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DISCUSSION PAPER NO. 246

The Alberta Economy 1980 - 2000: Theme and Variations

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RESUME

Cet ouvrage se présente comme la suite d'une étude antérieure, notre Document n° 221 intitulé Migration and the Small Long-term Econometric Model of Alberta. Nous utilisons encore ici le modèle mis au point dans ce dernier et nous simulons certains scénarios de rechange, dont un portant sur des perspectives optimistes pour le secteur énergétique de l'Alberta; nous comparons ces résultats avec ceux relativement pessimistes des scénarios de référence décrits dans notre document précédent.

Voici nos principaux résultats :

1) Dans le cas des perspectives optimistes touchant le secteur énergétique, le taux de croissance du produit provincial réel de l'Alberta est plus élevé que dans le scénario de référence, mais même dans ce scénario optimiste, le taux de croissance de l'économie albertaine n'atteint même pas la moitié de ce qu'il était durant la période de 1961 à 1979. Cependant, il est à peu près le même que le taux de croissance du Canada durant la période de projection. Soulignons que le scénario de référence ne diffère du scénario optimiste qu'en raison des effets directs et indirects de leurs hypothèses respectives touchant le secteur énergétique. Pour le reste, les deux reflètent les relations et les tendances de l'économie durant la période échantillon 1961-1979. De nouvelles

sources de croissance peuvent apparaître, dont certaines sont énumérées dans le dernier chapitre de l'étude. Elles pourraient relever la performance de l'Alberta au-dessus de notre simulation optimiste.

2) Une subvention générale accordée à tout le secteur de la fabrication n'aurait pas pour effet de relever le taux de croissance de l'économie provinciale d'une façon significative. Ainsi, un programme de subventions équivalent à 30 % des recettes de la province provenant des ressouces naturelles (soit à peu près le montant déposé dans le Fonds du patrimoine jusqu'au récent budget provincial) n'augmenterait le taux de croissance de l'économie provinciale que d'un dixième de 1 % l'an.

3) Dans le scénario de référence, l'augmentation du prix mondial du pétrole dépasse de 2 % le taux d'inflation. Chaque hausse additionnelle de 1 % du prix du pétrole fait monter de 0,14 points de pourcentage le taux de croissance du produit provincial réel de l'Alberta.

4) Que la progression des salaires en Alberta soit relativement lente en temps de chômage élevé ou qu'elle se poursuive à une allure relativement rapide, il en résulte des différences importantes. Les restrictions salariales provoquent une baisse du revenu réel du travail par personne employée, un ralentissement de l'immigration et une chute du produit provincial réel, mais ces

restrictions entraînent aussi une diminution du chômage et une hausse des avantages fiscaux par personne.

5) Dans le Document n° 221, nous constatons que les immigrants prêtent plus d'importance aux salaires qu'aux avantages fiscaux. En supposant qu'ils accordent une importance égale aux deux variables, l'immigration en Alberta est alors accélérée, le produit provincial réel est de 8 à 9 % plus élevé en l'an 2 000, mais le revenu réel du travail par personne employée est réduit d'environ 4 %.

6) En supposant que les taux de migration ne subissent pas l'influence des avantages fiscaux, mais qu'ils sont marqués par les taux de chômage, l'immigration en Alberta est alors sensiblement inférieure à ce qu'elle est dans le scénario de référence, le produit provincial réel est réduit de 3 à 7 % en l'an 2 000 et le revenu réel du travail par personne employée est augmenté de 12 à 15 %. Nos simulations indiquent que l'immigration en Alberta est un moteur de croissance pour l'économie provinciale, mais qu'elle a tendance à réduire le revenu réel du travail par personne employée.

Abstract

This paper is a sequel to our Discussion Paper No. 221 Migration and a Small Long-term Econometric Model of Alberta. In the present paper we use the model developed in Discussion Paper No. 221 and simulate certain alternative scenarios, including one with an optimistic energy outlook for Alberta, and compare the results with those of the relatively pessimistic base cases described in our previous paper.

Our main results are:

1) The optimistic energy outlook increases the growth rate of Alberta's real provincial product, compared to that of the base case; but even in the optimistic case Alberta's economy grows at less than half of the province's growth rate during the 1961-79 period. This is, however, about the same as Canada's growth rate during the projection period. It should be emphasized that the base case and the optimistic case differ only because if the direct and indirect effects of their respective energy scenarios. Otherwise both reflect the economic relationships and trends of the 1961-1979 sample period. Possible new sources of growth may emerge, some of which are enumerated in the last chapter of this study. These could raise Alberta's performance above that of our optimistic simulation.

2) Across the board subsidization of manufacturing will not increase the growth rate of the province's economy substantially. Spending thirty per cent of the province's natural resource revenues (approximately the amount put into the Heritage Fund until the recent provincial budget) would increase the growth rate of the provincial economy by less than one-tenth of a per cent per annum.

3) In the base case the world oil price increases two per cent faster than inflation. Each additional per cent of oil price inflation increases the growth rate of Alberta's real provincial product by 0.14 percentage points.

4) It makes a big difference whether Alberta wages grow relatively slowly under high unemployment or continue to grow relatively fast. The wage restraint results in lower real labour income per employed person, lower immigration, lower real provincial product, but also in lower unemployment and higher fiscal benefits per person.

5) In Discussion Paper No. 221 we found that migrants attach more importance to wages than to the fiscal benefit. If we assume that migrants attach equal importance to both variables, then migration to Alberta is higher, real provincial product in 2000 is 8-9 per cent higher, but real labour income per employed person is about 4 per cent lower.

6) If migration is not influenced by the fiscal benefit, but is influenced by the unemployment rate, then migration to Alberta will be substantially lower than in the base case, real provincial product in 2000 3-7 per cent lower, and real labour income per employed person 12-15 per cent higher. Our simulations indicate that migration to Alberta is an engine of growth to the provincial economy but tends to result in lower real labour income per employed person.

Acknowledgments

I wish to thank Neil Swan for his encouragement and constructive criticism. I benefited from many fruitful discussions with Ludwig Auer, Bobbi Cain, Peter Eglington, Paul Jacobson, William Jarvis and Someshwar Rao. André Bourdon's help with the model coding is gratefully acknowledged. I am responsible for any shortcomings of this paper.

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Chapter 1

INTRODUCTION

This paper is a sequel to our study: Migration and a Small Long-Term Econometric Model of Alberta (referred to in the following as Migration). In order to keep the present study as far as possible self-contained we have reproduced Chapter 4 (Outline of the Theory and Structure of the Model) and Chapter 5 (Description and Discussion of the Empirical Estimates) of Migration as Appendix A and B. Migration was originally undertaken in order to investigate the magnitude and shape over time of future migration into Alberta. As our work progressed, our investigation led to additional, perhaps more interesting questions. We found that the growth-rate of Alberta's economy is likely to be substantially lower during the 1980-2000 period than during the previous two decades (Migration, p. 142). Depending on the flexibility of wages, either the unemployment rate of Alberta will climb substantially above the national average (Migration, p. 144) or Alberta's real labour income per employed person will remain at about the 1980 level throughout the next two decades (Migration, p. 143). Net migration into Alberta will gradually subside and turn into substantial out migration in the 1990s (Migration, p. 145). Even the construction of four oil-sand plants between 1983 and 2000 would only mitigate these unfavourable changes but would not reverse them completely.

A number of other interesting questions followed from the foregoing:

a) In <u>Migration</u> we based our assumption of Alberta's oil output on the modified base case (but without additional oil-sand plants) of the National Energy Board's study entitled Canadian Energy: Supply and Demand 1980-2000, June 1981, p. 147 and Alberta's gas output in the same publication, p. 218.

These assumptions may be too pessimistic. Indeed, the National Energy Board has recently raised its estimate of Canada's natural gas delivering capacity in its Gas Export Omnibus Hearing, 1982, p. 32. Also, the Federal Department of Energy, Mines and Resources has published a Long-Term Energy Supply-Demand Outlook (July 1983, p. 28) which shows a higher productive capacity than the National Energy Board projection used in <u>Migration</u>. Would more favourable oil and gas output assumptions (resembling the Aggressive Supply projection of Energy, Mines and Resources combined with a strong gas projection surpassing that of the 1982 Omnibus Hearing) restore the high economic growth of Alberta?

b) Alberta draws very substantial provincial revenues from its natural resources. This enables the province to keep its taxes low, provide more or better services to residents and to accumulate asets in the Heritage Fund. The existence of these "fiscal benefits" make Alberta more attractive to migrants, however our estimates in Appendix B indicate that migrants attach less importance to a dollar of fiscal benefits than to a dollar of wages. Assuming that migrants regarded the fiscal benefit as no different than labour income, how would this influence migration and Alberta's economic future?

c) The Western provinces wish to diversify their economies, in particular into secondary manufacturing. Alberta draws very big revenues from oil and gas production. Assuming that the Alberta government decided to subsidize manufacturing to the extent of ten per cent of the price of manufactured products, would this restore Alberta's economic growth rate to that of the 1961-79 period and keep the province's unemployment rate below that of the rest of Canada? Would the real growth of labour income per employed person maintain the impressive growth of the last two decades?

d) In the projections reported in Migration we assumed that international oil prices will rise by 2 per cent per annum in real terms. Would a slower price growth influence our results, and if so, to what extent?

e) In our Base Case we assumed that migration into and out of Alberta depended on three factors: Alberta's labour income per employed person relative to that of the rest of Canada, Alberta's governmental natural resource revenue per person relative to that of the rest of Canada, and the country's manufacturing capacity utilization rate. Assuming that the natural resource revenue ratio does not influence interprovincial migration, but the unemployment rate in Alberta and in the rest of Canada does: will the findings of our Base Case change?

The following six chapters will deal with these questions. Each chapter consists of three sections:

a) discussion of the problem;

b) implementation of the solution; and

c) discussion of the results.

In our work we derived two variants of the base case solution. In the variant designated as Base.Flex we assumed that wages are flexible and are restrained relatively strongly by high unemployment. This solution has a linear unemployment rate term in the wage equation (Appendix B, p. 126). The second variant (Base.Inflex) assumes relatively inflexible wages and that high unemployment has less restraining effect on wages. Here we used the reciprocal of the unemployment rate in the wage equation (Appendix B, p. 125).

In the following chapters we shall report on simulations made with both wage equations and shall compare them with the corresponding base case simulations.

Chapter 2

A MORE OPTIMISTIC OIL AND GAS SCENARIO

a) The Problem

Our basic solutions Base.Flex and Base.Inflex suggest a difficult period for Alberta in the 1990s. The growth of real provincial product would fall short of the 1961-79 experience by a wide margin. The unemployment rate would grow well above the levels experienced in the past - in case of less flexible wages above that of the national economy. One of the reasons for this unsatisfactory performance is the weakness of the mining sector. During the 1961-79 period the real output of the mining industry increased by 7.1 per cent per annum. In our basic solutions during the 1980-2000 period it declined by 0.5 per cent per annum. We based our projection on the crude oil productive capacity of the "modified base case" (but excluding the construction of further oil-sands plants) of the National Energy Board publication: Canadian Energy, Supply & Demand 1980-2000, June 1981 and on a 71.0 exajoule natural gas supply capability for 1982-2000 in the same volume (pp. 147 and 218). These projections assume that Alberta's oil output has already peaked out and by 2000 will be only one half of the 1980 level. Natural gas output is assumed to reach its peak in the late 1980s and decline thereafter, so that the gas output of the year 2000 would be some 13 per cent below the 1980 level. Even though we assumed very considerable increases in Alberta's coal output (production more than quadrupling between 1980 and 2000), this would be insufficient to compensate for the oil and gas decline.

Some readers of Migration suggested that our assumptions about Alberta's oil and gas producing capability may be too pessimistic. Indeed, shortly after the publication of Migration the National Energy Board revised its gas deliverability estimate in its Gas Export Omnibus Hearing, January 1983, to 83.0 exajoules. The Department of Energy, Mines and Resources has released its oil supply forecast in July 1983 and it is higher than that of the National Energy Board.

b) Implementation

In the base case solutions we used for oil the National Energy Board Modified Base Case, but assumed no construction of further oil sands plants and for gas the supply tracking projection (Migration, p. 137, 146).

In this Chapter we assume

1) for oil: the construction of two additional oil sand plants, the construction of the first plant starting in 1986 and of the second in 1990, and the plants coming on stream in 1991 and 1995 respectively. Also we assume that the capacity of the present syncrude plant is increased by some forty percent between now and 1990. We also assume higher discoveries of new reserves during the projection period. The result of these more optimistic

assumptions is that Alberta's oil output declines only by ten per cent between 1980 and 2000, while in the base case it declined by fifty per cent (Chart 2-1).

2) for natural gas: we assume substantially higher new gas discoveries and a very energetic gas export policy. In our base case gas ouput peaked out in 1988, at a level 37 per cent above that of 1980 and then declined to a level 13 per cent below that of 1980 in the year 2000. In the present Chapter the gas output increases until 1991, where it reaches a level of 55 per cent above that of 1980, and it remains unchanged thereafter (Chart 2-2).

We have made these changes on the basis of discussions with industry experts and they agreed that the assumptions of this Chapter are quite optimistic.

To allow for the employment in the additional oil sand plants and in more enhanced oil recovery we have also adjusted upward the employment in the mining industry of 4.5 thousand for the years 1991-1994 and by 9.0 thousand thereafter.

Our assumptions of coal and other mining output remains unchanged from the base cases, because they were already very optimistic.

As a consequence of the revised oil and gas assumptions Alberta's mining output does no longer decline by 0.5 per cent per annum, as it did in the base cases but it increases by 1.5 per cent per annum. We assumed that the discovery and production costs of the additional oil and gas output were such that no additional provincial natural resource revenues would accrue to Alberta beyond those assumed in our base case solutions.

c) Results

Charts 2-3 to 2-6 indicate that the more optimistic energy scenarios (Optim.Flex and Optim.Inflex) result in much more favourable outlooks for Alberta than do the basic solutions (Base.Flex and Base.Inflex). Nevertheless, the growth rate of real provincial product remains below that of the 1961-79 period, migration subsides and unemployment rises.

The direct and induced effects of the higher mining output and higher migration result in a 24-30 per cent higher real provincial product in 2000, however even these simulations display a gradual flattening of the growth rate (Chart 2-3). Table 2-2 contains information on the population, labour force and real provincial product.

Chart 2-4 indicates that in the case of less flexible wages (Optim.Inflex) the unemployment rate is consistently below that of the corresponding base case (Base.Inflex). The difference is biggest in 1991 (3.7 percentage points) when the first additional oil sand plant comes on stream and the second is under construction, and then declines to 0.4 percentage points by the year 2000. In the case of flexible wages (Optim.Flex) the biggest difference between it and its base case (Base.Flex) is 2.4 percentage points in 1991. In the 1990s the unemployment rate of Optim.Flex fluctuates around that of Base.Flex.

Not surprisingly, the favourable impact of higher oil and gas producing capability on real labour income per employed person (Chart 2-5) is bigger in the case of flexible wages (12.8 per cent in 2000) than in the case of less flexible ones (9.7 per cent).

Higher economic activity creates more migration into Alberta (Chart 2-6). The construction of two additional oil-sand plants creates a second "hump" in the immigration curve in the late 1990s (Simulations Optim.Flex and Optim.Inflex). In consequence net migration, which turned negative in 1992 or 1995 in our base case (Simulations Base.Flex and Base.Inflex) do so now in 1996 or 1999 respectively.

Table 2-1

Net Migration into Alberta, 1980-2000
(Thousand Persons)

	Base Cases		Optim	
	Wages flexible	Less flexible	Wages flexible	Less flexible
Total Net Immigration	410	497	635	772
Total Net Outmigration	327	121	95	10
Total Net Migration	83	376	540	762

Table 2-2

Percentage Difference in Selected Economic Variables in the Year 2000, Alberta

	Flexible Wages Optim - Base Case	Less Flexible Wages Optim - Base Case
Population Aged 15+	18.2	13.7
Labour Force	21.0	16.5
Real Provincial Product	30.3	23.6

CHART 2-1
OIL PRODUCTION, ALBERTA
(MILLION 1971$)

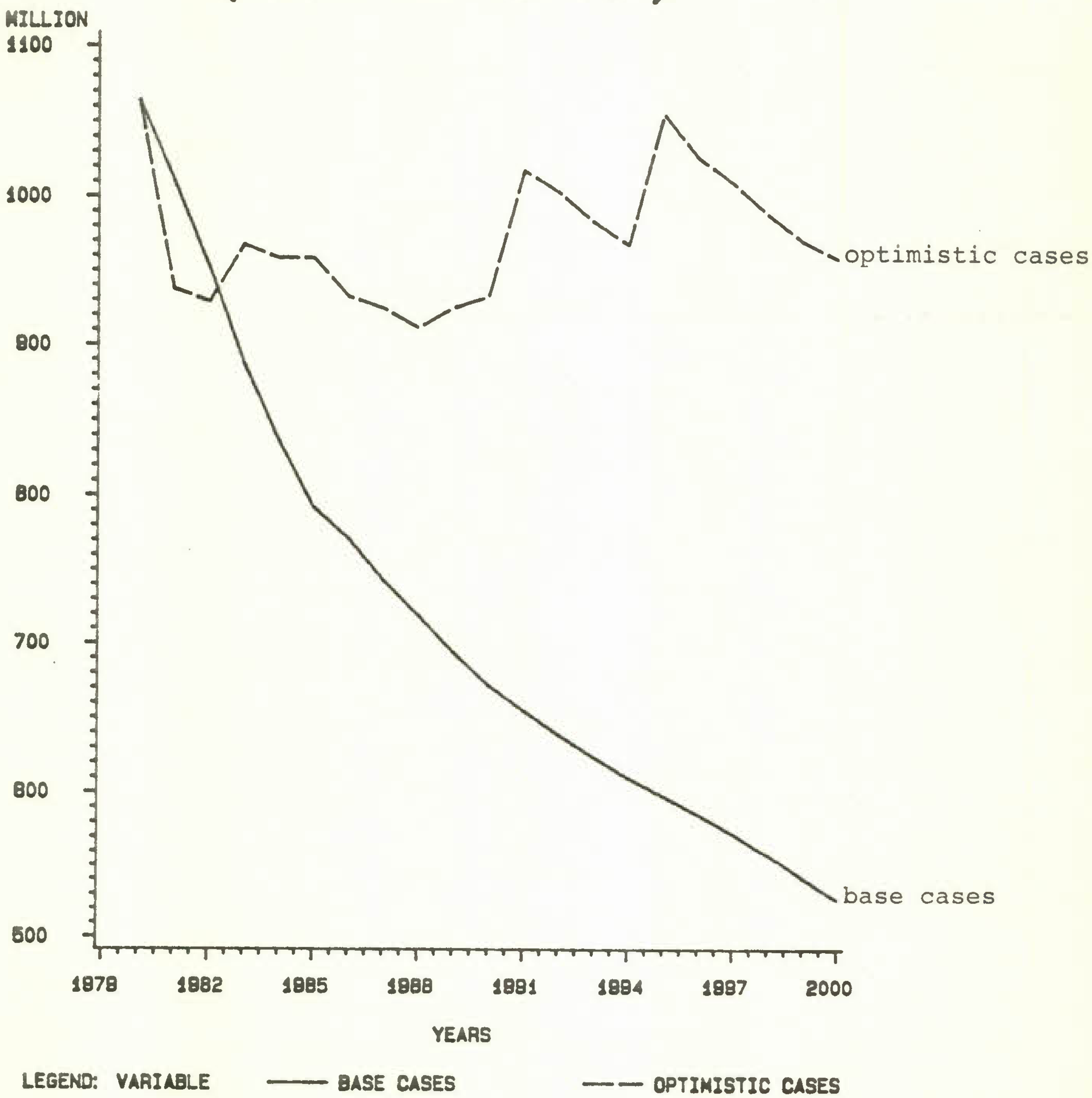


CHART 2-2
NATURAL GAS PRODUCTION, ALBERTA
(MILLION 1971$)

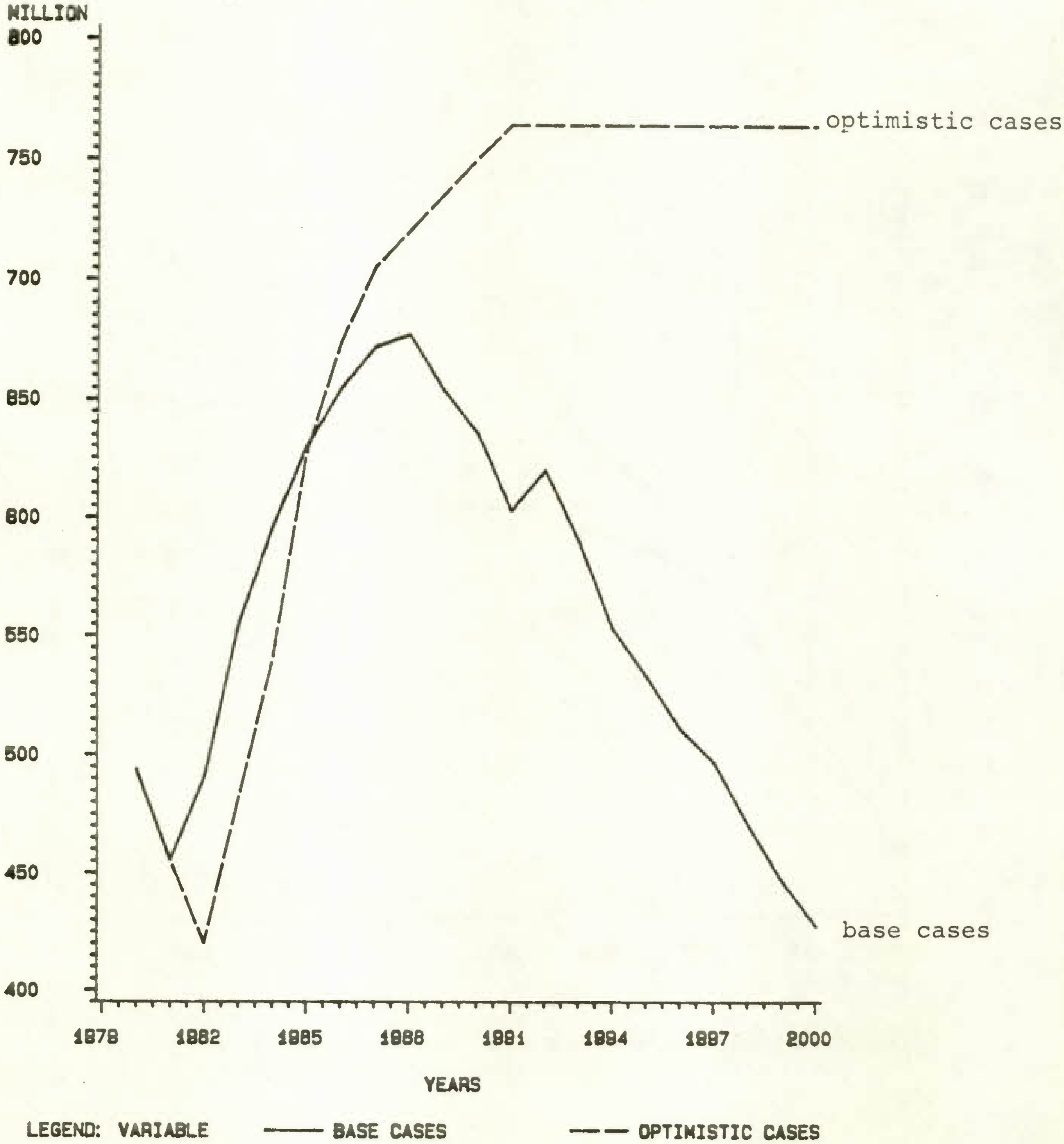


CHART 2-3
REAL PROVINCIAL PRODUCT, ALBERTA
(BILLION 1971$)

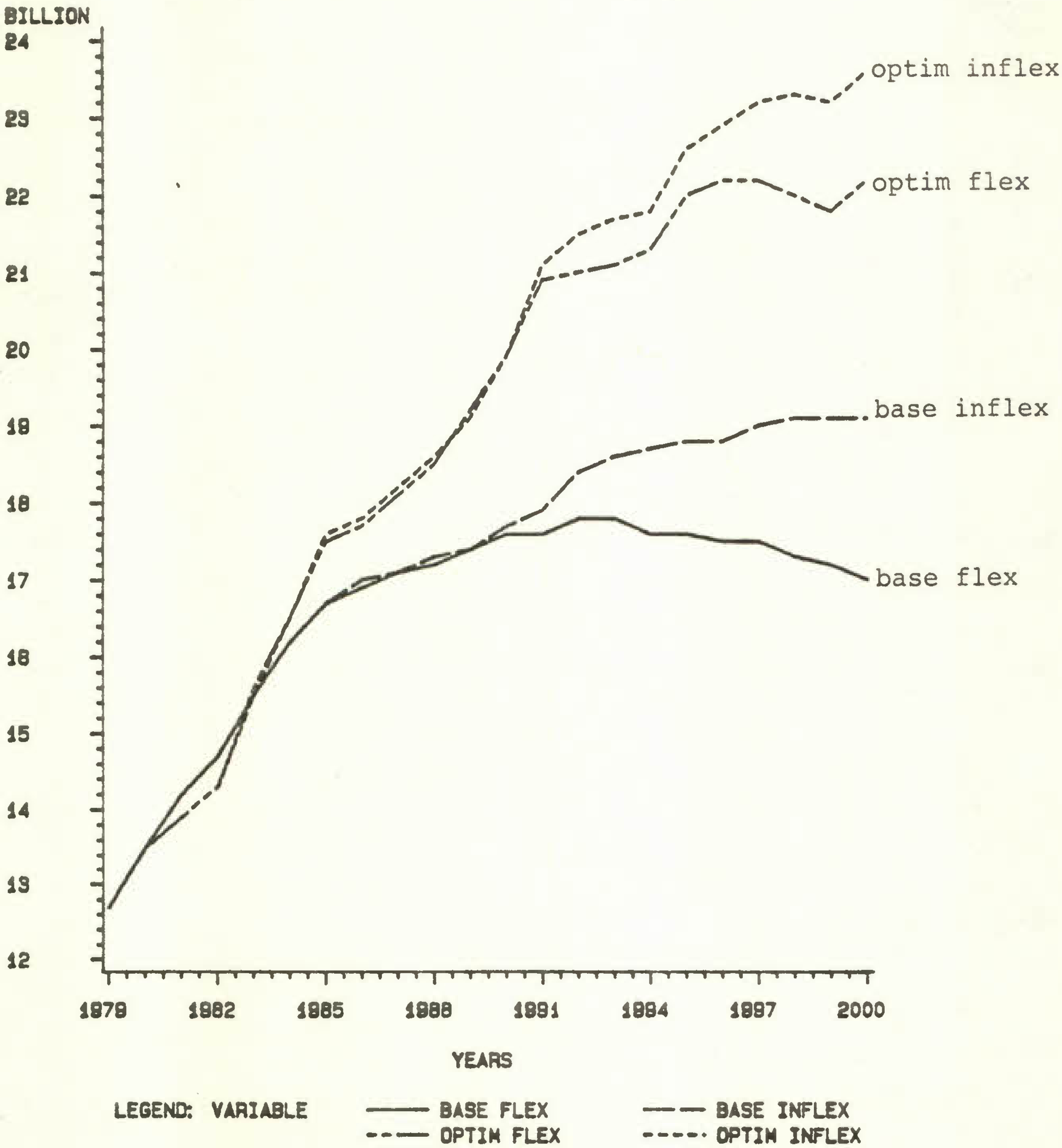


CHART 2-4
UNEMPLOYMENT RATE, ALBERTA
(PERCENT)

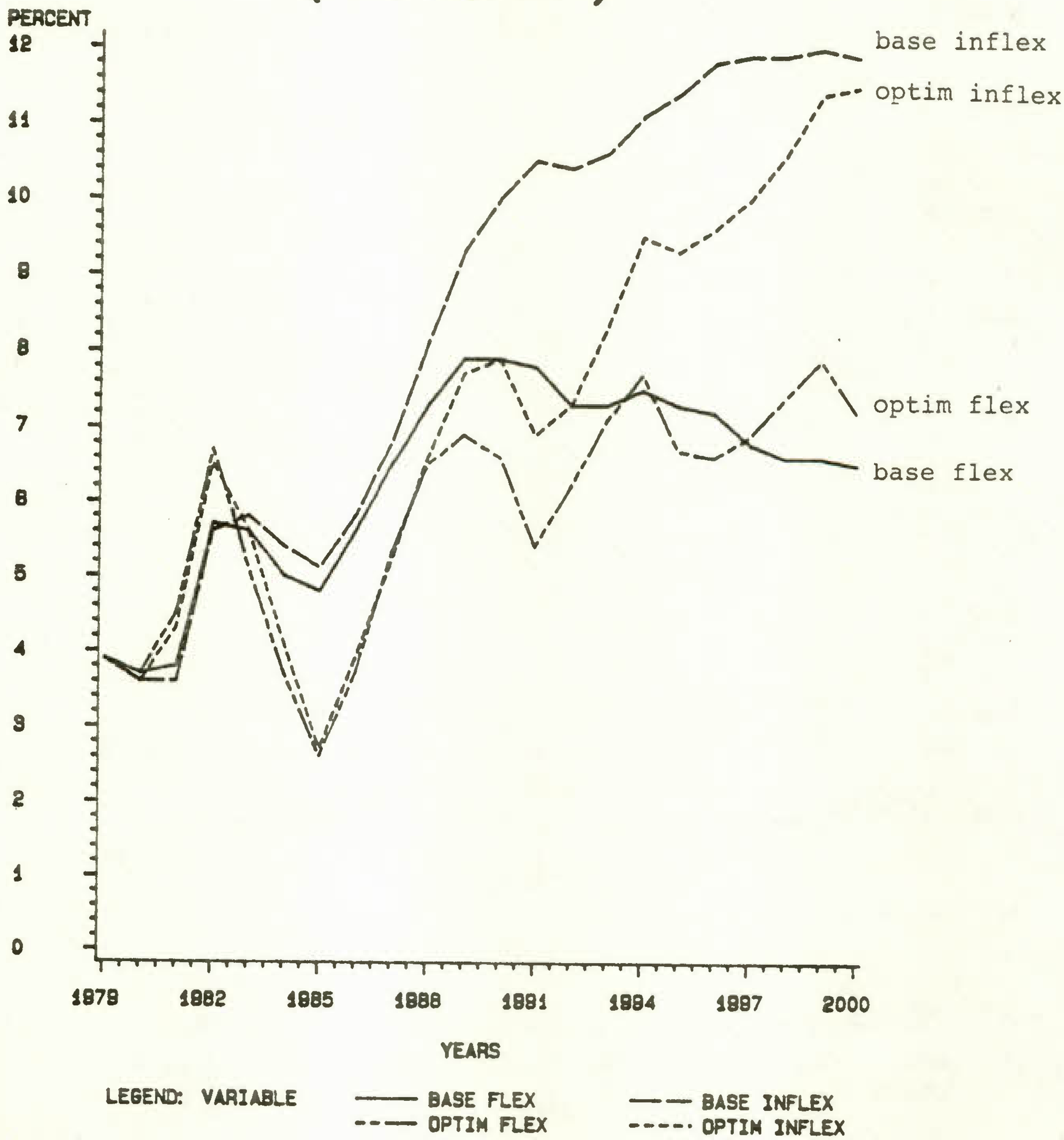


CHART 2-5
REAL LABOUR INCOME PER EMPLOYED PERSON, ALBERTA
(THOUSAND 1971$)

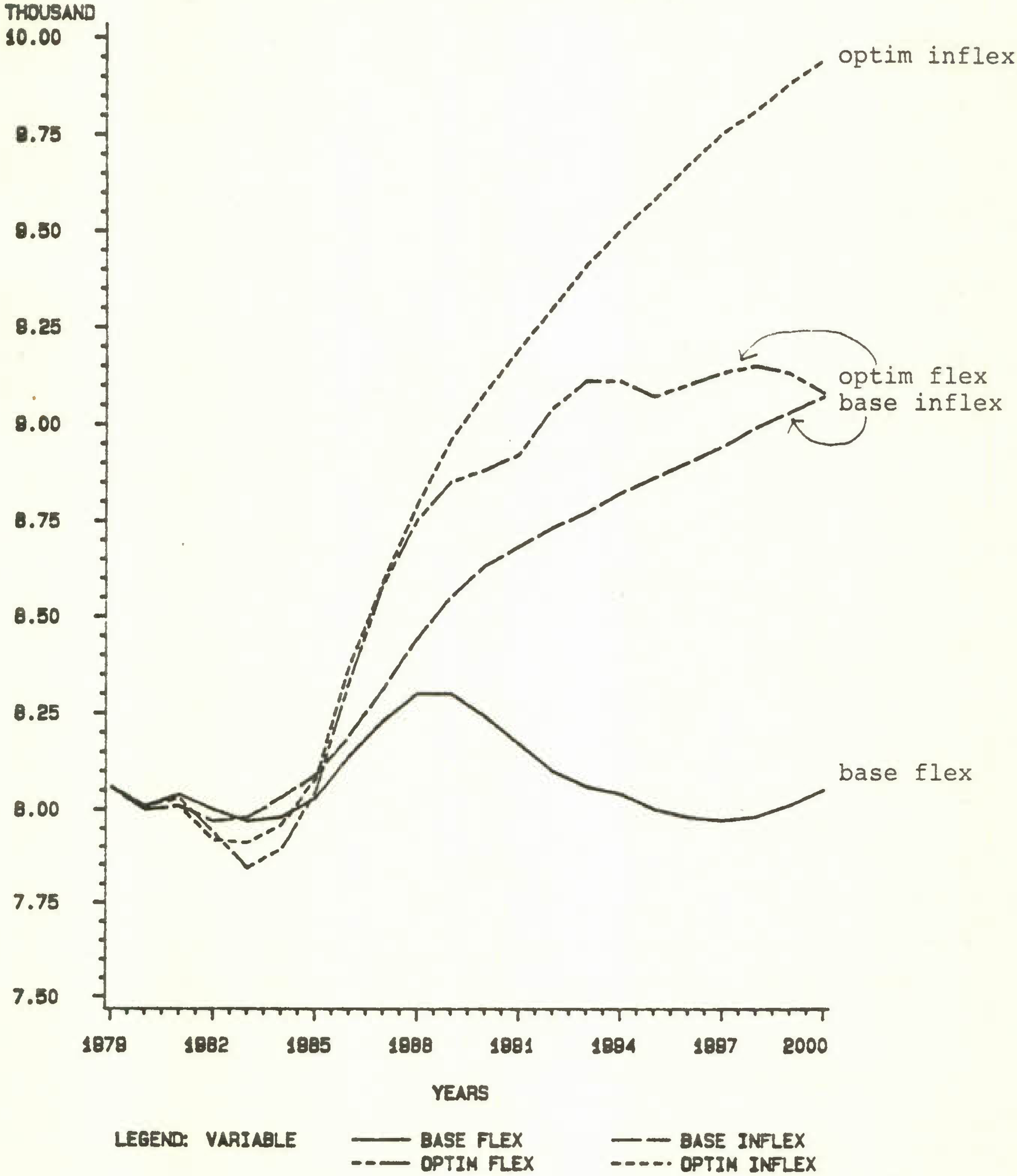
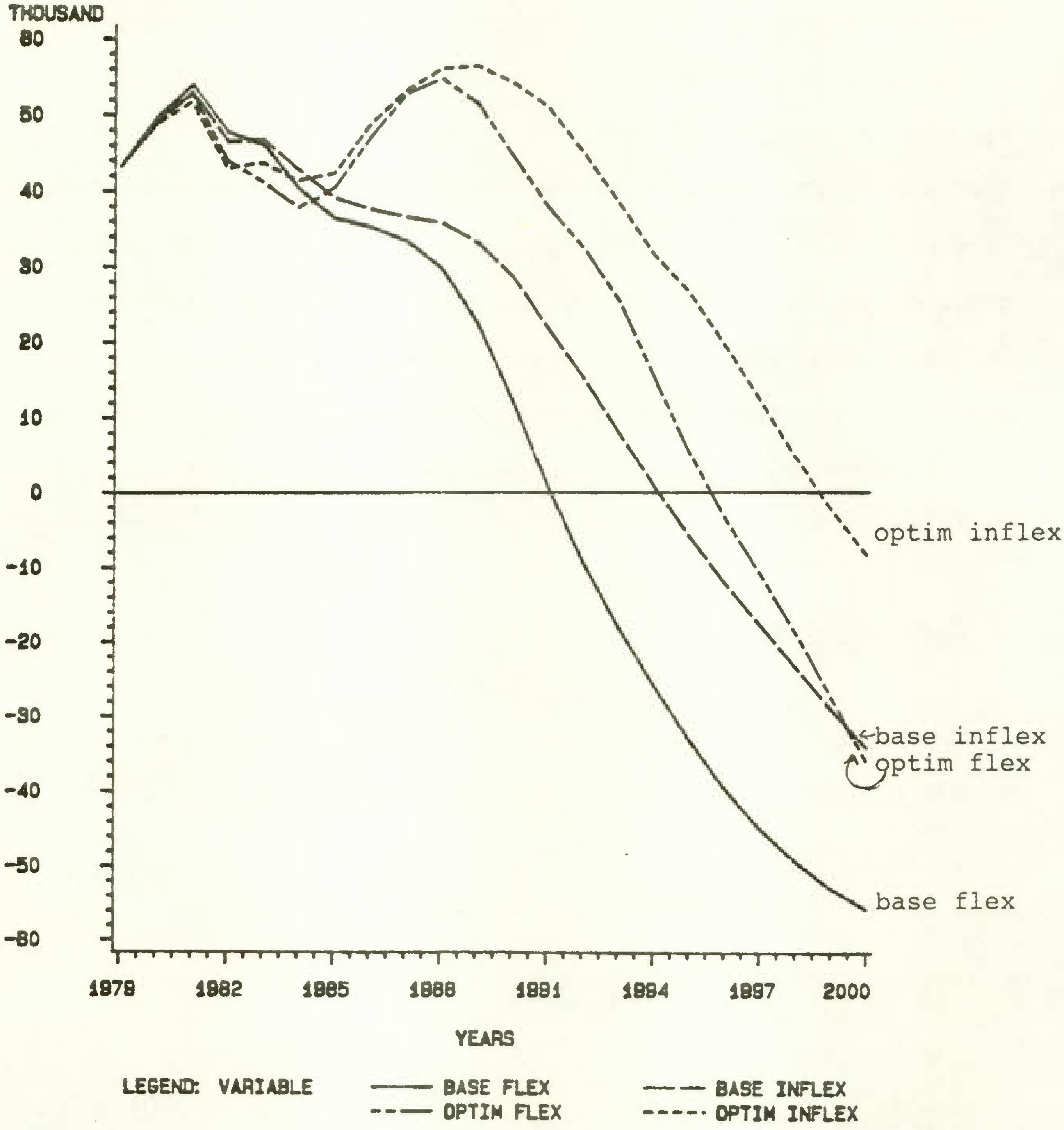


CHART 2-6
NET MIGRATION INTO, ALBERTA
(THOUSAND PERSONS)



Chapter 3

THE FISCAL BENEFIT AND LABOUR INCOME TREATED AS EQUIVALENT

a) The Problem

Some economists (e.g. Purvis and Flatters, 1980) assume that migrants do not differentiate between wages and fiscal benefit. The migration equations derived in Appendix A, pp. 85-91 and Appendix B, pp. 128-133 indicate that migrants attach a different (higher) value to expected wages than to the fiscal benefit. The question arises: what difference would it make if migrants regarded the fiscal benefit as equivalent to wages - or if the provincial governments simply distributed a five per cent real return on the capitalized value of their natural resource rents equally, on a per capita basis to all residents aged 15 and over.

b) Implementation

We re-coded the two interprovincial migration equations as follows: (For Mnemonics see Appendix B, Annex 1, pp. 136-141.)

Interprovincial Migration into Alberta

$$\ln(MIGPIA/POP15+R_{-1}) = -9.42238$$

$$+2.48304 \quad \ln\left(\frac{(WRTA\$+GRNRA\$/POP15+A_{-1})}{(WRTR\$+GRNRR\$/POP15+R_{-1})}\right)$$

$$+0.938225 \quad \ln\,(MFCAPUTC)$$

and

Interprovincial Migration from Alberta

$$\ln(MIGPOA/POP15{+}A_{-1}) = -8.82417$$

$$-0.271803 \quad \ln\left(\frac{(WRTA\$+GRNRA\$/POP15{+}A_{-1})}{(WRTR\$+GRNRR\$/POP15{+}R_{-1})}\right)$$

$$+1.35463 \quad \ln\ (MFCAPUTC)$$

These two equations replaced those quoted in Appendix B, p. 132. In Migration p. 39 we calculated the capitalized asset value of oil and gas rents as 294.5 billion (1982) dollars for Alberta and 356.0 billion (1982) for the rest of Canada. We assumed a five per cent real return on these capitalized assets, and then obtained new values for GRNRA$ and GRNRR$ by multiplying the real returns by the deflator of the Canadian Real Domestic Product. No other changes were made.

We re-ran the simulations for the 1980-2000 period, both with wages flexible (Simulation Rentaswage.Flex) and with wages less flexible (Simulation Rentaswage.Inflex) and compared the results with the corresponding base cases (Simulations Base.Flex and Base.Inflex respectively).

c) Results

Not surprisingly, this simulation (which is equivalent to distributing the return on the capitalized resource revenues to all residents) results in an initial rush of migration to Alberta (Chart 3-4). The inflow rapidly ebbs away as the fiscal benefit is distributed among more and more Alberta residents. From 1988-1989 on net migration to Alberta falls below that of the base cases. Total migration is summarized in Table 3-1.

Nevertheless, Alberta's population in the year 2000 is higher under these simulations than in the base cases, and so is its labour force and real provincial product (Chart-1 and Table 3-2).

However higher population and higher real provincial product are the only things in favour of a policy represented by simulations Rentaswage.Flex and Rentaswage.Inflex. The higher immigration in the 1980s leads to higher unemployment, particularly in the second half of the decade (Chart 3-2), but in the case of the less flexible wages (Simulation Rentaswage.Inflex) also throughout the 1990's. For the simulation with flexible wages (Rentaswage.Flex vs. Base.Flex) real labour income per employed person in the year 2000 is 4.1 per cent lower than in the corresponding base case, for less flexible wages (Rentaswage.Inflex vs. Base.Inflex) 3.0 per cent lower (Chart 3-3).

Table 3-1

Net Migration into Alberta, 1980-2000
(Thousand Persons)

	Base Cases		Rentaswage	
	Wages flexible	Less flexible	Wages flexible	Less flexible
Total Net Immigration	410	497	674	761
Total Net Outmigration	327	121	391	171
Total Net Migration	83	376	283	590

Table 3-2

Percentage Difference in Selected Economic Variables in the Year 2000, Alberta

	Flexible Wages Rentaswage - Base Case	Less Flexible Wages Rentaswage - Base Case
Population Aged 15+	9.5	9.1
Labour Force	8.5	8.2
Real Provincial Product	8.3	7.7

CHART 3-1
REAL PROVINCIAL PRODUCT, ALBERTA
(BILLION 1971$)

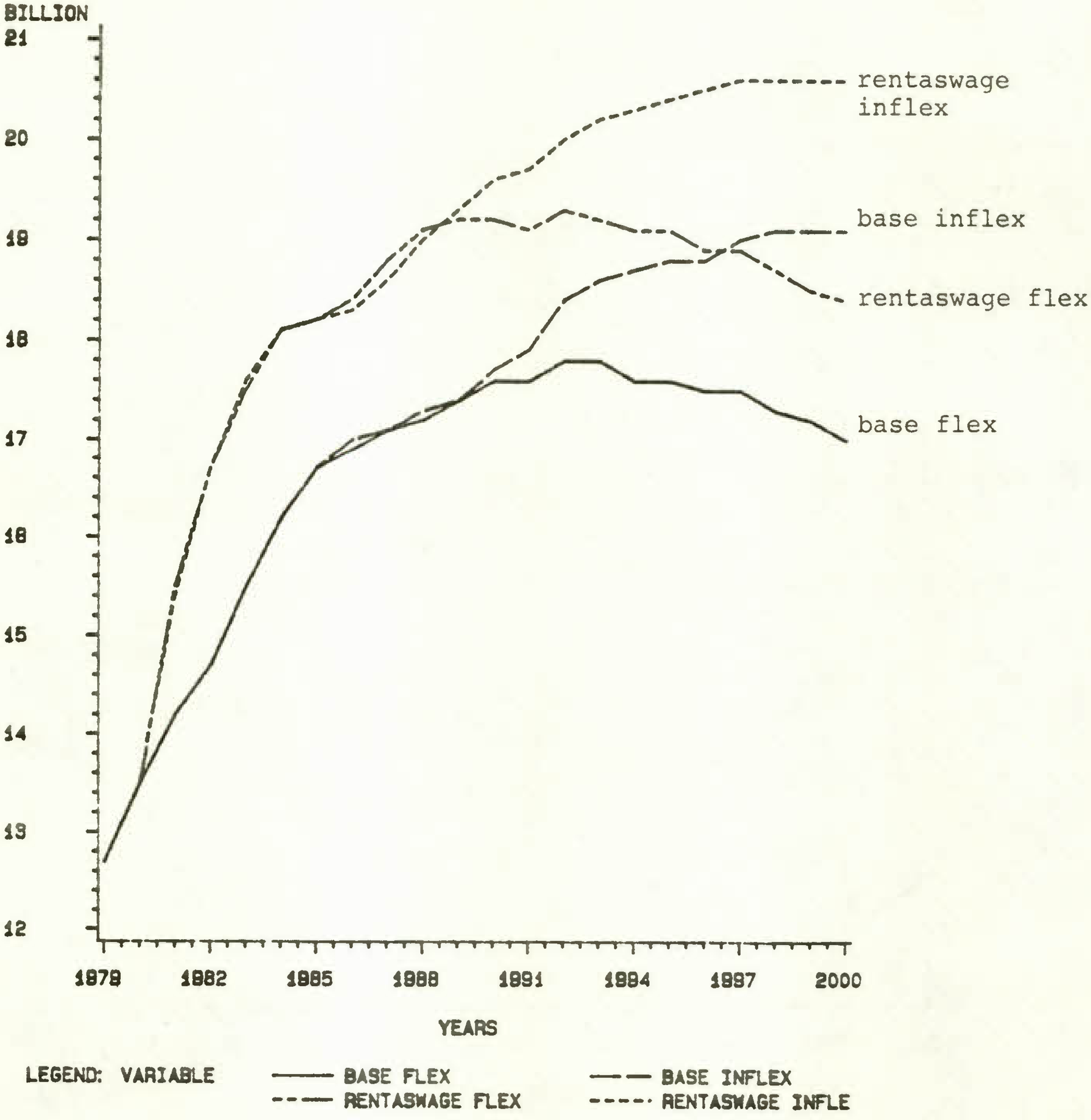


CHART 3-2
UNEMPLOYMENT RATE, ALBERTA
(PERCENT)

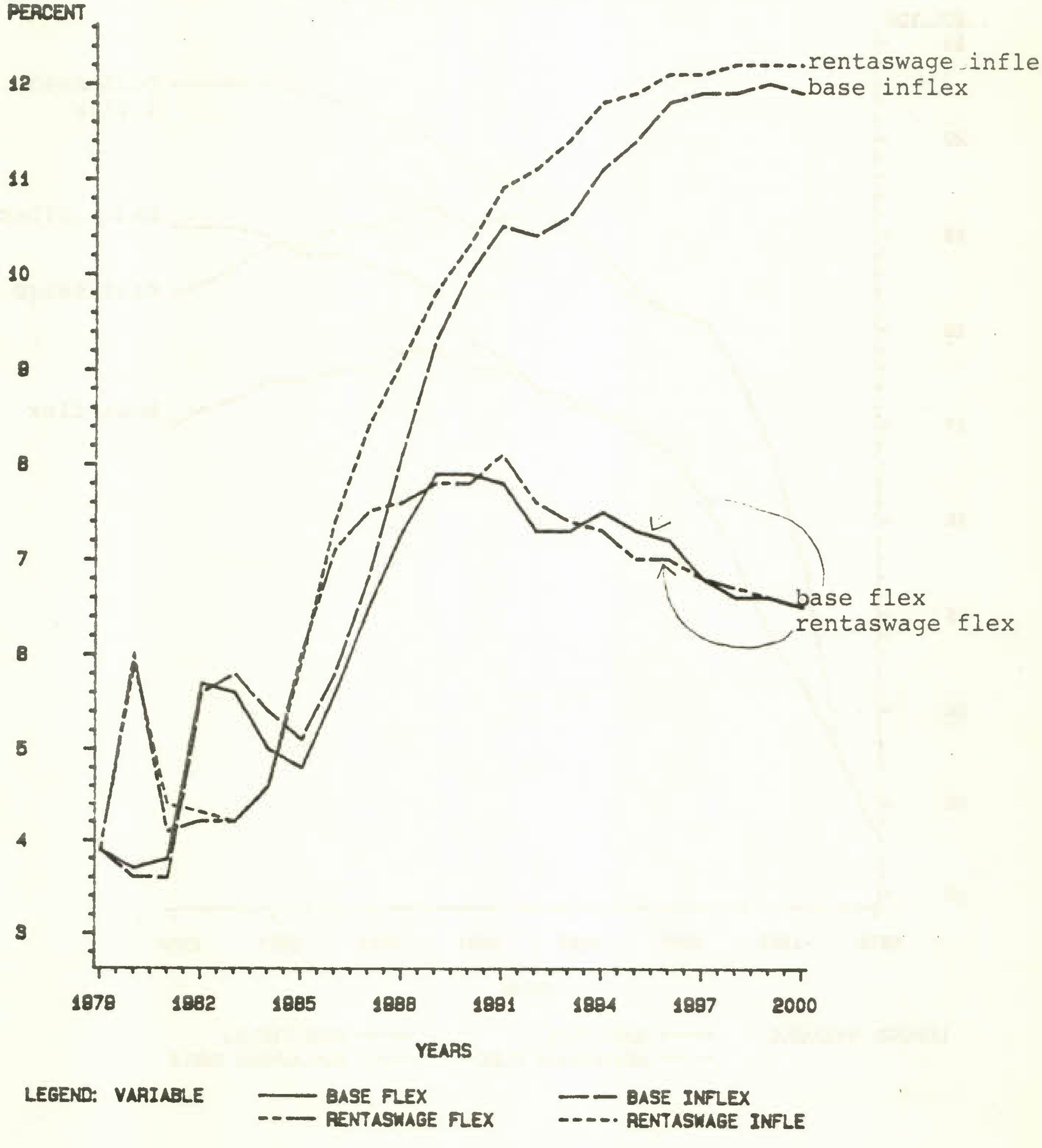


CHART 3-3
REAL LABOUR INCOME PER EMPLOYED PERSON, ALBERTA
(THOUSAND 1971$)

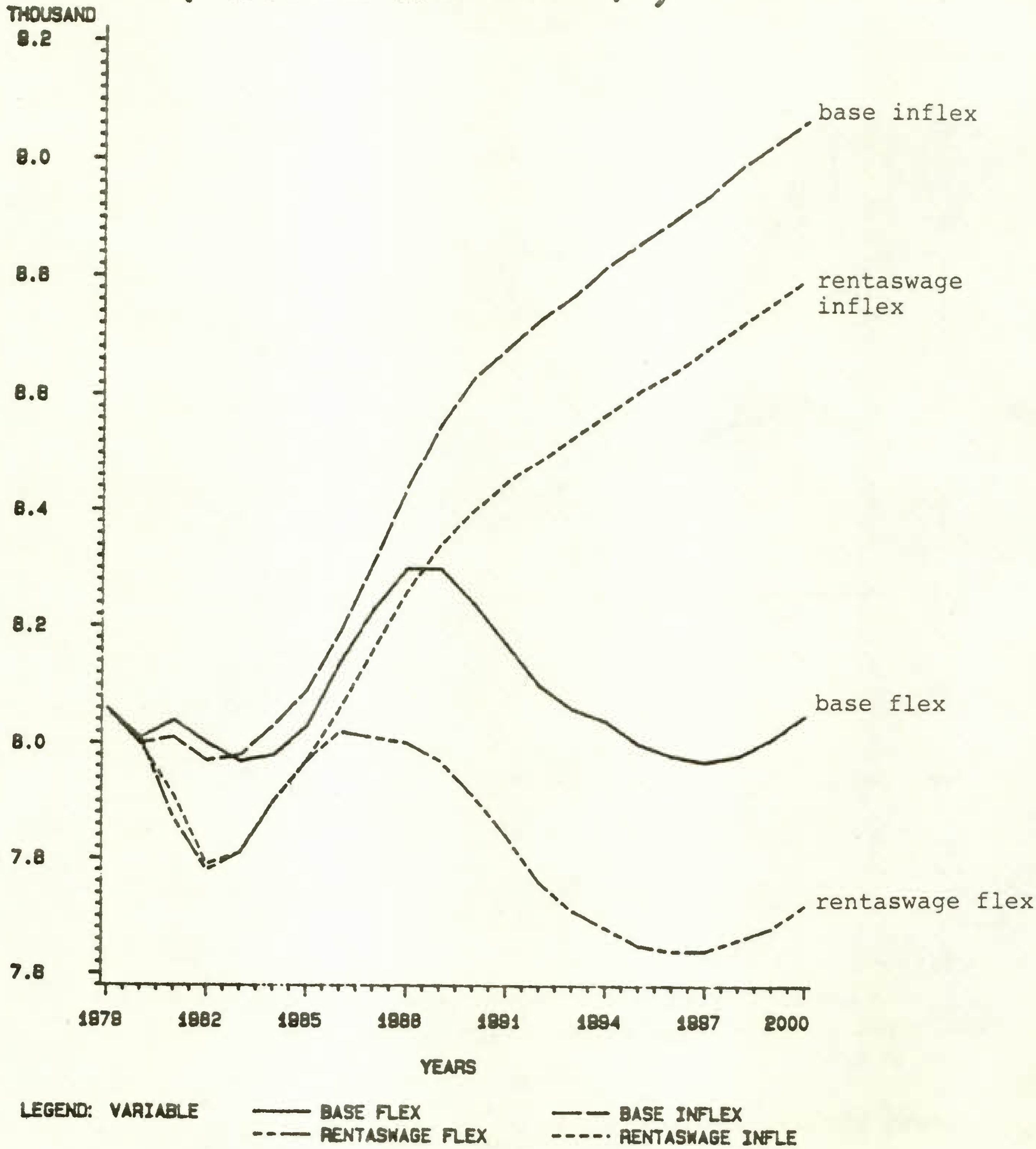
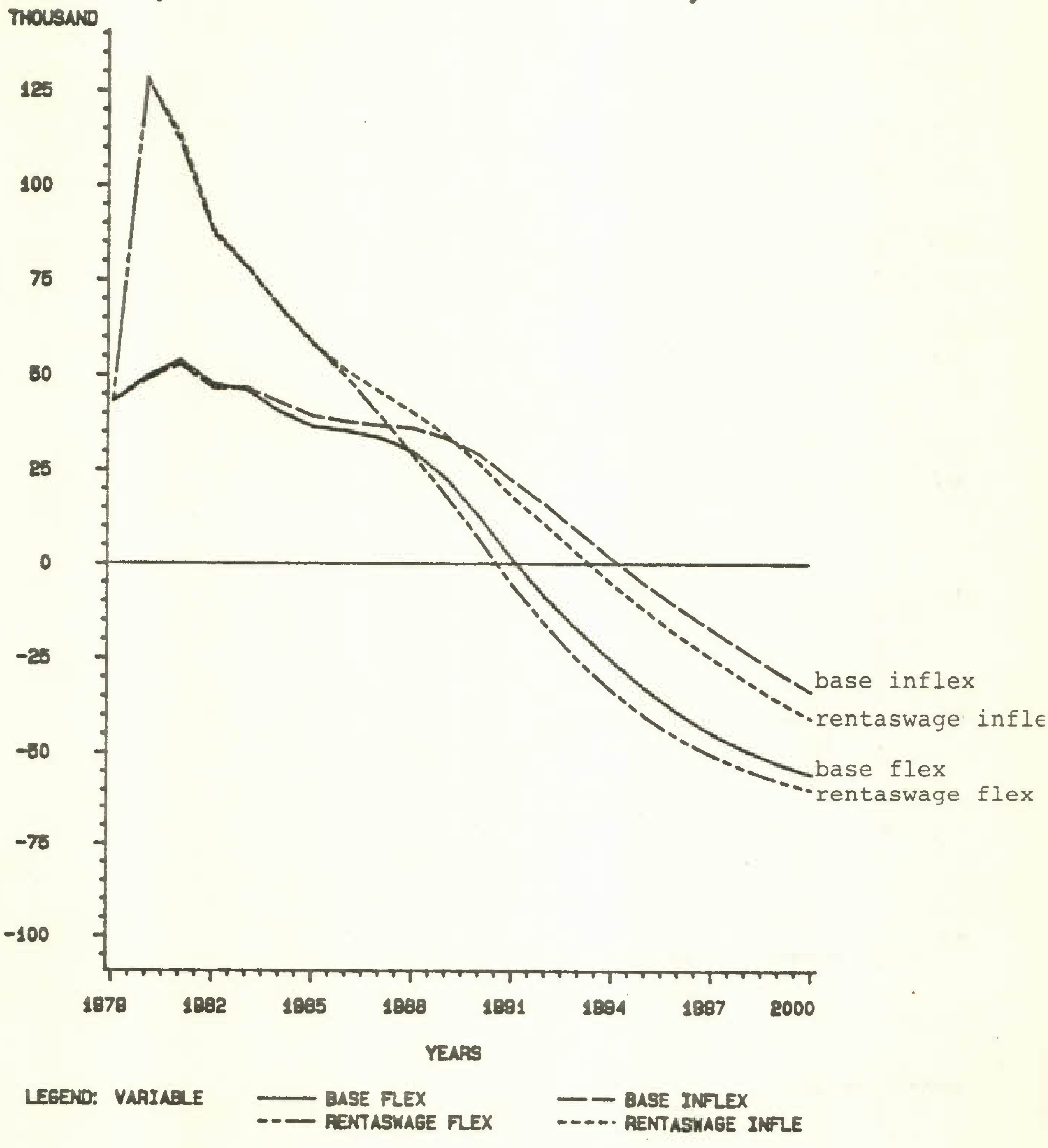


CHART 3-4
NET MIGRATION INTO, ALBERTA
(THOUSAND PERSONS)



Chapter 4

SUBSIDIZING MANUFACTURING

a) The Problem

The base case solutions indicate that the growth rate of Alberta's economy during the rest of this century will be substantially lower than during the 1961-1979 period and the unemployment rate very considerably higher (Migration, pp. 138-149). The Prairie premiers have repeatedly emphasized that they wish to accelerate the growth of manufacturing in their provinces (see e.g., Western Economic Opportunities Conference, pp. 19-23). Assuming that the Alberta government were to use the province's natural resource revenue to subsidize manufacturing, would such a policy significantly alleviate Alberta's future economic problems?

b) Implementation

Assume that the Alberta government subsidized manufacturing to the extent of k per cent of its value-added price. Then the supply by an individual manufacturing establishment in Alberta will be modified from:

$$X_i^s = d \left(\frac{PX_i}{WRT\$} \right)^e$$ (Appendix A, p. 66) equation (A-2) to

$$X_i^s = d'' \left(\frac{PX_i \; (1+k)}{WRT\$} \right)^e$$

With some easy but tedious arithmetic it can be shown that the manufacturing output equation (A-11) in Appendix A, p. 74 still holds, except that the constant term has to be increased by $\gamma' \ln(1+k)$. We assumed in our simulations a subsidy of thirty per cent of the manufacturing value added price, i.e., $k=0.3$. Our calculations indicate that a subsidy of this magnitude would amount to approximately thirty per cent of the government's natural resource revenues, i.e. the amount the government places into the Heritage Fund. The estimated manufacturing output equation (Appendix B, p. 110) shows that $\gamma'=0.281721$. The change in the constant term of the manufacturing output equation has to be, therefore

$+0.281721 \ln(1+0.3) = +0.073913$, or the constant term has to be increased from -2.35703 to -2.283117. The subsidy shifts the manufacturing output equation upward. No other change has to be made in the manufacturing output equation.

The Alberta manufacturing price deflator is a function of the rest of Canada manufacturing price (Appendix B, p. 115). No adjustment is needed for this equation.

If a part of provincial natural resource revenues is spent on subsidizing manufacturing, less is available for other forms of fiscal benefit. This is an important point, when we consider the specification of the interprovincial migration equations quoted in Appendix B, p. 132, in which the Alberta-Rest of Canada natural resources revenue ratio is shown to be an important determinant of migration. In the present simulations we proceeded as follows: first, we made simulations with the modified manufacturing output equation as described above. We observed the increase in manufacturing output. This was the (first pass) effect of the subsidy. Then we calculated thirty per cent of the (first pass) current dollar output of manufacturing in Alberta. This is the amount of the subsidy. We revised the Alberta natural resource revenues used in the migration equations downward by the amount of the subsidy and repeated the simulation (second pass). This reduced migration relative to the first pass, and also reduced manufacturing output. The process could be repeated until migration converges to a final equilibrium value. We found, however, that the change in manufacturing output changes little between pass one and pass two (about 2.2 per cent in the year 2000). We decided, therefore, that pass two gives a sufficiently close approximation of the effect of the subsidization policy.

We performed the two modifications described above and applied them to the 1980-2000 period, with the following results.

c) Results

As expected, the policy of subsidization stimulates manufacturing activity. The effect of stimulation builds up gradually and then levels off in the mid-1990s. In any case, the effect is quite moderate. In the year 2000 the simulation with flexible wages (Subsidy.Flex) shows an increase in real manufacturing output of 8.4 per cent over its corresponding base case (Base.Flex), the simulation with less flexible wages (Subsidy.Inflex) 8.7 per cent over Base.Inflex. Manufacturing activity being only a small part of total economic activity, the relative effect on Alberta's real provincial product is even smaller, 1.2 per cent and 1.5 per cent respectively (Chart 4-2). The effect on migration is slight, as shown in Table 4-1 and Chart 4-5.

Under such circumstances it is not surprising that the effect of the simulations on the provincial unemployment rate is negligible (Chart 4-3). The subsidization of manufacturing increases real labour income per employed person by about 1.5 per cent (Chart 4-4). In sum, our simulations suggest that across the board subsidization of manufacturing would not significantly increase Alberta's economic growth.

However, the subsidization of manufacturing reduces that part of the fiscal benefit which is available for tax reductions, better social services, etc. Table 4-2 indicates that the average recipient of labour income would be worse off under the subsidization scheme than in the base case scenario. (This assumes that workers attach the same value to a dollar of labour income as to a dollar of fiscal benefit.)

Table 4-1

Net Migration into Alberta, 1980-2000
(Thousand Persons)

	Base Cases		Subsidy	
	Wages flexible	Less flexible	Wages flexible	Less flexible
Total Net Immigration	410	497	437	529
Total Net Outmigration	327	121	352	142
Total Net Migration	83	376	85	387

Table 4-2

Cumulative Undiscounted Real Labour Income Per Employed
Person and Real Fiscal Benefit Per Person Aged 15 Years and Over
Alberta, 1980-2000

	Flexible Wages		Less Flexible Wages	
	Subsidy	Base Case	Subsidy	Base Case
	Thousand (1971) dollars			
Real Labour Income	172.0	169.6	181.8	179.0
Fiscal Benefit	22.4	30.0	22.0	29.0
Total	194.3	199.6	203.9	208.0

CHART 4-1
REAL PROVINCIAL PRODUCT MANUFACTURING, ALBERTA
(BILLION 1971$)

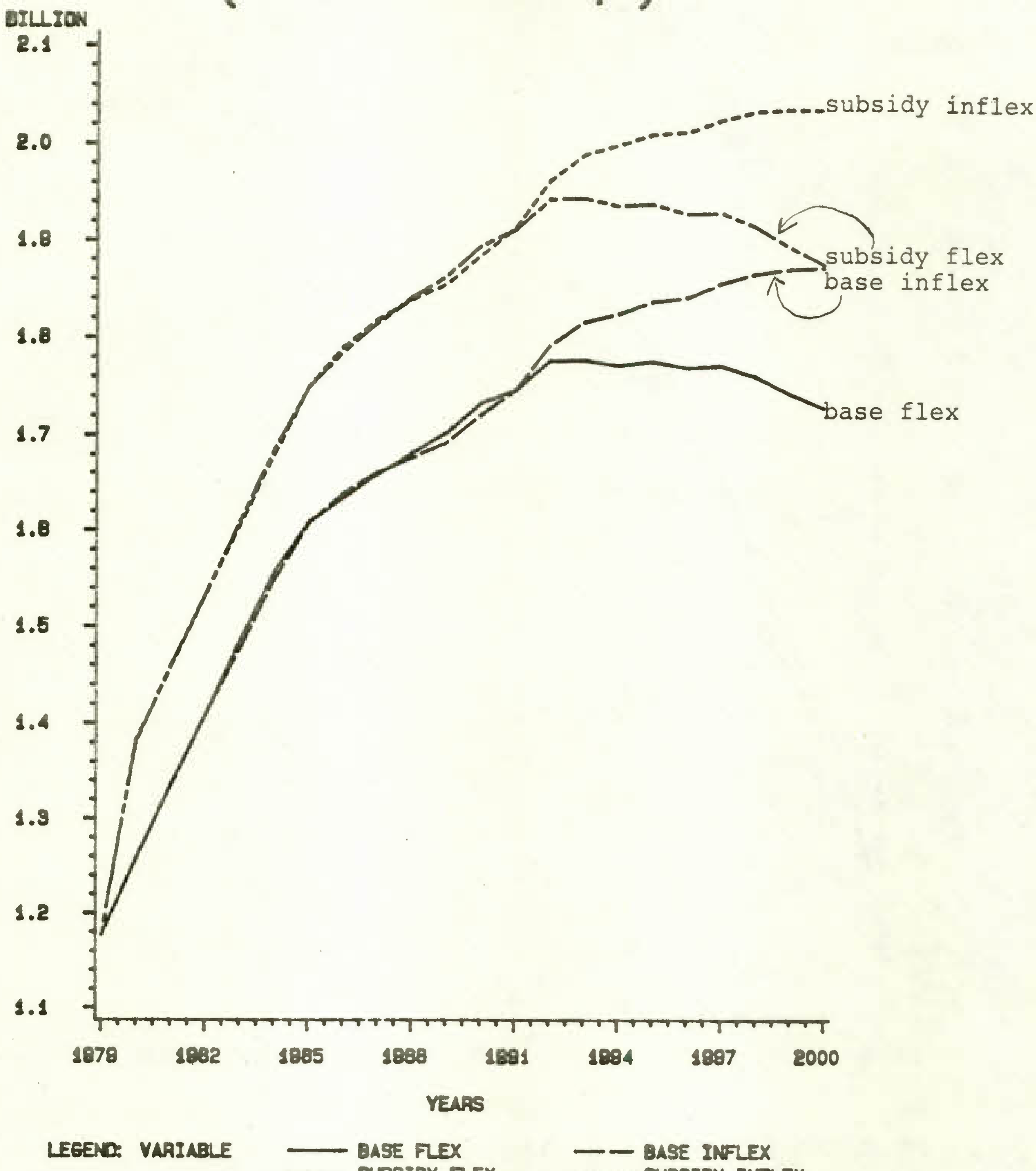


CHART 4-2
REAL PROVINCIAL PRODUCT, ALBERTA
(BILLION 1971$)

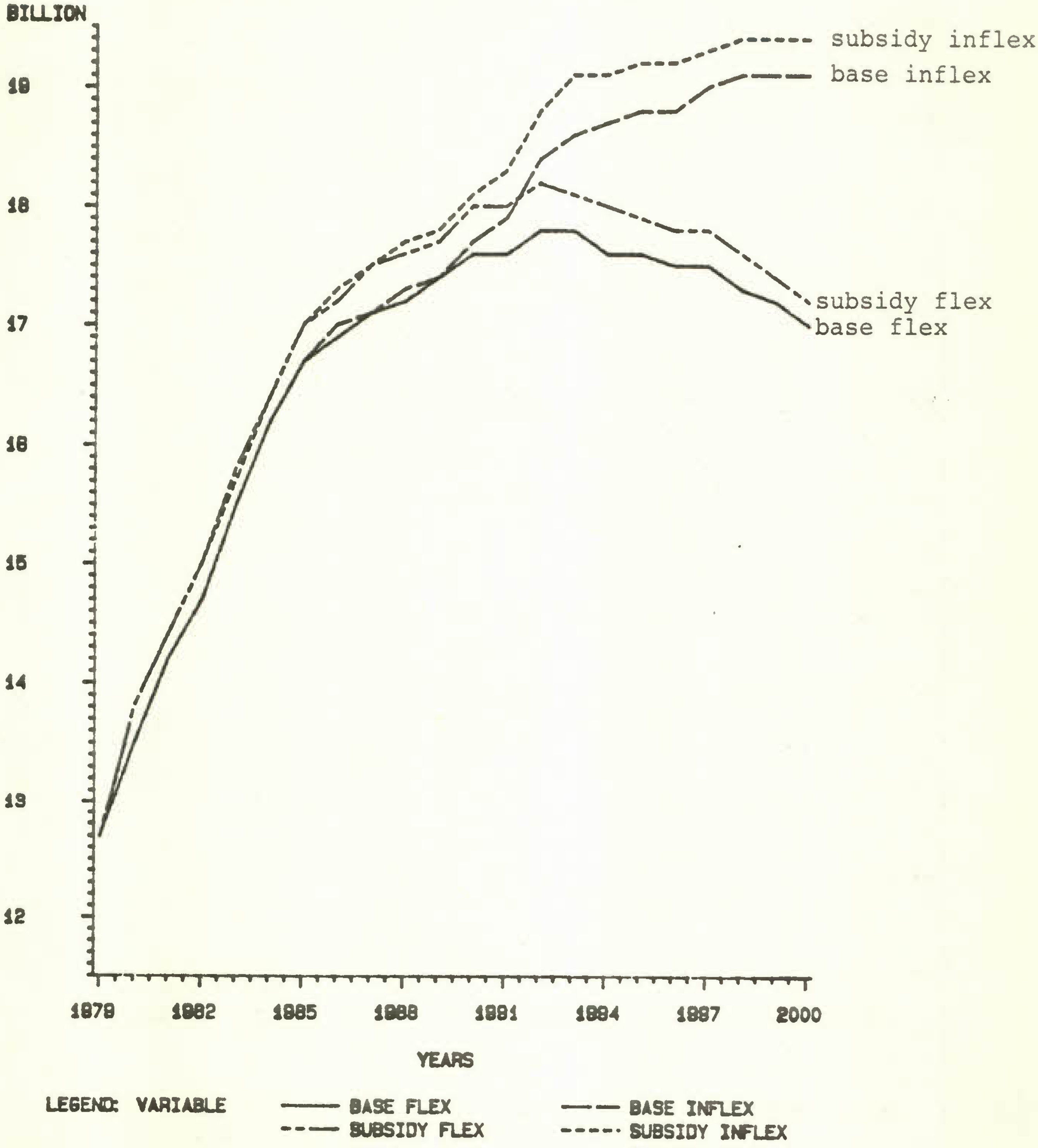


CHART 4-3
UNEMPLOYMENT RATE, ALBERTA
(PERCENT)

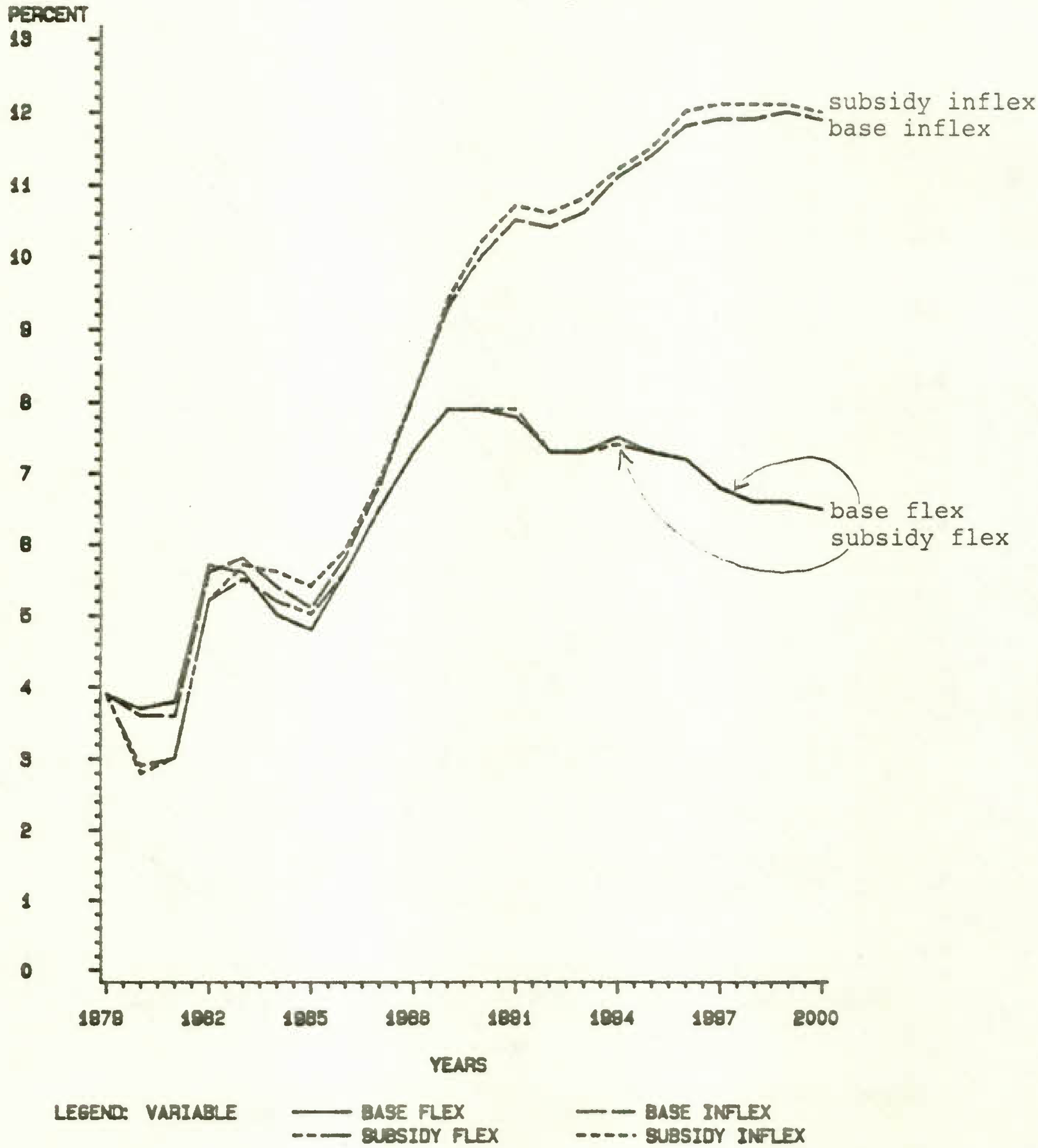


CHART 4-4
REAL LABOUR INCOME PER EMPLOYED PERSON, ALBERTA
(THOUSAND 1971$)

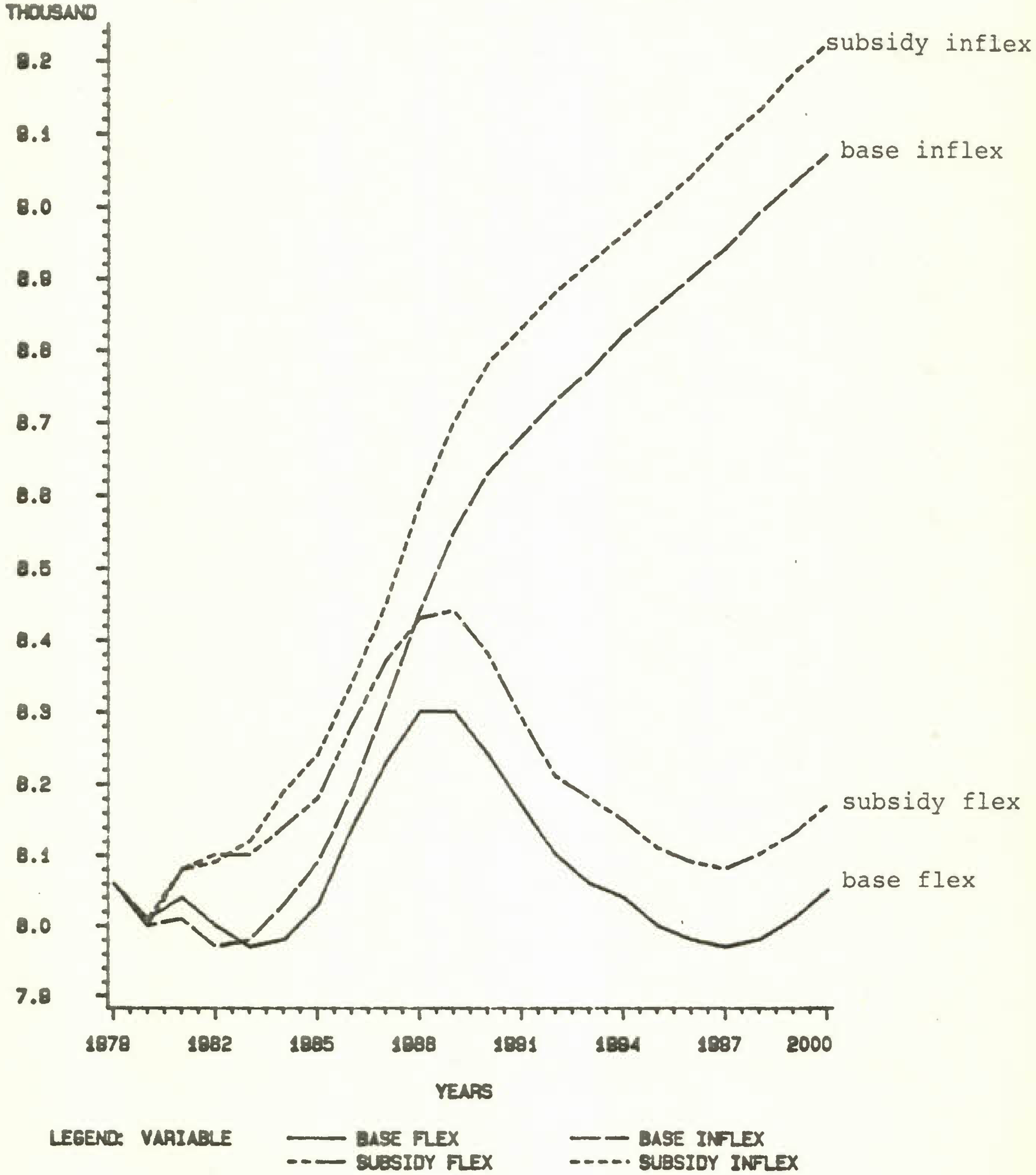
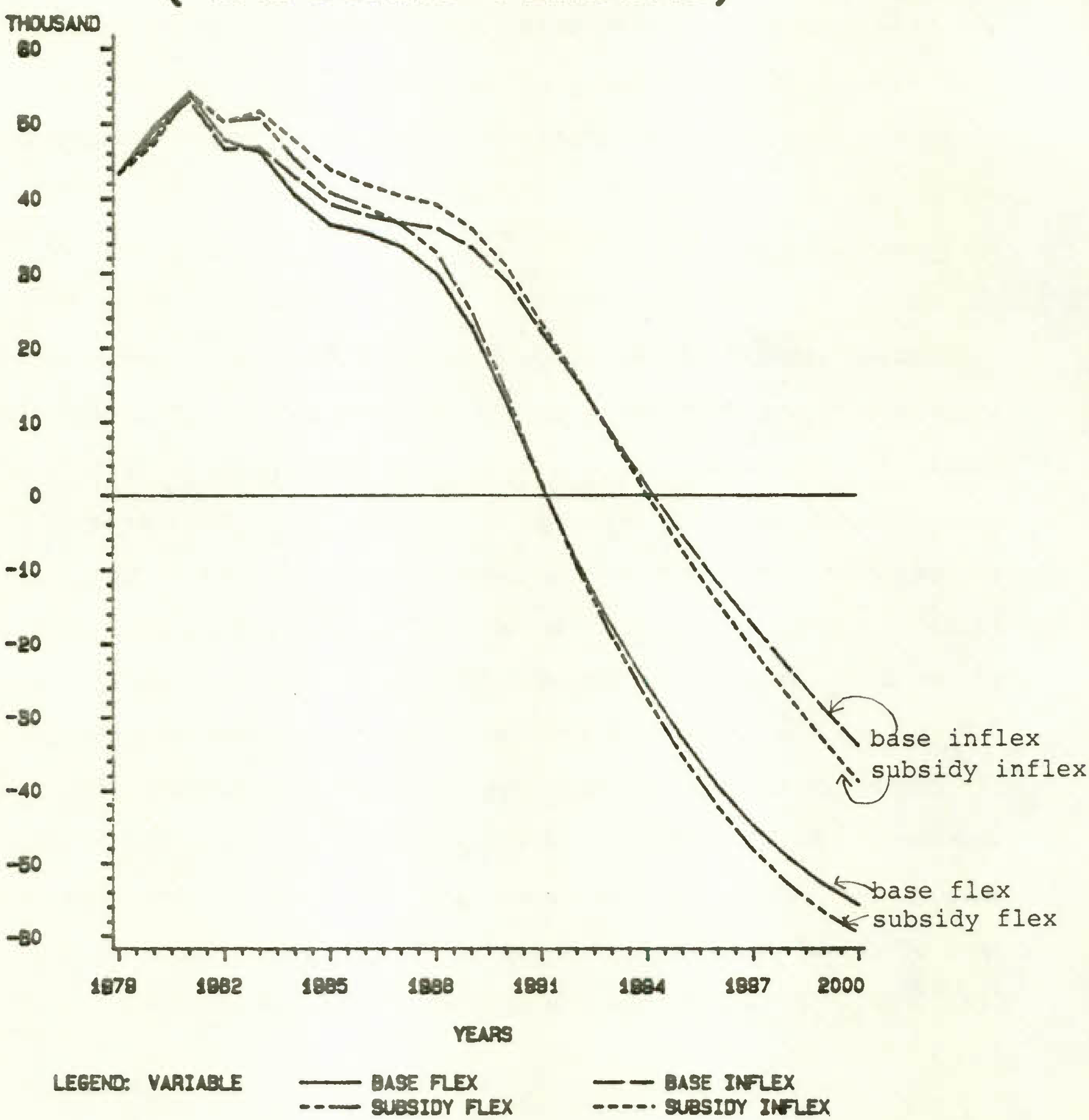


CHART 4-5
NET MIGRATION INTO, ALBERTA
(THOUSAND PERSONS)



Chapter 5

LOWER OIL AND GAS PRICES

a) The Problem

Our base case solutions assumed that the world price of hydrocarbons will rise by 2 per cent per annum in real terms. How would our results change under some alternative price assumption?

b) Implementation

In these simulations we assumed that the real world price of hydrocarbons would increase by one per cent per annum between the years 1983 and 2000. The effect of this assumption is that by the year 2000 the implicit deflator of mining output of Alberta is 6.4 per cent lower than in the base case simulations. The National Energy Policy and the Federal-Alberta accord on energy prices attenuates the effect of world prices on Canadian prices. This is why the price differential between the lower international oil price simulations and the base cases is so low. The Alberta government natural resource revenues are in the year 2000 10.9 per cent lower than in the base case. The exogenous variables for the Rest of Canada were derived from the CANDIDE projection F27.LOWOIL. Detailed data are available from the author.

c) Results

Charts 5-1 to 5-4 indicate that the effects of this simulation is quite small whether we observe the solution Lowoil.Flex or Lowoil.Inflex. Net migration into Alberta is slightly reduced, as shown in Table 5-1.

As a consequence, Alberta's population of labour force age, labour force and real provincial product are all reduced relative to the base cases (Table 5-2).

The effect of the simulations on real labour income per employed person (Chart 5-2) and on the Alberta unemployment rate (Chart 5-3) is negligible. Evidently, it would take much bigger changes in world hydrocarbon prices to have a substantial effect on the Alberta economy. The direction of the change is, however, clear-cut: lower oil and gas prices depress migration into Alberta and reduce the real provincial product.

Table 5-1

Net Migration into Alberta, 1980-2000
(Thousand Persons)

	Base Cases		Lowoil	
	Wages flexible	Less flexible	Wages flexible	Less flexible
Total Net Immigration	410	497	390	469
Total Net Outmigration	327	121	349	137
Total Net Migration	83	376	41	332

Table 5-2

Percentage Difference in Selected Economic Variables in the Year 2000, Alberta

	Flexible Wages	Less Flexible Wages
	Lowoil - Base Case	Lowoil - Base Case
Population Aged 15+	-1.7	-1.6
Labour Force	-2.0	-2.0
Real Provincial Product	-2.3	-2.3

CHART 5-1
REAL PROVINCIAL PRODUCT, ALBERTA
(BILLION 1971$)

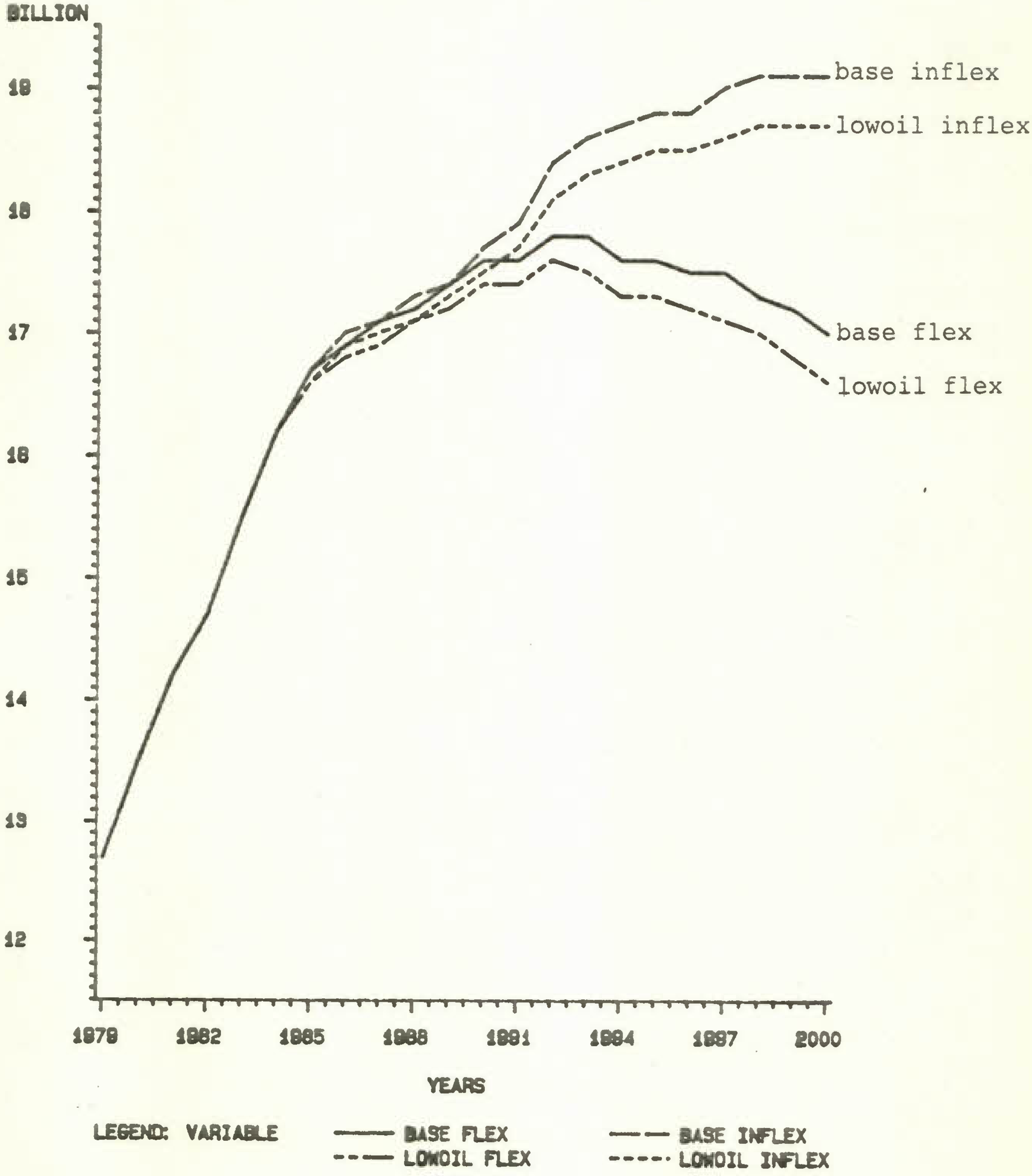


CHART 5-2
UNEMPLOYMENT RATE, ALBERTA
(PERCENT)

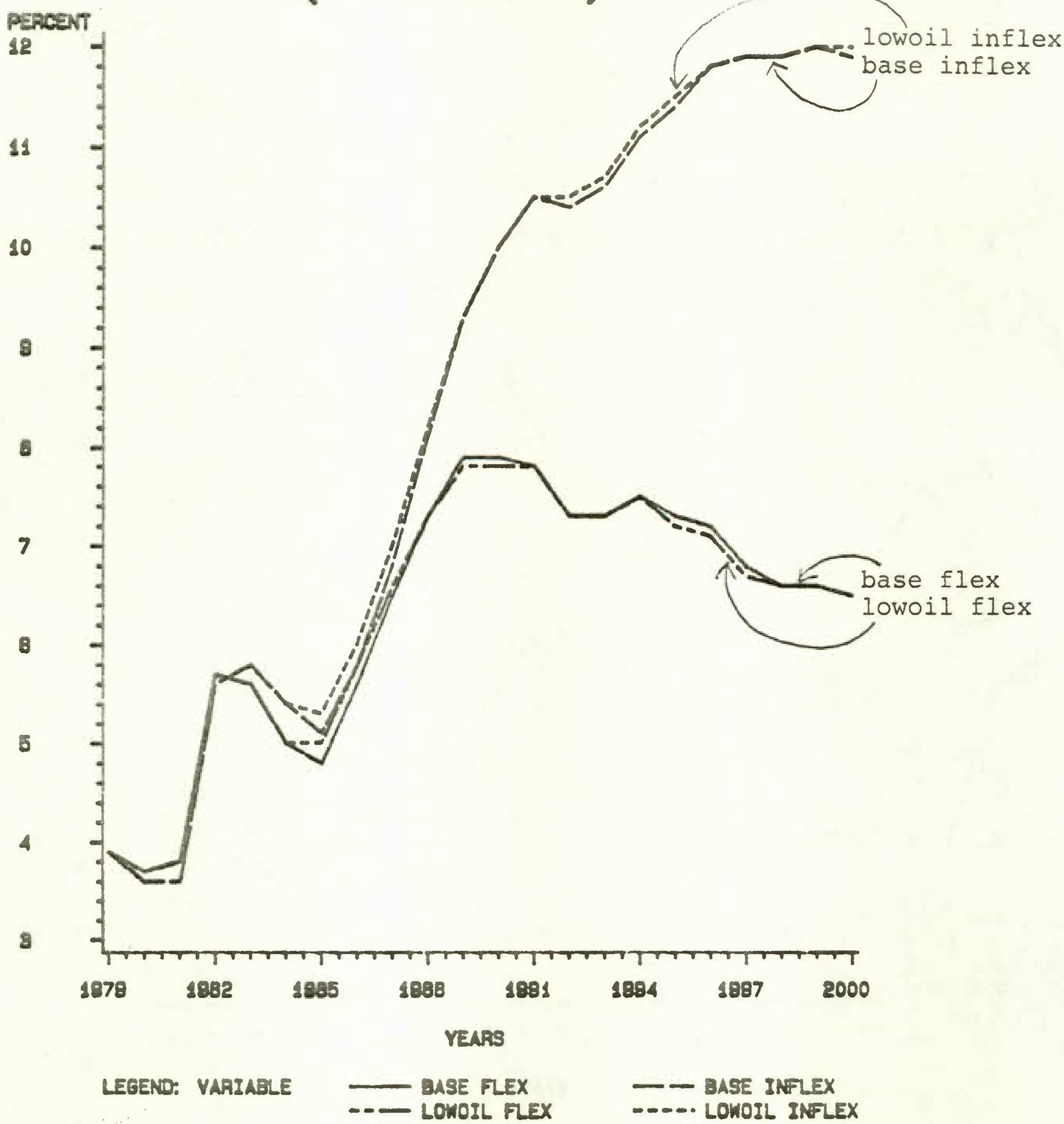


CHART 5-3
REAL LABOUR INCOME PER EMPLOYED PERSON, ALBERTA
(THOUSAND 1971$)

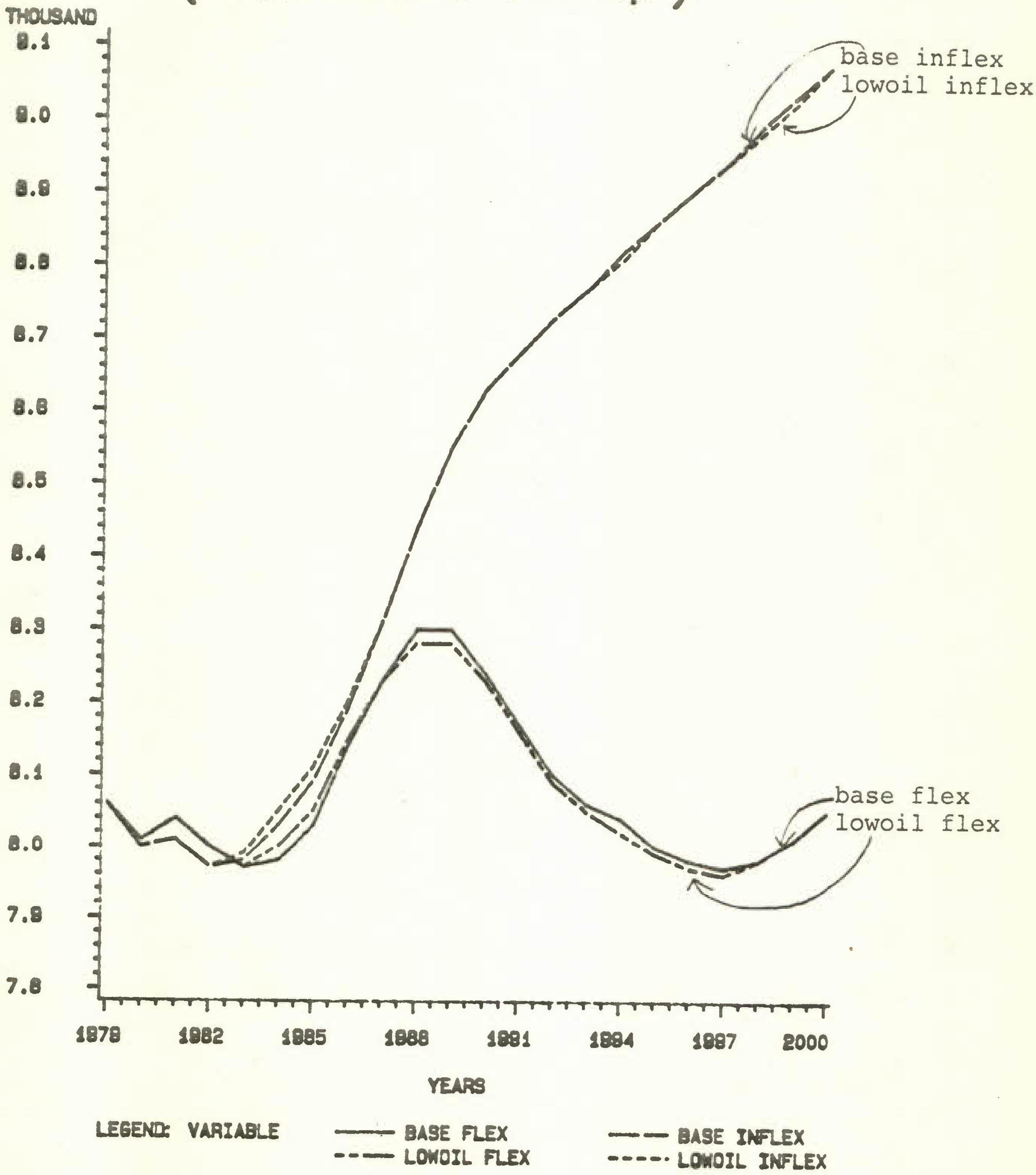
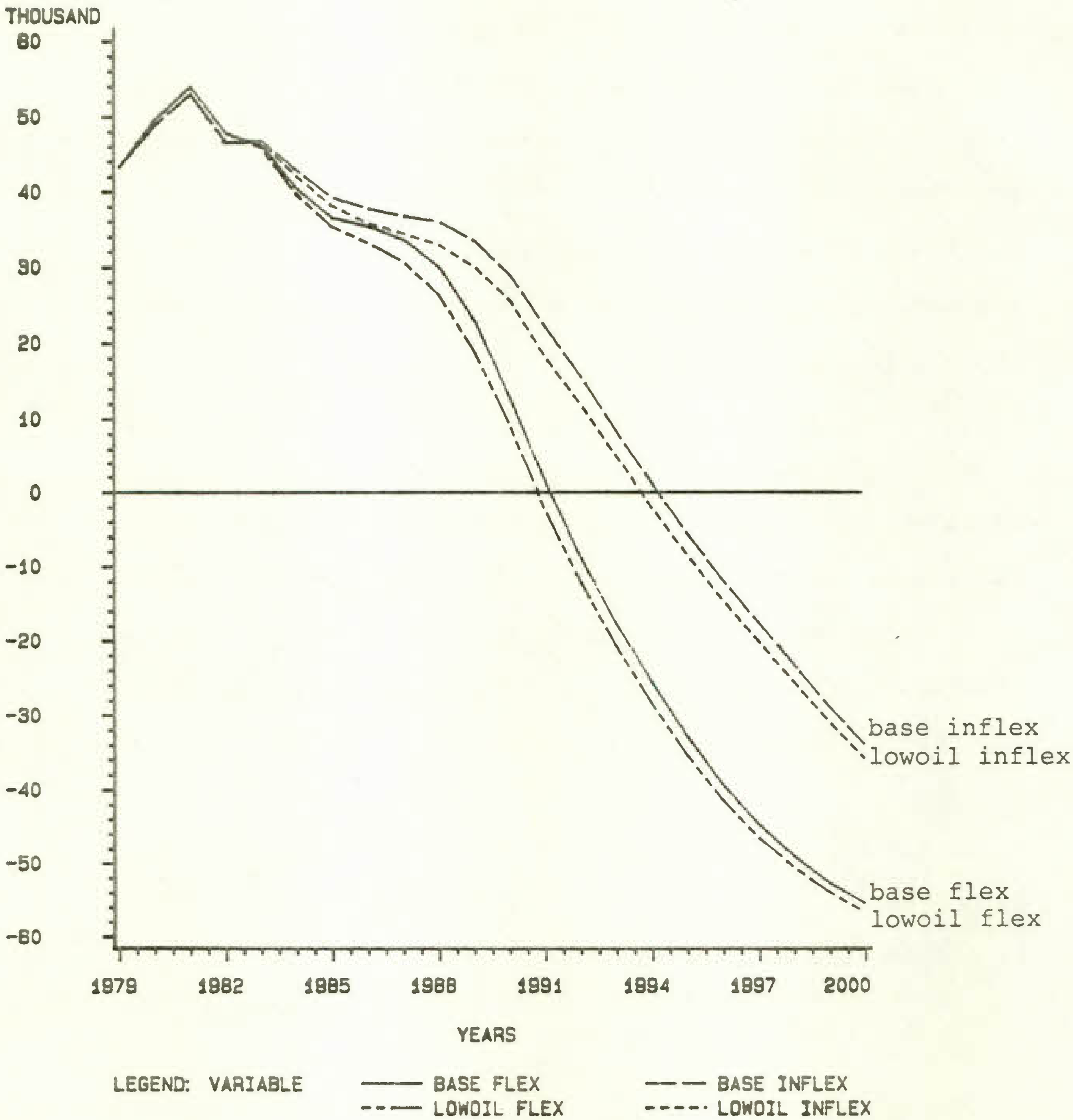


CHART 5-4
NET MIGRATION INTO, ALBERTA
(THOUSAND PERSONS)



Chapter 6

AN ALTERNATIVE ASSUMPTION ABOUT INTERPROVINCIAL MIGRATION

a) The Problem

As Chart 6-3 indicates, our base case solutions Base.Flex (flexible wages) and in particular Base.Inflex (less flexible wages) project Alberta unemployment rates much above those experienced during the 1961-79 sample period. Nevertheless, Chart 6-4 shows that net migration into Alberta continues throughout the 1980s and turns negative only in the 1990s. Is this a realistic result?

In Appendix A, pp. 85-91 we discuss numerous alternative hypotheses of economic forces determining interprovincial migration. We also point out in Appendix B, p. 131, that many explanatory variables proved highly collinear. Our preferred equations contained provincial natural resource revenues as explanatory variables, as follow:

Name: Interprovincial Migration into Alberta
Mnemonic: MIGPIA — Period: 1961-79
Method: OLS

$$\ln(MIGPIA/POP15{+}R_{-1}) = \underset{(9.80)}{-9.42238} \; \underset{(6.61)}{+2.48304}\ln(WRTA\$/WRTR\$) \; \underset{(4.22)}{+0.938225}\ln(MFCAPUTC) \; \underset{(2.21)}{+0.0687485}\ln\left(\frac{(GRNRA\$/POP15{+}A_{-1})}{(GRNRR\$/POP15{+}R_{-1})}\right)$$

$\bar{R}^2 = 0.904$ S.E.E. = 0.0444 D-W = 2.206

Name: Interprovincial Migration from Alberta
Mnemonic: MIGPOA
Period: 1961-79
Method: OLS

$$
\begin{aligned}
\ln(MIGPOA/POP15{+}A_{-1}) = & -8.82417 \\
& \ (5.98) \\
& -0.271803 \quad \ln(WRTA\$/WRTR\$) \\
& \ (0.47) \\
& +1.35463 \quad \ln(MFCAPUTC) \\
& \ (3.97) \\
& -0.0873836 \quad \ln\left(\frac{(GRNRA\$/POP15{+}A_{-1})}{(GRNRR\$/POP15{+}R_{-1})}\right) \\
& \ (1.83)
\end{aligned}
$$

$\bar{R}^2 = 0.578$ S.E.E. = 0.068147 D-W = 1.775

Note that these equations do not contain the Alberta and Rest of Canada unemployment rates as explanatory variables. When we attempted to use the unemployment rates as additional explanatory variables we found that neither the unemployment rates nor the natural resource revenues were statistically significant. In Migration we attached particular importance to the natural resource revenue differential and we decided to adopt the above-quoted equations as our preferred ones. These were the interprovincial migration equations used in Migration and in the preceeding chapters of this study.

We have, however, also estimated interprovincial migration equations using the unemployment rates, but discarding the natural resource revenues as explanatory variables. These alternative migration equations are:

Name: Interprovincial Migration into Alberta
Mnemonic: MIGPIA
Period: 1961-79
Method: OLS

$$
\begin{aligned}
\ln(MIGPIA/POP15+R_{-1}) = & -11.0096 \\
& \quad (10.04) \\
& + 2.39921 \quad \ln(WRTA\$/WRTR\$) \\
& \quad (5.38) \\
& + 1.36802 \quad \ln(MFCAPUTC) \\
& \quad (5.10) \\
& - 0.154813 \quad \ln(URATEA) \\
& \quad (2.50) \\
& + 0.236548 \quad \ln(URATER) \\
& \quad (2.36)
\end{aligned}
$$

$\bar{R}^2 = 0.910$ S.E.E. = 0.0430 D-W = 1.850

Name: Interprovincial Migration from Alberta
Mnemonic: MIGPOA
Period: 1961-79
Method: OLS

$$
\begin{aligned}
\ln(MIGPIA/POP15+A_{-1}) = & - 7.05862 \\
& \quad (3.79) \\
& - 0.291630 \quad \ln(WRTA\$/WRTR\$) \\
& \quad (0.39) \\
& + 0.850147 \quad \ln(MFCAPUTC) \\
& \quad (1.87) \\
& + 0.120809 \quad \ln(URATEA) \\
& \quad (1.15) \\
& - 0.233041 \quad \ln(URATER) \\
& \quad (1.37)
\end{aligned}
$$

$\bar{R}^2 = 0.516$ S.E.E. = 0.0730 D-W = 1.570

Comparing these two equations with the ones used in Migration we find that there is little to chose between them, as far as economic reasoning and single equation fit is concerned.

We have repeated our base case simulations, with the only difference that we applied the alternative migration equations in the 1980-2000 period.

c) Results

Chart 6-4 indicates that projected interprovincial migration is substantially lower if we assume that provincial natural resource revenues do not have any influence on migration, but the unemployment rates do have an influence. The extent of the influence is summarized in Table 6-1.

It is not surprising that the reduction in net migration relative to the base case is bigger in the case of less flexible wages (Migunem.Inflex vs. Base.Inflex) than in the case of flexible wages (Migunem.Flex vs. Base.Flex). Less flexible wages result in higher unemployment (Chart 6-3) and it is exactly the effect of unemployment on migration that characterizes the simulations of this chapter. By the end of the 1990s Alberta's unemployment rate is about half a percentage point below the base case in the less flexible wages simulation. In the flexible wages case the unemployment rate of the simulation and of its base case converge.

The lower unemployment of simulations Migunem.Inflex and Migunem.Flex leads to higher current and constant dollar wages (Chart 6-2) and the combination of lower labour force and of lower competitiveness to lowered output (Chart 6-1). As expected, the reduction of real provincial product is bigger in the case of less flexible wages (Migunem.Inflex) than in the case of flexible ones (Migunem.Flex) (Table 6-2).

This set of simulations yields interesting results. In case it is the relative severity of the unemployment rate, not the relative abundance of provincial natural resource revenues, which influences migration, then there will be less migration to Alberta and the province's real product will be lower, but real labour income per employed person (and per capita fiscal benefit) will be higher.

Table 6-1

Net Migration into Alberta, 1980-2000
(Thousand Persons)

	Base Cases		Migunem	
	Wages flexible	Less flexible	Wages flexible	Less flexible
Total Net Immigration	410	497	320	356
Total Net Outmigration	327	121	286	144
Total Net Migration	83	367	34	212

Table 6-2

Percentage Difference in Selected Economic Variables in the Year 2000, Alberta

	Flexible Wages	Less Flexible Wages
	Migunem - Base Case	Migunem - Base Case
Population aged 15+	-3.7	-6.3
Labour Force	-2.0	-5.8
Real provincial Product	-1.4	-5.7

CHART 6-1
REAL PROVINCIAL PRODUCT, ALBERTA
(BILLION 1971$)

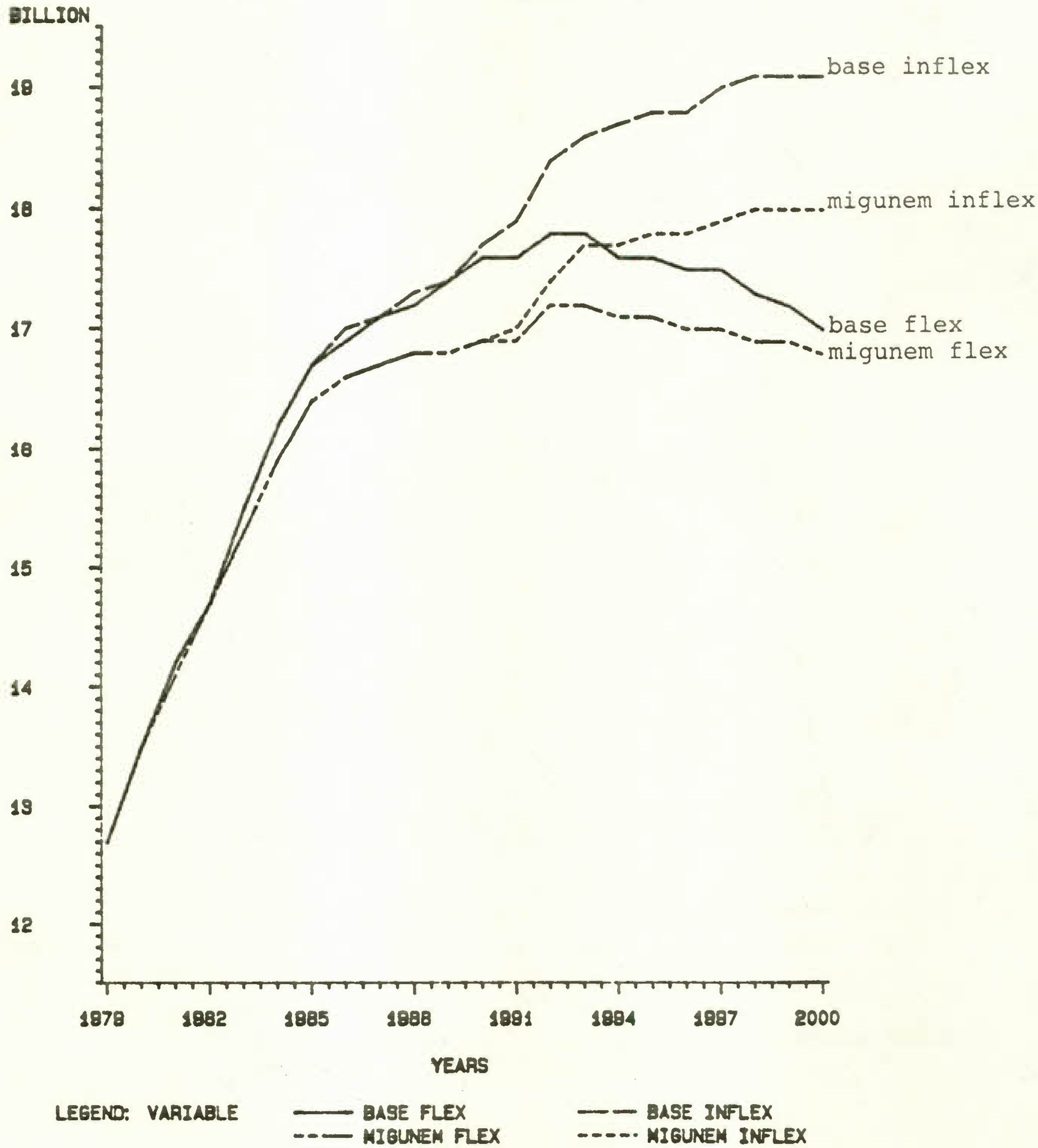


CHART 6-2
UNEMPLOYMENT RATE, ALBERTA
(PERCENT)

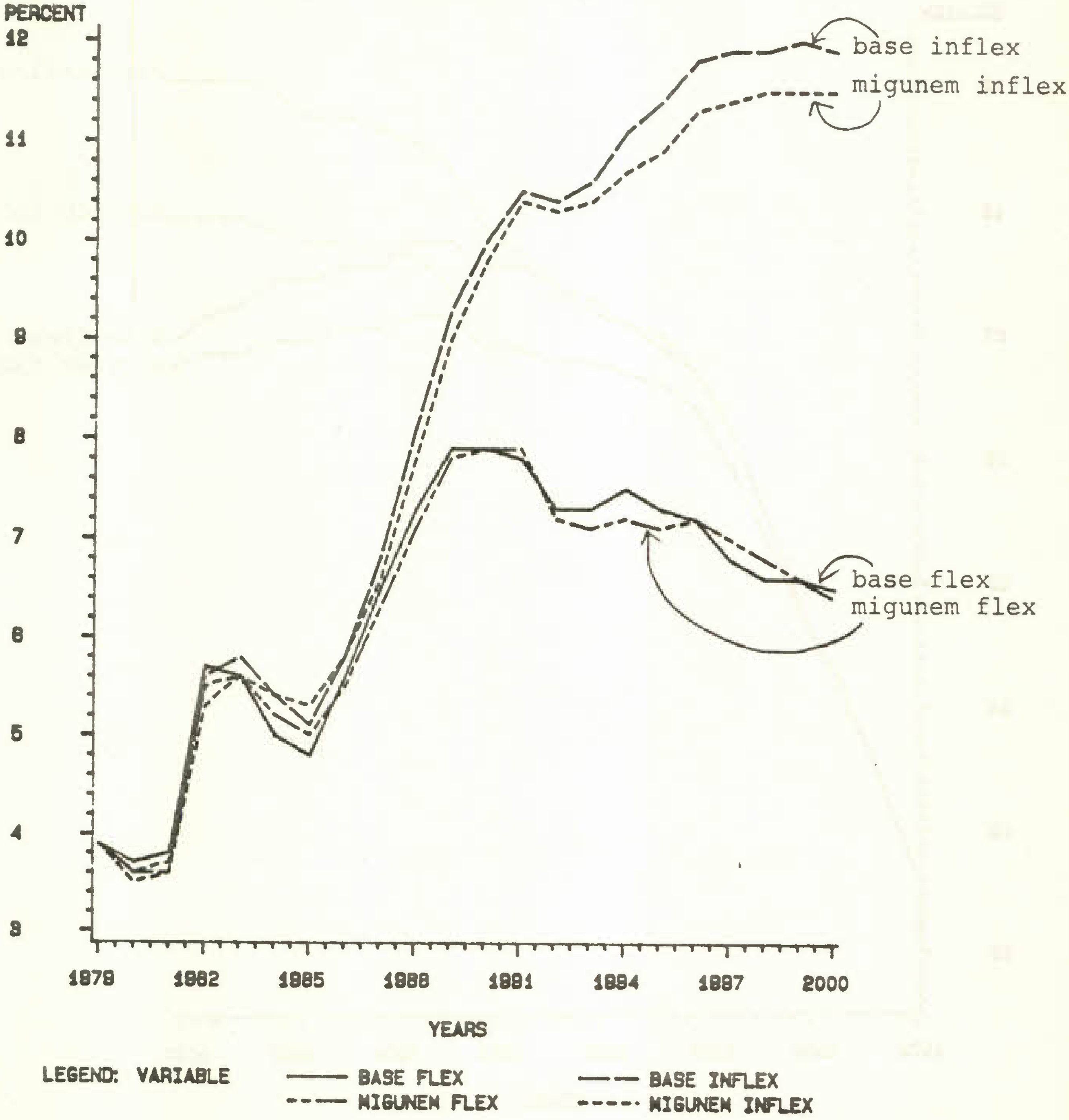


CHART 6-3
REAL LABOUR INCOME PER EMPLOYED PERSON, ALBERTA
(THOUSAND 1971$)

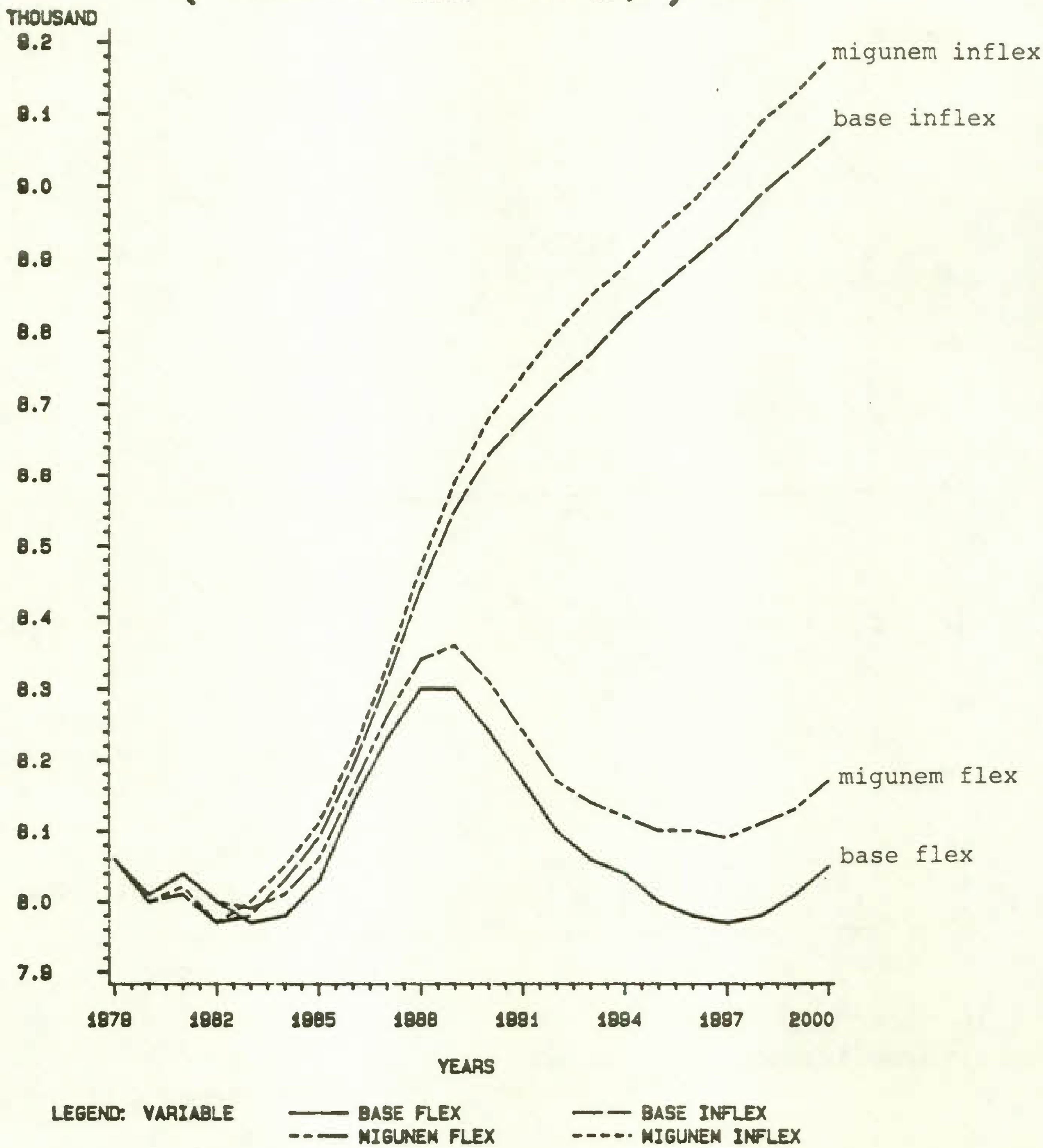
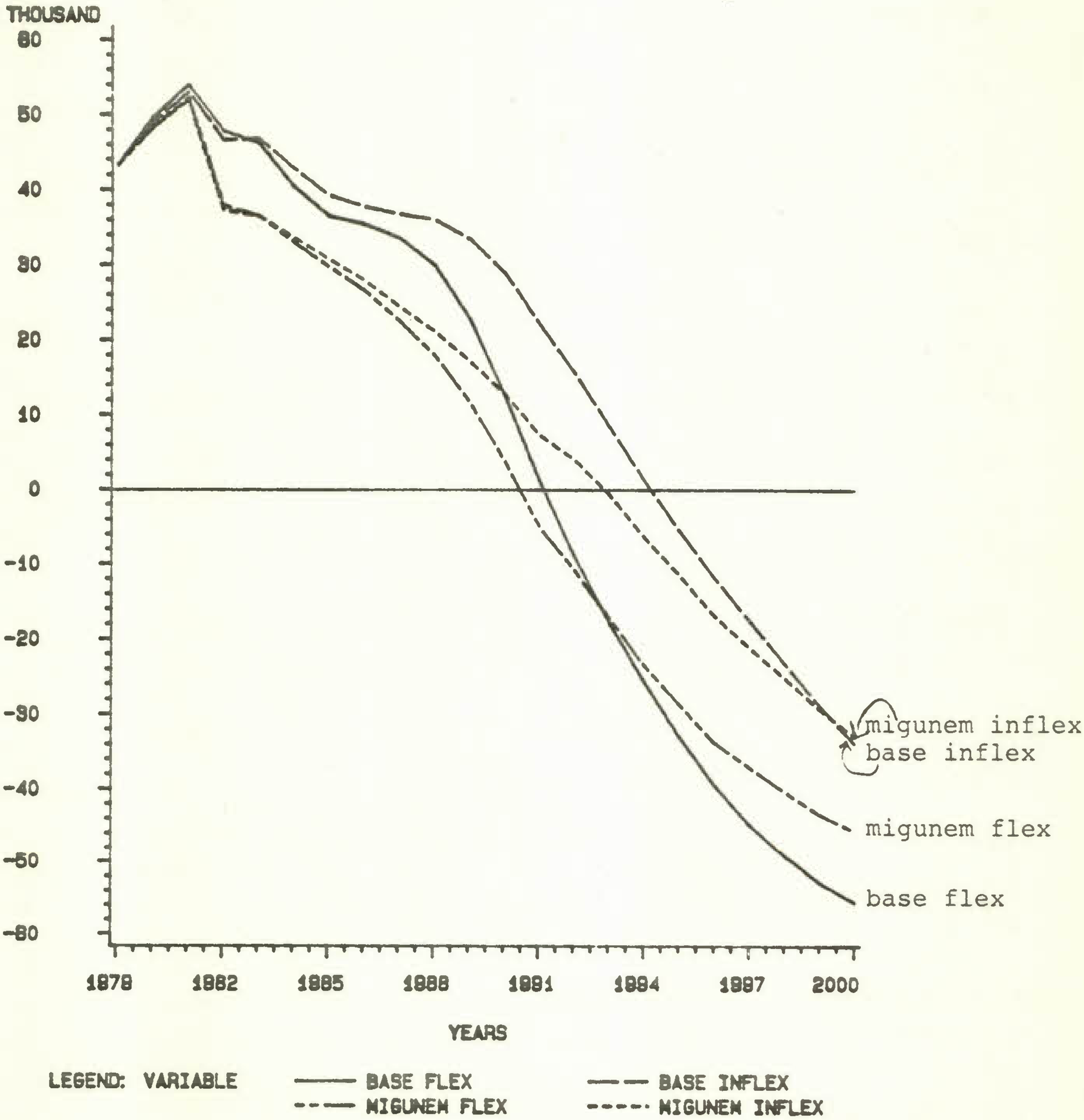


CHART 6-4
NET MIGRATION INTO, ALBERTA
(THOUSAND PERSONS)



Chapter 7

SUMMARY AND CONCLUSIONS

We have performed a series of simulations with a model of the Alberta economy. We found that the results are very sensitive to assumptions regarding future oil and gas output. We have used two sets of such assumptions: a base case and an optimistic one.

a) Oil

a.1) base case: this was based on the National Energy Board [1981] modified base case projection, but without additional oil sand plants. Oil production declines from 1064 million $(1971) in 1980 to 527 million $(1971) in 2000, i.e., by about 50 per cent.

a.2) optimistic: two more Syncrude-size oil sand plants are built; the existing Syncrude plant's production is increased by 50 per cent; substantial additional reserves are found. In consequence, oil production declines much less, to 958 million $(1971), i.e., by 10 per cent. (Chart 2-1)

b) Natural Gas

b.1) base case: this was based on the National Energy Board [1981] supply tracking. Production increases from 494 million $(1971) in 1980 to 677 million $(1971) in 1988, then declines to 428 million $(1971) in 2000.

b.2) optimistic: substantial additional reserves are found; Canada pursues an energetic export policy. Production increases to 764 million $(1971) in 1991 and remains at that level until 2000. (Chart 8-2)

Throughout Migration and this paper we performed simulations with two kinds of wage behaviour: in one wages are sensitive to the unemployment rate (wages flexible), in the other wages are less sensitive to the unemployment rate (wages less flexible).

Conclusions

In order to help the evaluation of our base case and optimistic projections we shall compare them with the sample period (1961-1979) performance of the Alberta economy and with the sample period and assumed projection period performance of the Rest of Canada. The latter is based on the CANDIDE projection FCST.27.CNTL.

1.a) during our sample period (1961-1979) the Alberta real provincial product grew at an annual compound rate of 6.6 per cent. Over the 1979-2000 period, in our optimistic projections it grows by 2.7-3.0 per cent, in our base cases by 1.4-2.0 per cent. The real provincial product of the Rest of Canada grew during the sample period at a 4.8 per cent rate and is assumed to grow at a 2.8 per cent rate during the projection period. Thus we project that under our optimistic assumption Alberta's economy would grow roughly at a similar rate as that of the Rest of Canada, even though slower than during the boom period of 1961-1979.

1.b) during the sample period the Alberta real labour income per employed person grew at an annual compound rate of 3.0 per cent. In our optimistic projection it grows by 0.6-1.0 per cent, in our base cases by 0-0.6 per cent. Real labour income per employed person in the Rest of Canada grew at a 2.3 per cent rate in the sample period and is assumed to grow at a 0.9 per cent rate during the projection period. Here again we project that the Alberta optimistic projection growth is similar to that of the Rest of Canada, but lower than that of the province's growth in the 1961-1979 period.

1.c) during the sample period Alberta's unemployment rate was consistently below that of the national average. With flexible wages it will move to the national average, with less flexible wages it will rise above it.

At this point a caveat is indicated. In our simulations the respective base case and optimistic scenarios differ only because of different assumptions regarding hydrocarbon production and because of the induced effects of the difference in such production. Otherwise the projections reflect the economic relationships and trends of the sample period. It is conceivable that Alberta will experience certain favourable exogenous or structural changes not reflected in our model and our assumptions.

For instance the quality of the labour force may improve faster than in the past, the tourist trade may grow faster, agriculture may become more competitive, the abundance of water resources may bestow additional competitive advantage. Other possible sources of strength are faster growth of the service industries than in the past (including the servicing of the oil and gas industry in the Artic), and of forestry output. Such developments, combined with the optimistic oil and gas scenario may lead to a future Alberta economic growth rate superior to that of the Rest of Canada. However, the present study does not deal with such additional assumptions.

Alberta's economy may grow faster than in our projections for another reason. One of our basic assumptions was that the economy of the rest of Canada would grow at an annual average rate of 2.9 per cent. This is not unreasonable when we recall that the labour force source population growth will slow down as the "low fertility generation" follows the "baby boom generation" into the labour force. Should, however, the performance of the rest of Canada surpass our expectations, then Alberta's growth rate may also be higher than that of our projections.

2) Across the board subsidization of manufacturing will not add much to Alberta's growth. Even if thirty per cent of the province's natural resource revenues is spent on subsidization it increases the growth rate of the real provincial product by less than one tenth of one per cent per annum. It causes slight

reduction in unemployment, compared to the base cases. The small improvement in real labour income per employed person is more than outweighed by the lower fiscal benefit per person available after 30 per cent of provincial resource revenue is spent on the manufacturing subsidy.

3) In the base case the world oil price increases two per cent faster than inflation. For each one per cent additional oil price inflation throughout the projection period, the Alberta real provincial product would be about 2.3 per cent higher in 2000. Similarly for each per cent less oil price inflation the Alberta real provincial product would be 2.3 per cent lower.

4) It makes a big difference whether wages are flexible (grow relatively slowly under high unemployment) or are less flexible (continue to grow relatively fast under high unemployment). In all our simulations flexible wages result in lower real labour income per employed person, lower immigration, lower real provincial product, but also in lower unemployment and higher fiscal benefit per person.

5) In most of our simulations we assumed that interprovincial migration is a function of three variables: the ratio a of the Alberta to rest of Canada labour income per person, the ratio of Alberta to rest of Canada provincial government natural resource revenues per person aged 15 and over, and of national economic

activity as proxied by the Canadian manufacturing capacity utilization rate. We found that the elasticity of migration with respect to the labour income ratio was much higher than the elasticity with respect to the resource revenue ratio (i.e., migrants attach more importance to the former than to the latter) (Appendix B, p. 132).

If we assume that migrants attach equal importance to both variables (Chapter 3 of the present paper) then migration to Alberta is higher, real provincial product in 2000 is about 8-9 per cent higher than in the base case solutions, but real labour income per employed person is some 4 per cent lower.

6) If migration is not influenced by the resource revenue ratio, but is influenced by the unemployment rate in Alberta and in the rest of Canada, then migration to Alberta will be substantially lower (Chapter 6). Real provincial product in 2000 was 3-7 per cent lower than in the base cases and real labour income per employed person is 1.2-1.5 per cent higher. These simulations indicate that migration to Alberta is an engine of growth to the provincial economy, but results in a lower real labour income per employed person.

Appendix A

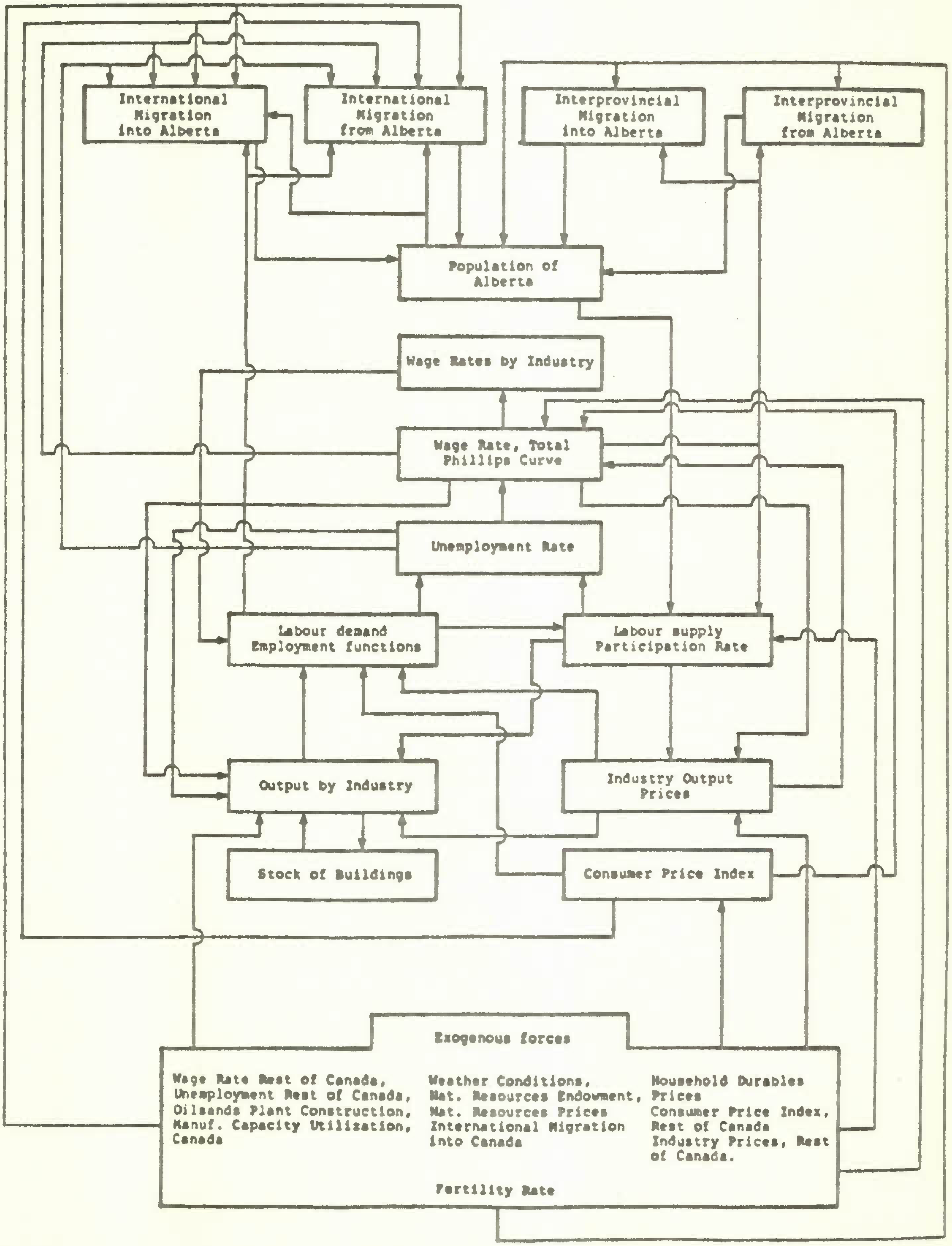
OUTLINE OF THE THEORY AND STRUCTURE OF THE MODEL

In order to investigate some long-term problems of the Alberta economy we have constructed a small neo-classical model of Alberta. We can subdivide it into five sectors: 1) Output, 2) Prices, 3) Labour Demand and Supply, 4) Wages and 5) Migration and Population. We have disaggregated Alberta's economy into five industries, namely Mining (M), Other Primary (OP) (in the case of Alberta this consists predominantly of Agriculture, because Fishing and Forestry are comparatively small), Construction (C), Manufacturing (MF), and all other industries-designated as Services (S).

The output and price equations are based largely on long-run supply and demand considerations in the respective markets. The employment equations are inverted C.E.S. production functions under profit maximization. The labour supply equation incorporates short- and long term forces. In the short run, the aggregate labour force participation rate is influenced by cyclical forces. In the long run the participation tends to rise because the increase of the wage rate relative to the price of household durables induces women to substitute work in the market economy for household work.

Chart A-1

Flow Chart of the Alberta Migration Model



Labour supply minus demand determines unemployment. Excess labour demand and prices determine wages via the Phillips curve. The Alberta-Rest of Canada wage ratio and the per capita Alberta-Rest of Canada government natural resource revenues are the main moving forces of migration, following the conclusions of Chapter 2 of Migration.

1) Real Output or Production (X) plays a crucial role in the model because labour demand is derived from it. For mining we have left output exogenous, because events outside Canada's borders and domestic political forces (federal and provincial) have an overwhelmingly strong influence on production. For construction we have used an approach pioneered by Jorgensen. For all other industries we have developed semi-reduced form equations based on applying conventional long-run supply-demand analysis to the industry in quesiton. It will simplify the industry by industry presentation below if we begin here with a general exposition of how this supply-demand analysis can be used to derive a semi-reduced form equation applicable to ouput of the three industries other than mining and construction.

Demand for the output of the i'th of these industries can in general (exceptions noted below) be taken as a (positive) function of aggregate Alberta income (X) and a (negative) function of the price of its output (PX_i) relative to the price of all competing products (PNX_i).

$$(A\text{-}1) \quad X_i^D = aX^b \left(\frac{PX_i}{PNX_i} \right)^c$$

On the supply side, supply by an individual establishment in the industry ($\hat{X}_i^s$) is a (positive) function of profitability, proxied by the ratio of output price (PX_i) relative to the wage rate (WRT\$):

$$(A\text{-}2) \quad \hat{X}_i^s = d \left(\frac{PX_i}{WRT\$} \right)^e$$

If we wish to extend this argument from the establishment to the (provincial) economy as a whole, we must explain the number of establishments in each industry. At our level of aggregation we cannot suppose, for a given labour force, that the supply of establishments is infinitely elastic at minimum average cost, as is expected in standard micro-theory of an industry. Industry supply, designated X_i^s, will be the product of $\hat{X}_i^s$ by the number of establishments. We shall assume that the number of establishments will depend on the number of persons with managerial talent, which in turn is assumed to be proportional to the size of the labour force (LF). Using this assumption and the equation (4-2) for $\hat{X}_i^s$, and defining a new constant d', we obtain

$$(A\text{-}3) \quad X_i^S = d' \left(\frac{PX_i}{WRT\$} \right)^e LF$$

We can now solve (A-3) for PX_i, substitute the result into (A-1), assume that in equilibrium $X_i^D = X_i^S$ and so obtain the equilibrium output of the industry as

$$(A\text{-}4) \quad X_i^* = a^{\frac{e}{e-c}} \, d'^{\frac{-c}{e-c}} \, X^{\frac{be}{e-c}} \, LF^{-\frac{c}{e-c}} \left(\frac{PNX_i}{WRT\$} \right)^{-\frac{ec}{e-c}}$$

or

$$(A\text{-}4a) \quad \left(\frac{X_i}{LF} \right)^* = a^{\frac{e}{e-c}} \, d'^{-\frac{c}{e-c}} \, X^{\frac{be}{e-c}} \, LF^{-\frac{e}{e-c}} \left(\frac{PNX_i}{WRT\$} \right)^{-\frac{ec}{e-c}}$$

or

$$(A\text{-}4b) \quad \left(\frac{X_i}{LF} \right)^* = \alpha \, X^\beta \, LF^\gamma \left(\frac{PNX_i}{WRT\$} \right)^\delta$$

Estimating an equation of the type (A-4b) is in practice very difficult, because total output (X) and the labour force (LF) are highly collinear. If we assume, however, that b does not differ much from unity, (i.e., $\beta \approx -\gamma$), then

$$(A\text{-}5) \quad \left(\frac{X_i}{LF} \right)^* = \alpha' \left(\frac{X}{LF} \right)^{\beta'} \left(\frac{PNX_i}{WRT\$} \right)^{\gamma'}$$

β' and γ' are expected to be positive. Equation (A-5) is in effect a kind of semi-reduced form.

The economy is, of course, never in equilibrium, so we assume that observed scaled output $\left(\frac{X_i}{LF}\right)$ approaches its equilibrium value $\left(\frac{X_i}{LF}\right)^*$ with a lag. One plausible assumption is that $\left(\frac{X_i}{LF}\right)$ approaches $\left(\frac{X_i}{LF}\right)^*$ by the usual partial adjustment of any variable Z to its equilibrium value Z^* with $Z = Z_{-1} + \lambda\,(Z^* - Z_{-1}) = \lambda\,Z^* + (1-\lambda)\,Z_{-1}$, where $0 < \lambda < 1$.

This formulation, applied to equation (A-5), yields

$$\text{(A-5a)}\quad \ln\left(\frac{X_i}{LF}\right) = \alpha'' + \beta''\ln\left(\frac{X}{LF}\right) + \gamma''\ln\left(\frac{PNX_i}{WRT\$}\right) + \delta\ln\left(\frac{X_i}{LF}\right)_{-1}$$

In dynamic simulations the use of the lagged dependent variable frequently leads to troublesome error accumulation, therefore we often employed an alternative specification of omitting the lagged dependent variable and using Almon-type lags on the right hand side variables of (A-5):

$$\text{(A-5b)}\quad \ln\left(\frac{X_i}{LF}\right) = \alpha'' + \sum_{o}^{r}\beta''_n \ln\left(\frac{X}{LF}\right)_{t-n} + \sum_{o}^{s}\gamma''\ln\left(\frac{PNX_i}{WRT\$}\right)_{t-m} \qquad \begin{matrix} n=o\ldots r \\ m=o\ldots s \end{matrix}$$

where the expected signs of $\Sigma\ \beta''$ and of $\Sigma\ \gamma''$ are positive. Also, in the course of our estimation we used the labour force of the preceding year (LF_{-1}) as the scaling factor instead of LF, in order to reduce the simultaneity of our system. This change does not impair the logic of the preceding argument, and helps to reduce the computer iterations per time period by accelerating the convergence of the model.

Let us now consider in turn the equations for output in each of our five industries.

Mining output (XMA) is assumed to be exogenous. As noted, this is because international political developments, domestic regulation, and export licensing have very strong effects on production.

Output of Other Primary Industries (XOPA) consists mainly of agricultural output. The general analysis described above applies, with one important exception. We suppose that demand is completely elastic at the Rest of Canada (ROC) price. On the supply side the general analysis hold. On a practical point regarding industry price, we note that the price data of the disaggregated components of Other Primary Industries are identical for Alberta and ROC [Conference Board, 1980], so any difference in the aggregate Other Primary Industries price between

Alberta and ROC arises from differences in the composition of output. The appropriate price for this equation is, therefore, the Alberta price PXOPA (which is the ROC price adjusted for the Alberta product mix).

Bearing all of the above in mind, we obtain;

$$\text{(A-6)} \quad \ln \left(\frac{XOPA}{LFA_{-1}} \right)^{*} = \alpha + \beta \ln \left(\frac{PXOPA}{WRTA\$} \right)_{-1}$$

where the asterik indicates equilibrium output. Actual output is assumed to approach equilibrium by the usual partial adjustment, yielding the equation

$$\text{(A-7)} \quad \ln \frac{XOPA}{LFA_{-1}} = \alpha\ \lambda + \beta\ \lambda \ln \left(\frac{PXOPA}{WRTA\$} \right)_{-1} + (1-\lambda) \ln \frac{XOPA_{-1}}{LFA_{-2}}$$

β and λ are expected to be positive and λ less than unity.

The output of the Construction Industry (XCA) is modelled using an approach due to Jorgensen. The industry produces additions to building capital stock, and also replacement for worn-out building stock. Thus XCA is the real value added by the construction industry to gross building capital formation. The theory we follow below applies to net demand, so that XCA cannot be our dependent variable directly. Instead, an appropriate dependent variable incorporating XCA as part of its definition is estimated as follows: Examining the constant (1971) dollar historical data over the 1961-1979 period we find that capital consumption allowances amounted, on the average, to about 3.1 per cent of the net building capital stock at the end of the preceding year ($K1A_{-1}$). Also, real value added by the construction industry amounted to about 45 per cent of final demand construction capital formation. Therefore, real value added by the construction industry which was devoted to replacement of capital stock amounted to 1.4 per cent (0.45*0.031) of the capital stock. The appropriate dependent variable for <u>net</u> investment demand is the XCA devoted to net addition of construction stock, i.e., XCA - $0.014{*}K1A_{-1}$.

Following the Jorgensen neo-classical investment model (see e.g., White, D.A. 1974), desired investment demand under profit maximization can be modelled as

$$\text{(A-8)} \quad (XCA - 0.014K1A_{-1})^{*} = \alpha \left[\left(\frac{PQ}{C}\right)_t - \left(\frac{PQ}{C}\right)_{t-1} \right]$$

where Q stands for real provincial product, P for the provincial implicit deflator and C for the user cost of capital.

As pointed out by White: "not all of the increased capital stock can be put into place immediately. For technical, institutional and economic reasons, changing the volume of capital stock takes time. In any period, the part of current investment that represents a change in the stock of capital is a sum of the effects of desired changes in the current period and in a number of earlier periods."

$$(A\text{-}9)\quad XCA - 0.014{*}K1A_{-1} = \sum_{0}^{n} \alpha_i \left[\left(\frac{PQ}{C}\right)_{t-i} - \left(\frac{PQ}{C}\right)_{t-i-1}\right] \quad i=0...n$$

In our specification Q was replaced by real provincial product excluding construction, P by the corresponding deflator. We also made the strong assumption that the deflator of value added in construction (PXCA) was an adequate proxy for the user cost of capital C. $\Sigma\, \alpha_i$ is expected to be positive.

Manufacturing output in Alberta (XMFA) can be regarded as consisting of two parts: products which are not traded with the rest of Canada, like bread, beer, local newspapers, etc., and traded manufactured goods.

We have data only on manufacturing as a whole, not on traded manufactured goods separately. If we had data on nontraded manufactured goods, equations (A-1) to (A-5b) would apply. The price term corresponding to PNX_i in these equations would have to be the implicit price index of all those goods and services which are competing with Alberta manufactured goods for the Albertans' income. These competing goods have two components: Albertan non-manufacturing output, and imports of goods and services into Alberta. Therefore, the appropriate price concept corresponding to PNX_i in equations (A-5a) or (A-5b) is a weighted average of Alberta's non-manufacturing industries' deflator and of the goods component of the Canadian Consumer Price Index. We have designated this weighted average as PXNMFTA. Thus, if the Alberta manufacturing output did consist only of nontradables, the appropriate specification would be analogous to equation (A-5), and, using lagged labour force as the scaling factor and designating Alberta's total real output as XA, we should estimate

$$\text{(A-10a)} \quad \left(\frac{XMFA}{LFA_{-1}}\right)^{*}_{UNTRADED} = \alpha \left(\frac{XA}{LFA_{-1}}\right)^{\beta} \left(\frac{PXNMFTA}{WRTA\$}\right)^{\gamma}$$

with β and γ expected to be positive.

However, we have data only on manufacturing as a whole, not on traded and untraded manufactured goods separately. This introduces a complication.

It can be argued that under simple but plausible assumptions the output of tradeable manufactures is a (negative) function of the stock of natural resources per member of the labour force and a (positive) function of the price of manufactured goods relative to the price of resources. Suppose this to be so, and assume that Alberta was originally endowed with a stock S of non-renewable resources. The cumulative output of the mining industry ($\sum_{t=-1}^{-\infty} XMA$)

can be regarded as an acceptable proxy for the using-up of non-renewable resources. Then $S/[\sum_{t=-1}^{-\infty} XMA)*LFA]$ will be an acceptable proxy for the remaining non-renewable resource stock per member of the labour force. Defining PXRESA as the appropriately weighted price of the mining and other primary industry sectors, PXMFA/PXRESA is the relative price of manufacturers to resources output.

For traded manufactured goods we should therefore estimate

$$\text{(A-10b)} \quad \left(\frac{XMFA}{LFA_{-1}}\right)^{*}_{\text{TRADED}} = \alpha' \left(\frac{S}{(\sum_{t-1}^{-\infty} XMA_t)*LFA_{-1}}\right)^{\delta} \left(\frac{PXNMFTA}{PXRESA}\right)^{\eta}$$

Adding (4-10a) and (4-10b) and assuming that a logarithmic specification is an adequate approximation, we obtain

$$\text{(A-11)} \quad \ln\left(\frac{XMFA}{LFA_{-1}}\right)^{*} = \alpha'' + \beta'\ln\left(\frac{XA}{LFA_{-1}}\right) + \gamma'\ln\left(\frac{PXNMFTA}{WRTA\$}\right) + \delta'\ln\left(\frac{1.}{(\sum_{t-1}^{-\infty} XMA_t)*LFA_{-1}}\right) + \eta'\ln\left(\frac{PXMFA}{PXRESA}\right)$$

The $\delta'\ln S$ term is subsumed under the constant term α'. This is the specification we have fitted. β', γ' and η' are expected to be positive, δ' negative.

Once again, we shall assume that equilibrium will be approached by either a partial adjustment, reflected by a lagged dependent variable, or with an Almon-type specification of the right-hand side variables.

The output of Service Industries (XSA) consists essentially of non-tradeables, even though certain components like Finance, Insurance and Real Estate may be, to some extent, traded outside Alberta. In consequence the equation of this industry is analogous to that of the non-traded part of manufacturers (A-10a). PXNSTA is the service industry counterpart of PXNMFTA of (A-10a) and the discussion of that concept on page 67 applies here with appropriate changes.

$$\text{(A-12)} \quad \ell n \left(\frac{XSA}{LFA_{-1}}\right)^{*} = \alpha + \beta \ell n \left(\frac{XA}{LFA_{-1}}\right) + \gamma \, \ell n \left(\frac{PXNSTA}{WRTA\$}\right)$$

Here again β and γ are expected to be positive.

Real Capital Stock, Construction (K1A)

This variable is used in the dependent variable in equation (A-9) industry output (XCA), therefore it is necessary to estimate the stock.

By definition, the end-of-year capital stock of year n equals the end of year capital stock of year n-1 plus gross investment

(ICA) in year n minus depreciation (DEPRCA) of the stock during year n. Observe that in this identity gross investment is a final demand component. It includes not only the value added by the construction industry, but also all the intermediate inputs which enter a finished building.

(A-13) $K1A \equiv K1A_{-1} + ICA - DEPRCA$

In our model we do not use the concept of final demand investment. Instead we assume that investment is a constant (estimated) multiple of value added of the construction industry (XCA). Nor do we calculate depreciation directly, but assume that it is a constant (estimated) fraction of the previous year's capital stock. This leads to the estimating equation

(A-14) $K1A = K1A_{-1} + \alpha * XCA + \beta * K1A_{-1}$

Total real provincial product (XA) is by definition the sum of the five industry products and of a small (exogenous) adjusting entry (RPPADJA) which allows for minor inconsistencies in the statistical methods used by the Conference Board when estimating the total and the disaggregated output figures.

(A-15) $XA \equiv XMA + XOPA + XCA + XMFA + XSA + RPPADJA$

2) Consider now the derivation of equations to explain industry prices. Mining prices (PXA), like output, are taken as examples,

and for similar reasons. For other primary industries the price (PXOPA) is determined, as explained above, by industry price in the rest of Canada. Construction prices (PXCA), given our specificaiton at demand, must be regarded as the price at which the industry is willing to supply the output demand. We suppose that the Alberta wage rate would affect this price. While the output required should also, in principle, affect PXCA, the only variable resembling this that worked was a (scaled) dummy variable representing oil-sand plant construction. Thus we regressed

$$\text{(A-16)} \quad PXCA = \alpha(WRTA\$)^{\beta} \left(\frac{DTSPA}{LFA_{-1}}\right)^{\gamma}$$

For manufacturing prices (PXMFA) we do not have the actual Alberta price. It is not collected by any statistical agency. Thus the supply-demand theory developed above to help obtain a semi-reduced form for manufacturing output cannot legitimately be used for price. What we have for manufacturing prices is a weighted average of disaggregated national price indexes for two-digit industries [Conference Board, 1980, p. 23]. Thus the Alberta manufacturing price index differs from that of the ROC because of the differing output mix at the two-digit level. We have therefore estimated the aggregate Alberta manufacturing price equation as the function of the current and previous year's aggregate ROC manufacturing price.

The output of the service industry is assumed to consist entirely of non-tradeables.

In deriving an appropriate equation for PXSA we return to the supply and demand equations in the general industry case, (4-1) and (A-3).

These yield

$$\text{(A-17)}\quad PX^{*}_{i} = \left(\frac{a}{d'}\right)^{\frac{1}{e-c}} X^{\frac{b}{e-c}}\, LF^{-\frac{1}{e-c}}\, WRT\$^{\frac{e}{e-c}}\, PNX_{i}^{-\frac{c}{e-c}}$$

or

$$\text{(A-17a)}\quad PX^{*}_{i} = \alpha\, X^{\beta}\, LF^{-\gamma}\, WRT\$^{\delta}\, PXN_{i}^{\eta}$$

As in the case of equation (A-4b), leading to (A-5), we assumed that b does not differ much from unity, and therefore

$$\text{(A-18)}\quad PX^{*}_{i} = \alpha' \left(\frac{X}{LF}\right)^{\beta'} WRT\$^{\delta'}\, PNX_{i}^{\eta'}$$

where β', δ' and η' are expected to be positive.

The appropriate price is a weighted average of Alberta's non-service industries' deflator and of the goods component of the Canadian Consumer Price Index. We have designated this weighted average PXNSTA.

We apply this general result to the service sector, and as in the case of the output equations we use LFA_{-1} as the scaling factor, to obtain

$$\text{(A-19)}\quad PXSA^{*} = \alpha'' \left(\frac{XA}{LFA_{-1}}\right)^{\beta''} PXNSTA^{\gamma''}\, WRTA\$^{\delta''}$$

The industry-specific current dollar provincial products are obtained by multiplying their constant dollar outputs by the corresponding prices (i.e., $X_iA\$ = X_iA * PX_iA$). The deflator of the total provincial product is defined as the ratio of the total current over constant dollar provincial product.

$$\text{(A-20)}\quad PXA \equiv \frac{XMA\$ + XOPA\$ + XCA\$ + XMFA\$ + XSA\$}{XMA + XOPA + XCA + XMFA + XSA + RPPADJA}$$

The Consumer Price Index of Alberta can be assumed to consist of two major components, namely of goods (which are predominantly tradeables) and of services (which are essentially non-tradeables). The goods price component will be determined by the Canadian Consumer Price Index subcomponent for goods, suitably adjusted for the fact that Alberta has not provincial retail sales tax, while the rest of Canada does. We have designated this component as CPIGSTAC. The services price component is determined by the Services industry deflator of Alberta. The weights are those of goods and of services in the Canadian CPI. The series is scaled so as to agree with the Alberta CPI in 1971.

(A-21) CPIA = [0.6033 * CPIGSTAC + 0.3967 * PXSA] * 0.996477

3) Labour demand (E) is a derived demand, calculated separately for each of the five industries, using inverted C.E.S. production functions under profit maximization. Following Adams, F.C. et al [1975], the equations are:

$$\text{(A-22)} \quad \ell n\, E_i^* = \alpha + \beta\, \ell n\, X_i + \gamma\, \ell n\, (WR_i\$/PX_i) + \delta\, TIME \qquad i=1...5$$

where E* is equilibrium employment, X is real output, WR$ the wage rate, PX the price of output and TIME a linear time trend. The expected signs of the coefficients are positive for β, negative for γ and δ. For modelling the actual employment we applied the usual partial adjustment model or the Almon-lag technique.

Total employment (ETA) is the sum of the five industry employments:

$$\text{(A-23)} \quad ETA \equiv \sum_{i=1}^{5} E_iA$$

Labour supply is given by the product of labour force source population (POP15+) and the participation rate (PARTR). The participation rate displays two kinds of changes: short-term cyclical fluctuations and a long-term rising trend.

Differing hypotheses exist regarding the effects of business conditions on the participation rate [see e.g. S. Ostry and M.A. Zaidi, 1979, pp. 72-74, M. Gunderson, 1980, pp. 53-54, P.J. Kuch and S. Sharir, 1978, pp. 112-120]. One school of thought emphasizes that a high unemployment rate tends to discourage unemployed persons of labour force age from searching for work and results in their dropping out of the labour force (the "discouraged worker effect"). An alternative view propounds that if the chief breadwinner of a household loses his job, this will result in the other members of the household entering the labour force in order to attempt to make up for the income loss (the "additional worker effect"). The relative importance of these alternative hypotheses is an empirical question which we shall attempt to answer in the next chapter. The introduction of the unemployment rate or its counterpart, the employment rate, into the participation rate equation introduces an identification problem, which is discussed in Annex A-1 of this chapter.

Apart from the short-term fluctuations, the Alberta labour force participation rate has displayed a rising trend during the sixties and seventies. In this respect it resembles the participation rate of Canada as a whole, which shows the same tendency. As pointed out by Ostry and Zaidi [1979, p. 33], the main source of the nation-wide increase in the participation rate was the sharply rising female participation rate; the male participiption rate changed little.

Several plausible hypotheses can be made about the rising female participation rate. In particular, it has been pointed out long ago [Long, C.D., 1958, p. 123-133] that smaller families lead to less need for work in the home. The total fertility rate in Alberta has declined from 4.267 in 1961 to 1.972 in 1979. The number of births showed no rise at all during this period, even though Alberta's population about doubled. It follows that one of the important forces which was keeping women traditionally out of the labour force, namely giving birth and caring for young children in the home, was diminishing during the period under discussion.

An alternative hypothesis is based on the consideration that domestic appliances increase the productivity of the home-maker's activity. Since this idea, though rather obvious, does not appear to have been treated in the literature, an exposition of the theory behind it is given in Annex A-2. There it is shown that when the wage rate rises relative to the price of domestic appliances (WRTA$/PFCDH20), as it did during our sample period, women are more likely to substitute capital equipment (in the form of domestic appliances) for their labour at home. They obtain the equipment in part by using their labour in the market instead of the home.

Beside these two relatively easily quantifiable forces which are conducive to raising the female participation rate, there occurred during the sixties and seventies a whole host of changes in public mores and attitudes towards women in the labour force, which we cannot express in numerical terms but which can be proxied by a time trend. One of these changes was the effort on part of the various levels of government to reduce discrimination in the hiring, promotion and remuneration of women. The example set by the governments had also some spill-over effect into the private sector. Another relevant change was the substantial increase of single-earner families with female heads, due to the increase in divorces and separations.

Thus a reasonable specification of the Alberta participation rate (PARTRA) regresses it on (a suitable transformation described in Chapter 5 of) the wage rate relative to the price of domestic appliances (WRTA$/PFCDH20), on the weighted birth rates of the most recent five years (WBIRTHSRA), on the time trend (TIMEA) and on the employment rate (ETA/POP15+A). The coefficient of the employment rate cannot be estimated directly, for identification reasons, as explained in Annex A-1. The Annex also describes the correct way to obtain the coefficient, which then has been imposed on the following equation:

$$\text{(A-24)}\quad PARTRA - \beta(ETA/POP15{+}A) = \alpha + \gamma(WRTA\$/PFCDH20) + \delta(WBIRTHSRA) + \eta TIMEA$$

Labour demand and supply determine unemployment (UA) and <u>the unemployment rate</u> (URATEA)

$$(A\text{-}25)\quad URATEA \equiv \frac{LFA - ETA}{LFA}$$

4) The Alberta-wide wage rate (WRTA$) is calculated by the Phillips-curve specification i.e., the rate of change of wages is a function of excess labour demand and of price inflation. We used the reciprocal of the unemployment rate as indicator of excess labour demand. We assume that when striking the wage bargain, workers are thinking in terms of the consumer price index (CPIA), while employers are consider whether the price of output permits the wage increase. We constructed a "hybrid price" inflation rate ($\dot{PHPA}$) which is the arithmetic average of the inflation rate of the Consumer Price Index ($\dot{CPIA}$) and of the provincial output deflator ($\dot{PXA}$).

$$(A\text{-}26)\quad \dot{WRTA\$} = \alpha + \beta \left(\frac{1.0}{URATEA}\right) + \gamma\ \dot{PHPA}$$

The expected signs of β and γ are positive, with γ non-significantly different from unity.

The industry-specific wage-rates were originally assumed to be functions of the Alberta overall wage-rate and of indicators of industry-specific labour-market tightness, however no significant indicator of this sort was found. Finally we reluctantly specified the ratio of the industry specific wage rate ($WR_{iA\$}$)

and the Alberta-wide wage rate (WRTA$) as a function of its own lagged value.

$$\text{(A-27)} \quad \frac{WR_iA\$}{WRTA\$} = \alpha \left(\frac{WR_iA\$}{WRTA\$}\right)_{-1}^{\beta}$$

We employed the Zellner seemingly unrelated regression technique under the restriction that the sum of the wage bills of the five industries equal the total Alberta wage bill, i.e.

$$\text{(A-28)} \quad WRTA\$*ETA \equiv \sum_{i=1}^{5} (WR_iA\$*E_iA)$$

The restriction implies that one equation in the estimation process has to be suppressed. In this instance we suppressed the wage equation for services. The services industry is by a wide margin the biggest industry in our five-industry disaggregation; it accounts for approximately sixty per cent of total provincial product. We judged that it would cause relatively the least trouble if we let it absorb the errors and shortcomings of our wages sector.

5) The literature review of Migration Chapter 2 suggests that it is advisable to disaggregate total net migration to Alberta (MIGTNA) into four gross movements

1) International migration into Alberta (MIGFIA)

2) International migration from Alberta (MIGFOA)

3) Interprovincial migration into Alberta (MIGPIA)

4) Interprovincial migration from Alberta (MIGPOA)

Total international migration into and out of Canada is assumed to be exogenous. We have attempted to model Alberta's share of these two migration streams.

As a starting point it may be convenient to assume, that *ceteris paribus* international migrants would settle in Alberta and in the Rest of Canada in the same proportions as the total population of the two areas in the previous year.

$$\text{(A-29)} \quad \frac{MIGFIA}{MIGTIC-MIGFIA} = \frac{POP15{+}A}{POP15{+}R}_{-1}$$

where MIGTIC is total gross international migration into Canada.

A plausible improvement on (A-29) might be the hypothesis that the ratio would be modified by the wage ratio of the two receiving areas:

$$\text{(A-30)} \quad \frac{(MIGFIA/POP15{+}A_{-1})}{[(MIGTIC-MIGFIA)/POP15{+}R_{-1}]} = \alpha \left(\frac{WRTA\$}{WRTR\$}\right)^{\beta}$$

Here the actual wage ratios would act as proxies for expected incomes.

Following Todaro, we might further improve the expected wage concept by multiplying the actual wage by the probability of obtaining a job. A simple but convenient way to proxy such a concept is to multiply the prevailing wage rate by the employment rate. If we denote the left-hand side of equation (A-30) as RMIGFIAPC1, this would lead to

$$\text{(A-31)}\quad RMIGFIAPC1 = \alpha_1 \left(\frac{WRTA\$\ (1-URATEA)}{WRTR\$\ (1-URATER)}\right)^{\beta_1}$$

If we further assume that it is the expected <u>real</u> wage rate ratio that influences migration, then (4-31) would change to

$$\text{(A-32)}\quad RMIGFIAPC1 = \alpha_2 \left(\frac{WRTA\$\ (1-URATEA)/CPIA}{WRTR\$\ (1-URATER)/CPIR}\right)^{\beta_2}$$

Some experts on migration maintain that expected real income is the single most important economic force influencing migration, while others are of the opinion that job opportunities play an equally or more important role. We might attempt to proxy job availabilities by the growth of non-agriculture employment in Alberta (ENOPA) and in the rest of Canada (ENOPR), where ENOPA is defind as total employment in Alberta (ETA) minus employment in other primary industries (EOPA) ENOPR is defined correspondingly. This would yield

$$\text{(A-33) RMIGFIAPC1} = \alpha_3 \left(\frac{\text{WRTA\$ (1-URATEA)/CPIA}}{\text{WRTR\$ (1-URATER)/CPIR}}\right)^{\beta_3} \left(\frac{\text{ENOPA/ENOPA}_{-1}}{\text{ENOPR/ENOPR}_{-1}}\right)^{\gamma_3}$$

Returning now to equation (A-30) we should consider that the economic attractiveness of a region does not consist solely of a high wage rate prevailing there. The Alberta government receives much more revenue from the area's natural resources than do the provincial governments of the rest of Canada from theirs. Migrants may not know in what form and at what time these government natural resource revenues will be transferred to the residents of each area; nevertheless the mere existence of such revenues (GRNRA$) may influence their location decision. This hypothesis would lead to the specification

$$\text{(A-34) RMIGFIAPC1} = \alpha_4 \left(\frac{\text{WRTA\$} + (\text{GRNRA\$/(POP15+A)}_{-1})\theta}{\text{WRTR\$} + (\text{GRNRR\$/(POP15+R)}_{-1})\theta}\right)^{\beta_4}$$

which can be conveniently approximated by

$$\text{(A-34a) RMIGFIAPC1} = \alpha_5 \left(\frac{\text{WRTA\$}}{\text{WRTR\$}}\right)^{\beta_5} \left(\frac{\text{(GRNRA\$/(POP15+A)}_{-1}}{\text{(GRNRR\$/(POP15+R)}_{-1}}\right)^{\delta_5}$$

Such a specification would assume that migrants are indifferent about the form and timing of natural resource revenue disbursments.

Alternatively we might assume that this is not so, but that different uses of the provincial natural resource revenues could have differing effects on migration and try to model this in more detail. First of all, in the case of Alberta we know that these revenues enabled the provincial government to avoid imposing a provincial retail sales tax - Alberta is the only province without such a tax. The consumer Price Index includes the provincial sales tax; thus Alberta's price index is lower than it would be in the presence of such a tax.

Second, Alberta's natural resource revenue enables the province to keep its personal income tax rates lower than it would be in the absence of oil and gas revenues. Having calculated the marginal income tax rate at median taxable income (ITRA), we might expand equation (A-30) by using the real disposable income ratio.

$$\text{(A-35) } RMIGFIAPC1 = \alpha_6 \left(\frac{WRTA\$ \ (1-ITRA)/CPIA}{WRTR\$ \ (1-ITRR)/CPIR} \right)^{\delta_6}$$

Third, if we assume that the size and pattern of government expenditure expresses the preference of the electorate, per capita government expenditure may also attract migrants by providing better administration, education, health services, crime prevention etc. This could be proxied by per capita provincial, local and hospital government expenditures excluding interest payments (PLHEXIA\$). If we designated the right-hand term of (A-35) as RDWR, introduction of this variable would lead to

$$\text{(A-36) RMIGFIAPC1} = \alpha_7(\text{RDWR})^{\beta_7}\left(\frac{\text{PLHEXIA\$/(POP15+A)}_{-1}}{\text{PLHEXIR\$/(POP15+R)}_{-1}}\right)^{\eta_7}$$

This specification would assume that migrants are not influenced by the unspent part of the natural resource revenues. Equation (A-36) can be further expanded by assuming a reasonable real return of say, two per cent on the assets of the Alberta Heritage Fund and adding the per capita share of this return to WRTA\$.

The possible specifications of Alberta's share of gross international out-migration from Canada (RMIGFOAPC1) are analogous to those of the in-migration. Of course in the case of in-migration the expected signs of β, γ, δ and η are positive, while in the case of out-migration we expect negative signs.

After considerable experimentation with the various income concepts of equations (A-30) to (A-36), we chose (A-33) as our preferred specification.

We also experimented with specifications (A-30) to (A-36) in the cases of gross interprovincial migration to and from Alberta (MIGPIA and MIGPOA respectively). With this modification the migration streams are standardized by the (lagged) population of the area of origin. The left hand side variables are, therefore, $MIGPIA(POP15+R)_{-1}$ and MIGPOA/(POP15+A)-1.

In the case of the interprovincial migration equations our preferred specification was (A-34a), but further augmented by using the Canadian manufacturing capacity utilization rate as an additional right-hand side variable. It should be recalled from our summary of the migration literature (Migration Chapter 2) that favourable business conditions have a stimulating effect on migration in both directions.

As pointed out in Migration Chapter 2, an alternative hypothesis suggests a different specification for equations of interprovincial migration: namely one in which the change of the right-hand side variables of equations (A-30) to (A-36) explain migration. We have estimted such alternative equations and the results are reported in Appendix B.

Total net migration into Alberta (MIGTNA) equals international migration into Alberta (MIGFIA) minus international migration from Alberta (MIGFOA) plus interprovincial migration into Alberta (MIGPIA) minus interprovincial migration from Alberta (MIGPOA):

(A-37) $MIGTNA \equiv MIGFIA - MIGFOA + MIGPIA - MIGPOA$

Alberta's population aged 15 and over (POP15+A) equals the previous year's population multiplied by (1+POPNGA) where POPNGA is the (exogenous) natural growth rate of the Alberta population aged 15+, plus KMIGA times MIGTNA, where KMIGA is the (exogenous) share of persons aged 15+ among the migrants.

(A-38) $POP15{+}A = POP15{+}A_{-1}\ (1 + POPNGA) + (KMIGA)\ MIGTNA$

Appendix A, Annex 1

Technical Aspects of Estimating the Participation Rate Equation

Our original intention was to regress directly the participation rate on the employment rate and on other independent variables. Query: is this procedure legitimate? In this Appendix we shall use the following notation:

e = employed/working age population

ℓ = labour force participation rate $(e + u)$

u = unemployed/working age population

u^* = "natural rate" of u

w = wage rate

w^* = exogenously determined w

z = exogenous variable

ε = stochastic error

In a world H_0 of flexible wages and a natural rate of unemployment

(A1-1) $\quad e = f(w) + \varepsilon_e$

(A1-2) $\quad \ell = g(z,e) + \varepsilon_\ell$

(A1-3) $\quad u = u^* + \varepsilon_u$

(A1-4) $\quad \ell \equiv e + u$

H_0 could be designated as "classical".

In a world H_1 of <u>rigid wages</u> and <u>unemployment as a residual</u>

(A1-5) $e = f(w) + \varepsilon_e$

(A1-6) $\ell = g(z,e) + \varepsilon_\ell$

(A1-7) $u \equiv \ell - e$

(A1-8) $w = w^* + \varepsilon_w$

H_1 could be designated as "Keynesian".

Now, returning to the "classical" world H_0 and substituting (A1-3) into (A1-4), we obtain

(A1-1) $e = f(w) + \varepsilon_e$

(A1-2) $\ell = g(z,e) + \varepsilon_\ell$

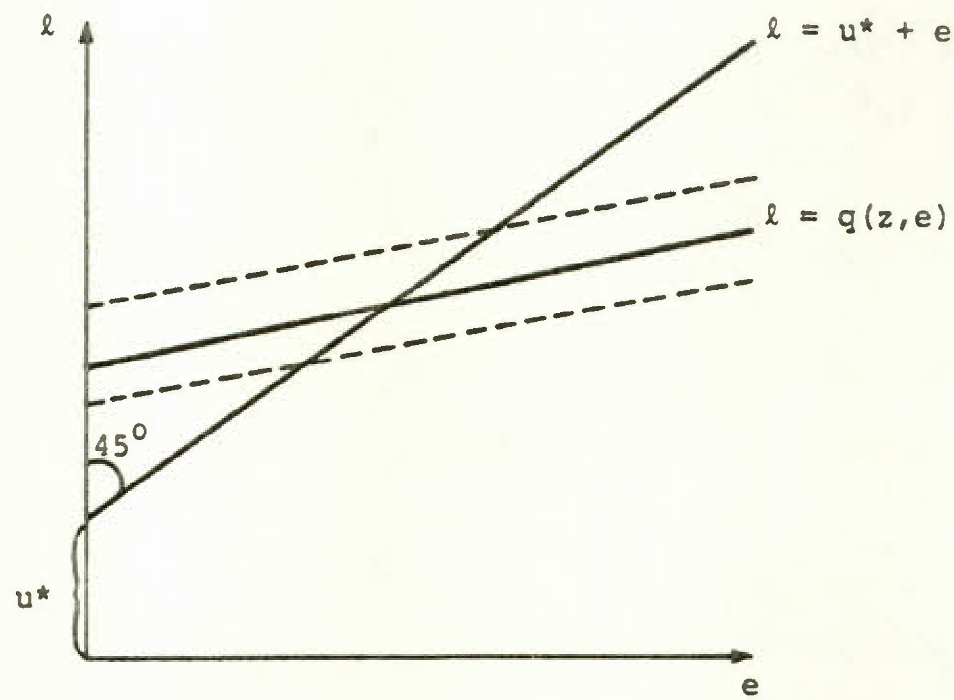
(A1-3) $\ell = u^* + e + \varepsilon_u$

Equation (A1-2) is not identified. This can be illustrated by Chart (A1-1)

Assume, we estimate $\ell = g(z,e)$ directly. With z varying, the estimating equation will pick up the slope of $\ell = u^* + e$, thus overstating the coefficient of e.

In the "Keynesian" world H_1 we can eliminate the identity (A1-7) by eliminating u, leaving

Chart A1-1



(Al-5) $e = f(w) + \varepsilon_e$

(Al-6) $\ell = g(z,e) + \varepsilon_\ell$

(Al-8) $w = w^* + \varepsilon_w$

Now (Al-6) is identified.

Consider now in more detail what happens if the H_0 world applies, if linearity may be assumed and if there does exist a discouraged worker effect. Then, in this H_0 world, we shall have

(Al-9) $u = u^* + \varepsilon_u$

(Al-10) $\ell = \bar{\alpha} + \bar{\gamma}z + \bar{\beta}e + \bar{\varepsilon}_\ell$

(Al-11) $\ell \equiv e + u$

Substituting (Al-9) into (Al-11)

(Al-12) $\ell \equiv e + u^* + \varepsilon_u$

Taking a weighted combination of (Al-10) and (Al-12)

(Al-13) $\theta_1\ell + \theta_2\ell = \theta_1\bar{\alpha} + \theta_1\bar{\gamma}z + \theta_1\bar{\beta}e + \theta_1\bar{\varepsilon}\ell + \theta_2 e +$
$\theta_2 e + \theta_2 u^* + \theta_2\varepsilon_u$

$$\text{(A1-14)} \qquad \ell = \frac{\theta_1\bar{\alpha} + \theta_2 u^*}{\theta_1 + \theta_2} + \left(\frac{\theta_1\bar{\beta} + \theta_2}{\theta_1 + \theta_2}\right)e + \left(\frac{\theta_1}{\theta_1 + \theta_2}\right)z + \frac{\theta_1\varepsilon_e + \theta_2\varepsilon_u}{\theta_1 + \theta_2}$$

Now suppose we mistakenly think that the H1 world applies, also with a discouraged worker effect. In this case we have, again assuming linearity as convenient,

$$\text{(A1-15)} \qquad \ell = \alpha + \beta e + \gamma z + \varepsilon_\ell$$

$$\text{(A1-16)} \qquad u \equiv \ell - e$$

Now we have a problem. It arises because we cannot distinguish between (A1-14) and (A1-15), and we cannot say a priori whether the world is Keynesian or classical. If it happens to be classical (H_0), then even with no discouraged worker effect at all, the regression of ℓ on e will fit well, but will be meaningless.

However:

in the H_0 world, substituting (A1-11) into (A1-10) and solving for e gives

$$\text{(A1-17)} \quad e = \bar{\alpha} + \bar{\gamma}z + \bar{\beta}e - u + \bar{\varepsilon}_\ell$$

and solving for e

$$\text{(A1-18)}\quad e = \frac{\bar{\alpha}}{1-\bar{\beta}} + \left(\frac{\bar{\gamma}}{1-\bar{\beta}}\right)z - \left(\frac{1}{1-\bar{\beta}}\right)u + \frac{\varepsilon_e}{1-\bar{\beta}}$$

in the H_1 world, substituting (A1-16) into (A1-15) gives

$$\text{(A1-19)}\quad e + u = \alpha + \beta e + \gamma z + \varepsilon_\ell$$

and solving for e

$$\text{(A1-20)}\quad e = \frac{\alpha}{1-\beta} + \left(\frac{\gamma}{1-\beta}\right)z - \left(\frac{1}{1-\beta}\right)u + \frac{\varepsilon_\ell}{1-\beta}$$

Comparing (A1-18) with (A1-20) we find: regress e on z and u. In either world with no discouraged worker effect the coefficient of u will be nonsignificantly different from -1.0. If the coefficient of u is significantly greater in absolute value than -1.0, we are in a world with discouraged worker effect.

The estimated coefficient of u in the regression of e on u and z will give the correct estimate of β in equation (A1-15).

Appendix A, Annex 2

Price of Durables and Labour Force Participation in a Very Simple Case

The purpose of this Appendix is to provide a formal exposition of the effect of the ratio of wages to household equipment prices on the participation of women in the labour force.

Consider one person, free to allocate hours and services of durables to household work (L hours, services D of durables). Output of household work (H) is then given by

(A2-1) $H = f(D, L)$

If Y denotes market income net of the purchase of the services of durables this is given as the difference between returns from market work [(8-L) W, where W is the wage rate, and assuming a total of 8 workable hours], and expenditure on services of durables, Dp (if prices of the services of durables is p). So

(A2-2) $Y = (8-L)W - Dp$

Total utility, to be maximized, depends on both Y and H, i.e., (A2-3) $U = U\ (Y, H)$

Let (A2-1) be a Cobb Douglas production function with constant returns to scale, so that

(A2-4) $H = D^{\alpha}\ L^{1-\alpha}$

For any <u>given</u> Y one should always choose D and L to obtain maximum possible H. This is an efficiency condition. It implies we must maximize H in (A2-4), by choice of D and L, subject to the restriction imposed by (A2-2).

Denoting the Lagrangian by 8 we have

$$Z = D^{\alpha}\ L^{1-\alpha} + \gamma\ \{Y - 8W + LW + Dp\}$$

Maximizing, by choice of D, L <u>and</u> γ, we obtain:

(A2-5) $\dfrac{\partial Z}{\partial D} = \alpha\ D^{\alpha-1}\ L^{1-\alpha} + \gamma p = 0$

(A2-6) $\dfrac{\partial Z}{\partial L} = (1-\alpha)\ D^{\alpha}\ L^{-\alpha} + \gamma W = 0$

(A2-7) $\dfrac{\partial Z}{\partial \gamma} = Y - 8W + LW + Dp = 0$

Solving (A2-5), (A2-6) and (A2-4) for D and L [first eliminating γ from (A2-5) and (A2-6)] we obtain

$$\text{(A2-8)}\quad D = \left(\frac{\alpha}{1-\alpha}\ \frac{W}{p}\right)^{1-\alpha} H$$

$$\text{(A2-9)}\quad L = \left(\frac{1-\alpha}{\alpha}\ \frac{p}{W}\right)^{\alpha} H$$

Using these last two equations in (A2-7) we also obtain

$$\text{(A2-10)}\quad Y = 8W - HW^{1-\alpha}\ p^{\alpha}\left[\left(\frac{1-\alpha}{\alpha}\right)^{\alpha} + \left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}\right]$$

Or, denoting the square bracketed term by B

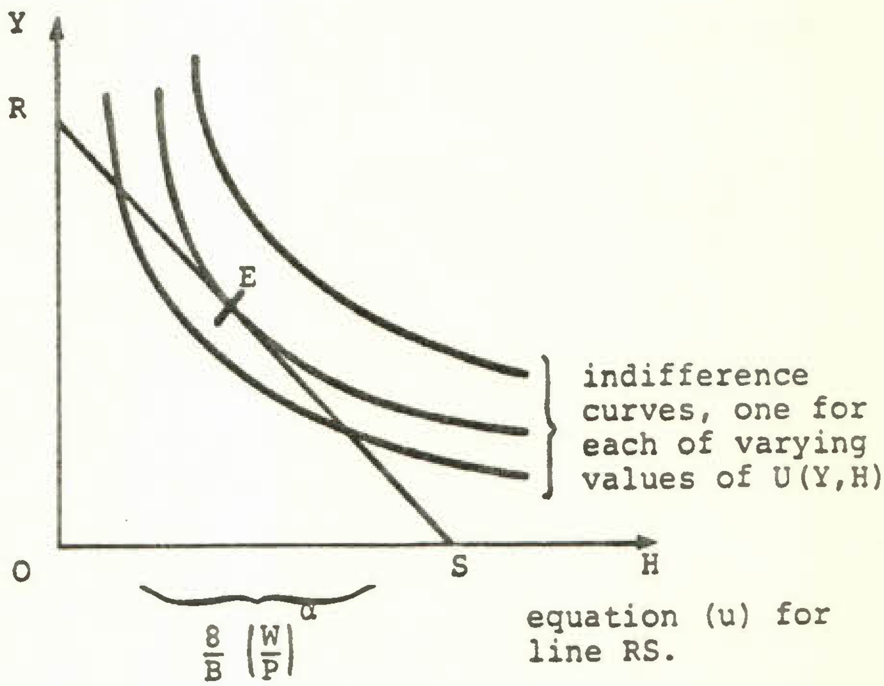
$$\text{(A2-11)}\quad Y = 8W - HW^{1-\alpha}\ p^{\alpha}\ B$$

Consider now the maximizing of utility as given by (A2-3), subject to the constraint (A2-11), by choice of Y and H. This can be done graphically, as shown overleaf, in Chart A2-1.

The maximum is shown at E.

* * *

Chart A2-1


Y
R
E
O
S
H
indifference curves, one for each of varying values of U(Y,H)
$\frac{8}{B}\left(\frac{W}{P}\right)^{\alpha}$
equation (u) for line RS.

Consider now the following problem: what happens to the equilibrium values of Y and H if the price of durables declines?

A decline in p will increase the distance OS, but leave the distance OR unchanged. A new equilibrium is shown in Chart A2-2, on the assumption that Y is a sufficiently superior good for the income effect on consumption of it to offset the fact that it is now relatively more expensive. Thus, at E', both Y and H have risen.

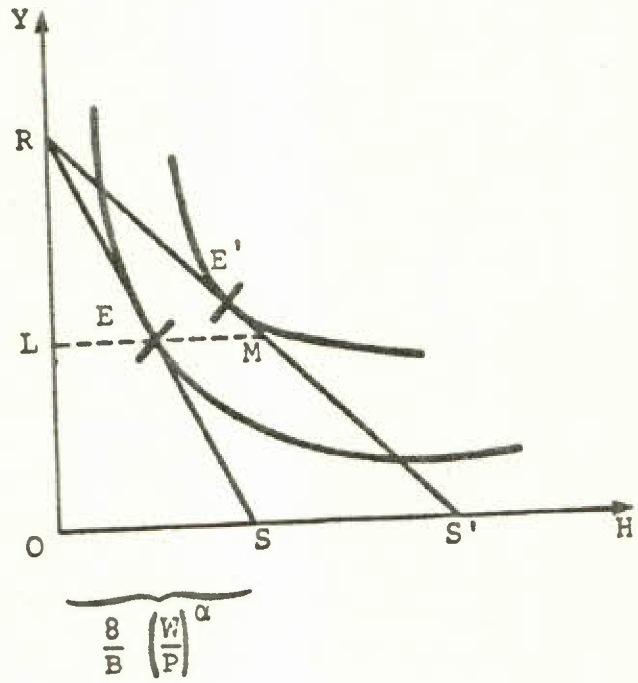
What does this imply for household work, i.e., for the value of L?

To answer this, notice first that in Chart (A2-2) the percentage horizontal shift of the line RS, for any given percentage drop in the price of durables p, is known. Suppose, for example, that p has dropped 10 per cent. Thus SS' will be 10α per cent of OS, so that the horizontal shift of RS is 10α per cent.

In particular, ML is 10α per cent larger than EL. But, because E' is to the left of M, this implies that the increase in consumption of H is <u>less than 10α per cent</u>.

Now consider equation (A2-9). According to equation (A2-9) the percentage change in L when p drops 10 per cent will be the sum of two items: -10α per cent, and the percentage rise in H.

Chart A2-2



But we just argued that the percentage rise in H was less than 10α per cent. Consequently the net percentage change in L is negative. Thus, household work goes <u>down</u>. Thus, outside work goes <u>up</u>.

We conclude that in this simple model, with certain assumptions, outside work goes up if the price of durables needed in household work goes down.

Appendix B

DESCRIPTION AND DISCUSSION OF THE EMPIRICAL ESTIMATES

In this chapter we apply the theoretical approach of the previous chapter to the empirical data and discuss the results. Annex B1 contains a glossary of the mnemonics.

1. Output

The real output of the Mining industry is accepted as exogenous.

The equation of Other Primary Industries follows equation (A-5). The predominant part of this industry consists of Agriculture, the output of which is strongly influenced by weather conditions. Wheat yield per acre sown in Alberta (WY/AA) seemed a useful indicator of weather conditions; however it is necessary to allow for improving agricultural technology, which imparts a rising trend to the yield. Our weather-conditions proxy variable is defined as $(WY/AA)_t/[\sum_{i=0}^{9} (WY/AA)_{t-1}]$, or the current yield over the average of the most recent ten years. The resulting estimate is

Name: Real Output, Other Primary Industries
Mnemonic: XOPA — Period: 1962-79 — Method: OLS

$$\ln(XOPA) = +0.0247705$$
$$\underset{(0.21)}{}$$
$$+\underset{(3.67)}{1.151225}\ \ln(PXOP/WRTAS)-1$$
$$+\underset{(3.67)}{0.552514}\ \ln(WY/AA)/\frac{\sum_{i=0}^{9}(WY/AA_{t-1})}{10}$$
$$+\underset{(3.25)}{0.501544}\ \ln(XOPA)_{-1}/LFA_{-2})$$

$\bar{R}^2 = 0.728$ S.E.E.= 0.0728 D-W= 1.998

Elasticity of Output	Short-term	Long-term
with respect to price/wage ratio	+0.15	+0.30

The numbers in parantheses are t-values.

Construction

This estimate follows the equation (A-9) with several important additions:

a) we have added a dummy variable for the construction of the oil sands plants;

b) we assumed that the Alberta government follows a counter-cyclical policy in the construction of roads, hospitals, schools, government buildings, etc. - i.e., during period of boom government construction is postponed, while in periods of rising unemployment government accelerated construction activity. However, there is a recognitional, decisional and operational lag between the rise of unemployment and the subsequent rise in government-induced construction activity; therefore we entered unemployment (UA) with a year's lag into our specificaiton.

c) in our estimates we found that specificaiton (A-9) consistently and substantially over-estimated the amount of construciton activity in 1974. This is not surpirsing when we recall that (A-9) uses the chang in <u>current</u> dollar provincial product. In 1974 there was considerable doubt whether the new, high oil price would prove lasting. Indeed, inspection of Alberta's narural resource revenue indicates, that only in 1975 did the oil companies raise their bids for drilling rights by a signifiant amount (Alberta Statistics Review, 1979, Annual). If the business community was not convnced in 1974 that the oil price increase was lasting, it is not surprising that it did not react to the increase with more construction activity. We decided to dummy out the year 1974, with the following results:

Name: Real Output, Construction Period: 1965-79
Mnemonic: XCA Method: OLS

$$XCA-0.014*K1A_{-1} = \underset{(7.52)}{204.980} \; \underset{(5.04)}{-170.881}\; D74 \; \underset{(2.24)}{+2.44738}\; UA_{-1} \; \underset{(8.22)}{+7.13046}\; DTSPA$$

$$+\text{sum } (i=0,)\; b(i) \left(\frac{XNCA_i * PXNCA_i}{PXCA_1} - \frac{XNCA_{i-1} * PXNCA_{i-1}}{PXCA_{i-1}} \right)$$

i	b(i)	t(i)
0	+0.196102	(8.89)
1	+0.188514	(14.92)
2	+0.153301	(7.16)
3	+0.090462	(5.05)
sum	0.628380	(14.92)
	(2,4, FAR)	

$\bar{R}^2 = 0.987$ S.E.E. = 30.685 D-W = 2.349

Substituting the value of 100 for DTSPA into the above equation we find that the Syncrude plant construction increases XCA by approximately $(71) 713 million. Applying to this the deflator of XCA at mid-construction period, we find that according to our equation the Syncrude plant construction amounted to about $1.3 billion in current dollars value added in the construction industry. According to Syncrude Ltd. [The Syncrude Story, n.d. p. 11] the actual cost of the project, exclusive of the utility plant was $2.26 billion.

Manufacturing

This equation was, as we shall see, dogged by a great deal of collinearity between the right-hand side variables. When attempting to fit equation (A-11) the ratio of manufacturing prices/resource industry prices had consistently the wrong (negative) sign. The lagged dependent variable was not significant. We decided to omit the price ratio and arrived at the following preferred version:

Name: Real Output, Manufacturing   Period: 1962-79
Mnemonic: XMFA   Method: OLS

$$\ln(XMFA/LFA_{-1} = \underset{(11.01)}{-2.35703}$$

$$\underset{(1.71)}{-0.0533758} \ \ln 1./[(\sum_{t=-1}^{-\infty} XMA) * LFA_{-1}]$$

$$\underset{(3.05)}{+0.849561} \ \ln(XA/LFA_{-1})$$

$$\underset{(2.44)}{+0.281721} \ \ln(PXNMFTA/WRTA\$)$$

$\bar{R}^2 = 0.977$ S.E.E. = 0.023048   D-W = 2.225

Elasticity of Output

with respect to real provincial product	+0.85
with respect to non-manufactures prices/wage ratio	+0.28

Note that even though the t-values are on the low side, they jointly explain 98 per cent of the variation of the dependent variable. This indicates the high degree of correlation among them.

<u>Services</u>

This follows equation (A-12) in a straightforward manner, with one addition: just as in the case of the construction industry. here too we assumed that govenmnet reacts (with a year's lag) to higher unemployment with more employment creation in the non-commercial service sector.

Name: Real Output, Services | Period: 1964-79
Mnemonic: XSA | Method: OLS

$$\ln(XSA/LFA_{-1} = -0.782059 \atop (9.24)$$

$$+1.06643 \; URATEA_{-1} \atop (2.58)$$

$$+\text{sum } (1{=}0,3) \; b(i) \; \ln(XA_{-1}/LFA_{-i-1})$$

$$+\text{sum } (i20,3) \; c(i) \; \ln(PXNSTA_{-1}/WRAT\$_{-1})$$

i	b(i)	t(i)	c(i)	t(i)
0	+0.689008	(6.62)	-0.0139208	(0.51)
1	+0.395012	(18.75)	+0.0930620	(4.66)
2	+0.182179	(4.55)	+0.131043	(4.07)
3	+0.050508	(1.21)	+0.100022	(3.81)
sum	+1.31671	(18.75)	+0.310207	(4.65)

$\bar{R}^2 = 0.996$ S.E.E. = 0.000762 D-W = 2.396

Elasticity of Output	Short-term	Long-term
with respect to real provincial output	+0.69	+1.32
with respect to non-services price/wage ratio	-0.01	+0.31

The long-term elasticity with respect to provincial product is somewhat on the high-side. However the wage rate tends to grow faster than non-service prices and in the long run this prevents Services output from growing much faster than total provincial output.

Real Captial Stock in Buildings

Following equation (A-14) we obtain

Name: Capital Stock, Buildings — Period: 1961-79
Mnemonic: K1A — Method: OLS

$$K1A - K1A_{-1} = \underset{(26.36)}{+2.25373}\ XCA \quad \underset{(9.02)}{-0.0339178}\ K1A_{-1}$$

$\bar{R}^2 = 0.994$ S.E.E. = 45.154 D-W = 2.082

This equation implies that the stock of buldings depreciates at a rate of 3.4 per cent per year. This figure does not appear unreasonable when we recall that the average service-life of industrial buildings is assumed to range between 20 and 50 years [Statistics Canada, 1981, Catalogue No. 13-211 pp. XI-XIII] and that of residential buldings 80 years.

2. Industry Output Prices

The price of mining output (PXMA) is exogenously determined by international prices, taxes and government regulation.

The price of other primary industries (PXOPA) is determined by the price prevailing in the rest of Canada (PXOPR).

Name: Price, Other Primary Industries
Mnemonic: PXOPA

Period: 1962-79
Method: OLS, Hildreth-Lu

$$\ln(PXOPA) = +0.0710688 \underset{(1.92)}{} + 1.55047 \ln(PXOPR) \underset{(7.46)}{} - 0.544975 \ln(PXOPR)_{-1} \underset{(2.45)}{}$$

$\bar{R}^2 = 0.967$ S.E.E.= 0.0784 D-W= 1.558 RHO= +0.420

Elasticity of Price with respect to price in ROC	Short-term	Long-term
	+1.55	+1.01

It is somewhat puzzling to find that the price of Alberta's agricultural output is in the short-run substantially more volatile than that of the rest of Canada as reflected by the short-term elasticity. However, the long term elasticity is practically unity, which is a very plausible result.

In estimating the price of the Construction industry we attempted to follow equation (A-18). We added, however, two further dummy variables. The first introduces a dummy variable (D72+) which has the value of zero in the period up to 1971 and unity thereafter. The introduction of this dummy is due to the fact that starting with 1972 the method of compiling the series has been changed by the organization which provides the price data used in this paper (the Conference Board). Prior to 1972 the construction industry implicit price deflator for Alberta and Rest of Canada are identical, but they diverge after 1971 [Conference Board, 1980, p. 25].

The second dummy serves to dummy out the year 1978 (D78). According to our database the construction industry price deflator remained unchanged between 1977 and 1978. This seems extremely improbable. Indeed data revisions which became available after we have completed our estimation indicate that the 1978 price was about eight per cent higher than our data-base indicated.

Name: Price, Construction Industry   Period: 1961-79
Mnemonic: PXCA   Method: OLS

$$
\begin{aligned}
\ln(PXCA) = & -1.63528 \\
& (34.46) \\
& +0.846257 \quad \ln(WRTA\$) \\
& (27.20) \\
& +2.15922 \quad \ln(DTSPA/LFA_{-1}) \\
& (3.16) \\
& -0.0719069 \quad D78 \\
& (2.20) \\
& +0.0989219 \quad D72+ \\
& (3.60)
\end{aligned}
$$

$\bar{R}^2 = 0.997$ S.E.E. = 0.029362   D-W = 1.841

The Price Equation of Manufacturing Output assumes that the bulk of manufactured goods is traded or is at least potentially tradeable. In consequence the price is determined in the Rest of Canada, and any difference between the Alberta and Rest of Canada price is due to the differences in the composition of industrial output.

Name: Price, Manufacturing Industries
Mnemonic: PXMFA
Period: 1962-79
Method: OLS

$$\ln(PXMFA) = \underset{(5.89)}{-0.0118401} \; \underset{(28.43)}{+1.15748} \ln(PXMFR) \; \underset{(2.03)}{-0.0946872} \ln(PXMFR)_{-1}$$

$\bar{R}^2 = 1.00$ S.E.E. = 0.00586 D-W = 2.111

This equation suggests that the Alberta manufacturing output price is slightly more volatile in the short run than that of the Rest of Canada, but in the longer run the elasticity of Alberta's price with respect to that of R.O.C. is practically unity.

The specification of the price of the Service Industries follows equation (A-19). However, we found that the income variable (XA/LFA_{-1}) yielded a negative coefficient whenever the wage rate variable was also used. Our preferred estimate is:

Name: Price, Service Industries
Mnemonic: PXSA
Period: 1964-79
Method: OLS

$$\ln(PXSA) = \underset{(17.02)}{-0.986158} + \sum_{i=0}^{3} b(i) \ln(WRTA_{-i}) + \sum_{i=0}^{3} c(i) \ln(PXNSTA_{-i})$$

i	b(i)	t(i)	c(i)	t(i)
0	+0.294828	(4.10)	+0.398751	(8.52)
1	+0.164196	(15.40)	+0.0978864	(7.34)
2	+0.0715138	(1.78)	-0.0688604	(2.56)
3	+0.0167820	(0.43)	-0.101489	(4.08)
sum	+0.547319 (2,4,FAR)	(15.40)	+0.326288 (2,4,FAR)	(7.34)

$\bar{R}^2 = 0.999$ S.E.E. = 0.0137 D-W = 1.867

3. Labour Demand

As mentioned in Appendix A, the labour demand, represented by employment, is estimated as inverted C.E.S. output functions under profit maximization. The results are as follows:

Mining

The time trend was not significant in this equation, and was therefore omitted.

Name: Employment, Mining   Period: 1964-79
Mnemonic: EMA   Method: OLS

```
ln(EMA) = -1.12669
           (2.58)
          +0.957845 ln(XMA)
           (13.78)
          +sum (i=0,3) b(i) ln(WRMA$(-i)/PXMA(-i))
```

i	b(i)	t(i)
0	-0.122093	(0.98)
1	-0.309245	(9.27)
2	-0.351279	(3.78)
3	-0.248198	(2.95)
sum	-1.03081 (2,4, FAR)	(9.272)

$\bar{R}^2 = 0.972$ S.E.E. = 0.0678   D-W = 1.943

Elasticity of Employment	Short-term	Long-term
with respect to real output	+0.96	+0.96
with respect to wage/price ratio	-0.12	-1.03

Other Primary Industries

In this equation output (XOPA) and the time trend proved non-significant.

It should be emphasized that the wage/price ratio entering the employment equation (A-22) applies to the expected wage/price ratio. Our knowledge of expectation formation is very imperfect, but we assumed it to be permissible to represent expectations by distributed lags. In order to increase the flexibility of the equation we entered the price term (PXOPA) and the wage rate (WROPA) as separate variables. This procedure is valid, provided that the sum of the (negative) coefficients of the wage term does not differ significantly from the sum of the (positive) coefficients of the price term. In order to reduce their collinearity (they correlate at +0.89) we deflated both by the Alberta Consumer Price Index.

Name: Employment, Other Primary Industries   Period: 1964-79
Mnemonic: EOPA   Method: OLS

```
ln(EOPA) = +4.91256
            (133.584)
           -0.352927 ln(WROPA$/CPIA)
            (9.59)
           +sum (i=0,3) b(i) ln(PXOPA/CPIA)

       i   b(i)        t(i)
       0   +0.118944   (2.91)
       1   +0.0989292  (3.87)
       2   +0.0724337  (2.49)
       3   +0.0394574  (1.73)

     sum   +0.329764   (3.87)
           (2,4, FAR)
```

$\bar{R}^2 = 0.857$ S.E.E. = 0.0383   D-W = 2.710

Elasticities of Employment	Short-term	Long-term
with respect to real price	+0.12	+0.33
with respect to real wage rate	-0.35	-0.35

The fit of this equation is reasonable, but it is the poorest among all the employment equations. However, this is not surprising. Weather conditions may influence output, irrespective of the size of labour input. The contribution of unpaid family members is an important part of the labour input, but it is difficullt to measure. The owner-operator frequently exerts more effort in running his farm, than strict profit vs. effort calculations would justify. Finally, the price of the output is very volatile and may become known only after the harvest.

Construction

Output seems to be by far the strongest determinant of employment. The wage/price ratio displays the correct sign, so we decided to retain it even though it is not significant.

Name: Employment, Construction — Period: 1962-79
Mnemonic: ECA — Method: OLS

$$
\begin{aligned}
\ln(ECA) = & -2.30467 \\
& \ (8.47) \\
& +0.760653 \ln(XCA) \\
& \ (5.14) \\
& +0.221058 \ln(XCA(-1)) \\
& \ (1.36) \\
& -0.122155 \ln(WRCA\$/PXCA) \\
& \ (1.28)
\end{aligned}
$$

$\bar{R}^2 = 0.992$ S.E.E.= 0.0328 D-W= 2.221

Elasticity of Employment	Short-term	Long-term
with respect to output	+0.76	+0.98
with respect to wage-price ratio	-0.12	-0.12

Manufacturing

In this equation the coefficient of output was consistently non-significant when the time-trend was included in the specification. It turned highly significant when the time-trend was suppressed. In our preferred equation we chose to retain the output variable and omit the time trend.

Name: Employment, Manufacturing, Alberta
Mnemonic: EMFA — Period: 1961-79
Method: OLS

$$
\begin{aligned}
\ln(\text{EMFA}) = & -0.210507 \\
& \quad (1.12) \\
& +0.538569 \quad \ln(\text{XMFA}) \\
& \quad (4.85) \\
& -0.455565 \quad \ln(\text{WRMFA\$/PXMFA}) \\
& \quad (3.86) \\
& +0.414822 \quad \ln(\text{EMFA}(-1)) \\
& \quad (2.68)
\end{aligned}
$$

$\bar{R}^2 = 0.984$ S.E.E.= 0.0272 D-W= 2.056

Elasticity of Employment	Short-term	Long-term
with respect to real output	+0.54	+0.92
with respect to wage/price ratio	-0.46	-0.78

Services

Here the time trend proved positive and non-significant, if used together with the lagged dependent term. In our final choice the time trend is suppressed.

Name: Employment, Services, Alberta   Period: 1961-79
Mnemonic: ESA   Method: OLS

$$\begin{aligned} \ln(ESA) = & -0.00227 \\ & \ (0.03) \\ & +0.4743 \ \ln(XSA) \\ & \ (3.90) \\ & -0.1951 \ \ln(WRSA\$/PXSA) \\ & \ (2.88) \\ & +0.4055 \ \ln(ESA(-1)) \\ & \ (2.47) \end{aligned}$$

$\overline{R}^2 = 0.999$ S.E.E.= 0.00958   D-W= 2.114

Elasticity of Employment	Short-term	Long-term
with respect to real output	+0.47	+0.80
with respect to wage/price ratio	-0.20	-0.33

Summarizing the employment equations, we find that -- with a single exception -- all equations show a positive output elasticity of employment, and this elasticity is below unity. The one exception which did not show a significant effect of output on employment, is Other Primary Industries, i.e., in Alberta's case Agriculture. Employment in this industry consists of a very large percentage of owner-operators; therefore employment policy in this case would differ substantially from other industries.

Employment is in all cases negatively related to wages and positively related to output prices. Mining employment is particularly sensitive to fluctuations of this profitability proxy. The Service industry is least sensitive to it, which is not surprising when we recall that a large part of the service industry is in the non-commercial sector (civil service, schools, hospitals, etc.).

Labour Supply

The Alberta labour supply is represented in this study by that part of the population aged 15 years and over (POP15+A), which is employed or actively searching for work. We define the labour force participation rate of Alberta (PARTRA) as

(B-1) $PARTRA \equiv LFA/POP15{+}A$

where LFA is the labour force of Alberta.

Appendix A, Annex 1 has demonstrated that it is not appropriate to introduce the ratio of employed persons/population aged 15 and over (ETA/POP15+A) directly into the participation rate equation. Instead, it is necessary to regress ETA/POP15+A on the ratio of unemployed/population aged 15 and over (UA/POP15+A) and whichever additional variables we intend to introduce into the participation rate equation.

As mentioned in Appendix A, we have attempted to explain the rising trend of the participation rate by three variables: the ratio of births to population, the ratio of wage to the price of household durables (WRTA$/PFCDH20) and a time trend.

We used WRTA$/PFCDH20 in the following way: PFCDH20 is a price index on 1971=1.0 base, therefore we normalized WRTA$ similarly by dividing it by its 1971 value of 6.609. In order to restrain the effect of the normalized WRTA\$/PFCDH20 variable to the range between zero and unity, (the dependent variable has to be within this range) we used the hyperbolic tangent transformation

(B-2) TANHIW/PA = (e**[WRTA\$/(PFCDH2O*6.609)] -1.0) /
(e**[WRTA\$/(PFCDH2O*6.609)] +1.0)

which has the desired value of zero, when the ratio WRTA\$/PFCDH2O is zero, and approaches the value of unity as the wage/price ratio reaches ever higher values and approaches infinity.

Unfortunately the ratio of births to population WBIRTHSRA specified as $[(0.5*Births_t + 0.4*Births_{t-1} + 0.3*Births_{t-2} + 0.2*Births_{t-3} + 0.1*Births_{t-4})/POP15+A_t]$, the domestic appliances/wage rate ratio, and the time trend are all very highly correlated with each other. When we attempted to introduce both the wage price ratio and the births/population ratio into the equation (Al-20), we found that the births/population ratio had the wrong (positive) sign and was non-significant. Using the three proposed variables individually, we obtained the following three results (ETA/POP15+A is the dependent variable).

	1.	2.	3.
C	+0.519623 (122.0)	+0.240661 (18.51)	+0.736823 (35.80)
UA/POP15+A	-1.59373 (8.84)	-1.26749 (6.46)	-1.09818 (2.28)
TANHIW/PA	+0.258041 (29.62)		
WBIRTHSRA			-3.75639 (10.05)
TIMEA		+0.00548 (26.36)	
$\overline{R}^2$	0.980	0.975	0.848
S.E.E.	0.00425	0.00476	0.01171
D-W	2.082	1.348	0.342

These results clearly show that equation 1 is the best of the three. Both the correlation coefficient and the Durbin-Watson statistic indicate that the wage/appliance price ratio explains the employment/source population ratio better than does the birth-rate. The equation with the time-trend is also inferior to the one with the wage/price ratio. In addition we believe that using a time-trend as a proxy for changing social forces is a dangerous practice in forecasting, because it assumes that the changes of the past will continue monotonically and in a linear fashion in the future. Using the equation utilizing TANHIW/PA we find that the coefficient of UA/POP15+A is -1.59373, indicating a discouraged worker effect. This corresponds to the coefficient $(-\frac{1}{1-\beta})$ in equation (A1-20). Solving for β we obtain +0.37254. This is the correct estimate for β in our desired equation (A1-15). In estimating our equation for the participation rate PARTRA we imposed the coefficient +0.37254 on the variable ETA/POP15+A, with the following result

Name: Labour Force Participation Rate
Mnemonic: PARTRA

Period: 1960-79
Method: OLS

$$\text{PARTRA} -0.37254\ (\text{ETA/POP15+A}) = \underset{(161.13)}{+0.326175} \underset{(35.63)}{+0.161542}\ \text{TANHIW/PA}$$

$\overline{R}^2 = 0.985$ S.E.E.= 0.00257   D-W= 2.041

4. Wage Rate

The overall average wage rate of Alberta (WRTA$) is modelled as a Phillips curve. The percentage change of the wage rate is a function of the reciprocal of the lagged unemployment rate (the proxy indicator of labour surplus), in order to capture the possible non-linear relationship between labour surplus and wage changes. The wage bargain is assumed to be concluded in real terms; however, the two parties to the wage bargain, labour and management are looking at two different price indicators: labour at the consumer price index, management at the product price, here represented by the provincial product deflator (PXA). We have, for simplicity's sake, assumed that the arithmetic average of the CPI inflation and of the PXA inflation (PHPA) will be an acceptable indicator. Also, we introduced a dummy variable to represent the 1976-78 effect of wage controls (DWRC).

Name: Wage Rate, Total Period: 1964-79
Mnemonic: WRTA$ Method: OLS

$$(WRTA\$ - WRTA\$_{-1})/WRTA\$-1 = \underset{(0.11)}{0.00284915} \\ +\underset{(1.88)}{0.00142962}\ (1.0/URATEA-1) \\ -\underset{(1.98)}{0.0129637}\ DWRC \\ +\mathrm{sum}\ (i=0,2)\ b(i) \\ ((PHPA_{-i} - PHPA_{-i-1}/PHPA_{-i-1})$$

i	b(i)	t(i)
0	+0.390348	(2.72)
1	+0.310441	(4.45)
2	+0.180324	(1.80)
sum	+0.88114	(6.72)
	(2,3,FAR)	

$\bar{R}^2 = 0.738$ S.E.E. = 0.0188 D-W = 2.400

The long term effect of one per cent average increase of CPI and PXA on wages is 0.88 per cent, but this does not differ significantly from unity.

Theoretical considerations strongly suggest that the unemployment rate should appear in the wage equation in reciprocal form, as modelled above. However, several important studies (for reference see Santomero A.M. and Seater J.J. [1978] p. 505) found the use of the linear form preferable in empirical work; therefore we have also estimated the wage equation with the rate in linear form.

$$(WRTA\$ - WRTA\$_{-1})/WRTA\$_{-1} = \underset{(4.22)}{0.08335539} \underset{(2.01)}{-1.04529} \; URATEA_{-1} \underset{(2.06)}{-0.0131756} \; DWRC + \text{sum } (i=0,2) \; b(i) \; ((PHPA_{-i} - PHPA_{-i-1})/PHPA_{-i-1})$$

i	b(i)	t(i)
0	+0.419389	(2.87)
1	+0.295459	(4.29)
2	+0.155663	(1.54)
sum	+0.870511	(6.87)
	(2,3,FAR)	

$\bar{R}^2 = 0.748$ S.E.E. = 0.0184 D-W = 2.339

The single-equation fits of the two versions are practically indistinguishable from each other.

We intended to model the wage rate of the individual industries in the following manner: the ratio of industry i wage rate to the overall wage rate is a function of the industry-specific labour surplus and of a partial adjustment process. We intended to proxy the specific labour surplus by the growth-rate of the output of the corresponding industry (Xi/Xi_{-1}). Unfortunately this approach proved completely unsuccessful. We were reduced to regressing the wage ratio on a constant and its own lagged value. The sum of industry-specific wage rates multiplied by the corresponding employment figures have to be equal to the total wage bill of Alberta. We imposed this constraint by using Zellner's seemingly unrelated regression technique. The restriction forces the omission of one equation from the estimation -- the wage rate of this industry is obtained as the residual. We chose to omit the Services industry. This is the biggest industry in our disaggregation; so it will do relatively least harm if it is the one forced to absorb all the errors of our wages sub-system.

Name: Wage Rate, Mining
Mnemonic: WRMA$
Period: 1962-79
Method: Zellner seemingly unrelated regressions

$$\ln(WRMA\$/WRTA\$) = \underset{(1.55)}{+0.1938272} \; \underset{(4.07)}{+0.7136329} \; \ln(WRMA\$/WRTA\$)_{-1}$$

$R^2 = 0.4629$

Name: Wage Rate, Other Primary Industries
Mnemonic: WROPA$
Period: 1962-79
Method: Zellner seemingly unrelated regressions

$$\ln(WROPA\$/WRTA\$) = \underset{(1.56)}{-0.270309} \; \underset{(3.56)}{+0.6705313} \; \ln(WROPA\$/WRTA\$)_{-1}$$

$R^2 = 0.3962$

Name: Wage Rate, Construction
Mnemonic: WRCA$
Period: 1962-79
Method: Zellner seemingly unrelated regressions

$$\ln(WRCA\$/WRTA\$) = \underset{(1.64)}{+0.153555} \; \underset{(2.76)}{+0.5974973} \; \ln(WRCA\$/WRTA\$)_{-1}$$

$R^2 = 0.3579$

Name: Wage Rate, Manufacturing
Mnemonic: WRMFA$

Period: 1962-79
Method: Zellner seemingly unrelated regressions

$$\ln(WRMFA\$/WRTA\$) = \underset{(2.39)}{+0.0461099} \; \underset{(4.35)}{+0.6007476} \; \ln(WRMFA\$/WRTA\$)_{-1}$$

$R^2 = 0.5077$

5. Migration

a) International Migration into Alberta

We have experimented with the numerous income concepts described in equations (A-30) to (A-36). The most successful was the one corresponding to (A-33). The ratio of provincial resource revenues per capita was not significant. On the other hand the ratio of employment growth had the desired sign and was significant.

Name: International Migration to Alberta
Mnemonic: MIGFIA

Period: 1963-79
Method: OLS

$$\ln\left(\frac{(MIGFIA/POP15+A_{-1})}{((MIGTIC-MIGFIA)/POP15+R_{-1})}\right) = \underset{(3.02)}{+0.142175}$$

$$+ \underset{(1.98)}{1.94639} \ln\left(\frac{(ETA-EOPA)-(ETA-EOPA)_{-1})/(ETA-EOPA)_{-1}}{(ETR-EOPR)-(ETR-EOPR)_{-1})/(ETR-EOPR)_{-1}}\right)$$

$$+ \text{sum } (0,3)\ b(i)\ \ln\left(\frac{WRTA\$_{-i}(1-URATEA_{-i})/CPIA_{-i})}{WRTR\$_{-i}(1-URATER_{-i})/CPIR_{-i})}\right)$$

i	b(i)	t(i)
0	+3.76947	(7.53)
1	+1.01833	(8.02)
2	-0.526962	(1.70)
3	-0.866405	(3.02)
sum	3.39443	(8.02)

$\bar{R}^2 = 0.945$ S.E.E. = 0.0621 D-W = 1.549

b) International Migration from Alberta

This equation is the counterpart of the preceding one

Name: International Migration from Alberta
Mnemonic: MIGFOA
Period: 1961-79
Method: OLS, Hildreth-Lu

$$\ln\left(\frac{(MIGFOA/POP15+A_{-1})}{((MIGTOC-MIGFOA)/POP15+R_{-1}}\right)$$

$$= \underset{(1.70)}{-0.237506}$$

$$\underset{(1.29)}{-1.74808} \quad \ln\left(\frac{WRTA\$(1-URATEA)/CPIA}{WRTR\$(1-URATER)/CPIR}\right)$$

$$\underset{(1.49)}{-3.68090} \quad \ln\left(\frac{[(ETA-EOPA)-(ETA-EOPA)_{-1}]/(ETA-EOPA)_{-1}}{[(ETR-EOPR)-(ETR-EOPR)_{-1}]/(ETR-EOPR)_{-1}}\right)$$

$R^2 = 0.536$ S.E.E. = 0.191 D-W = 1.641 RHO = +0.532

The right-hand side variables are correlated with each other, therefore their low t-values are deceptive. If the wage ratio variable is used by itself, its t-value is 3.30; and if the employment growth variable is used by itself its t-value is 1.88.

c) Interprovincial Migration into Alberta

During our work on this equation it became increasingly obvious that general business conditions have a strong positive effect on migration both into <u>and</u> out of Alberta. This is in agreement with the findings of Vanderkamp [1968] and of Courchene [1970], who used the unemployment rate as the indicator of business activity. Their explanation for this phenomenon was that generally favourable conditions promote migration to high-income regions;

however a high number of optimistic migrants also results in a higher number of disappointments and therefore a higher number of return migrants to the lower-income region. Since the Vanderkamp and Courchene studies the natural rate of unemployment in Canada has risen. We have therefore chosen the manufacturing capacity utilization rate (MFCAPUTC) as the indicator of economic prosperity.

Any attempt to model migration with disaggregated indicators of provincial resource revenues proved unsuccessful. While this is regrettable, it is not surprising. Our migration data base starts as recently as the 1961-62 demographic year. Also, the big increase in Alberta's resource revenues started as recently as 1974 and the various uses of these revenues (tax reductions, expenditure increases, Heritage fund asset growth) are all highly correlated with each other. Under such circumstances it is not surprising that only the aggregate per capita ratio of provincial resource revenues proved itself useful in explaining migration, besides the wage ratio and the capacity utilization rate.

Name: Interprovincial Migration into Alberta
Mnemonic: MIGPIA
Period: 1961-79
Method: OLS

$$
\begin{aligned}
\ln(MIGPIA/POP15{+}R_{-1}) = & \underset{(9.80)}{-9.42238} \\
& \underset{(6.61)}{+2.48304} \ \ln(WRTA\$/WRTR\$) \\
& \underset{(4.22)}{+0.938225} \ \ln(MFCAPUTC) \\
& \underset{(2.21)}{+0.0687485} \ \ln\left(\frac{(GRNRA\$/POP15{+}A_{-1})}{(GRNRR\$/POP15{+}R_{-1})}\right)
\end{aligned}
$$

$\overline{R}^2 = 0.904$ S.E.E. = 0.0444 D-W = 2.206

d) Interprovincial Migration from Alberta

The equation corresponding to the preceding is

Name: Interprovincial Migration from Alberta
Mnemonic: MIGPOA
Period: 1961-79
Method: OLS

$$
\begin{aligned}
Ln(MIGPOA/POP15{+}A_{-1}) = & \underset{(5.98)}{-8.82417} \\
& \underset{(0.47)}{-0.271803} \ \ln(WRTA\$/WRTR\$) \\
& \underset{(3.97)}{+1.35463} \ \ln(MFCAPUTC) \\
& \underset{(1.83)}{-0.0873836} \ \ln\left(\frac{(GRNRA\$/POP15{+}A_{-1})}{(GRNRR\$/POP15{+}R_{-1})}\right)
\end{aligned}
$$

$\overline{R}^2 = 0.578$ S.E.E. = 0.068147 D-W = 1.775

It is interesting to note that the wage-ratio has a very significant (positive) effect on migration into Alberta, but no significant effect on the out-migration. The government natural resource revenue ratio has an approximately symmetrical effect, and capacity utilization has a pronounced positive effect on movements in both directions -- rather stronger on migration out of Alberta than into the province.

e) Alternative Specifications for Interprovincial Migration

Here we have followed stocks-flows specification recommended by Lianos. We took as our point of departure the specifications of sections 5c and 5d of the present Appendix and used (the Almon distributed lags of) the change of the right-hand side variables. We shall designate this specification as the "stock-flow" (s-f) specification.

Recall that according to the "stock-flow" hypothesis net interprovincial migration should be zero in the long run if the change in the explanatory variables is zero. However, when we estimated the equations for interprovincial in- and out-migration with s-f specification, but with the constant term unrestricted, we obtained a (small) net migration even when the right-hand side variables remained unchanged. In our final estimate we modified the constant terms so as to yield zero net migration and imposed these constant terms on the equations, with the following results:

Name: Interprovincial Migration into Alberta (s-f)
Mnemonic: MIGPIA Period: 1965-79
Method: OLS

$$\ln(MIGPOA/POP15{+}R_{-1}) + 5.46266 =$$

$$+\mathrm{sum}\ (0,3)\ b(i)\ \ln\left(\frac{\dfrac{WRTA\$_i}{WRTR\$_i}}{\dfrac{WRTA\$_{(i-1)}}{WRTR\$_{(i-1)}}}\right)$$

$$+\mathrm{sum}\ (0,3)\ c(i)\ \ln\left(\frac{MFCAPUTC_i}{MFCAPUTC_{i-1}}\right)$$

$$+\mathrm{sum}\ (0,3)\ d(i)\ \ln\left(\frac{\dfrac{GRNRA\$_i}{POP15{+}A_{i-1}} \Big/ \dfrac{GRNRR\$_i}{POP15{+}R_{i-1}}}{\dfrac{GRNRA\$_{i-1}}{POP15{+}A_{i-2}} \Big/ \dfrac{GRNRR\$_{i-1}}{POP15{+}R_{i-2}}}\right)$$

i	b(i)	t(i)	c(i)	t(i)	d(i)	t(i)
0	+4.01532	(2.54)	+1.84286	(3.49)	+0.244524	(2.53)
1	+4.74511	(6.71)	+1.11547	(2.49)	+0.165510	(3.42)
2	+4.31915	(3.82)	+0.565867	(1.03)	+0.984181	(1.44)
3	+2.73745	(2.86)	+0.194043	(0.46)	+0.0432482	(0.75)
sum	+15.8170	(6.17)	+3.71825	(2.49)	+0.551700	(3.42)
	(2,4,FAR)		(2,4,FAR)		(2,4,FAR)	

$\overline{R}^2 = 0.635$ S.E.E. = 0.079431 D-W = 1.591

Name: Interprovincial Migration from Alberta
Mnemonic: MIGPOA
Period: 1965-79
Method: OLS

$$\ln(MIGPOA/POP15{+}A_{-1})+2.93886 =$$

$$+\text{sum}\ (0,3)\ b(i)\ \ln\left(\frac{WRTA\$_i/WRTR\$_i}{WRTA\$_{i-1}/WRTR\$_{i-1}}\right)$$

$$+\text{sum}\ (0,3)\ c(i)\ \ln\left(\frac{MFCAPVTC_i}{MFCAPVTC_{i-1}}\right)$$

$$+\text{sum}\ (0,3)\ d(i)\ \ln\left(\frac{\dfrac{GRNRA\$_i}{POP15{+}A_{i-1}} \Big/ \dfrac{GRNRR\$_i}{POP15{+}R_{i-1}}}{\dfrac{GRNRA\$_{i-1}}{POP15{+}A_{i-2}} \Big/ \dfrac{GRNRR\$_{i-1}}{POP15{+}R_{i-2}}}\right)$$

i	b(i)	t(i)	c(i)	t(i)	d(i)	t(i)
0	+0.791032	(0.72)	+1.38174	(3.77)	-0.162633	(2.42)
1	-1.64447	(3.08)	+0.530769	(1.71)	-0.0944462	(2.81)
2	-2.58814	(3.30)	+0.0168211	(0.04)	-0.0446124	(0.94)
3	-2.03999	(3.07)	-0.160102	(0.55)	-0.0131303	(0.33)
sum	-5.48156	(3.08)	+1.76923	(1.71)	-0.314821	(2.81)
	(2,4,FAR)		(2,4,FAR)		(2,4,FAR)	

$\overline{R}^2 = 0.759$ S.E.E. = 0.055138 D-W = 1.611

It is not possible to determine by inspection whether the "conventional" or the "s-f" specification is superior. We have performed dynamic full period simulations over the 1965-79 period with both specifications. The conventional specification yielded convincingly superior results.

Appendix B, Annex 1

Glossary of Mnemonics

BIRTHSA	Number of Births, Alberta
CPIA	Consumer Price Index, Alberta
CPIC	Consumer Price Index, Canada
CPIGC	Consumer Price Index, Goods, Canada
CPIGSTAIC	= CPIGC * (1+RSTRA)*.93925/(1+RSTRR)
CPIR	Consumer Price Index, Rest of Canada
DTSPA	Oil Sand Plant Construction Dummy, Alberta
DWRC	Wage Control Dummy, Canada
D72+	Dummy Variable, value = 1.0 in 1972 and after, zero before 1972
D74	Dummy Variable, unity in 1974, zero else
D78	Dummy Variable, unity in 1978, zero else
ECA	Employed, Construction Industry, Alberta
EMA	Employed, Mining Industry, Alberta
EMFA	Employed, Manufacturing Industry, Alberta
EOPA	Employed, Other Primary Industries, Alberta
EOPR	Employed, Other Primary Industries, Rest of Canada
ESA	Employed, Service Industry, Alberta
ETA	Employed, Total, Alberta
ETR	Employed, Total, Rest of Canada
GRNRA$	Government Revenues from Natural Resources, Current $, Alberta
GRNRR$	Government Revenues from Natural Resources, Current $, Rest of Canada

KMIGA	Share of population aged 15+, of total migrants, Alberta
K1A	Capital Stock, Buildings, in constant $, Alberta
LFA	Labour Force, Alberta
LFR	Labour Force, Rest of Canada
MFCAPUTC	Capacity Utilization Rate, Manufacturing, Canada
MIGFIA	Gross International Migration into Alberta
MIGFNA	Net International Migration into Alberta
MIGFOA	Gross International Migration from Alberta
MIGPIA	Gross Interprovincial Migration into Alberta
MIGPNA	Net Interprovincial Migration into Alberta
MIGPOA	Gross Interprovincial Migration out of Alberta
MIGTIC	Gross International Migration into Canada
MIGTNA	Net Total Migration into Alberta
MIGTNC	Net Total Migration into Canada
MIGTNR	Net Total Migration into Rest of Canada
MIGTOC	Gross Total Migration out of Canada
PARTRA	Labour Force Participation Rate, Alberta
PFCDH20	Price Index, Household Appliances, Canada
PHPA	$PHPA + PHPA_{-1} + PHPA_{-1} * -.5* \left(\frac{CPIA - CPIA_{-1}}{CPIA_{-1}} + \frac{PXA - PXA_{-1}}{PXA_{-1}}\right)$

POPNGA	National Population Growth Rate, Alberta
POPNGR	Natural Population Growth Rate, Rest of Canada
POP15+A	Population aged 15 and over, Alberta
POP15+R	Population aged 15 and over, Rest of Canada
PXA	Real Provincial Product Deflator, Alberta
PXCA	Real Provincial Product Deflator, Construction Industry, Alberta
PXCR	Real Provincial Product Deflator, Construction Industry, Rest of Canada
PXMA	Real Provincial Product Deflator, Mining Industry, Alberta
PXMR	Real Provincial Product Deflator, Mining Industry, Rest of Canada
PXMFA	Real Provincial Product Deflator, Manufacturing Industry, Alberta
PXMFR	Real Provincial Product Deflator, Manufacturing Industry, Rest of Canada
PXNCA	$\frac{XA\$ - (XCA * PXCA)}{XA - XCA}$
PXNMFA	(XMA*PXMA + XOPA*PXOPA + XCA*PXCA + XSA*PXSA) / (XMA + XOPA + XCA + XSA + RPPADJA)
PXNMFTA	= 0.6 * PXNMFA + 0.4*CPIGSTAIC
PXNSA	(XMA*PXMA + XOPA*PXOPA + XCA*PXCA + XMFA*PXMFA) / (XMA + XOPA + XCA + XMFA + RPPADJA)
PXNSTA	= 0.53 * PXNSA + 0.47*CPIGSTAIC
PXOPA	Real Provincial Product Deflator Other Primary Industries, Alberta
PXOPR	Real Provincial Product Deflator Other Primary Industries, Rest of Canada

PXR	Real Provincial Product Deflator, Rest of Canada
PXSA	Real Provincial Product Deflator Service Industries, Alberta
PXSR	Real Provincial Product Deflator, Service Industries, Rest of Canada
RPPADJA	Real Provincial Product Adjusting Entry, Alberta
RPPADJR	Real Provincial Product, Adjusting Entry, Rest of Canada
RSTRA	Provincial Retail Sales Tax Rate, Alberta
RSTRR	Provincial Retail Sales Tax Rate, Rest of Canada
SXMA	Cumulated Real Provincial Product, Mining Industry, Alberta
TANHIW/PA	= (e**[WRTA$/(PFCDH20*6.609)] - 1.0) / (e**[WRTA$/(PFCDH20*6.609)] + 1.0)
TIMEA	Time Trend
UA	Unemployed, Alberta
UR	Unemployed, Rest of Canada
URATEA	Unemployment Rate, Alberta
URATER	Unemployment Rate, Rest of Canada
WBCA$	Labour Income, Construction, Alberta
WBIRTHSRA	$= [(0.5 * BIRTHSA + 0.4 * BIRTHSA_{-1} + 0.3 * BIRTHSA_{-2} + 0.2 * BIRTHSA_{-3} + 0.1 * BIRTHSA_{-4}) / POP15+A]$
WBMA$	Labour Income, Mining, Alberta
WBMFA$	Labour Income, Manufacturing, Alberta
WBOPA$	Labour Income, Other Primary Industries, Alberta
WBSA$	Labour Income, Service Industries, Alberta

WBTA$	Labour Income, Total, Alberta
WBTR$	Labour Income, Total, Rest of Canada
WRCA$	Labour Income per Employed Person, Construction Industry, Alberta
WRMA$	Labour Income per Employed Person, Mining Industry, Alberta
WRMFA$	Labour Income per Employed Person, Manufacturing Industry, Alberta
WROPA$	Labour Income per Employed Person, Other Primary Industries, Alberta
WRSA$	Labour Income per Employed Person, Service Industry, Alberta
WRTA$	Labour Income per Employed Person, Alberta
WRTR$	Labour Income per Employed Person, Rest of Canada
WY/AA	Wheat Yield per Acre, Alberta
XA	Real Provincial Product, Alberta
XA$	Gross Provincial Product, Alberta
XCA	Real Provincial Product, Construction Industry, Alberta
XCR	Real Provincial Product, Construction Industry, Rest of Canada
XMA	Real Provincial Product, Mining Industry, Alberta
XMR	Real Provincial Product, Mining Industry, Rest of Canada
XMFA	Real Provincial Product, Manufacturing, Alberta
XMFR	Real Provincial Product, Manufacturing, Rest of Canada
XNCA	XA-XCA

XOPA	Real Provincial Product Other Primary Industries, Alberta
XOPR	Real Provincial Product, Other Primary Industries, Rest of Canada
XR	Real Provincial Product, Rest of Canada
XSA	Real Provincial Product, Service Industries, Alberta
XSR	Real Provincial Product, Service Industries, Rest of Canada

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