Prices Group
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DIFFERENTIAL INCOME EFFECTS OF FEDERAL OIL AND NATURAL GAS PRICE POLICY

Summary

In response to international crude oil price increases and actual and potential supply problems, the Federal Government has instituted a comprehensive energy policy that has as its central objectives a reduction in the rate of growth of energy demand and an increase in exploration effort in Canada. The most important immediate means of achieving these objectives is an increase in the price of domestic crude oil and natural gas. Increases envisioned by the Government through 1977 could be as high as 300% for crude oil and 250% for natural gas over the prices that prevailed in 1969. To complement the pricing policy, the Government has instituted a program to encourage more efficient utilization of energy resources, i.e., a conservation program.

It is recognized that price increases of this magnitude will have serious implications for Canadian consumers; in particular low income consumers. The conservation program is seen as playing a role in alleviating some of the negative economic impacts on consumers as well as contributing to achieving the macro resource utilization objectives. This paper is an attempt to measure the differential impact of the price increases on different income groups and regions. Estimates are also made of the reduction in estimated consumption in 1977 that can be attributed to a change from 1969 actual prices to 1977 estimated prices. The core of the analysis is a series of Engel curves computed for five regions of Canada based on data drawn from Statistics Canada family expenditure surveys. Income elasticities are calculated for four different income levels, and income and consumption effects calculated for the same groups.

The findings indicate that the demand for energy by Canadian consumers is income inelastic, with an average value for all income levels and regions of .4. The average income effect, i.e., percent reduction in real income, is 6.2%, and consumption in 1977 will be reduced by an average of 2.6% as a result of the reduction in real income. As demand is income inelastic, the income effect among different income groups is regressive, ranging from 4.8% for those

consumption units with incomes in excess of $15,000. Variation in income and consumption effects are apparent among the regions with differences being attributable to differences in income levels among the regions and to the mix of energy sources employed in each region. The importance of hydro as a source of electricity has a major influence on extent to which the Government's pricing policy adversely affects consumers.

Among the regions, the Atlantic Provinces are the hardest hit with an overall reduction in real income of 8.7% and a consumption reduction of 3%. This may be attributed primarily to low income levels prevailing in the region. At the other end of the scale, Quebec is the least affected among the regions with an overall income effect of 5.3% and a consumption effect of 2.2%. In this case, the fact that virtually 100% of the region's electricity is hydro generated.

The findings suggest that ameliorative steps are in order if the Government is going to remain consistent with its oft stated objective of achieving a more equalitarian distribution of income. One step in this direction would be through assisting low income consumers to make more efficient use of energy, e.g., grants or low interest loans for energy related home improvements. Consumption of energy by low income consumers could be subsidized, but should be instituted in such a manner as to minimize spill-overs to other income groups and at the same time not contradict the stated goal of reducing consumption. In general, it would seem that the problem is not so much one of energy prices <u>per se</u>, but a combination of the inability of low income consumers to reduce their consumption through conservation and the income problem itself.

Introduction

In recent years, a number of factors have changed the Government's perception of Canada's oil and natural gas supply. Most dramatic of course were the series of steps taken by O.P.E.C. with regard to both the supply available and the price at which crude petroleum would be sold. Domestically the industry has been experiencing sharply diminishing returns to exploration effort as well as major downward revisions in reserve estimates. In response, the Government undertoook a major energy (read petroleum and natural gas) policy review. Following a series of Cabinet Decisions, a pricing strategy has evolved that is part of a program aimed at reducing the rate of growth of energy demand and increasing the cash flow available for exploration. This pricing strategy contains two major elements:

a) the price of Canadian crude petroleum be allowed to rise to world levels, and[1]

b) natural gas prices by allowed to rise to the point where they reach BTU equivalency with petroleum.

The Government has examined some of the implications of the policy by estimating the increases in total consumer cost by region at different price levels.[2] as well, net consumer costs have been computed on the basis of the estimated royalties going to producing regions, and equalization payments going to non-producing regions. Recognition is given to the fact that this pricing policy is likely to bear most heavily on lower-income consumers, but no estimates of the relative impacts are presented.

It is the purpose of this paper to develop measures of the impact of the pricing policy on different income groups and different regions of the country. Estimates will also be made of the reduction in consumption that could result from the price increases anticipated. These estimates are for 1977, at which time the pricing policy should be fully in operation. No attempt will be made to offset increased consumer expenditures by increased royalty or equalization payments. This has not been done because it is impossible to know before hand what the incidence of benefits from such payments will be. In any case, it would be quite unlikely that the incidence of benefits would correspond to the incidence of costs associated with the pricing policy.

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1. In practice, the U.S. blended crude price will likely be the ceiling for Canadian prices.

2. CD173-76, Oil and Natural Gas Pricing. March 31, 1976.

The impact on different income groups will be measured in terms of the reduction in real incomes attendent upon the estimated price increases. Changes in consumption levels will be estimated through income elasticities of demand calculated for each region.

Estimated Price Increases

Prices for which a rate of increase is computed are the well-head prices of crude petroleum and the Toronto "city gate" price (TCP) of natural gas. The TCP is chosen because price increases elsewhere in Canada are required to retain a constant relative position vis-a-vis the TCP. The rate of increase covers the period from 1969 to 1977. 1969 is used as the base period since these are the prices that are incorporated in the data used to calculate the income elasticities (see below). 1977 was chosen as the point for impact estimation in order to incorporate all of recommendations forwarded in CD173-76. The relevant prices and increases are shown in Table 1, where the 1969 prices are observed and the 1977 prices are those recommended in CD173-76.

TABLE 1: Crude Oil and Natural Gas Prices, 1969, 1977.

	1969	1977	Percent Increase
Crude Oil ($/bbl.)	2.55	10.00	292.2
Natural Gas ($/mcf,TCP)	.46	1.60	247.8[a]

a This increase is identical for residential or commercial use.

This percentage increase shown in Table 1 must be adjusted to correspond to the consumer energy expenditure categories used in the analysis, i.e., oil and natural gas, electricity, and gasoline. Because data are not available to differentiate the different types of oil consumed, the transformation rate from crude to fuel oil was used. The transformation rates for fuel oil and gasoline from crude were derived from CPI price data that covered an observed change in crude oil prices. The appropriate increases in fuel oil and gasoline from 1969 to 1977 due solely to the increase in crude are 188.8% and 101.1% respectively. The calculation of the impact of oil and natural gas price increases on electricity prices is somewhat more complicated. The data in the first four columns of Table 2 enable us to make this calculation.

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TABLE 2: Percentage of Fuel Oil and Natural Gas Embodied in Different Energy Categories, by Region.

	Electricity[a]				Oil and Gas[b]	
Region	% from secondary sources	oils	natural gas	other	fuel oil	natural gas
Atlantic Provinces	46.5	79.5	-	20.8	96.2	3.8
Quebec	.5	98.6	1.4	-	81.7	18.3
Ontario	39.6	78.4	21.2	.4	56.5	42.5
Prairie Provinces	56.7	1.5	37.7	60.8	34.1	65.9
British Columbia	14.8	22.4	60.9	16.7	52.5	47.5

a Statistics Canada. Detailed Energy Supply and Demand in Canada. 1958-69, Catalogue 57-505.

b Statistics Canada. Family Expenditure in Canada. Catalogue 62-535, 536.

The first column in Table 2 shows the proportion of electricity that is generated from secondary sources i.e., non-hydro. The next three columns show the distribution of this electricity by secondary sources. Thus 54.5% of electricity generated in the Atlantic Provinces comes from hydro sources. Of the 46.5% generated by secondary sources, 79.2% comes from oil fired plants and the remaining 20.8% from "other" sources; primarily coal fired plants. The remaining two columns show the weights of fuel oil and natural gas in the Oil and Gas consumption category for each region. Applying these weights to the price increases for fuel oil and natural gas shown above we get the appropriate increase for each consumption category by region. These are shown in Table 3.

TABLE 3: Rate of Price Increase for Energy Consumption Categories by Region 1969-1977. (percent)

Region	Oil & Gas	Electricity	Gasoline
Atlantic Provinces	191.0	69.5	101.1
Quebec	199.6	.9	101.1
Ontario	213.9	59.4	101.1
Prairie Provinces	227.7	54.6	101.1
British Columbia	216.8	28.6	101.1

It cannot be stressed too much that these increases are due only to the increase in the wellhead price of crude oil and the TCP of natural gas. Other factors have obviously been in operation causing price increases for energy directly consumed, e.g., transmission and distribution costs, capital equipment costs, and other generating costs. From observation, we know that the cost of electrical energy in the Atlantic Provinces has risen by more than 70% since 1969 even without the final stage price increases recom-

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mended in CD173-76.

The figures in Table 3 reflect the relative importance of energy sources in the different regions and thus, the differential impact of Federal policy. The preponderance of hydroelectric power in Quebec and British Columbia has the effect of moderating the impact of energy policy on those provinces. At the same time, the heavy reliance on natural gas on the Prairies - especially Alberta - has the ironic effect of magnifying the policy impact in producing areas.

Income Elasticities of Demand

As a means of obtaining energy consumption levels for 1977 and the income elasticities of demand a series of Engel equations were calculated for the three energy consumption categories found in the 1969 Statistics Canada survey of family expenditure, i.e., oil and gas, electricity, and gasoline. The three equations were computed for five regions; Atlantic Provinces, Quebec, Ontario, Prairie Provinces, and British Columbia. The dependent variables were the level of expenditures in each consumption category and the independent variables were income and the average size of the consumption unit for each income level.[3] Two types of equations were tested; the first being linear in logarithms and yielding a constant elasticity, and the second being linear and yielding elasticities that varied with income level. The details of these calculations are presented in Appendix B.

Based on a combination of statistical and theoretical considerations, the variable elasticity equations were utilized in the analysis. Employing the coefficients from Table 1 of Appendix B, and the expenditure and income levels for 1969 found in Tables 3 through 6 of Appendix B, income elasticities of demand were computed for each of the consumption categories by income level and region. The results of these computations are shown in the following three tables.

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3. In this study income refers to "total consumer expenditure", i.e., total income less savings. This was done because of the unreliability of income data in the survey. In private communication, those familiar with the data noted a high degree of underreporting at both ends of the income range. It was suggested that the procedure followed in this paper would be most appropriate. Also, for the complete definition of a consumption unit see: Statistics Canada. Family Expenditure in Canada, 62-535, pg. 7.

TABLE 4: Income Elasticity of Demand for Oil and Natural Gas by Income Level and Region.

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
4,999	.129	.235	.195	.121	.250
5-9,999	.223	.328	.330	.219	.390
10-14,999	.298	.433	.418	.278	.424
15,000	.379	.506	.509	.402	.557

TABLE 5: Income Elasticity of Demand for Electricity by Income Level and Region.

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
4,999	.241	.116	.166	.051	.117
5-9,999	.330	.153	.263	.087	.166
10-14,999	.398	.199	.326	.117	.216
15,000	.534	.269	.425	.172	.277

TABLE 6: Income Elasticity of Demand for Gasoline by Income Level and Region

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
4,999	.444	.535	.658	.472	.602
5-9,999	.319	.316	.420	.398	.391
10-14,999	.375	.325	.439	.457	.429
15,000	.541	.474	.574	.588	.528

The values of these elasticities are not surprising, as they are joint consumption products whose consumption is largely determined by the stock of owner-occupied houses and automobiles. Also, once the capital stock has been selected the consumer has little or no ability to substitute among energy sources. One would therefore expect the income demands to be inelastic as indeed they are. The fact that gasoline is less inelastic than the other categories is merely a reflection of the higher degree of discretion owners have over automobile use. With the exception of gasoline, all the elasticities increase in value as incomes increase reflecting the discretionary power that comes with higher levels of incomes. In the case of gasoline, the weighted average elasticity for incomes less than $5,000 is .577 as compared with the weighted average for incomes greater than $15,000 of .542. No doubt, this is in part

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related to the sensitivity of automobile and truck ownership to [illegible] income levels. Only 39.7% of consumption units with income levels less than $5,000 are owners as compared with 82.4% for all other income levels. If the rate of car ownership is standardized to 82.4%, the average expenditure of the less than $5,000 income group would be $156.9. This is still less than half the average for the other income groups.

The significant point is that irrespective of these variations the overriding observation is that the demand for all energy categories is income inelastic.

Income and Consumption Effects

The data developed above allows us to now estimate the impact of Federal oil and gas pricing policies on different income groups by region. The first step will be the estimation of 1977 consumption levels at 1969 prices. This involves the substitution of the estimated income levels for each income group into the linear Engel equations. Estimated income levels of each income group and the distribution of consumption units by income groups are found in Appendix A. It is assumed that the average size of consumption units remain constant at 1969 levels. The price increases from Table 3 above are then applied to the estimated 1977 consumption levels giving the increase in total expenditures for each consumption category by income level and region. The increase in total expenditures divided by the estimated 1977 income level yields, ceteris parabus, the reduction in real income associated with the pricing policy. Multiplying the income effects by corresponding elasticities gives a measure of the reduction (percent) in consumption that accompanies the price increases.

With regard to the consumption estimates for 1977 at 1969 prices, they have been adjusted to account for the percentage of home ownership within each group. The family expenditure surveys conducted by Statistics Canada count only those items directly purchased by the consumer. Thus, a person whose rental payments are all-inclusive would not enter the sample as a consumer of oil and natural gas or electricity. On the assumption that energy costs increases will be passed through to renters it will be necessary to adjust the consumption levels for 1977 estimated from the Engel equations. This is done by multiplying the estimated consumption levels by one hundred times the reciprocal of the percentage of home ownership in each group. These figures are shown in Table 7. It is assumed that the rate of home ownership remains constant during the period in question.

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TABLE 7: Percentage of Home Ownership by Income Level and Region, 1969.

Income Level ($)	Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
5,000	65.4	32.3	50.1	49.0	45.7
5-9,999	64.6	43.8	59.3	59.1	60.2
10-14,999	76.5	54.0	70.0	72.9	72.8
15,000	79.7	71.8	78.1	84.3	82.5

Some might question the use of equations and elasticities calculated on 1969 data for a period of eight years later. The appropriateness of this procedure will depend upon the stability of consumption patterns and the type of errors that are likely to occur if consumption patterns do change. Concerning the stability of consumption patterns, there is little published evidence available, especially for detailed expenditures. We are however, able to compare the consumption of major components for urban Canada in 1969 and 1974. The 1969 survey covers all urban areas over 100,000 population while the 1974 survey covers the fourteen largest cities. The samles are sufficiently similar that a comparison is valid. The consumption of major categories as a percent of total expenditures for 1969 and 1974 is shown in Table 8.

TABLE 8: Expenditure on Major Consumption Categories as a Percent of Total Expenditures; 1969, 1974.

Consumption Level	1969	1974
food	22.55	23.05
shelter	20.38	20.08
household operation	5.17	5.08
furnishings	5.74	6.53
clothing	10.22	9.49
personal care	2.75	2.29
medical and health	4.08	2.84
travel and transportation	15.89	16.36
recreation	4.54	5.17
reading	.83	.78
smoking and alcohol	4.78	4.57
education	1.21	1.02
miscellaneous	1.85	2.79

While there are some changes in the distribution evident in these figures, a Chi-square comparison of 1974 with 1969 yields a Chiesquare coefficient of 1.26, highly insignificant, which would not lead to a rejection of the hypothesis that the two distributions came from the population. Clearly, this is not proof that the distributions are stable over time, but it does not rule out that possibility.

If, however, changes in consumption patterns did occur between 1969 and 1977, i.e., if there were a shift in the Engel curve rather than movement to a higher income on a given curve, we have to ask whether or not this would invalidate the analysis. An upward

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shift in the Engel curve, that is to say, an increase in the proportion of expenditures allocated to energy would result in a lower elasticity. This would in no way change the conclusions of the study. On the other hand, if the Engel curve shifted downward as a result of a lower proportion of expenditures going to energy, the elasticities would rise in value. However, if we look closely at the nature of energy demand we find that, except for gasoline, it is unlikely that the elasticities would exceed, or even approach, a value of one. This is based on the realization that energy for space heating, cooking, etc., is of limited and substitutability and is a derived demand determined by such factors as housing and family size. Therefore, even if the assumption of stable consumption patterns does not hold, its relaxation should not significantly modify the conclusions of the analysis.

In Tables 9 through 13 we find the estimated adjusted consumption levels for 1977 by income class and region. In Tables 9a through 13a we find the income effects by income class and region as well as the overall percent reduction in expenditures.

TABLE 9: Estimated Consumption Levels Adjusted for Home Ownership: 1977: ($ at 1969 prices)

Atlantic

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	212.8	109.6	92.6	415.0
5-9,999	272.3	174.1	267.3	713.7
10-14,999	271.0	192.4	359.3	822.7
15,000	312.0	212.8	385.8	910.6
weighted Ave.	265.1	173.2	305.6	743.9
% price change	191.0	69.5	101.1	125.3

TABLE 9a: Estimated Income Effect: percent

Income Level	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	10.4	1.9	2.4	14.7
5-9,999	6.9	1.6	3.6	12.1
10-14,999	4.2	1.1	2.9	8.2
15,000	3.1	.8	2.0	5.9
overall	4.7	1.1	2.9	8.7
% reduction in expenditures	1.2	.4	1.2	3.0
overall elasticity	.259	.373	.411	.348

The income effects are calculated by multiplying the estimated 1977 consumption at 1969 prices by the appropriate price increase. Dividing this by the estimated 1977 income levels found in Table 9 of Appendix A we get the percent reduction in real income that can be attributed to Federal policy.

TABLE 10: Estimated Consumption Levels Adjusted for Home Ownership: 1977: ($ at 1969 prices)

Quebec

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	218.6	213.0	57.4	489.0
5-9,999	240.4	250.2	191.9	682.5
10-14,999	224.4	241.9	290.5	756.8
15,000	241.9	216.6	324.4	782.9
weighted ave.	232.1	230.6	263.3	726.0
% price change	199.6	.9	101.1	100.7

TABLE 10a: Estimate Income Effect: percent

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	10.4	0	1.4	11.8
5-9,999	6.2	0	2.5	8.7
10-14,999	3.6	0	2.3	5.9
15,000	2.3	0	1.6	3.9
overall	3.3	0	1.9	5.3
% reduction in expenditures	.422	.208	.398	.345

TABLE 11: Estimated Consumption Levels Adjusted for Home Ownership: 1977: ($ at 1969 prices)

Ontario

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	190.2	130.3	74.3	394.8
5-9,999	213.2	156.8	241.7	611.7
10-14,999	216.9	155.9	347.7	720.5
15,000	254.9	178.0	433.0	865.9
weighted ave.	231.8	164.2	352.2	748.2
% price change	213.9	59.4	101.1	126.9

TABLE 11a: Estimated Income Effect: percent

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	9.8	1.9	1.8	13.5
5-9,999	5.5	1.1	2.9	9.5
10-14,999	3.6	.7	2.7	7.0
15,000	2.6	.5	2.1	5.2
overall	3.5	.6	2.3	6.4
% reduction in expenditures	1.4	.2	1.2	2.9
overall elasticity	.433	.352	.513	.452

TABLE 12: Estimated Consumption Levels Adjusted for Home Ownership: 1977: ($ at 1969 prices)

Prairies

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	184.7	157.8	106.2	448.7
5-9,999	179.4	165.7	252.6	597.7
10-14,999	171.6	147.5	333.0	652.1
15,000	171.6	142.7	435.6	749.9
weighted ave.	174.1	149.2	336.0	659.3
% price change	227.7	54.6	101.1	124.0

TABLE 12a: Estimated Income Effect: percent

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	10.4	2.1	2.6	15.1
5-9,999	5.1	1.1	3.2	9.4
10-14,999	3.1	.6	2.7	6.4
15,000	1.8	.4	2.1	4.3
overall	2.8	.6	2.4	5.8
% reduction in expenditures	.8	.1	1.2	2.1
overall elasticity	.300	.127	.501	.363

TABLE 13: Estimated Consumption Levels Adjusted for Home Ownership: 1977 ($ at 1969 prices)

British Columbia

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	174.8	156.7	72.6	404.1
5-9,999	191.4	191.5	235.8	618.7
10-14,999	215.9	178.7	319.5	714.1
15,000	235.3	196.0	419.3	850.6
weighted ave.	215.0	183.9	316.2	715.1
% price change	216.8	28.6	101.1	117.1

TABLE 13a: Estimated Income Effect: percent

Income Level ($)	Oil & Natural Gas	Electricity	Gasoline	Total
5,000	9.4	1.1	1.8	12.3
5-9,999	5.1	.7	2.9	8.7
10-14,999	3.8	.4	2.6	6.8
15,000	2.5	.3	2.1	4.9
overall	3.4	.4	2.3	6.1
% reduction in expenditures	1.5	.1	1.1	2.4
overall elasticity	.445	.219	4.73	.400

Analysis and Conclusions

Perhaps the best way to begin an examination of the data from the previous section would be to summarize some of the key indicators on a regional basis. This is done in Table 14. The price increase shown in the first column is a weighted composite of the

TABLE 14: Summary of Regional Indicators

Region	% Price Increase	Elasticity	Income Effect%	Consumption Effect%
Atlantic Provinces	125.3	.348	-8.7	-3.0
Quebec	100.7	.345	-5.3	-2.2
Ontario	126.9	.452	-6.4	-2.9
Prairie Provinces	124.0	.363	-5.8	-2.1
British Columbia	117.1	.400	-6.1	-2.4
Weighted Average	118.6	.398	-6.2	-2.6

price increases for each category of consumer expenditure from 1969 to 1977. We see that for the country as a whole, the price increases for crude oil and natural gas result in nearly a 120 percent increase in the composite price of direct consumed energy. The key factor in explaining regional differences in this increase is the extent to which electricity is generated by hydro sources. The lowest increase of just over 100 percent is found in Quebec which generates virtually all of its electricity from hydro sources. This is followed by British Columbia where hydro accounts for slightly more than 85 percent of electric power. Such variation that appears among the other three regions can be attributed to the different mixes of oil and natural gas making up the final consumption categories.

Little comment need be devoted to the elasticities which are weighted averages of individual commodity elasticities for each region. The fact that the income elasticity of demand is inelastic is not remarkable for, as has been pointed out before, energy demands are derived and are largely a function of the consumer's capital stock.

The income and consumption effects found in the last two columns show some differences which are due to a combination of variations in the energy mix and distribution of consumption units by income level. As would be expected, the Atlantic Provinces which have the highest proportion of consumption units with less than $10,000 per year (42.6 percent versus an average of 22.0 percent for the rest of Canada), show the greatest income and consumption effects. Overall, the consumption effect of around 2.5 percent is modest but could well increase under the impact of some developments that will be discussed below.

While the regional impacts are of interest, the more sensitive issue is the impact on different income levels. In Table 15,

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we find the weighted average income effect for each income group in Canada. We see that the income effect on the lowest income groups is two and three quarters times larger than the income effect on

TABLE 15: Weighted Average Income Effect by Income Level, Canada

Income Level	Income Effect (percent)
5,000	13.4
5-9,999	9.5
10-14,999	6.7
15,000	4.8

the highest income group. For all consumption units whose income is less than $10,000 the oil and gas pricing policies mean a real income reduction of 10.7 percent. Regional differences are apparent among the income groups. For example, for the lowest group the income effect ranges from 11.8 percent in Quebec to 15.1 percent on the Prairies. Quebec displays the lowest income effect overall, as well as for each income level, showing again the significance of hydro-electric power in mitigating the burden of the pricing policy.

Actually these results are not at all surprising since an income inelastic demand will lead to a declining proportion of income spent on the commodity and therefore a price increase will bear more heavily on the lower income consumer. It may be argued that this is inequitable - and it may well be. But that conclusion misses the point. A given set of prices may lead to an economically efficient allocation of resources, but this outcome need not be in any sense termed equitable. The Government's present pricing policy is a reaction to an earlier situation where oil and gas prices were determined, at least in part, on equity grounds. The outcome of that earlier policy was an allocation of resources that was deemed undesirable, particularly with regard to investment levels in frontier areas on synthetic fuels. Whether this appraisal is correct and whether the decisions taken will yield the desired results are not issues of concern here. Our concern is with the fact that the policy initiatives taken bear most heavily on lower income consumers. Whether or not this is considered inequitable is a value judgement decision on which individuals may disagree. However, with growing regularity, Canadian Governments show by their public statements, if not always in their actions, a commitment to a more equalitarian distribution of income. It follows then that any policy that has a regressive impact on real income is inequitable. The foregoing analysis shows that the Government's oil and gas policy satisfies this criterion of inequity.

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The result is that federal oil and gas pricing policies pose a dilemma. On the one hand, the revised price structure is deemed essential to achieve a more satisfactory allocation of resources. On the other hand, achieving this objective via price changes results in income changes that run counter to professed income distribution objectives. A partial, or complete, resolution of this dilemma could come about as a result of policy initiatives on the part of one or more levels of government.

As a step in this direction, the Federal government as part of its total energy policy package is encouraging the conservation of energy resources.[4] While the United States has a higher per-capita consumption of energy than Canada, other industrialized nations whose standards of living are similar to ours are able to achieve their objectives with lower levels of energy consumption; Sweden being a case in point. Any program of energy conservation in Canada will involve two different approaches. The first is a reduction in energy consumption with no change in productivity, e.g., reduced utilization of private automobiles, or reduced temperature levels for space heating. The second is an improvement in the productivity of energy utilization, e.g., improved insulation standards or improved gasoline mileage for private automobiles. Additional measures could involve the use of a renewable energy source such as solar power to supplement residential energy from traditional sources. The maximum reduction in consumption would be achieved by a combination of the above.

We have seen that the income reduction resulting from the price policy yields an estimated reduction in energy consumption of around 2.5 percent for Canada as a whole. This reduction comes about via a movement along an existing Engel curve. A combination of the two types of conservation that would yield a greater consumption decrease implies a downward shift in the Engle curve. There are some indications that this shift is indeed occuring. My own very unscientific survey of local Ottawa building suppliers shows a sharp increase in the sales of all types of insulating materials for installation in private residences which should result in more efficient energy utilization. Federal gasoline consumption standards for private automobiles will have a gradual impact on gasoline consumption even if consumers do not shift to smaller less voracious

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4 It should be noted that this and following discussions deal with the energy consumption categories analyzed. Therefore we are talking predominately about domestic space heating and personal transportation. Industrial and indirect energy consumption does not enter the analysis.

5 Steps to assist PEI and Nova Scotia in increasing the efficiency of their energy use have been taken by the Federal Government - Globe and Mail, December 30, 1976.

automobiles. A good deal of publicity is being given to use of solar panels for supplementary use, but there is no evidence of any widespread adoption of this technique.

In the absence of a collapse of OPEC or a dramatic change in the domestic energy supply situation energy prices will undoubtedly remain in something the 1977 pattern vis-a-vis other prices for the foreseeable future. We can therefore expect, with a reasonable probability, that consumers will modify their energy consumption patterns and thus, Engel curves for energy will shift downward. The problem is that for low income consumers their ability to decrease and/or improve the efficiency with which they utilize energy is constrained. With regard to residential space heating, there are two considerations that mitigate against their achieving more efficient energy utilization. First, only 47.5 percent of the consumption units in the lowest income level are home owners as compared with 55.6 percent in the next level and more than 70 percent in the highest level. This means that they have the least control over their housing, and to the extent that renters can pass on increased energy costs in rents there is no incentive to improve efficiency. For the low income home owner his problem is two-fold. First, he is likely to be housed in relatively low quality accommodations where the cost per square foot of improving heating efficiency would be among the highest. Second, increasing energy efficiency requires a substantial initial investment which may well be beyond the capacity of low income consumers to finance.[6]

With regard to the level of gasoline consumption we see that the average expenditures of the lowest income group are $77.7, or approximately one-third of the next level, $231.3. Because of the age distribution of low income consumption units and the low level of vehicle ownership, the rate of consumption of actual drivers in the group may be only slightly less than that of drivers in higher income groups. The question still remains as to what extent their consumption can be reduced. If as we suspect, low income people typically own older cars and use them predominantly for non-recreational purposes we would expect them to have only a moderate degree of discretion. First, unless they shift to older imported

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6 It is a well known paradox that low income consumers frequently spend more for similar items than do higher income consumers. This occurs because of their cash flow situation, i.e., an item, say shoes will come in different qualities and the high quality item may be a bargain when its cost is amortized over its expected life. However, the low income consumer is not in a position to make the initial higher investment that would ultimately yield him to a lower total expenditure on shoes. The same situation operates where the consumer cannot finance the insulation investment but must pay the higher energy costs.

cars, the government's mileage standards will only have a moderate impact on these consumers. Second, the poor state of public transportation throughout Canada means that for many Canadians, no matter what their income level is, there is no reasonable option to the private automobile for commuting.[7]

In summary, we can see how conservation measures can be of some use in decreasing energy consumption, but may well have only a moderate impact on low income consumers. The question then becomes one of finding policy options that can relieve low income consumers of the burden imposed either by enabling them to take advantage of available conservation techniques thereby reducing their consumption or by other measures that attack the problem via consumers' expenditures. Any policies adopted must be designed such that the benefits flow to the target group with a minimum spill-over to other groups. Also, the policies should not encourage any increase in consumption that would conflict with the objectives of conservation.

As was pointed out, low income homeowners may face financial barriers that prevent them from making investment such as insulation improvement that would reduce their energy requirements. An obvious solution to this problem would be the institution of grants or subsidized loans for energy related home improvements. Such a program could be administered through existing government agencies dealing with housing and the spill-over to other groups could easily be minimized. Such a program would have two-fold benefits. First by increasing energy efficiency it would bring about a lower direct energy demand with no deterioration in space heating standards. It would also be a step toward upgrading the quality of existing housing stocks. Indeed it could form part of a comprehensive home improvement program that could improve and stabilize low income areas, both rural and urban.

For the non-homeowner, the problem is much more complicated. One of the first things that may come to mind is a rent control scheme that would not allow landlords to pass on increased energy costs. However, such a program would discriminate against landlords who are currently making efficient use of energy, and would also require the administration of minimum space heating standards. Even if such a program could be administered it would most certainly mean a deterioration of other services provided with rental housing. As a general aside, all the evidence we have shows

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7 An interesting sidelight here is that because many low income workers experience frequent changes of employment they may not be able to take full advantage of the public transportation that does exist without moving their residence frequently as well.

that rent controls in the absence of a growing housing stock can have only short-run benefits. One possible way to induce landlords to improve energy efficiency would be through some form of tax credit where documentation could show that rental rates would not be affected by higher energy costs. One of the most obvious difficulties with this approach would be to discriminate among tenants by income class.

Another approach that could cushion low income people from the effects of higher energy prices would be via a form of energy voucher. For example, low income consumers would be issued a number of vouchers that could be exchanged for comparable units of gasoline, fuel oil, electricity, etc. There are a number of questions that come to mind concerning the operation of a voucher system, e.g., would they be purchased on a sliding cost scale as are U.S. food stamps? and would they be transferable? These and other questions need a more detailed analysis than is possible in this paper.

It has been suggested in the discussion papers concerning energy policy that some form of energy tax credit could ease the policy's impact on low income consumers. However this poses at least two difficulties. First, unless the value of the tax credit is anticipated in the withholding rates, it could create a cash flow problem for low income consumers. For consumers without tax liability there would have to be some form of negative tax if the program is to be of benefit to those whose need is the greatest.

In general, it would seem that the problem is not so much a one of energy prices per se but a combination of the inability of low income consumers to reduce their consumption (i.e., conservation) and the income problem itself. As this Department is already involved in the conservation problem there is no reason why we should not be prepared to make recommendations concerning such aspects of conservation as are noted above. To this end, I would suggest that a small group be formed to prepare recommendations for Department initiatives that would enhance the ability of low income consumers to conserve energy and thereby minimize the burden of the government's energy policy.

The income problem is quite different and is only incidentally linked to energy policy. It would seem however, that where government policies such as the energy program yield results that conflict with stated income objectives serious consideration should be given to an income maintenance program as an automatic offset. Such a procedure is already recognized where pensions and child allowances are indexed. All that is suggested here is that a link be established with a particular policy initiative.

APPENDIX A

ESTIMATION OF INCOME LEVELS AND DISTRIBUTION OF CONSUMPTION UNITS BY INCOME LEVEL: 1977

Tables 1 and 2 show the distribution of consumption units by income level and region for the year 1969.[1]

TABLE 1: Consumption Units by Income Level and Region: 1969, (000's)

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia	Canada
4,999	217	466	539	246	186	1654
5-9,999	203	688	884	304	270	2349
10-14,999	59	275	509	143	136	1122
15,000	13	116	265	61	44	499
TOTAL	493	1545	2197	754	636	5624

TABLE 2: Distribution of Consumption Units by Income Level and Region: (1969) (percent)

Income Level ($)	Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia	Canada
4,999	44.0	30.2	24.5	32.6	29.2	29.4
5-9,999	41.2	44.5	40.2	40.3	42.5	41.8
10-14,999	12.0	17.8	23.2	19.0	21.4	20.0
15,000	2.6	7.5	12.1	8.0	6.9	8.9

1969 is the most recent year for which these data are available for all urbanization classes. The survey taken in 1974 covers the fourteen major cities only.[2] In order to develop an estimate of the 1977 estimate it will be necessary to develop an extrapolation using the 1969 figures as a reference point, with other data to develop rates of change. In Table 3, we find the percent distribution of economic families by income level, for Canada, for the years 1969 through 1973. The estimated distribution for 1977 is found in the next to last column is derived from a simple extrapolation of the linear trends for each group. The simple correlation coefficient for each trend estimation are found in the last column. Since these figures only cover economic families it was assumed the trend for unattached individuals in each income group was the same as for families in that group. The 1977 estimate for families was adjusted for

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1. Statistics Canada, Family Expenditure in Canada. Catalogue 62-535, 536
2. Statistics Canada, Urban Family Expenditure, 1974. Preliminary tables

TABLE 3: Distribution of Economic Families by Income Level: Canada, (percent)

Income Level ($)	1965	1967	1969	1961	1972	1973	1977(est.)	r
5,000	37.9	29.7	24.8	25.5	17.6	13.8	4.9	.957
5-9,999	48.0	47.9	41.8	34.2	29.5	21.0	12.1	.950
10-14,999	10.3	16.6	22.8	28.2	30.9	29.2	42.3	.979
15,000	3.5	6.0	10.6	17.1	22.0	30.5	40.7	.958
							$\Sigma = 100.0$	

Source: Statistics Canada, Income Distributions by Size in Canada, Catalogue 13-207,1974.

the difference between the 1969 distribution for families and unattached individuals in the same year.[3] The distribution for Canada adjusted for unattached individuals consumption units is found in Table 4.

TABLE 4: Estimated Distribution of Consumption Units, 1977 Canada, (percent).

Income Level	1977
5,000	9.5
5-9,999	12.1
10-14,999	39.5
15,000	39.0

The next step is to derive an estimation of the distribution of consumption units by income for each region. It was assumed that the regional distributions retained the same relationship to the national distribution in 1977 that prevailed in 1969. This relationship is shown in Table 5. The indices in Table 5 were applied

TABLE 5: Index of Distribution by Regions, 1969, (Canada = 100)

Income Level ($)	Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
5,000	1.497	1.027	.833	1.109	.993
5-9,999	.986	1.065	.962	.964	1.017
10-14,999	.600	.890	1.160	.950	1.070
15,000	.292	.843	1.360	.899	.775

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3. Catalogue 62-535, 536; op. cit. It should be noted that data similar to that in Table 3 is available for families and unattached individuals in Catalogue 13-208. However this publication uses the much more restrictive census definition of a family and is therefore not comparable to the base year data used here.

to the National distribution in Table 4 and each regional column was standardized to sum to one hundred percent. The estimated distribution for 1977 is shown in Table 6.

TABLE 6: Estimated Distribution of Consumption Units by Income Level and Region, 1977, (percent).

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
5,000	23.2	10.8	6.7	11.1	10.0
5-9,999	19.4	14.2	9.8	12.3	13.1
10-14,999	38.7	38.8	38.7	39.6	44.9
15,000	18.6	36.1	44.8	37.0	32.1

The total number of consumption units estimated for 1977, 7,500,000, is derived by dividing the estimated population in 1977 of 23,200,000 by 3.09, the average size of all consumption units in 1969. The population estimate is based on a continuation of the average population growth rate of 1.7% that prevailed between 1973 and 1975.[4] The regional totals are derived by adjusting the proportional distribution of units in 1969 by the population rates of growth that prevailed in the regions from 1973 to 1975. These proportions are shown in Table 7. Distributing the total number of units among the regions according to the proportions in Table 7, and applying the estimated distribution from Table 5 we get the total number of consumption units in each category. These are shown in Table 6. Because of adjustments that were made in the percent distributions, the rows in Table 6 do not precisely reconcile.

TABLE 7: Percent of Total Consumption Units in each Region: 1969 and 1977 Estimate.

Year	Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
1969	8.0	27.5	39.1	13.4	11.3
1977	8.4	25.0	40.0	13.4	13.2

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4. Statistics Canada. Canadian Statistical Review. Catalogue 11-003, February 1976.

TABLE 8: Estimated Number of Consumption Units by Income Level and Region: 1977 (000's)

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia	Canada
5,000	146	203	201	112	99	713
5-9,999	122	266	294	124	130	908
10-14,999	244	728	1161	398	445	2963
15,000	117	677	1344	372	318	2925
TOTAL	630	1875	3000	1005	990	7500

Income levels will be influenced by a change in the distribution of consumption units among different income levels as shown above. There will also be a rise in the average income for each level. It would be expected that the income range below $5,000 and above $15,000 would show the highest rate of increase. Below $5,000 there will be a reduction in the number of jobs that are poorly compensated, and improvements in various transfer payment schemes and minimum wage legislation will push up the average for those who remain in this income range. For the above $15,000 group, those who move into this level can be expected to continue to experience increases, and since this range is open at the upper end the overall increase can be expected to be higher than for the mid ranges. In the mid ranges, there will be consumption units entering from below as well as moving out to higher ranges and thus we can expect the average income for these ranges to show only moderate increases if indeed any increase is noted at all. It should be noted that a decline in average income for these ranges is quite possible depending upon the change in distribution of consumption units.

It proved necessary to employ partial data to estimate the changes in average income levels between 1969 and 1977. Data for families and unattached individuals resident in urban areas with more than 100,000 population were available from the 1969 survey of expenditures. This was compared with preliminary data from the 1974 survey of urban family expenditures that covered the fourteen largest cities. The samples are sufficiently alike to allow for a comparison of averages. The rate of change in average income levels were computed from these two observations, and these rates were extended to cover the period from 1969 through 1977. It was then necessary to assume that these rates applied to all urbanization classes, and that there were no differences among the regions. The increases applied to each income level were 18.4% for less than $5,000, 2.4% for $5-$10,000, 8.6% for $10-$15,000, and 13.2% for more than $15,000. The new income levels are shown in Table 9. The bottom row contains the weighted average income levels for each region. The weighted average national income per consumption unit is $14,306.

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TABLE 9: Estimated Average Income Levels by Income Level and Region: 1977

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
4,999	3914	4190	4163	4061	4044
5-9,999	7540	7790	8303	7991	8137
10-14,999	12328	12617	12879	12421	12483
15,000	19177	20746	21093	21422	20366
weighted average	10709	13943	15526	14279	13613

APPENDIX B

INCOME ELASTICITIES OF DEMAND

Two models were employed in estimating the income elasticities for the three categories of energy expenditures. The first model is linear in logarithms and therefore yields a constant elasticity across all income levels:

$$X_i = aY^{b1}\ F^{b2}$$

where X_i = is expenditure on the ith energy category for each income level.

Y = average income for each income level.

F = average consumption unit size for each income level.

The second model is a simple linear equation that yields variable elasticity:

$$X_i = a+b_1Y+b_2F$$

The equations were estimated by simple least squares techniques with one observation for each of the twelve income levels reported in the 1969 family expenditure survey. The results of these estimations are contained in Tables 1 and 2. The coefficients b_1 and b_2 designated as b_x and b_f in the tables, are accompanied by the appropriate 't' statistic in parenthises. As the number of observations, 12, is quite low, $\bar{R}^2$ is reported rather than R^2.

TABLE 1

VARIABLE ELASTICITY EQUATIONS

Region	b_x [a]	b_f [a]	$\bar{R}^2$
Atlantic Provinces			
oil and natural gas	.0053	12.5680	.899
	(4.96)	(2.18)	
electricity	.0050	15.7826	.947
	(6.40)	(3.75)	
gasoline	.0115	82.6724	.942
	(4.17)	(5.59)	
Quebec			
oil and natural gas	.0045	10.6812	.959
	(5.92)	(2.87)	
electricity	.0022	21.8346	.946
	(3.08)	(6.30)	
gasoline	.0079	71.4569	.920
	(2.18)	(3.99)	
Ontario			
oil and natural gas	.0051	10.6435	.928
	(4.72)	(1.86)	
electricity	.0030	11.7721	.978
	(7.02)	(5.17)	
gasoline	0.124	74.4875	.968
	(4.73)	(5.33)	
Prairie Provinces			
oil and natural gas	.0030	3.2884	.825
	(3.96)	(0.70)	
electricity	.0011	13.1558	.928
	(2.61)	(5.15)	
gasoline	.0129	67.2425	.967
	(6.37)	(5.38)	
British Columbia			
oil and natural gas	.0056	13.8508	.918
	(3.58)	(1.75)	
electricity	.0024	20.3086	.964
	(3.08)	(5.11)	
gasoline	.0115	71.7529	.970
	(4.04)	(5.00)	

a $t_{.05} = 2.26$

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TABLE 2

CONSTANT ELASTICITY EQUATIONS

Region	b_x [a]	b_f [a]	$\bar{R}^2$
Atlantic Provinces			
oil and natural gas	.261	.152	.907
	(4.11)	(1.00)	
electricity	.448	.272	.972
	(7.65)	(1.94)	
gasoline	.374	1.986	.988
	(4.52)	(10.03)	
Quebec			
oil and natural gas	.463	,090	.967
	(5.97)	(.64)	
electricity	.288	.469	.971
	(3.78)	(3.38)	
gasoline	.197	2.420	.985
	(1.30)	(8.79)	
Ontario			
oil and natural gas	.436	-,013	.849
	(2.68)	(-.05)	
electricity	.353	.189	.940
	(3.36)	(1.02)	
gasoline	.360	1.721	.961
	(1.47)	(4.01)	
Prairie Provinces			
oil and natural gas	.314	-.127	.814
	(3.64)	(-.69)	
electricity	.119	.338	.920
	(2.14)	(2.85)	
gasoline	.443	1.238	.971
	(3.66)	(4.79)	
British Columbia			
oil and natural gas	.430	.219	.895
	(2.14)	(.63)	
electricity	.215	.498	.968
	(2.23)	(2.99)	
gasoline	.548	1.209	.948
	(1.77)	(2.27)	

weighted average for all

.411

.295

.356

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a $t_{.05} = 2.26$

The first observation that may be made is that either model yields a quite good fit overall, e.g., the average values for $\bar{R}^2$ are identical. However, on closer inspection we see that the simple linear model displays superior statistical properties. With regard to the coefficient for income, only one coefficient, Quebec gasoline, is not significant at at least the 5% level. In the constant elasticity model, six out of the fifteen coefficients are not significant at the 5% level. This is particularly important, as we are computing the income elasticities of demand.

The variable elasticity model seems to be superior on statistical grounds as well as having interesting theoretical properties in that it recognizes that as consumers move to different income levels they adopt different behaviour patterns as well as changing their consumption bundle.

Tables 3, 4 and 5 contain the 1969 value of expenditure on energy categories by income level and region.

TABLE 3: Average Expenditures on Oil and Natural Gas by Income Level and Region. ($)

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
5,000	135.9	67.7	92.0	88.5	45.7
5-9,999	175.0	104.5	125.4	105.5	60.2
10-14,999	202.0	120.8	146.5	122.2	72.8
15,000	236.9	162.8	186.6	137.4	82.5

TABLE 4: Average Expenditures on Electricity by Income Level and Region. ($)

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
5,000	68.7	76.4	63.4	76.6	70.1
5-9,999	111.6	109.2	92.4	97.7	114.8
10-14,999	142.4	128.4	109.1	106.4	127.7
15,000	158.4	150.1	131.6	117.6	155.9

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1. Malinvaud, E. Statistical Methods of Econometrics. Chicago, 1966 pp. 142-5.

TABLE 5: Average Expenditures on Gasoline by Income Level and Region. ($)

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
5,000	85.6	52.3	66.3	97.6	65.3
5-9,999	265.2	190.4	239.3	250.1	233.7
10-14,999	348.2	282.6	335.0	320.2	308.1
15,000	359.9	305.2	402.4	404.1	391.9

Combining these figures with the income coefficients, b_x, from Table 1 and the average income figures from Table 6 we can compute elasticities for each energy category by income level and region.

TABLE 6: Average Incomes by Income Level and Region, 1969.

Income Level ($)	Region: Atlantic Provinces	Quebec	Ontario	Prairie Provinces	British Columbia
5,000	3307	3540	3517	3431	3417
5-9,999	7363	7607	8108	7804	7946
10-14,999	11348	11614	11855	11433	11490
15,000	16935	18320	18627	18917	17985
weighted average	6357	7938	9112	7985	8095