The effects of higher energy prices on long-run growth

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PREFACE

The document, Canada's Economy - Medium-Term Projections and Targets, projected a cyclically adjusted GNE line for Canada based in part on a judgement about the future growth rate of labour productivity. It was recognized that there are a number of factors which influence productivity: the growth of the capital stock; the growth, composition and quality of the labour force; the effects of substantially higher energy prices; and so on.

The purpose of this paper is to take up the issue of productivity growth raised in Canada's Economy. The paper focusses specifically on the effects of higher energy prices on productivity growth and Canada's longer-term growth potential. It sets out a framework in which to analyze the effects of an energy price increase on representative kinds of economies and then applies this framework to the Canadian situation.

The focus of the paper is clearly the long run. There is no attempt to address the important short-term economic stabilization problems to which dramtic energy price changes have contributed. Nor is there any attempt to discuss the dynamics of the transition to the longer-run equilibrium position.

The analysis contained in this paper has been discussed with persons in several independent organizations - the C.D. Howe Research Institute, Informetrica Ltd., the Institute for Policy Analysis of the University of Toronto and several faculty members in the Department of Economics at the University of British Columbia. Their comments, criticisms and suggestions have been extremely helpful. The responsibility for the views expressed in this paper, however, rests entirely with the Department of Finance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF CHARTS

1. INTRODUCTION

The rise in the price of oil in 1973 was one of the most dramatic economic events of the century. Controversy still surrounds the impact of this price increase on the world economy. There is little doubt that the increase had important destabilizing effects in the short run on the world economy, raising the rate of inflation, while imposing at the same time a substantial deflationary drag. Concern has also been expressed that the relative price shift fundamentally altered the growth potential of many countries.

The document, Canada's Economy[1], dealt in only a cursory fashion with the effect of the change in the price of oil on the Canadian economy. In developing the long-run growth line for the economy, a preliminary judgement was made that the studies done to date were not conclusive and, therefore, did not support any fundamental revision of projected trends in productivity growth. The estimates for the capital stock needed in 1981 allowed for a higher scrappage rate in the mining and manufacturing sectors, reflecting the need to replace energy-intensive equipment.

The purpose of this paper is to provide a more thorough analysis of the effect of changes in the energy sector on the Canadian economy. While in some cases more work is needed, or more time is necessary for trends to become evident, before definitive answers can be given, some general conclusions can now be reached. These conclusions are important if the current problems of the economy are to be understood and its future potential correctly evaluated.

The shorter-term impacts of the higher energy prices on the Canadian economy are not considered in this paper. Canada's Economy described the adjustments the economy has had to make over the last five years as well as those that will have to be made over the medium term if the economy is to reach higher levels of output and employment.

This paper does not deal with the role of higher energy prices in leading to the higher levels of inflation and unemployment that have been experienced over the last five years. It focusses on the effects of higher energy prices on the economy's income and GNE potential within a full-employment framework.

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[1] Canada's Economy - Medium-Term Projections and Targets, Department of Finance, February 1978.

Beginning in 1973, a number of simultaneous changes took place in the energy sector. The first change was, of course, the dramatic rise in the international price of oil. In response to that price increase the international prices of all other traded forms of energy - including gas and coal - also tended to rise. The price of oil imports rose from $2.42 to $13.40[1] per barrel between 1972 and 1977, an increase of 453.7 per cent. Coal prices, as measured by the price of coal imports from the United States, rose from $9.30 to $36.70 per short ton between 1972 and 1977, an increase of 294.6 per cent.

The Canadian government responded to the rise in international prices by introducing a policy of gradually increasing the domestic prices of oil and gas, while immediately raising the export price of oil and phasing in higher export prices for gas. The domestic well-head price of oil rose from $2.79 per barrel in 1972 to $3.43 in 1973, to $5.73 in 1974, to $7.21 in 1975, to $8.43 in 1976 and to $10.13 in 1977. Average retail gas prices to consumers rose from $0.65 per thousand cubic feet in 1973, to $0.75 in 1974, to $0.99 in 1975, to $1.38 in 1976 and to $1.61 in 1977. The domestic price of oil, gas and coal relative to the overall domestic rate of inflation more than doubled over the 1972 to 1977 period (see Chart 1). Imports of oil were subsidized to maintain the domestic price below the world price. Part of this subsidy was financed by an export tax on oil and part of it from general revenues. No export tax was placed on gas exports.

At about the same time as the oil price increases were taking place, Canada's energy potential was being reassessed. The outcome was a view that the availability of low-cost supplies was much less than had previously been thought, and that new sources of supply would be considerably more expensive. It is important to distinguish this change from the change in world prices. The two events were unrelated. A reassessment of Canada's energy potential would have occurred in the absence of a change in the relative price of energy.

In response to this new assessment of potential supplies, and to the increased realization, stemming from the oil boycott, of the potential disruptions which exclusive reliance on imports can bring, the Canadian government decided to limit exports of oil, and prevent further expansion of gas exports. Crude oil exports were gradually reduced from 1,139 to 272 thousand barrels per day between 1973 and 1977. Gas exports have been held to about one trillion cubic feet per year.

The following sections of this paper provide an analysis of the effects of these changes. In doing so, they focus on the longer-run effects of higher energy prices on the economy's income and GNE potential.

The analysis in this paper is quite technical and it may be worthwhile to summarize in advance the conclusions that emerge from the theoretical discussion that follows.

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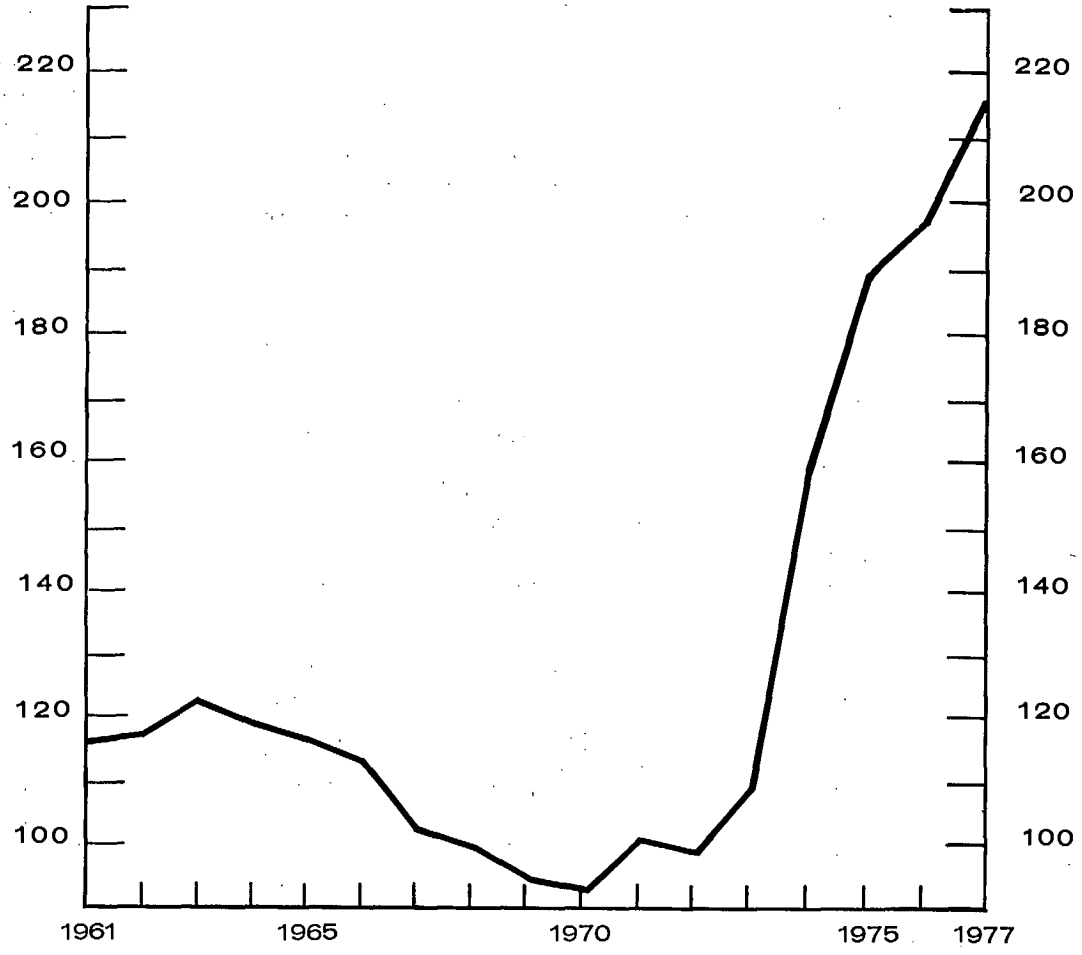
[1] All import prices are f.o.b., place of origin.

Chart 1
Real Domestic Price* Index for Oil, Gas and Coal, Canada, 1961-1977 (1971 = 100)



*Ratio of nominal price to the GNE implicit price deflator

Source: Calculated from Statistics Canada, General Review of the Mineral Industry, cat. 26-201, Canada's Mineral Production, cat. 26-202, and National Income and Expenditure Accounts, cat. 13-201.

An increase in the world price of energy results in immediate terms of trade losses for net-energy-importing countries, and immediate terms of trade gains for net-energy-exporting countries. The size of these gains and losses depends directly upon the size of the net trade position in energy. The returns to the factors of production in the energy-producing sector increase relative to those in the non-energy-producing sector and this sets in motion a re-allocation of productive resources from the non-energy sector to the energy sector.

Quite apart from this re-allocation of resources, it becomes economic for individuals and firms to reduce their demand for energy. Economic agents are induced to substitute capital and labour for energy. With a fixed amount of capital and labour, output in the non-energy sector falls as energy consumption is reduced. This fall in output is in addition to that due to the re-allocation of resources from this sector to the energy-producing sector.

The initial impact of higher energy prices is, therefore, to reduce the income and real GNE generated in the non-energy sector. Income and real GNE will increase in the expanding energy sector. The overall effect on income and real GNE depends on the economy's trade balance in energy. For a net energy importer both income and real GNE will tend to be lower overall. For the net energy exporter income rises and, initially, real GNE falls. This decline in real GNE may, however, be ultimately reversed if the higher income stemming from the terms of trade gains results in greater savings and capital formation: higher capital/labour ratios in the production process can in principle offset the effects in the non-energy sector of the substitution away from energy.

Induced increases in savings and capital formation may result from purely market forces in the case of a net energy exporter. This is not likely to occur in the case of a net energy importer, however, unless there are significant distributional effects in favour of capital which cause savings to rise despite the overall negative impact of higher energy prices on income. It is possible for governments to induce higher savings and capital formation but this is not necessarily desirable. This is a question which involves some difficult judgements about intergenerational transfers.

In analyzing the effects of higher energy prices on the economy of an energy producer, it is important to differentiate between a price increase due to the exploitation of market power and a price increase due to higher energy production costs. As a general proposition, the more price increases are a reflection of higher energy production costs rather than the exploitation of market power, the more likely is it that income, productivity, and GNE will be adversely affected.

For Canada, the effects of the increase in the international price of energy in the 1973 to 1977 period were mixed. The existence of an energy trade surplus resulted in income gains due to improvements in the terms of trade. The redistribution of income that followed the domestic energy price increases was probably favourable to increased savings and capital formation. The energy price increases had an adverse impact on output, income and productivity in the non-energy sectors and non-energy-producing regions of the country. While rough quantitative estimates of the magnitude of the terms of trade gains and of the internal redistribution of income are provided in the empirical sections of this paper, more work on these issues is clearly necessary.

For Canada as a whole, then, the effect of the increase in the price of energy in the period since 1973 was to increase income but probably to decrease real GNE. The conclusion with respect to GNE cannot be made categorically, however, because of the possibility, especially in the longer term, of feedback effects from higher income and savings on capital formation.

In the future this latter possibility is unlikely to exist. If Canada becomes a net energy importer or expands domestic energy production along a steeply rising energy cost curve, the effects on both income and GNE are likely to be adverse.[1]

Although the direction of the effects on income and GNE seem clear, their size and timing are not. There is a great deal of uncertainty about the steepness of the energy supply curve in Canada. One can also expect that there will be significant technological developments in the energy field which will reduce the future real cost of producing energy.

The discussion in this paper of the effects of higher energy prices focusses entirely on the longer-run impacts. Because the results depend very much on whether the economy is a net importer or exporter of energy, the discussion is structured in terms of a series of cases which combine various degrees of energy self-sufficiency with assumptions about the nature of the price increase. These cases and the implications for Canada's long-run growth path are discussed in section 2. Empirical estimates of the post-1973 terms of trade gains and their regional impact are provided in section 3. Canadian supply and demand projections for fossil fuels are outlined in section 4. Section 5 summarizes the impact of the recent price increases on the Canadian economy and the prospects for the future.

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[1] This assumes that distributional effects which shift income towards capital and raise the aggregate savings rate will not do so to a degree which causes more savings to be generated from a lower national income. If such distributional effects occur, they will increase capital formation, income, and GNE despite the movement towards greater energy imports and higher-cost domestic energy production.

2. THEORETICAL DISCUSSION

The discussion proceeds by considering the effects of a higher price of energy on: a country which has no energy sector at all, the pure energy importer; a country with only an energy sector, the pure energy exporter; and a country which has both an energy and non-energy sector, the two-sector economy.

Except where explicitly stated, full employment is assumed. Until these assumptions are relaxed in a subsequent section, international capital flows are precluded and a zero net current account balance is assumed. Energy is treated as an intermediate good in the production process and the increased price of energy is assumed to be the result of the exploitation of market power rather than of higher real costs of production. This latter assumption is also relaxed in a subsequent section. The assumption of full employment indicates clearly the medium-term focus of the analysis. Short-term stabilization problems are ignored.

There are numerous references in the analysis to the net trade balance in energy. In the empirical section of the paper, only Canada's net trade balance in primary energy is examined. In the theoretical section the term really applies to a wider definition which, in addition to the net trade in primary energy, includes the energy content of imported and exported products.

Before discussing the impact of higher energy prices in detail, there is a fundamental definitional question pertaining to the concepts of income and real GNE which must be addressed.

The question concerns the definition of real GNE, and the effect on it of higher energy prices. It is perhaps easiest to proceed by way of example. Suppose the pure energy importer is initially producing a given volume of final goods and services with a market value determined in international markets. The economy imports only energy and exports final goods and services to pay for these imports. Its GNE disaggregation before the price increase might look like column A in Table 1 below. Its nominal GNE is 100 and, measured in the prices of year 1, so is real GNE. The economy's nominal and real incomes are also equal to 100, where income is defined as the sum of the consumption, investment, and government expenditure components. These three items constitute the bundle of goods available to the economy for domestic absorption, recognizing that the imported component of this bundle has been paid for with an equivalent amount of exports.

Now assume the price of energy doubles but that the economy is one in which no factor substitution is possible. Capital and labour continue to be fully employed producing the same physical output as before, and the same volume of energy is imported, its value being twice as great as in the initial situation. If trade is to be balanced (as it is assumed to be) then the value, and volume, of exports must also double to pay for the higher-valued energy imports. The expanded export volume will

come out of domestic consumption, investment, and government spending. In column B, the effect is felt entirely in consumption which falls by 20. It is clear that the economy, as a result of the price increase, is worse off in terms of real income.

Table 1
The Effects of an Energy Price Increase on Nominal and Real GNE

	Year 1 Nominal GNE[1] (A)	Year 2 Real Income (B)	Year 2 Real GNE[1] (C)
C	70	50	50
G	15	15	15
I	15	15	15
X	20	40	40
-M	-20	-40	-20
	100	80	100

(1) Defined according to national accounting concepts.

While real income falls in the economy - and its citizens are worse off in terms of potential consumption per capita - real GNE does not fall.

Standard national accounting methodology defines real GNE as the value of outputs less the value of inputs, all measured at base-year prices. In the example here, real GNE is unchanged because the volume of final goods and services produced is exactly the same as before, as is the volume of energy imports. All that has happened is that the price of energy imports has doubled. To put the two years' GNE figures into real terms requires deflating the second year's energy imports by the higher energy price. Thus in column C, the GNE components are valued at initial prices. GNE remains unchanged from year 1 although its composition is altered towards exports and away from consumption.

Thus when terms of trade change significantly, real GNE does not provide an indication of real income. In this example, real GNE per capita remains constant while real income per capita falls 20 per cent. The distinction between the income and GNE concepts is important and one that is not widely made. The two measures serve quite different purposes. The income measure is a good indicator of how well the economy is doing in terms of the size of the bundle of goods and services available to it for consumption, investment and government spending. It is not useful as the basis for a measure of labour productivity since income can rise simply because of a favourable movement in the economy's terms of trade. Thus, real income could be rising while real GNE, employment and labour productivity are falling. The real GNE measure, on the other hand, provides in most circumstances a better indication of the economy's output performance and is, therefore, a more relevant guide for demand management policy.

In the discussion which follows, the term "real GNE" is used in the "national accounts" sense. It is an output measure. The term "domestic income" or just "income" is used to capture the alternative concept. It is a measure of the economic well being of the country in the sense that it reflects the

economy's ability to command goods and services for its own use in the form of consumption, investment, or government spending. Subsequently, a third concept - "potential consumption" is referred to. It is the part of domestic income not invested and which is available to individuals and governments for consumption purposes.

2.1 The Pure Energy Importer

One would expect an increase in the price of energy to have adverse effects in the short run and the long run for an economy which is completely dependent on imports as its source of energy. This is, in fact, the case and in this section these effects are discussed. Although Canada is not in the category of the "pure energy importer", it will become clear that the analysis of the pure energy importer is analogous to that of the non-energy sector in a two-sector economy like Canada's. It is worthwhile, therefore, developing the example of the pure energy importer in some detail.

This section proceeds by considering the effects of higher energy prices on the pure importer's income and GNE under different assumptions about the substitutability of capital, labour and energy in the production process. In the first case, it is assumed that the substitution of capital and labour for higher-priced energy is not possible. This is the case of fixed production coefficients. The second case assumes that such substitution is possible.

2.1.1 The Fixed Coefficients Case

For the pure energy importer with no scope for energy substitution in the production process, the effects on real GNE and income are precisely those of the numerical example described above in section 2. The economy continues to produce the same output as before the price increase, using the same amount of capital, labour and energy. Its real GNE, defined as the value of output less inputs, all measured at the old prices, is unchanged.

The composition of real GNE is changed, however. Exports must increase to pay for the higher-valued energy imports. Consumption, investment, or government spending must decrease correspondingly. This re-allocation of production towards exports results in a decrease in the economy's real income - its domestic absorption possibilities - and is directly attributable to the deterioration in its terms of trade.

In summary, the effect of an energy price increase on the pure energy importer - when there is no scope for factor substitution in the production process - is to leave real GNE unchanged but to decrease the economy's real income.

2.1.2 The Variable Coefficients Case

As a general proposition one would expect an economy to display some possibilities for factor substitution. With a conventional production function for the economy - one which reflects the diminishing marginal productivity of each of the factors of production - the ability to substitute labour and capital for energy in the face of a price increase results in a reduction of real GNE relative to the initial situation. This stems from the incentive

which higher energy prices provide to substitute capital and labour for energy. With the supplies of capital and labour fixed in the short run, increases in capital/energy and labour/energy ratios can take place only by means of a reduction in energy consumption and in output.

The adverse terms of trade effect reduces the economy's real income just as it did in the fixed production coefficients case. As a general proposition, however, the greater is the ease with which labour and capital can be substituted for energy, the smaller will be the reduction in domestic income and potential consumption.[1]

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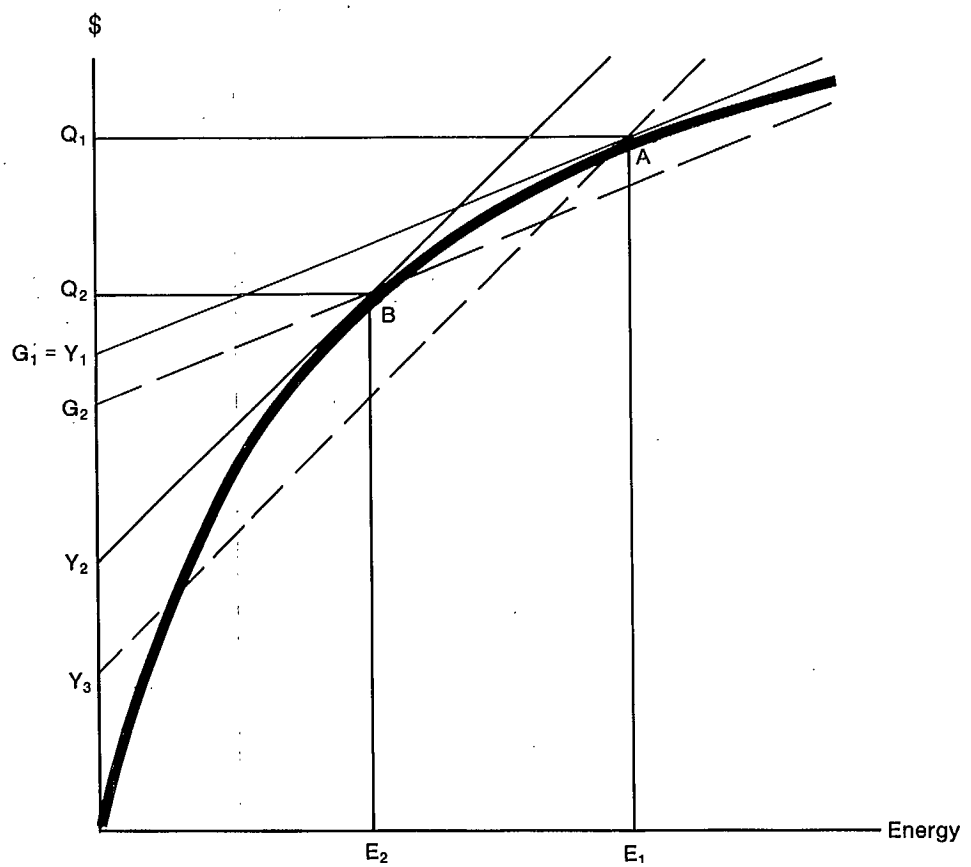
[1] Figure 1 below illustrates these points. With capital and labour fixed, real GNE and domestic income increase with additional energy inputs but at a decreasing rate. This is the assumption of diminishing marginal productivity. With the initial terms of trade, the economy is in equilibrium at A with income and GNE equal at Y_1. Exports are Q_1-Y_1, and are equal in value terms to energy imports E_1. The energy price increase causes the terms of trade to deteriorate. The new equilibrium is at B. Real income falls to Y_2. Real GNE - the new equilibrium with outputs and inputs valued at the initial prices - falls to G_2.

In the fixed coefficients case, the equilibrium would have remained at A but the fall in income to Y_3 would have been larger than in the factor substitution case. With fixed coefficients real GNE would remain constant at G_1.

Figure 1



The empirical evidence suggests clearly that labour and energy are substitutes. The evidence on the substitutability of capital and energy is mixed. One view is that capital and energy are substitutes; another view is that they are complements, so that a reduction in the demand for energy may lead to a reduced demand for capital. Where relevant, the effects of capital and energy complementarity are considered.

In summary, when factor substitution is possible, the effect of the energy price increase on a fully-employed energy-importing country is a reduction in real GNE and domestic income. This loss in income will be smaller the greater the ease with which capital and labour can be substituted for higher-priced energy. The policy implications of this are clear: any policy which impedes this factor substitution, such as a policy which permanently maintains the initial relative prices in the domestic economy, increases the income losses suffered by the economy as a whole.

In reality the losses described above will be larger if the economy suffers some unemployment as a result of the energy price increase. A large relative price change may generate strong inflationary pressures in the economy. It can also induce significant resource transfers. These inflationary pressures and the required resource transfers can lead to temporary unemployment.

As a general proposition, the reduction in the economy's domestic income due to the energy price increase will be shared by both labour and capital so that real wages and the rate of return on capital fall. In this situation, if labour resists the downward pressure on real wages some unemployment will result and the losses to the economy will increase.

In some situations this downward pressure on real wages will not occur. Thus, when labour is highly substitutable for energy, and capital is complementary, the effect of higher energy prices will be to increase the demand for labour and reduce the demand for capital. Wages will increase relative to the rate of return and a sufficiently larger share of a reduced domestic income may result in a higher real wage. The empirical work on factor substitutability suggests that labour is probably a better substitute for energy than capital and that in the pure energy-importing country, the share of any energy-price-induced loss will be greater for capital than for labour. In some cases, like the one just cited, the return to labour may increase so that the burden on capital is larger than the burden on the economy as a whole.[1]

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[1] This analysis ignores the implications of a fall in the rate of return for an economy which is integrated into world capital markets. Unless the world's rate of return also falls, there will be a tendency for investment to slow down until the rate of return is driven back up to the world level. In this case, wages will bear the full burden. The full implications of a fall in the domestic rate of return for an economy integrated in world capital markets are outlined in section 2.4.2.

2.1.3 Savings Effects

For the pure energy importer the effect of higher energy prices involves a reduction in real income and, except in the case of zero factor substitutability, a reduction in real GNE. While the economy may grow at the same rate in the future as in the past, this growth will be from a lower base because of the downward shift in the income and GNE paths.

Because of the substitution away from energy, the only way the pure energy importer can restore the initial real GNE, income, and consumption paths, given an exogenously-determined growth rate of the labour force, is with a sufficiently large increase in the economy's capital/labour ratio.[1] For this to occur, an increase in the savings

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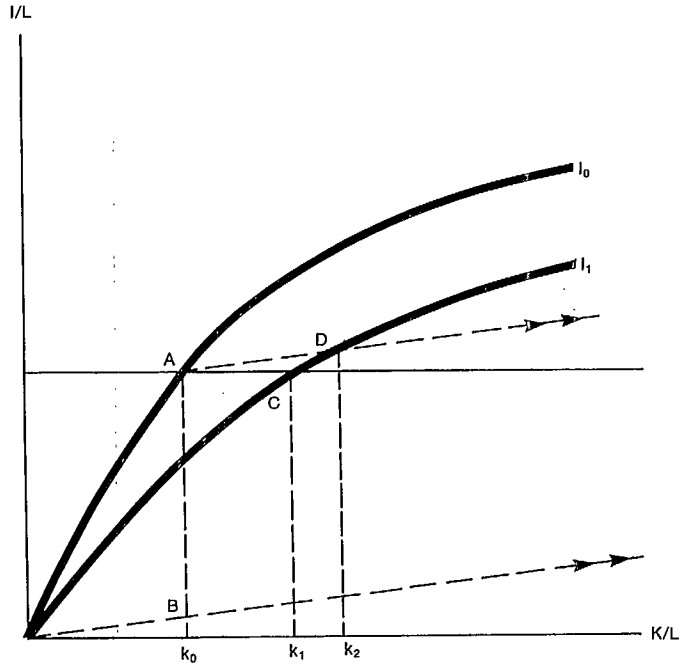
[1] There are some circumstances in which the initial paths cannot be restored regardless of the increase in the capital/labour ratio. This is more likely to be the case, the greater is the energy price increase.

In Figure 2 domestic income per unit of labour (I/L) is a positive function (I_0) of the capital/labour ratio (K/L) in a world in which the labour force grows at an exogenously-determined constant rate. The initial equilibrium is at A. Income per worker is Ak_0, consumption per worker is AB, and the difference is the investment per worker required to maintain the capital/ labour ratio. The effect of an energy price increase is to lower the income function to I_1. In this situation the initial level of domestic income can be restored only if I_1 rises above AC. The initial level of consumption can be restored only if I_1 rises above AD.

Figure 2



generated by the economy will be required. This is unlikely to be the result of purely market forces. The effect of the higher energy prices is to reduce the income out of which to save and, therefore, in the absence of distributional effects favourable to an increase in savings, total savings and the capital/labour ratio can be expected to decrease.

To the extent that distributional effects on savings do exist, they are likely to be unfavourable to an increase in total savings. If the propensity to save out of capital income is larger than out of labour income then an increase in capital's share of the smaller total income will be required if total savings are to increase. With the greater substitutability of labour for energy than capital for energy, the effect will be quite the opposite. The distributional effects will be towards labour income so that the aggregate rate of savings will fall along with the total income out of which to save.

In the absence of a substantial policy-induced increase in savings, market forces will likely result in a lower level of savings and a reduction in the economy's capital/labour ratio. This will reinforce the downward shifts in income and GNE described earlier.

Throughout this theoretical discussion there are references to the effects of a policy-induced increase in savings rates on the economy's capital/labour ratio and the future paths of real GNE, income and consumption. It is worth emphasizing that such an increase in savings rates is not necessarily desirable. It involves the sacrifice of current consumption for the benefits of future consumption (not necessarily by the same people) and, therefore, requires some judgements about the merits of the intergenerational transfers involved. Perhaps more to the point, if a policy-induced increase in savings rates is considered desirable, it is a policy option which could be pursued quite independently of the energy price changes analyzed here.

2.2 The Pure Energy Exporter

For the economy which is exclusively an energy producer, the effect of an increase in the price of energy is to improve its terms of trade, and therefore, its real income.

With a fully-employed labour force and capital stock, the economy has no scope in the short run for expanding energy output. Its real GNE (i.e., its volume of production valued at the old prices) remains unchanged. Over time, however, the greater flow of savings resulting from the real income gains can be used to expand the economy's productive capacity. As a result, the capital/labour ratio will increase and the economy's GNE potential line will shift upward.

2.3 The Two-Sector Economy

Germany and Japan are good examples of what was described as the pure energy importer. The Organization of Petroleum Exporting Countries (OPEC) countries are clearly the pure energy producers. The effects of the energy price increase on the former are in theory adverse and on the

latter beneficial. Many countries, Canada among them, have both an energy and a non-energy sector and the net effect of an increase in the price of energy on such economies is not immediately obvious.

Perhaps the easiest way to approach the problem is by means of a series of sub-cases which proceed from more to less restrictive sets of assumptions with respect to the determinants of the ultimate effects on income and GNE. These determinants include the energy export balance of the two-sector economy - it may be a net energy importer, net energy exporter, or it may have a zero balance. Another determinant is the degree of factor substitution possible in the non-energy sector. The ability of capital and labour to move between the energy and non-energy sectors is also important, as is the feedback effect of higher income onto savings and capital formation.

The simplest case is one in which there are fixed production coefficients; there are no resource transfers between the energy and non-energy sectors; and the economy has a zero energy trade balance. In this situation a rise in energy prices will leave production and real GNE in the non-energy sector unchanged but cause real income to fall by an amount equal to its energy usage times the price increase. This is the result arrived at for the pure energy importer and described earlier in 2.1.1.

In the energy sector, output and, therefore, real GNE remain constant. Income rises by the amount of energy production times the energy price increase, which is precisely the amount of the income loss in the non-energy sector.

Thus, real GNE in each sector, and in aggregate, remains constant. Income falls in the non-energy sector and rises in the energy sector by amounts which exactly offset each other leaving aggregate income unchanged. In the absence of distributional effects,[1] there are no feedback effects on savings, capital formation, and GNE potential.

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[1] As noted in the introduction to this paper, it is possible for the distribution of income between capital and labour to change in such a way that total savings rise despite a fall in national income. This will happen if there is a sufficiently large increase in the income share of the factor with the higher marginal savings rate. In the general case with substitutability in the production process and resource mobility between sectors, there could be a shift in income shares towards capital as a result of the increased demand for capital in the expanding capital-intensive energy sector. Given a greater propensity to save out of capital income than out of labour income, distributional effects could alter the conclusions described in the text. One cannot be sure, however, that such distributional effects will occur. In the case where labour is a much better substitute than capital for energy, or if capital and energy are complementary, then the increased demand for capital in the expanding energy sector may be offset by a reduced demand for capital in the non-energy sector. The share of capital income in total income could increase, decrease, or remain unchanged. The implicit assumption throughout this paper is that such distributional effects are neutral in the sense that they neither increase nor decrease the aggregate savings rate.

If the economy is a net energy exporter initially, rather than having a zero energy balance, the real income gains in the energy sector will be larger than the losses in the non-energy sector since energy production will exceed domestic energy usage. In this case real income will rise in aggregate. Over time, this will result in larger flows of savings and capital formation. For the economy which is a net energy importer, the savings effect will be in the opposite direction and the GNE path will eventually shift downward.

When substitution away from energy in the production process is possible, the effects for an economy which initially has a zero energy balance are a little different. Output and real GNE in the non-energy sector fall because of the substitution away from energy. Income falls because of the terms of trade effect. However, as was demonstrated earlier, the income reduction is smaller when factor substitution is possible than when production coefficients are fixed.

In the energy sector it is assumed that production continues at the same level as before - resource transfers between the two sectors are not permitted for now - and real GNE, therefore, remains constant.

Given the reduction in domestic demand for energy, the initial energy-output level can be maintained only if the amount of energy produced but no longer demanded by the domestic non-energy sector is exported. Real income in the energy sector rises by the amount of energy production times the price increase.

Thus, for the economy which initially has a zero energy balance and for which factor substitution is possible, the energy price rise will in theory turn it into an energy exporter. Real GNE falls in the non-energy sector, remains constant in the energy sector, and therefore, falls in aggregate. Real income falls in the non-energy sector but by less than the rise in income in the energy sector.[1] For the economy as a whole, real income rises.

Because of the rise in income, it is possible that savings and capital formation may increase sufficiently to offset the initial depressing effect of the energy price rise on real GNE. It is therefore not possible to be categorical about the ultimate effect of the energy price rise on the economy in these circumstances. This conclusion also holds for the economy which is initially a net energy exporter. For the net energy importer the income effect is negative for the economy overall and, therefore, the savings effect will compound the initial downward shift in income and GNE.

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[1] This follows from the proposition that in the fixed coefficients case the changes in real income in the two sectors are exactly offsetting and that, with factor substitution, the non-energy sector has the opportunity to reduce the size of its income loss, thereby increasing aggregate real income.

Throughout the analysis above, it was assumed that there was no transfer of resources from the non-energy sector of the economy to the energy sector. Given the higher price of energy one would expect such a transfer to occur and it is necessary to examine the effects of such resource transfers on the conclusions reached above.

As a general proposition one can argue that the resource transfers which occur in response to the new set of relative prices will tend to improve the economy's real income relative to the situation in which no resources are re-allocated. They will not, however, increase real GNE given that real GNE is final output valued at initial prices. If such transfers could increase GNE measured at the old prices, they would have occurred in response to market forces prior to the energy price rise. If they have any effect at all, such transfers might well have a negative influence on real GNE. Once again, however, these conclusions are with respect to the initial effect on GNE. When account is taken of the savings effects of the higher income to which the resource transfers lead, the effect on real GNE may ultimately be positive.

For a two-sector economy, conclusions about the effects on income and GNE of higher energy prices depend on the set of assumptions which best describe that economy. For Canada, in the period 1973-1977, the relevant sub-case would be one in which there are possibilities for factor substitution in the non-energy sector, in which resource transfers from the non-energy sector to the energy sector can occur, and in which the economy is a net energy exporter.

In these circumstances, one can argue that the impact of higher energy prices on real income was positive, that the initial impact on real GNE was negative, but that the feedback effect of higher income on savings and capital formation makes it impossible, in theory, to be categorical about the ultimate impact on the GNE path.

In practice, these feedback effects are likely to take place over a longer period of time. They are unlikely to have been strong enough over the period 1973-1977 to have offset the downward shift in GNE potential resulting from a substitution away from energy in the production process.

One should be careful, though, not to exaggerate the size of any downward shift in GNE potential. In theory, one can think of the GNE line shifting down at a point in time and continuing to grow at the initial rate thereafter. In reality, the substitution away from energy in the production process may take several years and the downward shift of the GNE line in any one year may be quite small.

For Canada it is not sufficient to comment simply on the effects of energy price increases on aggregate income and GNE. The transfer of resources from the energy to the non-energy sector has important regional implications and these are pursued below.

In the standard neoclassical economic model, resource transfers from one sector of the economy to another are assumed to occur smoothly. In a country as regionally diverse as Canada, the transfer process may have

serious implications for the regional and industrial concentration of economic activity, the movement of factors of production, provincial revenues, and regional income differentials.

An expansion of Canada's energy sector will necessarily influence the location of economic activity. Exploration and development of fossil fuel resources and major projects such as the tar sands, heavy oil, and the northern pipeline will increase primary activity in the west and north. This process has already begun. While direct employment effects in the energy sector may not be that significant given the capital intensity of most energy projects, service sector employment will expand in these regions and population flows from eastern and central Canada to the west will take place. They are an essential part of the adjustment process.

While these changes will involve some population flows towards the west, it will probably be the case that the associated changes in regional shares of total employment will be smaller than the changes in regional shares of gross domestic product (GDP). The energy sector is highly capital-intensive so that the flows of capital into western Canada - and the profits which such capital generates - are likely to be relatively more important than regional employment and labour income changes.

Because of the relatively larger shift in the regional distribution of profits than employment, regional per capita income differentials can be expected to widen. While this would not be a serious problem if the tax revenues from rising energy profits in the west could be redistributed so as to mitigate the effects on the adversely affected regions, the Canadian federal system does not permit this. Provincial government revenues are affected by the resource shifts which energy-sector expansion induces and it is difficult for the federal government to fully offset the effects of these shifts on the economic welfare of those in the regions from which capital and labour are diverted.

An important consequence of the constitutional fact that provinces control resources, and thus have benefitted from the rent on them, is that the rise in the price of energy has necessitated more geographical resource shifts than would have been the case if resources had fallen under national control. Rents collected by the provinces have been reinvested within provincial boundaries to expand the non-energy sectors as well as the energy sectors of those provinces and, thus, have accentuated the geographical resource shifts. Since such shifts are often difficult to bring about, the costs to the economy of higher energy prices have been larger because of this constitutional situation.

There are, of course, some factors which may partially offset the effects described above. Population shifts, for example, may reduce in the longer run the total infrastructure costs of those provinces from which out-migration is occurring.[1] Equalization payments to receiving

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[1] It is unlikely that per capita infrastructure costs will decline. They are more likely to increase.

provinces will tend to increase as a result of rising provincial royalties and corporate income taxes in the western provinces, although there are limits to the extent to which this effect can occur. Further, the increased provincial revenues from expanding energy production may be partly recycled throughout the economy. While one cannot ignore these possibilities, their effects do not appear to be sufficiently large to change the basic thrust of the argument being advanced here.

While the focus here is on the movement of productive factors towards the west, it would be a mistake to think that energy-sector expansion is entirely a western and northern Canadian phenomenon. The development of renewable resources such as wind, solar, and tidal power is oriented towards the east. Some major energy projects, such as hydro developments in Newfoundland and Quebec, remain to be exploited. One would expect nuclear power to play an increasingly larger role in Canadian energy production and, once again, the associated economic activity is likely to be in the central and eastern provinces.

There are implications as well for the relative size of the Canadian primary and manufacturing sectors. The closer the economy is to full employment, the more likely it is that a more rapid growth of the primary energy sector will require labour and capital which might otherwise have been utilized in the manufacturing sector. The effects on the manufacturing sector should not be exaggerated, however. To the extent that capital is a constraint, the Canadian economy has access to foreign savings. Further, while much of any energy-sector expansion is primary in nature, there will be many areas in which the impact on manufacturing will be positive: the expansion of a nuclear industry in Canada; solar energy and other renewable-resource industries; the impact of pipeline projects on the steel industry. All of these developments will assist in providing a larger energy orientation to secondary industry in Canada, rather than simply reducing its size.

The resource re-allocation process is, nevertheless, a difficult one, but one which should be accommodated rather than avoided.

2.4 The Effects of International Capital Flows

In the analysis to this point, the assumption has been made that the economy's current account is always in balance and that international capital flows do not occur. In this section, it is assumed that capital flows can occur and do so in response to any differential between the world cost of capital and the economy's rate of return on capital. Capital inflows or outflows are presumed to continue until the rate of return in the economy is equal to the international cost of capital.

This section begins by analyzing the effect of higher energy prices on the world cost of capital. There is no definite conclusion about the direction of this effect and the remainder of the section proceeds on the basis of a fixed international cost of capital.

The general conclusion which emerges from the analysis is that the existence of international capital flows strengthens the results arrived at earlier: economies which suffer adverse income and GNE effects when there are no

capital flows, suffer greater losses when such flows are permitted; conversely, economies which benefit from higher energy prices, benefit to a larger degree when capital flows can occur. (This section of the paper may be omitted, with no loss of continuity, by the reader).

2.4.1 The World Cost of Capital

A simple way to analyze the impact of higher energy prices on the world cost of capital is to assume that the world economy consists of two sectors, an energy sector and a non-energy sector. It is also useful to distinguish the case in which production coefficients are fixed from that in which production coefficients are variable.

In the fixed production coefficients case, a rise in energy prices will leave production and real GNE in the world non-energy sector unchanged but cause real income to fall. In the world energy sector, output and real GNE will remain unchanged but income will rise by an amount equal to the income loss of the world non-energy sector. As a result, aggregate real GNE and income will remain unchanged. In the absence of distributional effects, aggregate world savings and the world cost of capital will remain unchanged.

In the variable coefficients case, income, output, real GNE and energy consumption will fall in the world non-energy sector. In the world energy sector, income will rise but, unlike in the fixed coefficients case, output and real GNE will fall as a result of reduced world demand for energy. In consequence, the income loss by the non-energy sector will not be fully offset by the energy-sector income gain.[1] This fall in income, if not offset by income distributional effects on savings, will tend to reduce aggregate savings and put upward pressure on the world cost of capital.

To the extent that distributional effects on savings do exist, they are likely to be favourable to an increase in total savings. With capital and labour equally substitutable for energy, the distributional effects will tend to favour capital because of the incentive to expand in the capital-intensive energy sector. The effect of this is to increase aggregate savings and to exert downward pressure on the world cost of capital.

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[1] The labour and capital released from the world energy sector, as a result of the fall in energy output, could in theory be absorbed by the non-energy sector to expand that sector's output. But this transfer of resources between sectors, even if it could be accomplished smoothly, would not be sufficient to compensate for the initial loss of aggregate output and income. If such a transfer could increase income, it would have occurred in response to market forces prior to the energy price increase. This analysis assumes that the world's resources, prior to the energy price increase, are deployed in a way which maximizes world income.

Because the direction of the effect of higher energy prices on the world cost of capital is unclear, the rest of this section proceeds on the basis of a given and unchanging world cost of capital.

2.4.2 The Pure Energy Importer

For a pure energy importer, the effect of higher energy prices is to reduce income and real GNE and, as a general proposition, the fall in income is shared by both labour and capital. This reduction in the domestic rate of return on capital will lead to capital outflows and a slowing down of domestic investment until the domestic rate of return is driven back up to the world level. The capital/labour ratio should tend to fall and adversely affect real income and real GNE.

As discussed in previous sections, the effect of higher energy prices on a pure energy importer, assuming no international capital flows, is initially to reduce real income. In the longer term, due to the reduced income out of which to save, total savings and the capital/labour ratio can be expected to decrease. For an energy-importing country with access to world capital markets, the reduction in the capital/labour ratio can be expected to be more pronounced and, therefore, the impact on real income and real GNE should be more severe. The effect of capital flows is to strengthen the conclusions arrived at earlier.

2.4.3. The Pure Energy Exporter

For an economy which is exclusively an energy producer, the effect of an energy price increase is to improve its terms of trade, and therefore, its real income. In the absence of distributional effects, the domestic rate of return will tend to rise above the world cost of capital. To the extent that distributional effects do exist, they are likely to favor capital and, hence, accentuate the rise in the domestic rate of return.

This should tend to increase the flow of investment from abroad. Over time, the capital/labour ratio should rise and shift the economy's income and GNE potential lines upward. This reinforces the conclusions already reached for the case in which no international capital flows were assumed to take place.

2.4.4 The Two-Sector Economy

For the two-sector economy, it is important to distinguish three cases: the economy with a zero net trade balance in energy; the net energy exporter; and the net energy importer.

For an economy which initially has a zero energy trade balance and for which factor substitution is possible, the effect of a higher price of energy is to push it in the direction of becoming an energy exporter. Real income will rise due to the terms of trade effect and, in the absence of distributional effects, the domestic rate of return should rise relative to the world cost of capital.

If capital and labour are equally substitutable for energy in the production process, the distributional effects should favour capital as a result of the increased demand for capital in the expanding capital-intensive energy sector. Both the income and the distributional effects will, therefore, tend to raise the domestic rate of return relative to the world cost of capital. This should induce inflows of capital into the economy from abroad and raise the rate of capital formation and the capital/labour ratio, thus enhancing the economy's long-run real GNE and income potential.

The effects on a country which is a net energy exporter are similar to those described above for a country which initially has a zero energy trade balance. The net energy exporter will experience initial real income gains due to the improvement in its terms of trade. Unless the initial distributional effects strongly favour labour, the domestic rate of return should rise above the world cost of capital and, therefore, induce inflows of capital and raise the economy's capital/labour ratio. Ultimately the domestic rate of return should be driven back to the world level, but this will occur with the economy operating at a higher capital/labour ratio and with an expanded income and GNE potential.

For a net energy importer, the initial income effect is negative due to the unfavourable movement in the terms of trade. In the absence of distributional effects, the domestic rate of return should initially tend to fall relative to the world cost of capital. Domestic investment should tend to slow down until the rate of return is driven back up to the world level. Hence, the capital/labour ratio should fall, thereby reducing real GNE and income.

As was the case for the pure energy importer and the pure energy exporter, the effect of international capital flows on an economy with both an energy sector and a non-energy sector is to strengthen the results already arrived at earlier for the cases in which international capital flows were precluded. Because the introduction of capital flows into the analysis serves only to reinforce conclusions reached earlier, the analysis which follows is based on the initial assumptions of a current account balance and no international capital flows.

2.5 The Effects of a Higher Real Production Cost of Energy

All of the foregoing analysis assumed that the increase in the price of energy resulted from the exercise of market power and did not reflect any increase in the real cost of producing energy. If this assumption is relaxed, many of the conclusions reached above must be modified. In this section it is assumed that energy prices double because the costs of producing energy double. That is, constant average and marginal costs both double so that no economic rent accrues to any producer.

For the pure energy importer it makes no difference whether the price increase reflects higher production costs or not. It suffers an income and consumption loss because of the deterioration in its terms of trade and reduces these losses over time as it substitutes away from energy or increases its overall capital/labour ratio. Because of the substitution

away from energy, its real GNE path shifts down and there are unlikely to be any induced effects on savings and capital formation which will offset this shift. These results are the same as those arrived at in the earlier analysis.

For the pure energy exporter, the result is to leave it about as well off in income terms after the price increase[1] as it was before. Imagine, for example, that the cost to an OPEC country, in terms of the capital and labour required to produce a barrel of oil, doubles and that its selling price doubles. With continued full employment, the effect should be a corresponding reduction in the volume of oil it can produce and export and no change in the country's income. The price of non-energy-sector output which it imports is assumed unchanged[2] so that the country's income and consumption potential is the same after the price increase as before. It is no worse off but no better off either. This is a substantially different result from the earlier analysis when, with constant energy production costs, the doubling of the price doubled its income and consumption potential.

In terms of real GNE, the effects of the cost-related price increase are clearly adverse. The doubled cost and halved volume of energy production results in a halving of the pure exporter's real GNE. In the previous analysis the energy price increase left the economy's real GNE unchanged.

The two-sector-economy case combines the results of the pure-energy-importer and pure-energy-exporter cases described separately above. The effects on the two-sector economy of the cost-related price increase are to reduce income and real GNE relative to the situation in which the energy price increases are a reflection of the exercise of market power by energy producers.

The initial adverse effects on income and GNE in the non-energy sector are the same as before but now, with a cost-related energy price increase, the energy sector's income gains and real GNE are reduced relative to the situation in which the price increase is not cost-related; the energy sector's income remains the same while real GNE falls.

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1 This would be truly accurate only if the economy did not consume any energy itself. It would be adversely affected but the effect would be relatively minor compared to the pure importer or the two-sector economy.

2 More realistically, one would expect some marginal increase in the price of imports reflecting the higher-cost energy content in them. This does not alter the essence of the argument being made here.

In summary, a cost-related increase in energy prices (when the cost increase is on all energy production, not just marginal sources) benefits no one. The pure exporter is no better off in income terms after the price increase. All other economies are adversely effected. All economies are worse off in terms of real GNE and, because there are no income gains, there will not be any induced increase in savings and capital formation to offset the downward shift in the real GNE path.

An assessment of the effects on the Canadian economy in the period 1973-1977 is more complicated than the above analysis would indicate for several reasons.

First, to the extent that energy production costs are higher in real terms it is likely to be the case only for marginal energy production. The cost of production from existing sources should not increase, and these producers (and governments) earn economic rents which do not reduce the economy's income and consumption possibilities.

Second, one has to be careful to disentangle the effects of higher energy prices from any downward reassessment of the energy potential of the Canadian economy. Such a reassessment was made at about the same time as energy prices began to increase significantly. Failure to disentangle the effects of this reassessment from the effects of the price increase per se would lead to an overstatement of the probability that the effects of the price increase were detrimental to the Canadian economy.

2.6 Implications for Canada's Long-Run Growth Path

Taking all of the previous analysis into account, what conclusions may be drawn about the probable effects of the energy price increases on the income and GNE potential of the Canadian economy?

To the extent that price increases did not reflect higher production costs, Canada should have benefitted in income terms from improved terms of trade in 1973, this benefit decreasing in subsequent years as the net energy trade surplus declined. The value of these terms of trade gains are discussed in section 3.1 below. To the extent that the real cost of energy production increased in Canada over the 1973-1977 period, the benefits which Canada could have been expected to derive from the energy price increases would be smaller. Thus, the terms of trade gains estimated in section 3.1 represent an upper limit on the size of the income gain over that period.

In terms of real GNE potential the effects of the energy price increases are not unambiguous. Substitution away from energy in the non-energy sector would tend to depress GNE but the feedback effect of higher income on savings and capital formation could in theory reverse this conclusion. In practice, however, such feedback effects are likely to require a longer period of time to be fully felt, and it is probable that Canada's GNE potential was adversely affected over the period 1973-1977.

The effects on the Canadian economy over the next decade depend on the net energy export balance and the real cost of producing energy domestically. The steeper is the supply curve of energy the more likely it is that Canada's income and GNE potential will be adversely affected, either because the result is a substantial energy trade deficit which imposes terms of trade losses on the economy, or because Canada produces larger volumes of energy at higher real costs.

The evidence on the supply curve of energy is not clear. There are currently a number of higher-cost energy projects underway or being considered but, at the same time, there appears to be a substantially greater availability of lower-cost natural gas. Whether Canada has fully exploited its lower-cost energy resources is an issue which is not resolved at this point and, therefore, it is difficult to be specific about the shape of the energy supply curve. In consequence, the quantitative significance of the depressing effect of higher energy prices on Canada's income and GNE paths is not clear. This is an area requiring substantial further work.

Another issue which will require careful analysis is the role which a real GNE line should be expected to play in medium-term economic analysis. This distinction between income and GNE, and the divergence between them which terms of trade changes can create, leads to some surprising conclusions.

Consider, for example, a country which is a pure importer of energy and whose possibilities for substitution away from energy are limited. The effect of a price increase will be similar to that described in Table 1. Its physical output is unchanged despite the increase in energy prices. Its export volume and value increase, while its income and potential consumption decrease. Real GNE is constant, however, as is the physical productivity of labour.

Now suppose that the alternative to paying higher energy prices for imported energy is to develop a domestic energy sector. This was not worthwhile doing at the initial price of energy but, at the new energy price, the economy can meet its energy requirements at an average real cost equal to the higher price. Suppose this happens. Capital and labour are transferred to energy production from non-energy production. Energy imports and non-energy exports are eliminated. The economy becomes completely self-sufficient.

In terms of the economy's income, the result is the same as if the country simply paid the higher price for its energy imports. The composition of output changes because the capital and labour, which would have been used to produce a doubled volume of exports to pay for energy imports, are now used to produce an equivalent volume of energy domestically. Non-energy-sector (final goods) production available for domestic use is unchanged and the economy in this sense should be indifferent between the two possible reactions to the price increase.

In terms of real GNE, the difference between these two alternatives is substantial. In the first case, labour productivity and real GNE are unchanged. In the second case the volume of final goods (i.e., the output of the non-energy sector given that energy is treated as an intermediate good) declines and so, therefore, does real GNE and labour productivity.

In effect, what has happened is that the terms of trade loss suffered in the first case has been "internalized" in the second case into lower physical productivity. There is no terms of trade loss since the country no longer trades after the price increase. Thus, to the extent that a country creates or expands its energy sector in response to higher energy prices, the effect on measured productivity and the economy's growth path will be adverse.

The implication of the preceeding discussion is that real GNE may not be a useful measure of the economy's performance when terms of trade changes are important. It may be more appropriate to focus on the income line as a measure of how well off the economy is - the income measure incorporates both productivity and terms of trade gains - and to focus on another indicator, such as the unemployment rate, as a measure of economic activity.

2.7 Theoretical Discussion: Summary and Conclusions

For Canada, a net energy exporter in the period 1973-1977, the substantial increase in the international price of energy resulted in significant terms of trade gains. The analysis developed in this paper suggests that the terms of trade and income gains experienced by the Canadian energy sector should have exceeded the income losses of the non-energy sector so that in aggregate, the effect of higher energy prices was to increase real income. The improvement in the terms of trade contributed to real wage gains in excess of the growth in productivity in this period. With the reduction of Canada's trade balance, the importance of these terms of trade gains diminished.

The effect on real GNE potential in the post-1973 period is not clear. The direct impact of substitution away from energy in the production process is to reduce real GNE but, in theory, higher income from terms of trade gains can lead to greater savings and capital formation which will tend to push the GNE line upwards. Problems in assessing the size and timing of such an effect make it difficult to be categorical about the Canadian experience in the period since 1973, but this effect is likely to have been small relative to the adverse impact on GNE potential of the shift away from energy in the production process.

While Canada has benefitted from the improvement in its terms of trade over the period since 1973, it has suffered from the unemployment and inflationary effects to which dramatic changes in relative prices - and resistance to them - can lead. While these effects are clearly important, the discussion above ignored them. Relative price shocks likely worsen the inflation-unemployment trade-off.

In the long run the effect on Canada of higher energy prices will depend on the shape of the supply curve of domestically-produced energy. If incremental energy output to meet domestic requirements cannot be economically produced, Canada will become a net energy importer and will suffer terms of trade losses if the higher relative price of energy is maintained. To the extent that domestic energy production can expand, the terms of trade losses can be reduced. However, if this expansion of domestic energy production takes place along a sharply rising energy cost curve, there will be adverse effects on productivity, income, and GNE.

At present the evidence on the shape of the long-run supply curve is not clear. One can point to the higher cost of production from tar-sands plants and frontier sources, but one can also argue that the increased supply of natural gas from more conventional sources could make the sharply rising portion of the energy supply curve irrelevant for another decade. As a general proposition, however, Canada is unlikely to benefit from the effects of higher energy prices. The impact on both income and GNE is likely to be adverse and the question which needs further examination is the size and timing of these effects.

3. EMPIRICAL ESTIMATES OF THE EFFECTS OF HIGHER ENERGY PRICES ON CANADA'S TERMS OF TRADE AND REGIONAL DISTRIBUTIONAL OF INCOME

Based on the theoretical framework presented earlier, it is possible to estimate some of the effects on the Canadian economy of the increased prices of oil, gas, and coal in the post-1973 period. No attempt is made to evaluate the impact on the Canadian economy of increased prices of other energy commodities.

The effects considered are the terms of trade gains for the Canadian economy in recent years and the effects on the regional distribution of income within Canada. Although the energy price increases had important short-term macro-economic consequences which resulted in short-term output losses for the economy, no attempt is made here to assess their quantitative significance.

3.1 Terms of Trade Effects

The increase in the international prices of oil, gas, and coal which occurred in the post-1973 period resulted in immediate terms of trade gains for all net energy exporters and terms of trade losses for net energy importers. Table 2 below presents terms of trade indexes over the period since 1967 for Canada, the United States, Germany, and Japan.

Table 2

Terms of Trade Indexes(1), Selected Countries, 1967-1977
(1975 = 100)

	Canada	United States	Germany	Japan
1967	90.8	123.6	93.6	130.0
1968	91.4	124.1	94.5	130.5
1969	90.7	124.3	95.1	136.4
1970	91.8	122.7	97.6	136.8
1971	91.0	120.3	101.0	134.7
1972	91.8	115.3	104.5	142.9
1973	97.4	114.3	101.5	138.0
1974	104.6	96.5	93.1	107.1
1975	100.0	100.0	100.0	100.0
1976	102.0	100.4	98.6	97.2
1977	96.9	97.3	98.8	104.3

(1) Unit value of merchandise exports divided by unit value of merchandise imports.

Source: International Monetary Fund, International Finance Statistics, May 1978 and July 1978.

The substantial increase in Canada's terms of trade index in 1973 and 1974 is apparent. This improvement was due to the sharp rise in world commodity prices, including energy prices, which occurred at the time. Canada, in addition to being a net energy exporter, was also an important exporter of non-fuel mineral, forest and agricultural commodities whose prices rose sharply during those two years.

As world prices for raw and partially processed commodities surged, Canada's terms of trade improved dramatically. But as the world commodity price boom subsided in 1975 and previous commodity price increases worked their way through to manufactured products, Canada's terms of trade position deteriorated from the peak registered in 1974. It should be noted that raw and partially processed commodities represented about two-thirds of Canada's total merchandise exports. The opposite was true for Canada's merchandise imports, approximately two-thirds of which were manufactured products. Thus, as prices for manufactured products increased relative to commodity prices after 1974, Canada's terms of trade deteriorated. But despite this deterioration, Canada's index is still high by historical standards.

In contrast to Canada's performance, major energy importers, such as the United States, Germany and Japan, suffered a significant deterioration in their terms of trade in 1974. While Germany has recovered some of the ground that was lost in 1974, the United States and Japan have not. All three countries must now generate a greater volume of exports to pay for the same volume of imports. They have suffered terms of trade losses and are worse off than they would have been had all prices remained at their 1972 levels.

Chart 2 depicts the value to Canada of the terms of trade gains directly related to trade in oil, gas, and coal (fossil fuels) over the period 1969-1977. These gains are measured as the difference between the value of the fossil fuel trade surplus measured at each year's real price (i.e., the nominal price adjusted for overall inflation) and the value of this surplus measured at 1971 prices.

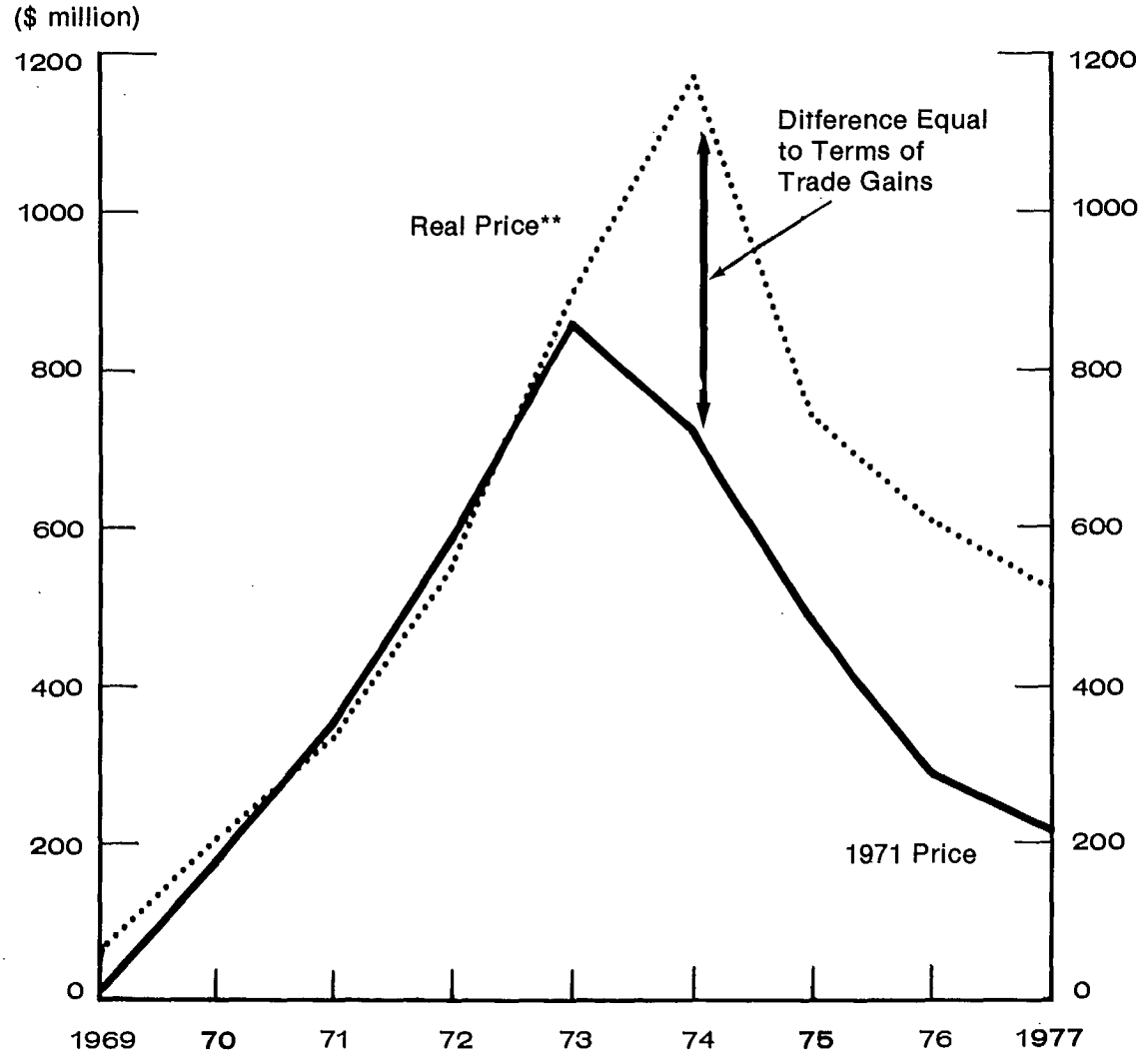
The largest gain in the terms of trade was recorded in 1974 following the sharp increase in OPEC oil prices (see Table 3). The gain in 1974 amounted to $447.3 million, equivalent to 38.0 per cent of the net fossil fuel trade balance or 0.4 per cent of GNE, measured in 1971 dollars.

As is clear from Chart 2, Canada's net positive trade balance in fossil fuels, measured in current and 1971 prices, declined steadily after 1973-1974. This decline was due to the growing deterioration in Canada's net trade balance in crude oil (see Table 4).

It should be emphasized that the terms of trade gains estimated here represent a maximum valuation of the real income gains to Canada derived from direct trade in oil, gas and coal. The two would be equal only if real costs of production did not increase over the period. To the extent that real cost increases did occur, nominal terms of trade gains exceed real terms of trade gains and the real income gains are smaller.

Chart 2

Net Trade Balance* Oil, Gas and Coal, Canada, 1969-1977



*Value of Exports minus value of Imports

**Ratio of nominal price to the merchandise import implicit price index.

Source: Statistics Canada, Exports — Merchandise Trade, cat. 65-202, Imports — Merchandise Trade, cat. 65-203, Bank of Canada Review; and data provided by the National Energy Board.

Table 3

Terms of Trade Gains from Trade in Oil, Gas and Coal, 1969-1977

	Current Price	Real Price[1]	1971 Price	Terms of Trade Gains
	(millions of dollars)			
1969	59.7	61.5	4.1	57.4
1970	199.2	202.0	185.4	16.6
1971	343.6	343.6	343.6	0
1972	562.7	550.0	594.8	-44.8
1973	1002.9	911.7	865.4	46.3
1974	1596.4	1177.3	730.0	447.3
1975	1174.9	750.3	489.8	260.5
1976	959.2	607.1	297.4	309.7
1977	926.2	525.1	208.8	316.3

[1] Current price divided by the merchandise-import implicit price index

Source: Statistics Canada, Exports - Merchandise Trade, Cat. 65-202, Imports - Merchandise Trade, Cat. 65-203; Bank of Canada Review; and data provided by the National Energy Board.

Table 4

Canada's Net Trade Balances[1] in Oil, Gas and Coal, 1969-1977

	Crude Oil	Petroleum Products	Natural Gas	Coal & Coke
	million barrels	million barrels	million Mcf	million short tons
1969	4.2	-48.9	632.1	-15.7
1970	33.3	-36.6	756.2	-15.0
1971	26.0	-15.0	887.1	-10.4
1972	60.2	21.2	993.3	-10.5
1973	94.9	45.3	1016.2	-4.8
1974	42.9	55.0	951.5	-2.1
1975	-36.1	56.4	939.1	-5.0
1976	-93.7	46.9	945.1	-3.6
1977	-125.1	48.2	1000.0	-3.0

[1] Exports minus Imports

Source: Statistics Canada, Exports - Merchandise Trade, Cat. 65-202, Imports - Merchandise Trade, Cat. 65-203; and the National Energy Board.

It is also worth pointing out, once again, that this section deals only with the terms of trade gains on primary energy flows. There has been no attempt here to estimate the net trade in energy embodied in the export and import of other products.

3.2 Regional Distribution of Income and Revenue

In addition to the transfer of income from energy importing countries to energy exporting countries (the terms of trade effects), the energy price increases, in the period since 1973, have had a significant regional impact within Canada.

Table 5 and Chart 3 compare the value of Canadian mineral fuel production at each year's real price (i.e., nominal prices adjusted for inflation) with the value of this production at 1971 prices. The increase in the real value of production represents the increase in revenues realized by fossil fuel producers and fossil-fuel-producing regions of Canada.

Table 5

Value of Canadian Mineral Fuel Production, 1969-1977

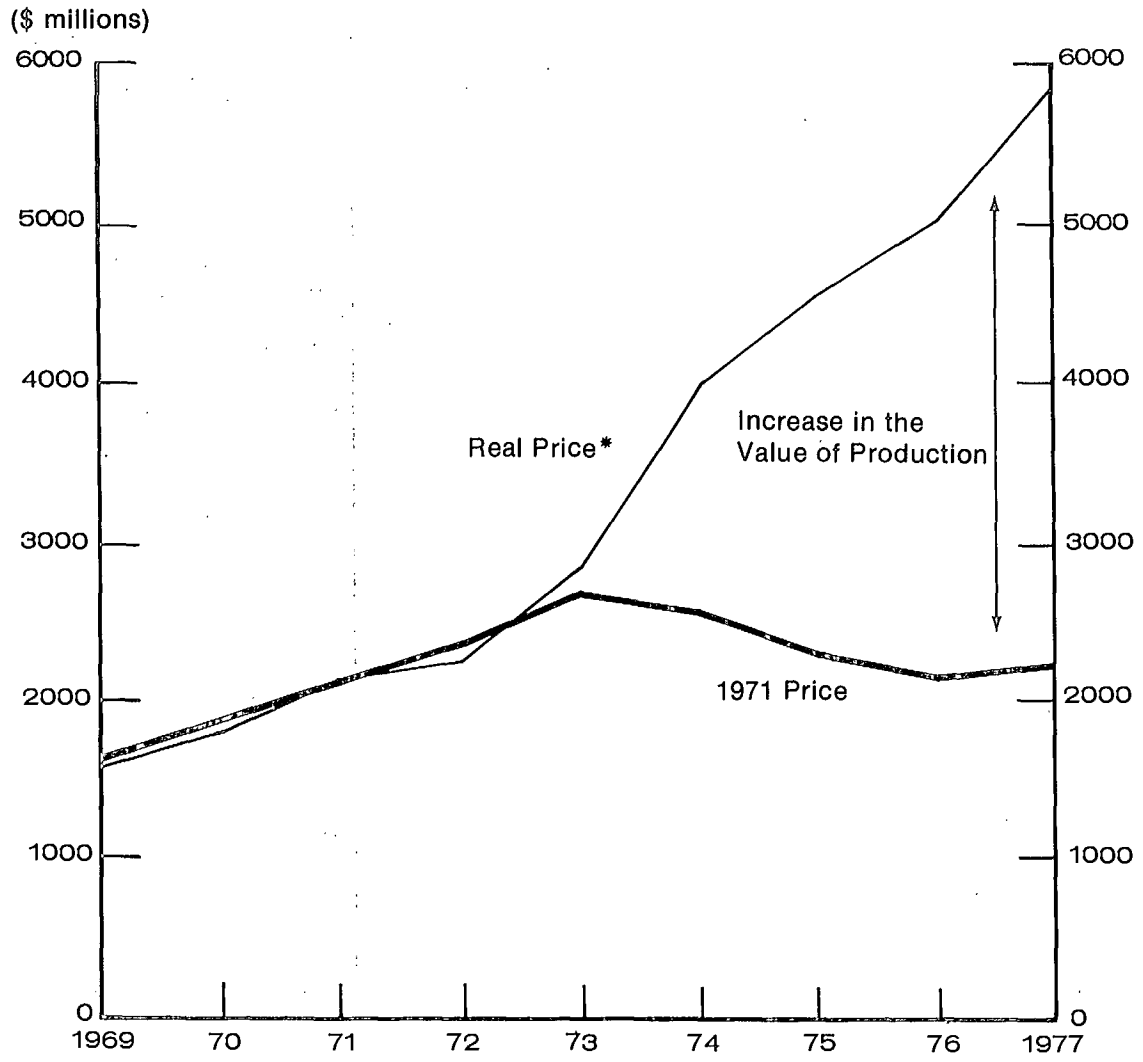
	Current Price	Real Price(1)	1971 Price	Increase in Real Value of Production
		(millions of dollars)		
1969	1,465.4	1,582.5	1,622.0	-39.5
1970	1,717.7	1,772.7	1,864.9	-92.2
1971	2,014.4	2,014.4	2,012.3	2.1
1972	2,367.6	2,254.9	2,325.7	-70.8
1973	3,227.1	2,816.0	2,641.9	174.1
1974	5,201.7	3,937.7	2,518.0	1419.7
1975	6,653.4	4,550.9	2,294.8	2256.1
1976	8,109.1	5,055.5	2,160.9	2894.6
1977	10,012.5	5,838.2	2,209.6	3628.6

(1) Current price divided by GNE implicit price deflator.

Source: Statistics Canada, General Review of the Mineral Industries, Cat. 26-201. For 1976 and 1977, Canada's Mineral Production, preliminary Cat. 26-202.

For 1977, the increase in the real value of production was equal to $3.6 billion, 3 per cent of Canada's GNE measured in constant 1971 dollars. This was equal to about 13 per cent of the combined provincial gross domestic product of Saskatchewan, Alberta and British Columbia (including the Yukon and Northwest Territories), the principal recipients of these increased revenues.

Chart 3
Value of Canadian Mineral Fuel Production 1969-1977



*Ratio of nominal price to the GNE implicit price deflator.

Source: Calculated from Statistics Canada, General Review of the Mineral Industry, cat. 26-201, Canada's Mineral Production cat. 26-202, and National Income and Expenditure Accounts, cat. 13-201.

One can get a very rough idea of the size of these regional transfers by subtracting the terms of trade gains from the increase in the real value of production in Canada. This is done in Table 6. This difference is the transfer from domestic consumers to producers (including governments) and, to the extent that the bulk of Canada's population is in the non-fuel-producing provinces, it represents in a very rough way the inter-regional transfer.[1] Once again, these transfers can be considered net real income transfers only to the extent that real costs of production did not rise over the period.

Table 6

Regional Revenue Transfers, 1969-1977

	Increase in Real Value of Production	Terms of Trade Gains	Regional Revenue Transfers(1)
	(millions of dollars)		
1969	-39.5	57.4	-96.9
1970	-92.2	16.6	-108.8
1971	2.1	0	2.1
1972	-70.8	-44.8	-26.0
1973	174.1	46.3	127.8
1974	1419.7	447.3	972.4
1975	2256.1	260.5	1995.6
1976	2894.6	309.7	2584.9
1977	3628.6	316.3	3312.3

(1) Increase in real value of production minus terms of trade gains.

Source: Tables 3 and 5.

[1] It should be noted that Canadian petroleum production is valued at well-head prices. Export taxes collected by the federal government are not included in the valuation. Therefore, the difference between the value of production and the terms of trade is equivalent to the real income loss of the consuming regions. This is roughly equal to the volume of fossil fuels consumed by those regions times the domestic price.

The provincial governments of the energy-producing provinces have clearly benefitted over the period. Non-income-tax-related revenues amounted to over $2 billion in fiscal year 1975-1976, a substantial increase from earlier years (Table 7). The revenues collected by Alberta for the 1975-1976 fiscal year were equivalent to 8.5 per cent of its provincial gross domestic product. Indeed it is clear that provincial governments were the major beneficiaries of higher energy prices.

Table 7

Gross Provincial Government Oil and Gas-Related Revenues, 1969-1977[1]

Fiscal Year	Saskatchewan	Alberta	British Columbia	Other	Total
		(millions of dollars)			
1970-71	28	235	40	1	304
1971-72	29	274	47	2	352
1972-73	30	333	46	2	411
1973-74	43	587	44	7	681
1974-75	224	1,387	86[2]	11	1,708
1975-76	195	1,768	86[2]	9	2,058
1976-77[e]	200	2,180	86[2]	12	2,478

e estimate

(1) Revenue derived from the exploration, development and exploitation of oil and gas resources, other than those received under income tax legislation and those derived through a government enterprise engaged in oil and gas-oriented operations.

(2) Does not include remittances from B.C. Petroleum Corp.: $26 million for 1974-1975, $199 million for 1975-1976, and an estimated $170 million for 1976-1977.

Source: Statistics Canada, Provincial Government Finance, Cat. 68-207.

4. SUPPLY AND DEMAND PROJECTIONS

The purpose of this section is to summarize briefly the different views on the evolution of energy supply and demand in Canada in the medium term.

One conclusion of the theoretical and empirical sections above was that the impact of the energy price increase on Canada's terms of trade was positive in the period 1973-1977. This need not be true in the future, however. There is clearly an evolution in energy supply and demand which could make the effect of higher energy prices negative in the future. If the cost of producing energy domestically were to rise significantly, or if Canada were to become a major net importer of energy, the effect of higher energy prices would become adverse and Canada's long-run growth potential would be reduced.

4.1 The Outlook for Oil

Canada is relatively well endowed with energy resources, particularly coal, hydro power, uranium and natural gas. The major concern is with oil. Most forecasts indicate that domestic oil demand is likely to outgrow domestic oil supplies for, at least, the next 10 to 15 years (Tables 8, 9 and 10). This demand/supply imbalance is expected despite projected increases in synthetic crude oil production. From 15 to 30 per cent of total domestic demand is expected to be supplied from synthetic crude by the late 1980s.

There is considerable controversy and uncertainty about the magnitude of the likely imbalance. The imbalance is of particular concern in view of Canada's announced "self-reliance" goal which is to limit oil imports by 1985 to one-third of total Canadian requirements or to 800 thousand barrels per day, whichever is less.

The controversy and uncertainty stems from a lack of consensus about the long-term effects of higher energy prices on energy demand. This is not surprising in view of the fact that energy consumption in Canada grew at about the same rate as the economy for the last decade and a half. This has fostered the view that vigorous economic expansion is not possible without a corresponding expansion in energy consumption.

This need not be the case, however. As noted in the theoretical framework developed in section 2, energy demand should fall in response to increases in energy prices as individuals and firms substitute non-energy inputs for energy. Between 1961 and 1974, the economy grew at a rate of 5.6 per cent per year, compared with 5.4 per cent per year for energy consumption. In the next 15 to 20 years, the rate of growth of energy demand should be substantially lower than that for the economy.

Just as there is no consensus on Canada's future energy demand growth, so there is no consensus on Canada's domestic energy supply prospects. Not only is there controversy over the ultimate size of reserves of oil and gas in Canada's frontier regions, but also over the size of the reserves of fossil fuels in the conventional producing regions of Canada. The shape of Canada's energy supply curve relative to the shape of the world energy supply curve will, to a large measure, determine whether Canada's dependency on foreign energy sources will increase or decrease in the future. At present, most forecasts indicate that domestic oil supplies will be insufficient to satisfy domestic demand but that natural gas and coal supplies will be adequate. These forecasts are summarized in Tables 8 through 12.

Table 8

Canadian Demand and Supply Balances
for Oil, Gas and Coal, 1977

	Oil excluding LPG[1]	Oil including LPG[1]	Gas	Coal and Coke
	thousand barrels per day	thousand barrels per day	billion cubic feet per year	million short tons per year
Domestic Demand	1776	1808	1560	36
Domestic Production	1451	1609	2590[2]	32
Net Exports (Net Imports)	(336)	(210)	1000	(3)
Inventory Change[3]	+11	+11	+30	-1

(1) Gas-plant-liquified petroleum gases.

(2) Deliveries of marketable gas.

(3) Includes unaccounted-for residual.

Source: Estimates based on Statistics Canada, Crude Petroleum and Natural Gas Production, December 1977, Cat. 26-006, Coal and Coke Statistics, December 1977, Cat. 45-002; and the National Energy Board.

Table 9

Canadian Supply and Demand Projections,
Crude Oil and Equivalent[1], 1985 and 1990

(thousand barrels per day)

	NEB		Imperial		Gulf		Shell	
	1985	1990	1985	1990	1985	1990	1985	1990
Demand	2,049	2,157	1,897	1,965	1,900	1,965	2,036	2,101
Producibility								
conventional	1,034	781	1,064	808	1,232	1,101	1,009	912
oil sands	255	550	256	565	320	555	194	590
Total	1,289	1,331	1,320	1,373	1,552	1,656	1,203	1,502
Net Imports[2]	760	826	577	592	348	309	833	599
Net Imports as per cent of Demand	37	38	30	30	18	16	41	29

(1) Excludes gas-plant-liquified petroleum gases.

(2) Assumes maximum producibility unrestricted by demand in conventional areas served by Canadian oil. Excess supplies are assumed to be either consumed east of the Ottawa Valley to reduce foreign imports or are exported.

Key Assumptions	NEB	Imperial	Gulf	Shell
Real Economic growth	4.6% per year (1978-1980), 4.5% (1980-1985), 3.6% (1985-1990)	4.3% per year (1975-1985), 3.5% (1985-1990)	4.7% per year (1975-1980), 4.1% (1980-1985), 3.4% (1985-1990)	4.2% per year (1977-1985), 3.2% (1985-1990)
World oil price	constant at 1977 level, in real terms	constant at 1978 level, in real terms	-	constant at 1978 level, in real terms
Canadian oil price	approaching world price by end of 1981	world level in the early 1980s	continue to increase in stages to world level	parity reached in 1981

Source: National Energy Board, Canadian Oil, Supply & Requirements, Sept. 1978; Imperial Oil Limited, Submission To The National Energy Board, April 1978; Gulf Oil Canada Limited, Submission To The National Energy Board, April 1978; Shell Canada Limited and Shell Canada Resources Limited, Submission To The National Energy Board, April 1978.

Table 10

Canadian Supply and Demand Projections,
Crude Oil and Equivalent,[1] 1985, 1990 and 2000

(thousand barrels per day)

	EMR		OECD		WAES	
	1985	1990	1985		1985	2000
			Reference Case	Accelerated Policy Case[2]		
Demand	2,359	2,739	2,400[3]	2,000[3]	2,176	3,116
Productibility						
conventional	1,136	736	1,126	1,126	1,205	479
oil sands	274	444	274	274	400	816
frontier areas[4]	-	500	-	-	1,235	1,274
Total	1,410	1,680	1,400	1,400	2,840	2,569
Net Imports (Net Exports)	949	1,059	1,100	700	(664)	547
Net Imports as per cent of Demand	40	39	46	35	-	18

(1) Includes gas-plant-liquified petroleum gases.

(2) Assumes stronger government conservation policies than reference case.

(3) Marine bunkers included in imports, but excluded from consumption.

(4) Includes eastern Canadian offshore areas.

Key Assumptions	EMR	OECD	WAES
Real economic growth	4.5% per year (1975-1990)	4.8% per year (1974-1980) 4.0% (1980-1985)	for 1985, 5.2% per year (1981-1985); for 2000, 3.6% (1980s) and 3.0% (1990s)
World oil price	constant at 1975 level, in real terms	constant at 1975 level, in real terms	constant at 1975 level, in real terms
Canadian oil price	approach world level before 1980	approach world level by 1980	approach world level before 1980

Source: Energy, Mines and Resources Canada, An Energy Strategy For Canada, 1976; Organization For Economic Co-operation and Development, World Energy Outlook, 1977; Workshop on Alternative Energy Strategies, Energy Supply - Demand Integrations to the Year 2000, The MIT Press, 1977.

Table 11

Canadian Supply and Demand Projections,
Natural Gas, 1985, 1990 and 2000

(billion cubic feet per year)

	EMR		OECD	WAES		NEB	
	1985	1990	1985	1985	2000	1985[1]	1990[1]
Demand	2,328	2,868	2,300	2,193	3,768	2,436	2,781
Producibility[2]							
conventional areas	3,126	2,363	3,126	2,300	1,010	3,149	2,651
frontier areas[3]	1,095	2,190	474	400	1,480	-	-
Total	4,221	4,553	3,600	2,700	2,490	3,149	2,651
Net Surplus (shortfall)	1,893[4]	1,685[4]	1,300	507	(2,278)	713[5]	(130)[5]
Net Surplus as per cent of Demand	81	59	56	23	-	29	-

(1) Total Canadian supply/demand balance assuming no frontier gas production.

(2) Deliveries of marketable gas.

(3) Includes eastern Canadian offshore areas.

(4) Includes contractual export commitments of 1062 and 363 billion cubic feet in 1985 and 1990 respectively.

(5) The net surpluses in 1985 and 1990 are insufficient to meet contractual export commitments of 896 and 215 billion cubic feet respectively.

Key Assumptions

For EMR, OECD and WAES, same as in Table 10. As well, the three forecasts assume that the domestic price of natural gas moves to a commodity-equivalent value with oil by the early 1980s.

The NEB forecast assumes: real economic growth of 4.6 per cent per year between 1977 and 1990, constant real world oil price at the 1975 level, the domestic price of crude oil to approach the world price in 1980, and the natural gas price to reach parity by 1980.

Source: EMR, OECD and WAES, same as in Table 10.
NEB - National Energy Board, Reasons For Decisions Northern Pipelines, Volume 1, June 1977.

Table 12

Canadian Supply and Demand Projections,
Coal, 1985, 1990 and 2000

	(million short tons)					
	EMR[1]		OECD	WAES		
	1985	1990	1985	1985	2000	
					Coal[2]	Nuclear[3]
Demand	49.5	62.5	49.5	38	119.0	59.5
Producibility	71.7	111.9	57.9	45	120	120
Net Exports	22.2	49.4	8.4	7	1	60.5
Net Exports as per cent of Demand	45	79	17	18	1	102

(1) Assumes favourable conditions for coal development.
(2) Assumes coal as a substitute or replacement fuel for energy sources in short supply.
(3) Assumes nuclear power as a substitute or replacement fuel for energy sources in short supply.

Key Assumptions

Same as in Table 10.

Source: Same as in Table 10.

5. CONCLUSIONS

The rise in the price of energy in 1973 and subsequent years had important macro-economic consequences which imposed a short-term output loss on the economy. These energy price increases, in addition to their employment and inflationary effects, also resulted in significant income transfers between, and within, the economies of energy-consuming and producing nations. Energy exporters experienced terms of trade gains while energy importers suffered equivalent losses.

Canada has benefitted from terms of trade gains as a result of the energy price increases, although these gains have decreased since 1973 as a result of the declining energy trade balance. These income gains contributed to increases in the real wages of Canadian labour in excess of the productivity gains which were experienced over the post-1973 period.

Quite apart from these static income gains, the energy price increases set in motion a process within Canada, and elsewhere, involving a re-allocation of productive resources from the non-energy to the energy sector. As a general proposition, this resource re-allocation is desirable and should be accommodated. The problem, however, is that it imposes enormous strains on the economy. It requires substantial shifts in the regional shares of output and, to a lesser extent, employment. This in turn implies significant changes in the revenue shares of provincial and federal governments and in regional per capita domestic product, changes which the federal government is unable to smooth as much as it could in a situation where economic rents accrued more to it than to provincial governments. The non-energy sector will also feel the strains of the resource re-allocation process, the obvious signals being low rates of return on capital relative to those in the energy sector.

The effect on the income and GNE potential of the Canadian economy in the future is difficult to quantify. It is unlikely to be favourable but whether it will become significantly adverse remains in doubt. Over time if Canada does not expand its energy sector significantly, the economy will become a net energy importer and will suffer terms of trade losses as a result. The alternative to this is to expand the domestic energy sector which may involve moving along a rising real cost curve for energy production. Which of the two solutions is preferable depends on the relative costs of each. This in turn requires knowledge of whether the supply curve of energy rises sharply or not. At present there is a great deal of uncertainty about the precise shape of the supply curve and it is difficult, therefore, to be specific about the size of the adverse impact, or about the period in which such an impact is likely to become significant.

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