.0050154	0.043155	3.57169	2.47597	0.229531	2.53734	0.090811	0.77391	9.5753
1985	0.310020	0.150426	0.0096210	0.115467	0.0057727	0.055817	4.96033	3.40641	0.192316	2.59911	0.120942	1.01462	12.2931
1986	0.375702	0.210075	0.0073712	0.119224	0.0099495	0.073511	6.01123	5.35119	0.156435	2.55963	0.158010	1.31259	15.5572
1987	0.404905	0.227987	0.0060905	0.122012	0.0113412	0.093500	6.47849	5.64779	0.135865	2.72181	0.202522	1.66964	16.9561
1988	0.419463	0.231734	0.0045891	0.124833	0.0126626	0.105324	6.71140	5.70774	0.102371	2.78474	0.226119	1.88079	17.4132
1989	0.425600	0.227459	0.0044470	0.127687	0.0138606	0.115500	6.90960	5.63935	0.099201	2.84839	0.247510	2.08036	17.7244
1990	0.427454	0.231704	0.0050084	0.130572	0.0151139	0.129413	6.93926	5.70727	0.111726	2.91276	0.269891	2.29308	18.1340
1991	0.418676	0.213282	0.0052384	0.133490	0.0159490	0.137572	6.69882	6.41251	0.116856	2.97785	0.284803	2.45664	19.0475
1992	0.407382	0.193015	0.0054114	0.136440	0.0169012	0.147814	6.51811	6.08825	0.120717	3.04365	0.301807	2.63954	18.7121
1993	0.397905	0.174526	0.0058822	0.139422	0.0182021	0.159901	6.35647	5.79602	0.131218	3.11018	0.325038	2.87323	19.5002
1994	0.390436	0.156582	0.0063554	0.142435	0.0195403	0.175461	6.21499	5.50692	0.141774	3.17743	0.350720	3.13109	19.5229
1995	0.376761	0.137753	0.0065484	0.145483	0.0209864	0.193455	6.02818	5.20405	0.146081	3.24539	0.374756	3.38294	18.3816
1996	0.363050	0.132174	0.0068124	0.148562	0.0222354	0.203159	5.80879	6.11479	0.151969	3.31407	0.397061	3.62784	19.4145
1997	0.345795	0.111343	0.0072325	0.151573	0.0231652	0.214555	5.59275	5.79969	0.151360	3.39349	0.413307	3.93297	19.1133
1998	0.330651	0.094358	0.0077599	0.154915	0.0244136	0.229190	5.29362	5.50939	0.173104	3.45363	0.436042	4.39267	19.9557
1999	0.318441	0.077974	0.0084533	0.157992	0.0251326	0.247506	5.09535	5.27799	0.193575	3.52444	0.466653	4.61971	19.9724
2000	0.306968	0.066932	0.0089264	0.161200	0.0279684	0.267208	4.91149	5.07092	0.199127	3.59600	0.499435	4.77150	19.0485

BLOCK 6 REPRODUCIBLE SUPPLY

YEAR	LAREP	LBREP	KAREP	KBREP	KREP
1979	.	.	25.0000	240.000	265.000
1980	.	.	26.8000	246.900	273.700
1981	0.803341	7.97959	28.3324	264.537	292.920
1982	0.793139	8.01199	28.9435	273.403	302.346
1983	0.771537	8.02521	28.8679	279.011	307.878
1984	0.739337	8.01952	28.4954	283.812	312.308
1985	0.693435	7.99095	27.3202	287.778	315.098
1986	0.649271	7.95576	26.5156	291.080	317.596
1987	0.649370	7.95514	26.7062	294.995	321.701
1988	0.660107	8.00117	27.3295	299.553	326.892
1989	0.675955	8.04530	28.2251	305.920	334.146
1990	0.694127	8.09295	29.2016	311.864	341.066
1991	0.723062	8.14558	30.5209	318.153	348.674
1992	0.753647	8.21034	32.0258	324.978	357.003
1993	0.790721	8.27055	33.4754	331.643	365.119
1994	0.807573	8.32923	34.9355	338.398	373.335
1995	0.836929	8.39952	36.5321	344.733	381.265
1996	0.867835	8.43759	38.2680	351.333	389.601
1997	0.902104	8.50309	40.1804	358.417	398.597
1998	0.933926	8.55326	42.0001	365.913	407.912
1999	0.953535	8.61576	43.9138	372.881	416.791
2000	0.987125	8.65752	45.7239	379.758	425.481

BLOCK 7 OTHER PRICES AND EXCHANGE RATE

YEAR	CUMRJP	NEKOIL	NEKGAS	NEKAELEC	NEKBELEC	NEKENT	EXCH	PEXREP	PWEKREP	PWIMREP	PIMREP	PY
1979	.	.	.	.	.	.	.	.	.	.	.	1.00000
1980	0.000	.	.	.	.	1.2000	1.00000	1.00000	1	1.00000	1.00000	1.00000
1981	-2.000	-2.5514	3.9775	-0.030384	0.36639	1.5501	1.01531	0.93361	1	0.99005	1.00570	1.01443
1982	-7.040	-2.3138	5.0044	0.035198	0.22309	2.9569	1.04780	0.95312	1	0.98020	1.02705	1.02880
1983	-14.217	-0.8998	7.0534	0.052060	0.98237	7.1891	1.05831	0.94153	1	0.97045	1.02703	1.04422
1984	-12.094	0.2299	9.3756	0.054031	1.55122	11.2207	1.05709	0.93975	1	0.96079	1.01564	1.06132
1985	-4.237	1.1835	12.4454	0.053389	2.05435	15.7357	1.00287	0.95694	1	0.95123	0.95396	1.09165
1986	1.733	2.9559	14.6147	0.059651	2.55162	20.1818	0.91269	1.07991	1	0.94176	0.85954	1.10392
1987	-0.075	3.4441	15.4938	0.078621	3.01175	22.0283	0.88092	1.11365	1	0.93239	0.82136	1.12044
1988	-1.375	3.5919	15.5784	0.008070	3.35903	22.6673	0.87191	1.11251	1	0.92312	0.80487	1.10450
1989	2.165	3.0517	15.3180	-0.031191	3.36279	21.5316	0.85915	1.10799	1	0.91393	0.79342	1.09959
1990	3.403	3.7231	14.9156	-0.012263	3.43350	22.0650	0.83653	1.14031	1	0.90484	0.75692	1.09344
1991	3.410	3.3540	14.1898	-0.009054	3.56388	21.0986	0.82517	1.14466	1	0.89583	0.73921	1.08563
1992	2.512	2.6236	13.3163	-0.023916	3.59157	19.7075	0.82655	1.13275	1	0.88692	0.73309	1.07713
1993	2.912	2.4036	12.5512	-0.023094	3.58737	18.6161	0.82260	1.12888	1	0.87810	0.72239	1.07199
1994	4.184	2.0736	11.9326	-0.009174	3.93719	17.7340	0.80999	1.13735	1	0.86936	0.70439	1.05522
1995	5.221	1.7824	11.0265	-0.012327	3.96770	16.6942	0.79474	1.14835	1	0.86071	0.68494	1.05580
1996	5.339	2.2057	10.1239	-0.019136	4.05480	16.4452	0.76853	1.17669	1	0.85214	0.65489	1.04871
1997	4.316	1.8231	9.1024	-0.023254	4.12548	15.0277	0.76274	1.17400	1	0.84366	0.64349	1.03502
1998	3.236	1.3254	8.1294	-0.029405	4.15754	13.5830	0.76354	1.15257	1	0.83527	0.63776	1.02624
1999	3.553	0.9723	7.3291	-0.019371	4.27299	12.5550	0.75845	1.16057	1	0.82696	0.62721	1.01945
2000	5.103	0.5751	6.6015	-0.010122	4.42515	11.6916	0.74519	1.17092	1	0.81873	0.61011	1.01190

BLOCK 8 REPRODUCIBLE INPUTS TO CAPITAL FORMATION

YEAR	SAVINGA	SAVINGB	MPKREPA	MPKREPB	[illegible]	VIREPA	VIREPB	NFCFA	NFCFB	KAREP	KBREP
1979	.	.	.	.	.	.	.	.	.	.	.
1980	.	.	.	.	.	3.82000	35.7200	0.0000	0.000	44.2000	397.400
1981	7.5578	61.649	0.151559	0.151549	0.1	3.82367	33.3707	-1.3919	-6.219	48.0237	430.771
1982	8.2720	57.148	0.141616	0.144572	0.1	3.32593	31.1287	-2.4036	-12.261	51.3495	461.939
1983	9.1465	70.300	0.131876	0.136533	0.1	2.67632	26.8732	-3.7659	-18.133	54.0259	488.773
1984	9.7677	73.350	0.123260	0.130391	0.1	1.99545	23.1574	-4.9508	-23.588	56.0116	511.363
1985	10.4168	76.070	0.113740	0.125591	0.1	1.09302	19.9541	-6.3967	-28.473	57.1044	531.914
1986	11.2675	78.664	0.107607	0.121575	0.1	0.47156	15.0327	-7.8197	-33.104	57.5759	547.947
1987	11.1899	81.715	0.106955	0.119103	0.1	0.40507	14.0315	-7.7979	-37.497	57.9920	561.978
1988	11.3653	83.651	0.109571	0.117423	0.1	0.59182	12.7371	-7.8211	-40.465	59.5539	574.715
1989	11.6445	85.821	0.111248	0.117403	0.1	0.87583	13.0423	-7.8168	-42.057	59.4397	587.758
1990	12.0690	88.464	0.113438	0.117053	0.1	1.12713	13.0136	-7.9888	-44.428	60.5668	600.771
1991	12.5249	91.503	0.116225	0.116674	0.1	1.45599	11.9323	-8.1177	-47.324	62.0228	612.703
1992	12.8157	93.011	0.119226	0.116993	0.1	1.82941	12.4793	-8.0263	-49.114	63.8512	625.132
1993	13.2937	95.732	0.121119	0.115303	0.1	2.10353	12.7342	-8.2001	-51.301	65.9517	637.967
1994	13.7777	99.605	0.122239	0.116550	0.1	2.30362	12.8294	-8.4327	-53.890	68.2533	653.776
1995	14.2369	102.447	0.123472	0.116483	0.1	2.53453	12.9494	-8.6220	-56.412	70.7949	663.745
1996	14.6666	105.306	0.124711	0.116369	0.1	2.78604	12.1300	-8.7540	-58.907	73.5909	675.875
1997	15.1466	108.598	0.125995	0.116542	0.1	3.06470	12.6372	-8.9100	-61.624	76.6456	688.513
1998	15.5625	111.512	0.126850	0.115323	0.1	3.30955	13.2795	-9.0189	-63.764	79.9551	701.812
1999	16.1072	114.714	0.126834	0.116787	0.1	3.45013	13.5871	-9.3401	-66.492	83.4053	715.399
2000	16.6444	118.014	0.126518	0.116575	0.1	3.55191	13.6530	-9.6883	-69.526	86.9572	729.352

BLOCK 9 REALIZED DOMESTIC RENTS

YEAR	RAOIL	RBOIL	RAGAS	RBGAS	RAOILGAS	RBOILGAS	RAELEC	RBELEC	RAALT	RBALT	RGAAOILG
1979	.	.	.	.	.	.	.	.	.	.	.
1980	.	.	.	.	.	.	.	.	.	.	.
1981	8.4414	3.29093	9.7950	1.82647	17.2374	5.1174	0.45835	4.0424	0.060355	0.53072	9.3082
1982	10.3889	3.55927	11.4450	2.46799	21.3331	6.1273	0.54451	5.6766	0.086558	0.74633	11.7933
1983	11.5990	4.15913	14.6075	3.39741	25.2065	7.5565	0.62497	5.5341	0.119631	1.01558	14.1515
1984	11.8025	4.53534	19.3424	4.67797	30.1453	9.2143	0.69035	7.4141	0.163403	1.34575	16.2792
1985	11.6027	4.78776	25.2469	7.41096	37.0496	12.1989	0.73501	8.3163	0.209796	1.74244	20.0068
1986	11.0049	6.60850	24.7938	7.55438	35.7987	14.1629	0.76922	9.2404	0.268357	2.21061	19.3313
1987	9.6276	5.89589	22.3096	6.63252	31.9373	12.5284	0.74299	10.1862	0.336572	2.75625	17.2461
1988	9.0064	5.55013	21.5293	5.35879	30.6347	12.0159	0.75953	11.1327	0.326020	2.73435	16.5429
1989	8.6702	5.59958	21.6958	6.37480	30.3660	11.9734	0.80272	12.1866	0.348216	2.95595	16.3976
1990	8.3830	7.39914	21.9091	6.43775	30.2920	13.8369	0.83674	13.2095	0.375311	3.22147	16.3577
1991	7.7239	7.05373	21.0121	6.02303	28.7361	13.0768	0.95997	14.2605	0.379445	3.32102	15.5175
1992	7.3073	6.90990	20.8145	5.88749	28.1217	12.7974	1.04057	15.3267	0.403630	3.55056	15.1057
1993	7.0255	6.93317	21.0534	5.91155	28.0759	12.7949	1.13559	15.4099	0.436950	3.99411	15.1510
1994	6.6641	6.79048	21.0615	5.83224	27.7257	12.6227	1.23547	17.5150	0.465053	4.20013	14.9719
1995	6.1914	6.60397	20.7078	5.60103	26.8992	12.2050	1.31450	18.6433	0.488694	4.45846	14.5255
1996	5.6861	8.27945	20.2252	5.31337	25.9113	13.5928	1.40125	19.7928	0.508798	4.70306	13.9921
1997	5.0739	7.93552	19.3152	4.87652	24.3891	12.8120	1.50379	20.9663	0.515156	4.84709	13.1701
1998	4.6421	7.84368	19.0678	4.55953	23.7119	12.5023	1.51797	22.1544	0.545441	5.10856	12.9744
1999	4.2459	7.83943	19.0283	4.49824	23.2742	12.3377	1.74923	23.3611	0.580136	5.61859	12.5681
2000	3.7727	7.77904	18.7805	4.27181	22.5532	12.0498	1.86415	24.5902	0.623764	6.00927	12.1787

YEAR	RGABOILG	RGBAOILG	RGBBOILG	RIAAOILG	RIABOILG	RIBAOILG	RIBBOILG	RFAOILG	RFBOILG	RATRES	RBTRES
1979	.	.	.	.	.	.	.	.	.	.	.
1980	.	.	.	.	.	.	.	.	.	.	.
1981	0.307044	6.2055	4.2986	0.137899	0.051174	0.55160	0.204696	1.03424	0.255870	10.3230	16.6335
1982	0.367636	7.8602	5.1469	0.174671	0.051273	0.69868	0.265091	1.31003	0.306363	13.0249	20.3735
1983	0.452792	9.4343	6.3391	0.209552	0.075455	0.93351	0.301952	1.57239	0.377327	15.6339	24.4536
1984	0.552858	10.8522	7.7400	0.248159	0.092141	0.95554	0.359572	1.90169	0.460715	18.0152	28.5952
1985	0.731935	13.3379	10.2471	0.296397	0.121999	1.18559	0.497957	2.22298	0.509946	22.1019	35.3172
1986	0.849772	12.8875	11.8968	0.286389	0.141629	1.14556	0.566515	2.14792	0.708144	21.6466	37.9474
1987	0.751705	11.4974	10.5239	0.255498	0.125284	1.02199	0.501136	1.91624	0.626421	19.4982	36.4969
1988	0.721134	11.0235	10.0959	0.245079	0.120189	0.98031	0.480756	1.83808	0.600945	18.7148	36.5025
1989	0.718403	10.9319	10.0575	0.242929	0.119734	0.97171	0.479935	1.92196	0.598659	18.6295	37.5925
1990	0.830214	10.9061	11.6230	0.242336	0.139369	0.95734	0.553476	1.91752	0.691845	18.8407	40.4919
1991	0.784606	10.3450	10.9845	0.229889	0.130768	0.91955	0.523071	1.72416	0.653838	18.0122	40.3537
1992	0.767844	10.1238	10.7498	0.224974	0.127974	0.89990	0.511896	1.68730	0.639870	17.7477	41.1628
1993	0.767689	10.1073	10.7477	0.224507	0.127949	0.89843	0.511793	1.53455	0.639741	17.8526	42.5592
1994	0.757364	9.9912	10.6031	0.221905	0.126227	0.98722	0.504909	1.55354	0.531136	17.7799	43.6915
1995	0.732300	9.6837	10.2522	0.215193	0.122050	0.86077	0.488200	1.61395	0.610250	17.3983	44.3966
1996	0.815569	9.2291	11.4180	0.207290	0.135929	0.82916	0.543713	1.55468	0.679641	17.0609	46.6140
1997	0.768722	8.7831	10.7621	0.195113	0.128120	0.78045	0.512481	1.46334	0.640602	16.2810	46.6495
1998	0.750139	8.5353	10.5019	0.189595	0.125021	0.75978	0.500092	1.42271	0.625115	16.0337	47.6631
1999	0.740260	8.2787	10.3635	0.186194	0.123377	0.74477	0.493507	1.39545	0.616883	15.9559	48.9603
2000	0.722991	8.1191	10.1219	0.190425	0.120491	0.72170	0.431994	1.35319	0.502492	15.6935	50.3441

BLOCK 13 BALANCE OF TRADE AND PAYMENTS

YEAR	EXREP	IMREP	DIVEXT	CUMNFCFR	CUMNFCFS	BOP
1979	.	.	.	.	.	.
1980	81.300	80.000	.	0.00	0.00	-2.0000
1981	86.885	80.633	1.23011	0.00	0.00	-5.0606
1982	98.997	97.022	1.51633	-1.33	-6.22	-7.1763
1983	104.706	87.301	1.94772	-3.80	-18.48	2.1223
1984	107.026	91.726	2.26941	-7.57	-36.61	7.8574
1985	98.633	95.055	2.03292	-12.52	-60.20	5.9697
1986	82.949	102.531	2.45505	-18.91	-89.57	-1.8381
1987	78.617	105.241	2.56255	-26.73	-121.78	-1.2996
1988	79.797	106.041	2.43903	-34.53	-159.28	3.5414
1989	81.753	116.291	2.62063	-42.35	-199.74	1.2365
1990	78.372	120.235	2.50937	-50.17	-241.93	0.0072
1991	79.916	125.365	2.37800	-58.16	-286.23	-0.8986
1992	83.423	130.612	2.32717	-66.28	-333.55	0.4009
1993	86.033	135.905	2.32629	-74.33	-382.66	1.2718
1994	86.597	141.533	2.29659	-82.53	-433.96	1.0367
1995	86.843	143.111	2.22620	-90.93	-487.16	0.1187
1996	84.535	155.575	2.23632	-99.55	-546.27	-1.0237
1997	86.781	163.389	2.13395	-108.31	-603.17	-1.0792
1998	90.539	170.362	2.04703	-117.22	-664.09	0.3163
1999	92.974	177.244	2.01334	-126.24	-728.58	1.5501
2000	93.926	185.022	1.95569	-135.59	-795.05	1.7477

BLOCK 11 INCOMES

YEAR	NEO	YA	YB	Y	YPC	YPCA	YPCB	YPCAD	YPCAN
1979	.	.	.	.	12.0000	15.0000	12.0000	.	.
1980	.	32.8800	268.040	300.920	12.5800	15.8000	12.2900	15.8000	15.8000
1981	2.57465	35.9653	291.958	327.924	13.5963	16.7183	13.2906	16.7183	16.7183
1982	2.66355	39.7587	305.651	345.410	14.2050	17.9317	13.8311	17.9317	17.9317
1983	3.35949	42.4591	318.714	361.172	14.7414	18.5299	14.3507	18.5299	18.5299
1984	3.52476	45.2934	330.737	376.029	15.2153	19.1425	14.7996	19.1425	19.1425
1985	3.78783	48.9891	342.016	391.005	15.6947	20.0686	15.2196	20.0686	20.0686
1986	4.44829	49.5517	355.234	403.935	15.9947	19.2990	15.7270	19.2990	19.2990
1987	3.14047	49.4187	363.700	413.119	16.3203	19.1216	16.0018	19.1216	19.1216
1988	2.74582	50.6282	373.135	423.764	16.6092	19.1722	16.3133	19.1722	19.1722
1989	2.52872	52.4739	384.527	437.001	15.9980	19.4825	16.7073	19.4825	19.4825
1990	2.48413	54.4562	397.340	452.297	17.4522	19.8414	17.1692	19.8414	19.8414
1991	2.41558	55.7203	408.745	464.465	17.7932	19.9427	17.5246	19.9427	19.9427
1992	2.19129	57.7989	420.576	478.375	18.1751	20.3493	17.9121	20.3493	20.3493
1993	2.24141	59.9029	433.066	492.969	18.5864	20.7525	18.3219	20.7526	20.7526
1994	2.26494	61.8994	445.423	507.322	18.9823	21.1096	18.7201	21.1096	21.1096
1995	2.25176	63.7578	457.850	521.608	19.3693	21.4178	19.1152	21.4178	21.4178
1996	2.18919	65.9530	472.155	538.108	19.9287	21.7970	19.5921	21.7970	21.7970
1997	2.12202	67.6631	484.833	552.496	20.2101	22.0835	19.9736	22.0835	22.0835
1998	2.33697	70.0312	498.756	568.787	20.6514	22.5506	20.4100	22.5506	22.5506
1999	2.09327	72.3668	513.103	585.469	21.1000	22.9948	20.8576	22.9948	22.9948
2000	2.11340	74.5999	527.394	601.994	21.5360	23.3973	21.2964	23.3973	23.3973

BLOCK 12 REAL CONSUMPTION

YEAR	GREPCONR	REPCONRA	REPCONRB	CONRA	CONRB	CONRPCAD	MIGCOST	CONRPCAN	CONRPCB
1979	.	.	.	.	.	.	.	.	.
1980	.	.	.	.	.	.	.	.	.
1981	279.233	22.9716	187.051	23.9593	193.466	11.0909	7.15359	3.9373	8.9073
1982	280.996	24.0371	181.439	24.9099	198.075	11.2363	3.25885	7.9754	8.5106
1983	277.449	23.3220	174.398	24.2223	180.555	10.5698	2.93874	7.6301	8.1252
1984	299.627	24.9513	190.935	25.3770	195.759	10.9976	2.17196	8.7366	8.3559
1985	308.322	28.0313	192.911	28.3796	198.623	11.8302	1.79982	10.0303	8.9397
1986	327.699	27.8239	208.632	28.5997	214.119	11.3746	1.79540	9.5792	9.4782
1987	329.835	27.9790	206.955	28.7090	212.315	11.1083	0.79265	10.3156	9.3413
1988	334.382	28.1597	208.257	28.9934	213.431	10.9377	0.53281	10.4049	9.3298
1989	352.510	30.1410	221.133	30.9217	225.559	11.4932	0.39996	11.0834	9.9455
1990	355.351	31.2635	229.935	32.0750	234.509	11.5957	0.33997	11.3460	10.1205
1991	375.199	31.6524	233.410	32.4909	239.112	11.6252	0.28565	11.3397	10.2517
1992	384.552	32.7011	237.756	33.5531	243.666	11.8131	0.21446	11.5986	10.3776
1993	396.875	33.8118	244.592	34.7022	250.624	12.0222	0.20174	11.8204	10.6033
1994	410.930	35.0631	252.644	35.9716	258.760	12.2674	0.18618	12.0812	10.9751
1995	425.328	36.2947	251.131	37.2265	257.412	12.5027	0.15759	12.3351	11.1444
1996	442.409	37.8332	271.910	38.7997	278.306	12.8390	0.14542	12.6936	11.5421
1997	455.007	38.7142	278.100	39.7005	284.674	12.9572	0.12574	12.8315	11.7277
1998	457.835	39.9529	284.497	40.9776	291.304	13.1951	0.10740	13.0077	11.9207
1999	482.479	41.2311	292.628	42.2911	299.572	13.4382	0.10436	13.3338	12.1776
2000	499.941	42.7708	302.844	43.8531	309.907	13.7539	0.09828	13.6557	12.5142

Notes - Chapter I

1. 'THESIS' stands for 'Tim Hazledine Economics Scenario Impact Simulator'. 'RD' denotes the Regional Development Group of the Economic Council of Canada, who commissioned this report. The number '1.4' distinguishes the current version of the model from its precursors.

Notes - Chapter II

1. The lowest-cost, constant-cost energy source will eventually (when all the cheap reserves have been emptied) determine the world price of oil. This is the (so far elusive) backstop technology. It is possible that Canada's 'non-conventional' oil and gas reserves are large enough to be the backstop, but in the present model, no attempt is made to endogenize the world price. For an interesting attempt at modelling the world oil market, see Nordhaus (1980).

2. Beginning from 1980, after the 2nd major OPEC price increase. No attempt will be made to trace the income effects of the smaller boom of the postwar period through to 1980.

3. Not all the rent-yielding oil and gas reserves will in fact be eliminated by then. As well, of course, Canada has some permanent sources of energy rents from its hydroelectricity capacity, concentrated in Newfoundland, Quebec, Ontario and B.C.

4. The point can be illustrated with an extension of the "not seeing the wood for the trees" analogy. If one cuts down and removes a particular tree, it is reasonable to state that the total weight of wood in the forest is thereby at once reduced by the weight of a tree, and such a statement might remain reasonable for a few months. But, over a period of years, the consequences of removing a particular tree can hardly be predicted. It is even possible -- if the tree was deserving to be culled -- that the eventual weight of wood in the forest would be greater as a result of the removal of the tree.

5. The main exception is the Leontief "Input-Output" method.

6. Note that extending this proposition back into the past implies that econometric models estimated on rather long databases (twenty years or more is common) are making invalid assumptions about the constancy of the relationships being estimated.

7. Thus, econometric modellers and forecasters in general seem to have been surprised by the size of the demand response to the last OPEC oil price shock.

   Another example is supplied by Tom Schweitzer, of the Economic Council of Canada, who finds little to choose, on goodness-of-sample-period-fit criteria, between a linear and a hyperbolic form for the Alberta Phillips Curve, though the two equations give markedly different, predictions of wage changes when used in a simulation in which the Alberta economy experiences unprecedently high unemployment.

Notes - Chapter III

1. It appears that the NEB and the provincial electricity utilities are not considering basing supply on marginal costs (as is implied in the oil and gas supply functions above). Jack Gibbons of Energy Probe (Financial Post, 14/11/81) refers to the utilities, '10-year, $130 billion program to increase their generating capacity by 50 per cent'. Even if 1980 costs could be replicated, the value added by this capacity at 1980 prices would be only about $3 billion per annum (1980 value added equalled about $6 billion), which implies a return on investment of less than 3 per cent.

Notes - Chapter IV

1. 2.30 increased by 2 per cent a year from 1983 would be 3.23 by the year 2000.

2. In particular, the shares of total energy demand taken by each energy type are policy-determined (Blocks 3, 4).

3. Energy used by the energy sector itself is ignored. This is acceptable when such energy is produced 'on-site', and so not marketed, but is less so when one energy sector purchases from another. In the model such purchases are treated as though they were purchases from the reproducibles sector.

4. Energy appears in the production function as well, but its level is determined by reproducibles demand, not by the external supply constraints that constrain labour and capital inputs.

5. Recall that, while other variables are measured in \$ billions, per capita numbers are in \$ thousands.

6. Given that energy prices increase over the simulation period, and on the assumption that the marginal utility of reproducibles is about constant, increases in CONRA and CONRB will overstate increases in welfare, since they do not allow for the losses in consumer surplus as consumers are forced up their energy demand curves by higher prices. This should not affect much comparisons between Alberta and RoC, since the two regions are assumed to experience the same energy price changes.

7. Since some foreign migrants to Canada would go to Alberta in the absence of an income differential, not all of each year's total flow of new Albertans can be said to be income-induced.

8. Year-to-year fluctuations in consumption are due to fluctuations in the availability of reproducibles, which in turn stem from year-to-year variations in the balance of reproducibles trade.

Notes - Chapter V

1. For simplicity, energy production costs are not affected in the model by changes in wage rates. There is some increase in demand-determined Alberta electricity ouput and thus some change in the all-energy price index, which includes electricity output in its weighting formula and which determines alternative energy production.

2. With year 2000 reproducibles imports at nearly $200 billion (in 1980 prices, this devaluation implies that nearly $1½ billion more reproducibles must be exported to maintain a given balance of payments on reproducibles trade.

3. Except that Alberta electricity output, which is demand-determined to satisfy demand not met by oil, gas, or alternative energy, falls to zero.

4. Reproducibles output is defined as the value added by all three primary factors -- labour, capital and energy. The reproducibles production functions are modified to be consistent with more elastic intermediate energy demand.

REFERENCE COPY

References

Appelbaum, E. and U. R. Kohli, "Canada - United States Trade: Tests for the Small-Open-Economy Hypothesis". Canadian Journal of Economics, February, 1979.

Berndt, E. R. and G. C. Watkins, Energy Prices and Productivity Trends in the Canadian Manufacturing Sector 1957-76, Economic Council of Canada, Ottawa, 1981.

Boadway, Robin and John Treddenick (1978), "A General Euqilibrium Computation of the Effects of the Canadian Tariff Structure", Canadian Journal of Economics, August.

Chambers, Edward J. and Donald F. Gordon, "Primary Products and Economic Growth: An Empirical Measurement", Journal of Political Economy, August, 1966.

Helliwell, John F., Robert N. McRae et al., "Energy and the National Economy: An Overview of the MACE Model", presented to the meetings of the Canadian Economics Association, University of Ottawa, June 4, 1982.

MacAvoy, Paul W., "Crude Oil Prices: As Determined by OPEC and Market Fundamentals", Yale School of Organization and Management, Research Program in Government Business Relations, Working Paper 2, June, 1981.

Major Projects Taskforce, Report on Major Capital Projects in Canada to the Year 2000, Ottawa, June, 1981.

Memorandum of Agreement between the Governments of Canada and Alberta relating to Energy Pricing and Taxation,. September 1, 1981.

National Energy Board, Canadian Energy Supply and Demand 1980-2000, Ottawa, June 1981.

National Energy Program 1980, Energy, Mines and Resources, Ottawa, May, 1982.

Nordhaus, William D., "Oil and Economic Performance in Industrial Countries", Brookings Papers on Economic Activity, 1980, 2.

Norrie, K. H. and M. B. Percy, "Terms of Trade, Rent Distribution, Regional Development and Interregional Adjustment: A General Equilibrium Approach", March, 1982.

Schweitzer, Thomas T. (1982), "Migration and a Small Long-Term Econometric Model of Alberta's Economic Council of Canada, Discussion Paper No. 221, December 1982.

________ (1983), "The Alberta Economy 1980-2000: Theme and Variations", Economic Council of Canada, Discussion Paper.

Watkins, G. C., "Econometric Models of Industrial Energy Demand: A Dynamic Formulation", presented to 30th Canadian Chemical Engineering Conference, October 19-22, 1980.

Waverman, Leonard, "The Visible Hand: The Pricing of Canadian Oil Resources", in Ontario Economic Council Energy Policies for the 1980s: An Economic Analysis, Volume 1, Toronto, 1980.

Witte, Willard E. "The Lagged Adjustment of Canadian Exports to Prices and Foreign Activity, 1973-78", Review of Economics and Statistics, May 1981.

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