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Issues in a Natural Resources Economy

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Abstract

The present paper reviews the performance of Canada's non-agricultural resources sectors over the past two decades and examines the main theoretical models designed to explain the structure of a natural resources economy (NRE). From the perspective of export and employment growth, resources sectors no longer occupy the central position in Canadian development that they once did. Productivity performance in Canadian resources sectors has been mixed with some signs of strengthening in the latter part of the 1970-1987 period. Depending on the assumptions of the NRE model used to describe the Canadian economy, resource performance impinges on rents, wage rates, and employment. Resource rents (though difficult to measure) occupied centre-stage in the 1970s. Falling resources prices in the 1980s combined with advances in the theory of public sector rent capture have shifted attention in the late 1980s away from rent issues to issues of competitive performance.

Introduction

Among the world's leading industrialized trading nations, Canada has the largest share of its total exports in unprocessed and semi-processed natural resources and the second largest share of its exports in the form of processed resources (Porter 1991, 10-11). Canada's dependence on resources may well be changing over time, however, and a number of recent discussions of the resources sector have downgraded its recent and prospective contribution to economic growth and welfare (Crane 1992; Demers 1992; Economic Council of Canada 1992; Halliwell 1991, Porter 1990,1991). Is the Canadian economy experiencing a significant shift away from its dependence on natural resources sectors? If such a shift is occurring, several causes could be at work. The shift could be due to slow productivity growth in resources sectors relative to non-resources sectors, weak world demands for primary goods, or resource depletion. If any or all of these factors are operating, what are the likely impacts of such structural changes on Canadian income and welfare? Is there a role for public policy in response to the causes and effects of such changes?

The first task in such an enquiry consists of a review of recent trends in Canada's resources sectors. The present paper begins by summarizing the post-1970 relative performance of Canada's major non-agricultural resources industries. Placing fisheries (less than 2 percent of exports) on one side, the non-agricultural resource sector consists of minerals and forest products categories. Over 40 percent of Canada's 1990 total export earnings are in unprocessed and fabricated minerals and forest products (Table 1). Terms-of-trade and export volume trends, along with growth in productivity, cost performance, and employment are used to provide a background picture of ongoing structural changes in the Canadian economy in section 1. The general outlines of that picture lend support to the notion that resources sectors are no longer functioning as Canada's engine of growth. Employment in the minerals and forest products sectors ceased to expand in the 1980s. Export volumes in the resources sectors have been growing at rates significantly less than export volumes for end products. Post-1970 productivity and cost performance has been mixed across sectors in the resources categories but has strengthened relative to end products since the late 1970s.

Table 1

Merchandise Exports by Category (percent of total) 1990

Agricultural Products		7.97
Crude Materials		13.49
Crude Petroleum	3.88	
Ores and concentrates	2.62	
Natural Gas	2.44	
Coal and related	1.13	
Fabricated Materials		32.10
Metals and Alloys	5.69	
Newsprint	4.23	
Woodpulp	4.04	
Lumber	3.56	
Petroleum/Coal Products	2.24	
Other Paper/Paperboard	1.48	
Organic Chemicals	1.40	
Synthetic Rubber/Plastics	1.40	
Fabricated Metal Products	0.97	
Fertilizers and related	0.93	
Steel bars, rods, etc.	0.91	
Inorganic Chemicals	0.74	
Other wood products	0.72	
End Products		44.54
Transportation Equipment	24.42	
Other Equipment and Tools	3.60	
Electrical/Electronics	3.49	
Machinery	3.46	
Aircraft, Engines, Parts	3.12	
Office Machines, Equipment	2.44	

Source: Statistics Canada: Summary of Canadian International Trade 65-001

What are the economic effects of changes in the relative size of Canada's resources sectors? Recent contributions to the resources and trade literature suggest that a reasonably consistent (if loose-jointed) model of a resource dependent economy can be described for the purpose of categorizing the income and welfare impacts of shocks originating in natural resources sectors. Section 2 sets out a natural resource economy model or NRE along these lines. Depending on the detailed structure of the NRE, resource sector productivity changes, terms-of-trade changes and changes in resource stocks lead to a mix of income and welfare impacts on the aggregate economy that operate through returns to resource stocks in the form of rents, real wage effects, and changes in employment. Because of the prominent role of rents in NRE models, particular attention is directed to resource rent issues in this section. While impressive advances have been made in the *theory* of rent determination and the methods that can be used to efficiently transfer resource rents from the private sector to the public sector, accurate *measures* of economic rent remain elusive. Calibrated regional NRE models developed in the 1980s suggest that the real wage and employment components are also important features of the NRE.

Section 3 turns to policy issues that emerge from the resource sector performance review in section 1 and the NRE modelling exercises in section 2. The policy discussion is organized around three themes. The first theme is the correction of market failures associated with resources production with an emphasis on traditional results from international trade theory and the theory of resource exhaustion. The second public policy theme is the search for efficient methods of transferring resource rents from the private to the public sector. Substantial advances in the theory of rent capture have been made since the mid-1970s but considerable room for improvement remains in the application of rent capture models to Canadian resources sectors. The final theme picks up on the performance issues summarized in section 1. Productivity and cost performance concerns are moving to the top of the public policy agenda, supplanting rent capture by governments as the main public policy focus in Canada's resources sectors. This shift of emphasis is no doubt due, in part, to the emergence of the 'competitiveness' paradigm with its message that 'something' can (and should) be done to enhance private sector efficiency. A case can be made for a mildly *dirigiste* policy on the productivity side. Productivity policy could take the form of closer monitoring of productivity and cost developments using industry, government, and academic expertise to examine technological and managerial performance and opportunites in selected resources sectors. The pulp and paper sector is offered as an example. Section 4 consists of a concluding summary.

1. Resource Sector Performance

1.1 *Trade Indicators*

Canada's reliance on crude and fabricated materials exports has been changing gradually in the 1970s and 1980s. In 1971, resource categories accounted for 52 percent of merchandise exports. In 1980, resource exports had increased to nearly 60 percent of merchandise exports, largely due to increasing world prices for important mineral commodities, especially oil and gas. Declining minerals prices in the early 1980s reduced earnings from the resource export categories to their present level of 45 percent by 1986.

Resource commodity export earnings during the post-1970 period can be broken down into price and volume performance indicators. The escalation of resource commodities prices in the 1970s, particularly oil and gas prices, produced impressive increases in the prices of crude and fabricated material exports. Canada's terms-of-trade for crude materials, measured as the ratio of the crude materials export price index to the price index for aggregate merchandise imports (Figure 1), increased by nearly 100 percent from 1971 to 1980. The terms-of-trade for fabricated materials increased by over 25 percent during the same period. After 1980 the terms-of-trade for resource exports declined. For crude materials, the 1970s terms of trade gains were nearly eliminated by 1990. For secondary manufactures (end products), the 1970-1990 terms-of-trade pattern was essentially the reverse of the resources pattern. The overall result of opposing terms-of-trade trends for resources and non-resources categories over the past two decades has been a degree of stability in Canada's overall merchandise terms-of-trade. From 1971 to 1980, Canada's overall terms-of-trade improved by only 9 percent. From 1980 to 1990, the overall terms-of-trade deteriorated by only 5 percent. From an aggregate viewpoint, Canada had a fortuitously balanced 'portfolio' of exports with terms-of-trade movements in end-product categories offsetting a significant portion of the large terms-of-trade swings in crude and fabricated materials exports over the past two decades.

Although the 1980s have witnessed a substantial reversal in resources prices, the terms-of-trade for crude materials improved over the whole 1971-90 period by 17 percent. The terms-of-trade for fabricated materials improved by 23 percent. In contrast, the terms-of-trade for end-products declined by 18 percent from 1971 to 1990.

Export volume indexes over the same period reveal slow real growth in the resources categories (Figure 2). Crude materials export volumes increased

Figure 1: Terms-of-Trade Indicators (1971=100)

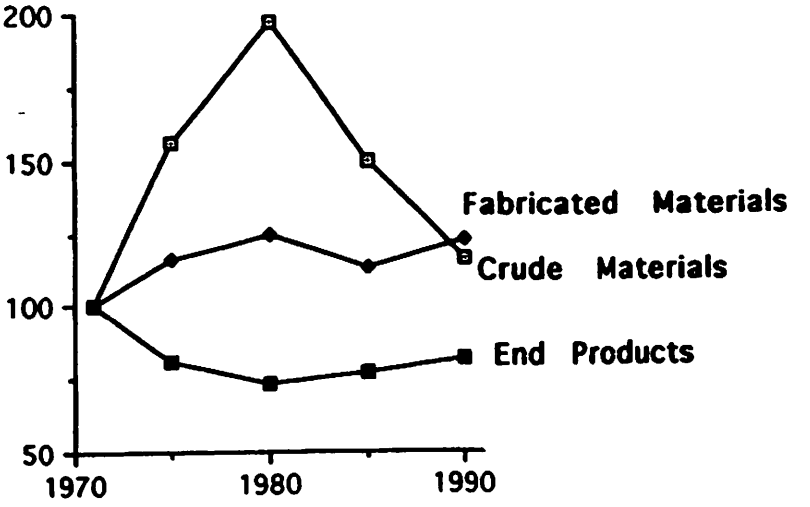
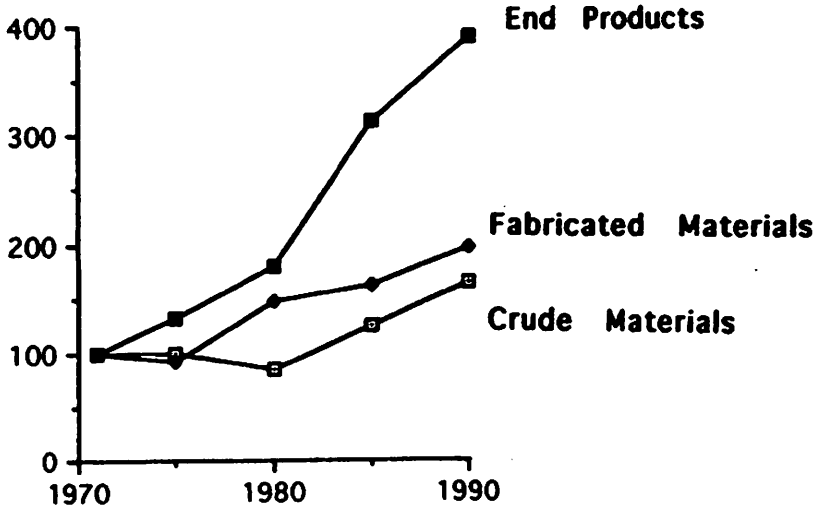


Figure 2: Export Volume Indexes (1971=100)



Sources: Statistics Canada: Summary of Canadian International Trade (65-001); The 1971-Based Price and Volume Indexes (65-001 Supplement)

in the early 1970s, declined from 1974 to the early 1980s, recovered and then grew fairly rapidly from 1982 to 1990. Just as with the terms-of-trade peformance, instability in the petroleum industry lay behind much of the problem of lagging export volumes from the mid-1970s to the early 1980s and the subsequent recovery of real exports. The 1973-82 period coincided with the federal government's crude oil export tax policy, relatively high provincial royalties in the Alberta petroleum industry, a mild recession in 1980, and a deeper recession in 1981-82. Canadian crude oil production declined from over 100 million cubic metres in 1973 to 65 million cubic metres in 1982 while crude oil exports fell from 66 million cubic metres in 1973 to less than 10 million cubic metres in 1981. Oil exports have since recovered but still remain below the peak 1973 level. Natural gas production was relatively stable in the 1970s and grew rapidly in the 1980s. Natural gas export volume doubled from 20 billion cubic metres in 1983 to over 40 billion cubic metres in 1990. The petroleum industry was almost entirely responsible for the 15 percent decline in real exports of crude materials from 1971 to 1981.

The striking feature of Figure 2 is the slow growth of natural resource export volumes relative to end-product export volume over the post-1970 period. Fabricated materials exports increased in real terms at an average annual compound rate of 3.6 percent from 1971 to 1990 while real end-product exports grew by 6.7 percent.

1.2 *Productivity and Cost Performance*

Productivity performance can be measured using either a single-factor or a multi-factor approach. The single-factor approach uses real income per employed worker or per person-hour of work as the productivity measure. If the measure of factor input is extended to include labour, capital, and intermediate inputs weighted by income shares then gains in output can be separated into gains due to the increased application of *all* factor inputs and the gain due to improvements in efficiency. The latter gain measures the improvement in total factor productivity or TFP. Productivity gains in Canada's resources sectors can be examined for extractive sectors, defined to include mining and timber harvesting, and for primary manufacturing sectors. For the extractive sectors, problems in the measurement of inputs, specifically the natural resource quality input, makes it difficult both to obtain and interpret TFP measures.

Much of the discussion of economic performance in North America in the 1980s has been dominated by observed slowdowns in North American productivity growth since the early 1970s (e.g.: Dertouzos, Lester and Solow 1989; Economic Council of Canada 1992; Denny, Bernstein *et al.* 1992; Rao and Lempriere 1992). Relative to the 1960s, Canadian

single-factor and multi-factor productivity growth measures in manufacturing slowed in the 1970s and slowed further in the 1980s. Against this background, Canada's extractive sectors have been somewhat atypical. The timber harvesting sector has experienced rapid gains in productivity since the mid-1970s due to the adoption of new mechanized harvesting methods. Using either real GDP in logging or a physical measure of roundwood production per employed worker, labour productivity increases of over 50 percent were achieved from the mid-1970s to 1987. Mineral extraction, however, shows a sharp contrast to logging and illustrates some of the problems of productivity measurement in extractive sectors. Throughout the 1970s, real GDP per employed worker declined for metals and mineral fuels and this decline was quite steep for mineral fuels. From the mid-1970s to the early 1980s, oil and gas production fell. Recent analysis of similar behaviour in the United States (Friedman 1992) suggests that fluctuating prices combined with changing resources quality lie behind this unusual pattern. The steep energy price increases of the 1970s extended recovery activities to lower quality deposits and reduced labour productivity at the same time that output from existing fields was declining. From 1970 to 1980, labour productivity in Canada's mineral fules sector declined at an average rate of nearly 10 percent a year. An analogous pattern was observed by Green (1984) in his examination of productivity behaviour in the Canadian gold-mining industry of the 1970s. Productivity in the metal mining sector fell by about 3 percent per year during the 1970s. Both mineral production levels and productivity levels have recovered since 1983. From 1980 to 1988, labour productivity has been increasing at 7.5 percent in the metals sector and at 0.2 percent in mineral fuels. Rao and Lempriere (1992) report a 0.3 percent average annual TFP improvement in the mining sector from 1980 to 1988 and a 3.3 percent growth rate in TFP for forestry (including logging) over the same period.

Table 2 documents the slowdown in labour productivity growth (measured by real GDP per person-hour) over the 1961-1987 period for Canadian manufacturing as a whole and for selected sectors, including the resource-based primary manufacturing industries. Annual productivity growth in aggregate Canadian manufacturing declined from nearly 4 percent during the 1960s to 2.6 percent in the 1970s and then to 1.5 per cent from 1977 to 1987. Table 2 divides Canadian manufacturing sectors into three groups. The first group, consisting of wood products, paper and allied products, primary and fabricated metal products, non-metallic mineral products (such as stone, clay, and glass), and petroleum and coal products, consist of major industries linked closely to the underlying forest and minerals resource base. The second group (synthetic rubber, plastics, and chemicals) uses resources as inputs but are not as closely linked to endowments of resources as the first group. The final group of

Table 2

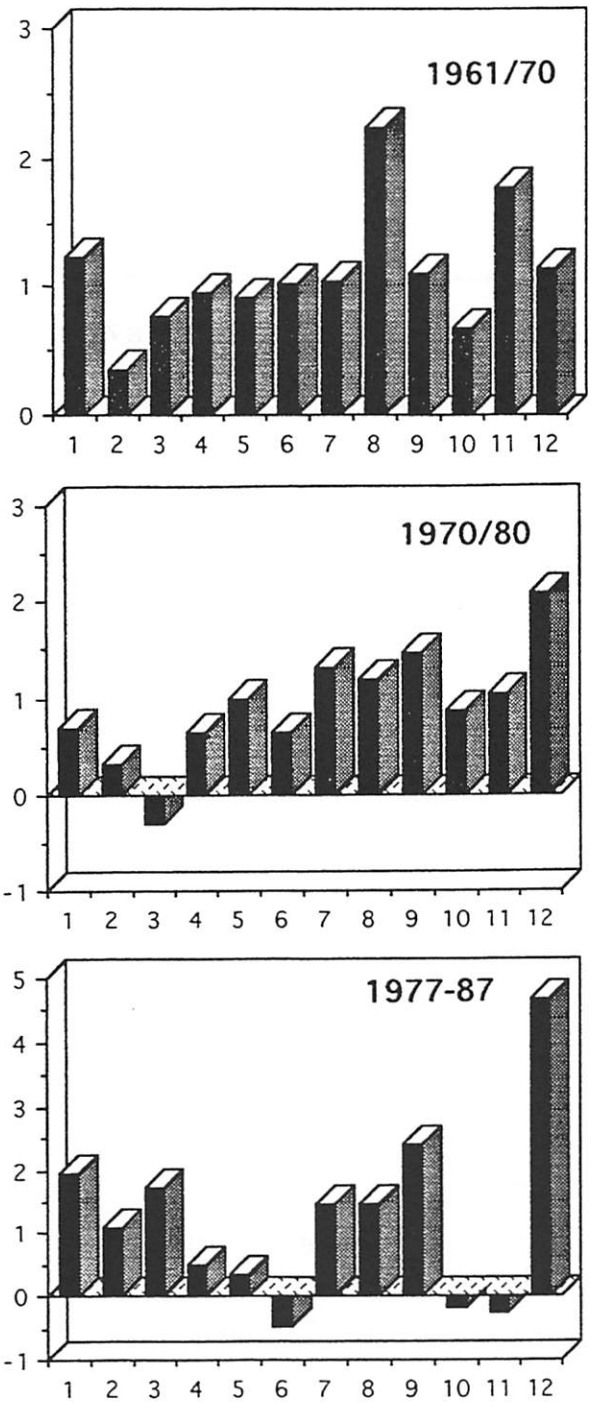
Average Annual Labour Productivity Growth (percent)
Selected Manufacturing Industries

	1961-70	1970-80	1977-87
Total Manufacturing	3.9	2.6	1.5
Fabricated Materials			
Wood Products	4.8	1.8	2.9
Paper and Allied	1.4	0.8	1.6
Primary Metals	3.0	-0.8	2.6
Fabricated Metals	3.7	1.7	0.7
Non-metallic minerals	3.6	2.6	0.5
Petroleum/Coal Products	4.0	1.7	-0.7
Rubber Products	4.1	3.4	2.2
Plastics	8.7	3.1	2.2
Chemicals	4.3	3.8	3.6
End products			
Machinery	2.6	2.3	-0.3
Transportation Equipment	6.9	2.7	-0.4
Electrical/Electronics	4.4	5.4	7.0

Source: Calculated from: Statistics Canada - Aggregate Productivity Measures. Cat. 15-204E (Annual), July 1991. Labour Productivity = Real GDP per person-hour.

Figure 3

Average Annual Labour Productivity Growth by Sector
(Relative to Total Manufacturing)



Sectors:

01 Wood Products
02 Paper and Allied
03 Primary Metals
04 Fabricated Metals
05 Non-metallic Mineral Products
06 Petroleum/Coal Products

07 Rubber Products
08 Plastics
09 Chemicals
10 Machinery
11 Transport Equipment
12 Electrical Equipment

Table 3

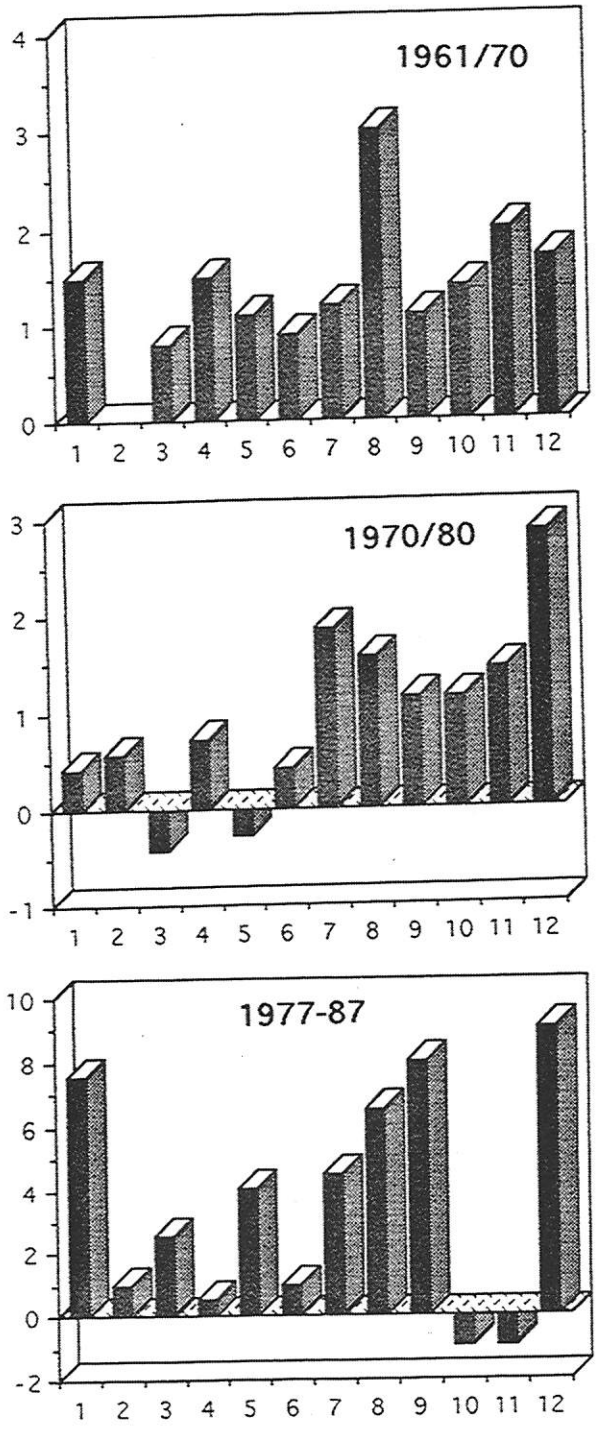
Average Annual Total Factor Productivity Growth (percent)
Selected Manufacturing Industries

	1961-70	1970-80	1977-87
Total Manufacturing	1.0	0.7	0.2
Fabricated Materials			
Wood Products	1.5	0.3	1.5
Paper and Allied	0.0	0.4	0.2
Primary Metals	0.8	-0.3	0.5
Fabricated Metals	1.5	0.5	0.1
Non-metallic minerals	1.1	-0.2	0.8
Petroleum/Coal Products	0.9	0.3	0.2
Rubber and Allied	1.2	1.3	0.9
Plastics	3.0	1.1	1.3
Chemicals	1.1	0.8	1.6
End Products			
Machinery	1.4	0.8	-0.2
Transportation Equipment	2.0	1.0	-0.2
Electrical/Electronics	1.7	2.0	1.8

Source: Calculated from: Statistics Canada - Aggregate Productivity Measures. Cat. 15-204E (Annual), July 1991.

Figure 4

Average Annual Total Factor Productivity Growth by Sector (Relative to Total Manufacturing)



Sectors:

01 Wood Products
02 Paper and Allied
03 Primary Metals
04 Fabricated Metals
05 Non-metallic Mineral Products
06 Petroleum/Coal Products

07 Rubber Products
08 Plastics
09 Chemicals
10 Machinery
11 Transport Equipment
12 Electrical Equipment

industries, consisting of automobiles, vehicle parts, trucks, machinery and electrical and electronics products constitute Canada's main end-products export industries and are not directly linked to the domestic resource base. Table 3 presents the same information using the multi-factor productivity measure (TFP). The TFP measure uses aggregate real output value for sectoral output together with the current-weighted sum of labour, capital, and materials as sectoral input. The current-weights used are the shares of the three inputs in the value of total sectoral output. Figures 3 and 4 have been derived from the two tables to show annual rates of productivity growth across manufacturing sectors *relative* to overall Canadian manufacturing productivity growth in each period.

The labour productivity growth comparisons in Figure 3 clearly indicate that the closely-linked resource sectors (sectors 1 through 6) experienced generally slower than average rates of productivity increase from 1961 to 1987. The major exceptions are wood products in the 1960s and 1980s and primary metals in the 1980s. When the growth of inputs other than labour are included in Figure 4, however, the performance of the resources sectors improves. Performance is mixed in the 1960s, uniformly below average in the 1970s and generally above average from 1977 to 1987. The above average performance for most resources sectors in the latter period reflects the strongly negative impact of TFP in the machinery and transport (automotive) equipment on aggregate manufacturing productivity growth from the late 1970s to the late 1980s.

Further insight into productivity trends in resource based *versus* non-resource based manufacturing sectors in the post-1970 period can be obtained through international comparisons of Canadian sectoral productivity performance. Denny, Bernstein *et al* (1992) and Rao and Lempriere (1992) report sectoral comparisons of TFP growth in Canadian manufacturing relative to the US and Japan. Referring to the Denny, Bernstein *et al* study, sectors 1 through 6 - the resource-linked sectors - all showed faster TFP growth in Japan than in the US or Canada over the 1961 to 1985 period and Canada ranked behind the US in about half of these sectors over the same time period. For the 1980s, the rankings are more diverse. Canada's TFP growth outstripped both the US and Japan in lumber, petroleum, and primary metals and ranked second in non-metallic minerals (behind the US) and fabricated metals (behind Japan). Canada's performance was mixed relative to the US and Japan in its end-products TFP rankings both over the longer 1961-1985 period and during the 1980s.

Based on the productivity evidence, it can be argued that Canada's primary manufacturing industries *did* experience lagging productivity prior to the 1980s, both relative to other manufacturing sectors in Canada and relative to their counterparts in the US and Japan. But the 1980s seem to have

altered this picture. Partly as a result of slowdowns in productivity growth in Canada's end-products industries and partly due to improved international productivity performance in Canadian resource-linked sectors, the resources industries as a whole have performed at least as well as other sectors since the late 1970s. As noted above, similar conclusions seem to apply to mining and logging activities. The evidence presented by the Economic Council is also broadly consistent with this conclusion. The Council noted marked deterioration in total factor productivity in the resources sectors relative to so-called 'high-tech' sectors (machinery and transportation equipment) from 1961 to 1979 with no noticable trend since 1979 (Economic Council 1992, p.15 and Figure 10).

The analysis of total unit costs undertaken by Rao and Lempriere (1992) is also consistent with these relative productivity results (see Rao and Lempriere, Tables 2 and 5). Average annual rates of increase of total unit costs in mining and forestry exceeded the average for Canadian manufacturing industries from 1974 to 1979 and were below average from 1980 to 1988. Of the six resource-linked manufacturing sectors, four experienced faster than average unit cost increases in 1974-79 and three experienced faster cost increases from 1980 to 1988. Taking Canada/US comparisons, unit costs increased in Canada relative to the US across all manufacturing sectors from 1974 to 1988. From 1974 to 1979 the average annual rate of increase of total unit cost in aggregate manufacturing exceeded the comparable US rate by 18 percent. All the resource-linked manufacturing sectors experienced lower cost increases relative to their US counterpart industries with the exception of the paper and allied sector. From 1980 to 1988, Canada's average annual unit cost increase in aggregate manufacturing was 55 percent higher than in the US. Four of the six resource-linked sectors had rates of unit cost growth relative to their US counterparts that were less than 55 percent.

1.3 *Employment and Relative Wages*

Declining relative employment in extraction and manufacturing is a well known consequence of the growth of the service sector in the postwar period. Employment in Canada's logging and mining-milling sectors fell from 1.8 percent of total employment in 1971 to 1.3 percent of total employment in 1990. From 1971 to 1981, the absolute number of extractive sector jobs increased by 20 percent. In 1990, however, there were 16,000 fewer jobs in Canada's extractive industries than in 1981 (Table 4). Jobs in the resource-linked manufacturing sectors fell from 487,000 in 1971 to 482,000 in 1990. Over the same period manufacturing employment outside the resource-linked industries rose by nearly 20 percent with the most rapid gains in transportation equipment (37 percent) and chemicals (44 percent). It is clear that extractive and

Table 4

Resource Sector Employment	1971-1990		(Year-end: 000)
	1971	1981	1990
Extractive Sectors			
Logging	36.2	30.1	29.7
Metal Mines	59.8	65.4	39.9
Coal	8.0	11.3	10.7
Oil and Gas	14.7	37.9	44.1
Non-metal mines	14.9	14.9	10.3
Quarries/Pits	3.8	3.1	9.4
Mining Services	13.5	18.9	20.7
Total Extractive	150.9	181.6	164.8
Resource-Linked Manufacturing			
Wood Products	83.4	72.9	89.0
Paper and Allied	115.6	124.5	114.7
Primary Metals	112.7	123.8	83.7
Fabricated Metals	114.2	116.3	132.5
Non-metallic Minerals	44.6	44.3	44.8
Petroleum/Coal Products	16.6	24.5	17.6
Total Resource-Linked	487.1	506.3	482.3
Total Manufacturing	1466.6	1540.3	1656.2
Canada Aggregate	8201.0	10722.0	12248.0

Sources: Statistics Canada: Employment, Earnings and Hours 72-002; Historical Labour Force Statistics 71-201

primary manufacturing sectors are no longer providing any growth in employment opportunities. In fact the Canadian labour force is gradually being reallocated from the resource sectors to manufacturing and service employment.

The Economic Council (1990) has noted that redeployment of labour away from traditional resource and smokestack industries has implications for average real wages. Canada's extractive and primary manufacturing sectors are dominated by relatively high-wage unionized firms. In 1990, extractive sectors and resource-linked industries in the wood, paper and allied, primary metals, and petroleum and coal products categories paid average hourly earnings in excess of average hourly earnings in other sectors. Some of these differentials are quite large. In the logging sector, for example, average hourly earnings exceeded the manufacturing average by 26 per cent in 1990. In the mining and paper and allied industries, the 1990 wage differentials relative to manufacturing were 33 per cent and 25 per cent respectively. These wage relatives have persisted in spite of the slow growth or decline in employment opportunities in resource extraction and processing over the past two decades.

1.4 *Resource Sector Performance: A General View*

The relative export volume evidence described in section 1.1, combined with resources sector employment performance noted in the previous section, serve to identify Canada's resources extraction and processing industries as relatively slow-growth sectors. Over the whole 1970-1990 period, the Canadian economy has been shifting its export activity away from dependence on resource-based industries and toward end-products exports. Canada's trade volume performance in crude and fabricated materials has not been high enough to sustain employment levels in these sectors over the past two decades. The terms-of-trade for resource-based products has deteriorated relative to end products in the 1980s but this deterioration followed large increases in many resources prices in the 1970s. Over the whole post-1970 period, the terms-of-trade has in fact improved for crude and fabricated materials while the end products terms-of-trade has worsened.

The review of productivity and cost performance in the extractive and resource-linked manufacturing sectors in section 1.2 produces a mixed picture. The hypothesis that productivity has been lagging in these sectors has some credibility for the 1970s but does not hold up for the 1980s. Recent productivity and unit cost performance has varied across resources sectors and over time but, overall, resources industries have not acted as a drag on overall Canadian productivity nor have the resources sectors been systematically outperformed by their counterparts internationally.

2. Modelling A Natural Resources Economy

2.1 *The Chambers-Gordon Paradigm*

The stylized facts of aggregate economic growth are usually developed using single-sector models. Technological progress and capital-deepening are accompanied by increasing real wages and approximately constant returns to capital over the long-run. While much can be learned from single-sector models, a more detailed approach seems essential to understanding the structure and long-run behaviour of individual economies embedded in trading relationships with the rest of the world. In the Canadian case, for example, the single sector approach might be replaced by two sectors: a natural resources or R-sector exporting unprocessed or processed resource commodities to the world economy and a manufacturing or M-sector existing in competition with imports of manufactures from the world economy. To keep the model as simple as possible, it could be assumed that capital is highly mobile internationally. With capital returns fixed, the model can focus on the returns to labour and natural resources. Such a two-sector/two-factor trading model has the advantage that it can draw on standard propositions in neoclassical international trade theory and, since the focus is to be on natural resources issues, the model might be designated as a natural resource economy model or NRE model.

The first formal statement of an NRE model along these lines can be found in Chambers and Gordon (1966). In the Chambers-Gordon (CG) version, the NRE is small enough that it accepts prices as fixed on world markets. The R-sector uses labour and a homogeneous stock of natural resources to produce natural resources commodities (R-goods) which are perfect substitutes for R-goods produced in the rest of the world. The M-sector uses labour to produce M-goods which are also perfect substitutes for M-goods produced elsewhere. While it is true that capital ought to be included in the production functions of both sectors, strong capital mobility ensures that either sector can obtain all its required capital inputs at a fixed price so little is lost by implicitly subtracting required capital returns in determining each sector's (net) output to be divided between labour and the owners of natural resource stocks. In true neoclassical tradition, the production functions in both sectors exhibit constant returns - doubling labour in the M-sector doubles output of M-goods; doubling labour and the resource base doubles R-sector output. There are diminishing returns to labour applied to the fixed resource stock in the R-sector. Resource stocks are large so that the R-sector exports and the M-sector is import-competing.

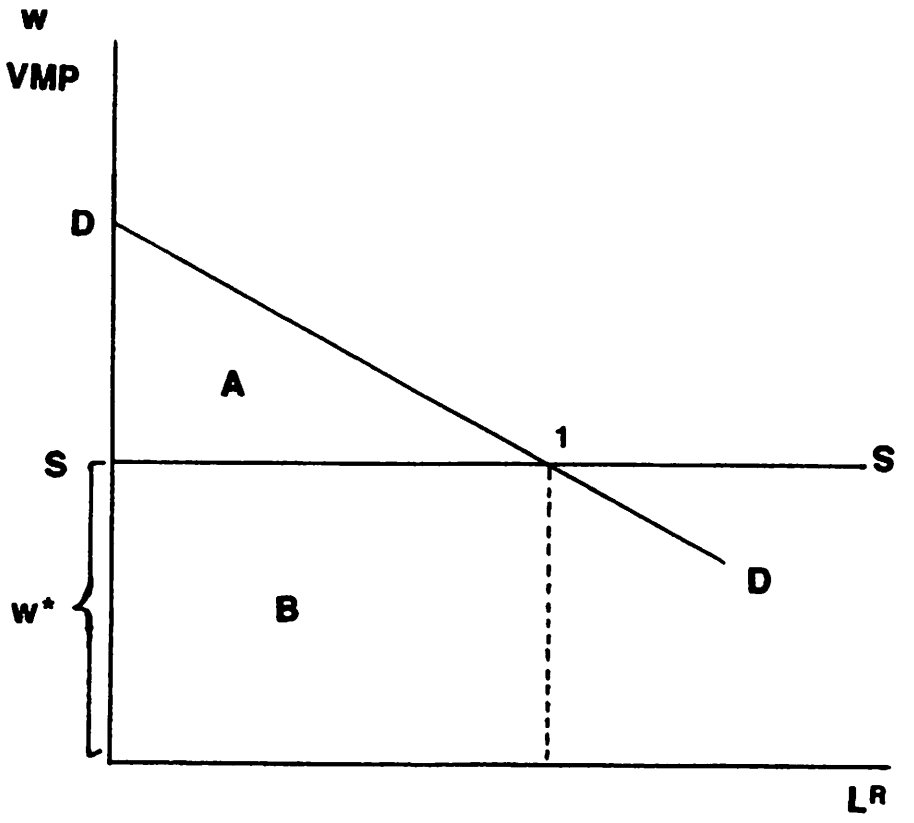


Figure 5

Chambers-Gordon Model

Figure 5 illustrates the relative simplicity of the CG model. Free entry and exit of firms in the M-sector ensures that the wage rate in the M-sector is determined by the international price of (perfectly substitutable) M-goods together with technical conditions in the M-sector. The wage rate has to be just high enough to eliminate profits for M-sector firms. Provided labour is perfectly mobile between the domestic M and R-sectors, the M-sector wage - call it w* - becomes the supply price of labour for the R-sector. Since R-sector firms can hire all the labour they want at w*, w* defines the height of the R-sector's perfectly-elastic labour supply curve denoted by SS in Figure 5. With a fixed natural resource base and a fixed international price for R-goods, the value of additional R-sector output produced by an additional worker in the R-sector is falling (diminishing returns to labour in the R-sector). This inverse relationship between the value of labour's marginal product (VMP) is shown by DD in Figure 5. At point 1 firms in the R-sector are hiring labour (L^R) up to the point at which the value of its marginal product equals the wage (VMP=w*).

Adding up the value of R-sector output produced by all workers hired up to point 1 in Figure 5 produces area A+B. Since total wages in the R-sector are measured by area B, the triangular area A measures the value of net output in the R-sector that accrues to the natural resource base as *economic rent.*

The CG model neatly dichotomizes the impact of exogenous variables on income determination. A productivity advance in the domestic M-sector, for example, raises w* (and the real wage) in Figure 5. Part of the real wage increase is a transfer from economic rent and the R-sector contracts in response. A productivity advance in the R-sector, an increase in the size of the underlying resource base, or an increase in the world price of R-sector goods shifts DD upward. Real wages are unaffected and rents increase. Indeed, the strong message of the Chambers-Gordon version of the NRE is that the entire impact of terms-of-trade effects, productivity effects, and resource stock effects are captured by resulting changes in the size of economic rent. Further, the value of the NRE's resource endowment can actually be measured by area A in Figure 5 as CG argued in their analysis of Canada's early 20th century wheat economy. If the underlying resource base was to disappear, R-sector workers would be transferred to the M-sector with no change in w* and the value of net output in the NRE would fall by A. If economic rent and/or its changes can be measured, goes the message of the CG model, then we have a complete view of the way in which natural resources sectors affect aggregate income and welfare in the NRE.

2.2 *How Large are Natural Resource Rents?*

The structure of the Chambers-Gordon model places rent at the centre of analysis of Canada's resources sectors. This emphasis dovetailed neatly with resources sector issues in the 1970s. Models of exhaustible resource utilization, begun in the 1930s by Hotelling (1931) and elaborated in the late 1960s and 1970s (e.g.: Devarajan and Fisher 1981) stressed maximization of present-valued economic rent as the objective in the optimal depletion of resource stocks over time. Rapidly increasing resource commodity prices in the 1970s, particularly for oil and gas, but evident as well for non-fuel minerals and forest products, generated windfalls in Canada's extraction sectors through upward shifts in DD in Figure 5. And provincial ownership of the underlying resource base, combined with federal policies to protect consumers from rising energy prices, focused a good deal of public policy attention on the issue of the distribution of resource rents among producers, consumers, and governments. Consistent with the spirit of the times, the Economic Council of Canada sponsored a series of studies of the role of economic rent in an NRE using the CG model as the analytical framework (Copithorne 1977, 1979a, 1979b). With all the theoretical and policy-related attention given to rents in the 1970s, one might be forgiven for assuming that the actual measurement of rent is a problem with a straightforward solution. After all, one need merely subtract costs from revenues to isolate area A in Figure 5. This apparent ease of measurement has turned out to be illusory, however.

The rent measurement problem can be illustrated using a case study. A careful attempt to measure resource rent in the Canadian base metal mining sector was undertaken by Mackenzie and Bilodeau (1979). MB examined discoveries of base metal deposits from 1951 to 1974 and calculated their net present values, defined as the difference between the present value of revenues from the sale of mineral products net of the present value of all costs required to generate those sales. The calculated net present values measured the economic rents on base metal deposits.

The average economic deposit in the MB study had a net present value of $32 million and the net present value of all deposits was $2751 million. These calculations assumed a discount rate (cost of capital) for the net present value calculations of 8 percent. The average annual (base-case) rents calculated by MB over the 1951-74 period amounted to less than .02 percent of GNP. MB also reported rent estimates for other discount rates, reflecting a range of possible assessments of mining sector risk. They

also examined high and low metals prices assumptions. At a capital cost of 5 percent, rent rose to $6255 million, more than twice the base case figure of $2751 million. With the discount rate at 10 percent, rent declined to $1509 million, just over 50 percent of the base case estimate. Higher and lower metals prices assumptions produced large variations in the rent estimates as well. The MB study illustrates that wide variation in measured rents is simply inherent in the residual nature of the way rent is defined. Even modest variations in assumed revenues and costs can lead to large variations in rent estimates - up to 100 percent or more in the MB study.

Similar rent estimation problems arise in other resources sectors. When standing timber resources are auctioned, for example, bidders often enter much higher estimates than the seller's appraised values (Haley 1980; Drushka 1985) and the data and methodology of the timber appraisal itself have been subjected to criticism (Pearse 1974; Scott 1976). Nor have timber appraisal systems been adapted to deal with the distinction between short-run (quasi) rent on timber resources and long-run rent. In the short-run, standing timber can be regarded as fixed in supply. In the long-run, reforestation costs have to be subtracted from stumpage appraisals in order to isolate the economic returns accruing to Canada's long-run timber supplies. Since regeneration expenditures are typically incurred many years prior to harvesting, an appropriate (but debatable) return on capital cumulated forward on these costs ensures significantly lower economic rents on regenerated timber supplies than their short-run appraised values. In some Canadian forest regions, the long-run rents on regenerated timber may be negative unless reforestation costs are kept to an absolute minimum (Anderson 1979; Benson 1988).

However difficult the measurement problem, resource rents were clearly large and positive in Canadian minerals sectors by the early 1980s. Using simpler measurement techniques than the Mackenzie-Bilodeau study, the Economic Council of Canada placed aggregate resource rents in the vicinity of 10 percent of 1980-81 Canadian GNP (Economic Council 1982). The Council defined rents as existing in two categories: first, natural resources revenues actually collected by provincial governments and second, resource revenues that could have been collected on natural resources products but which were actually passed forward to consumers in the form of below-market prices.

Below-market prices for oil and gas in 1980-81 reflected the federal government's domestic pricing policy in the petroleum sector. From 1973 to 1982, lower domestic oil prices were enforced through a tax on oil exports to US markets. The proceeds of the tax were directed to the cost of maintaining the domestic price below the cost of imported oil in Quebec

and the Atlantic region. Natural gas export prices to the U.S. were set by the National Energy Board above the domestic price with the export revenue proceeds shared by the companies and both levels of government. In addition, hydroelectric prices were set on the basis of average-cost pricing regulations for all power supplies. Since hydro power was cheaper to produce than thermal power from coal and nuclear installations, potential rent on hydroelectricity generation was being passed forward in the form of lower prices to both domestic and U.S. purchasers of power. Below-market pricing of energy resources transferred $22 billion in windfall resource rent to domestic and foreign consumers in 1981-82. The Economic Council estimated resource rents passed through to consumers plus rents in the form of provincial resource revenues at nearly $29 billion.

Provincial revenues from natural resources in the form of mining taxes, royalties, bonus bids on petroleum exploration prospects, and stumpage fees and dues amounted to $7 billion in 1980-81 or 2.5 percent of GNP. The use of resource revenues as a measure of rent captured by provincial governments does present problems, however. For such a procedure to be strictly valid, economic rent should constitute the tax base on which these revenues are collected. Placing a tax on wellhead prices in the petroleum sector, for example, as Alberta does, constitutes an impost on factor returns in general, not simply on rent. In the absence of efficient rent transfer mechanisms in resources sectors, there is little justification for the assumption that provincial revenues are some fraction of total resource rent (Bernard 1982). The issue of efficient rent transfer is discussed further in section 3.2.

As a guide to the *long-run* significance of resource rents in Canadian income, the ECC estimate is obvously far too high. Eighty to ninety percent of the Council's rent estimate derived from the petroleum sector. The two large energy price shocks in the 1970s were in 1973-74 and 1979-80. The point in history at which the Council made its estimates (1980/81) was almost uniquely guaranteed to produce unusually large rent estimates in the form of temporary windfalls on existing Canadian reserves.

It seems *a priori* improbable to expect any significant windfall rents in Canada in the late 1980s and 1990s. The oil and gas sector was the major source of rents in the Economic Council study and it is reasonable to assume that these have now disappeared. Below-market pricing is no longer present in the petroleum sector. Resource commodity prices have fallen significantly since the Council's earlier measurements. Canadian wellhead oil and field prices for natural gas (expressed in $US) increased by a factor of ten from 1970 to 1981 and then fell to half the 1981 level by the early 1990s (Scotiabank Commodity Price Indices, 1992). The

average cost of producing oil and gas is now much closer to wellhead prices than in the 1970s and early 1980s. Measuring the supply price of oil and gas by (present-valued) exploration, development and production cost per cubic metre, researchers at the National Energy Board have found little evidence of any systematic excess of wellhead/field prices over supply prices with the exception of the pre-1970 and 1982-85 periods for oil (Bowers and Kutney 1989). Depending on the discount rate selected, some positive rents may have been in evidence for natural gas from 1975 to 1985.

Provincial resource revenues relative to GNP have also declined since 1980. Table 5 shows the importance of provincial resources revenues in 1987-88 relative to total provincial revenue. Taking all the provinces together, resources revenues contribute only about 5 percent to provincial revenue and overall resource revenues collected by provincial resource owners was less than 1 percent of Canadian GNP in 1988. The impact of resources revenues on fiscal capacity is highly assymetric across provinces. Petroleum sector revenues are significant in Alberta and Saskatchewan and forestry revenues are important to the B.C. Treasury.

The likelihood that resource rents are a very small component of GNP in the early 1990s does need some qualification. First, as noted above in the Mackenzie-Bilodeau case study, precise estimates of rent are next to impossible to defend so any specific figure would be highly debatable. Second, some of the returns to Canadian resources could be accruing to non-resource factors of production. The possibility that labour is able to capture resource rents in the form of wage premia has been raised in previous studies (Copithorne 1979a; Percy 1986). The existence of wage premia in many resources sectors (section 1.3) lends plausibility to the notion that some fraction of resource rents are being transferred to labour. If such rent-in-wages transfers do exist, movement of workers from resource sector employment to jobs in other sectors leads to losses in the form of a reduction in the average returns to labour. Based on 1979 data, Percy argued that less than half of forestry rents in British Columbia took the form of resource revenues with most forestry rents absorbed in logging and forest products sector wage contracts. A difficulty with this argument lies in the fact that significant wage premia also exist in several non-resource sectors (e.g.: transportation equipment) as well. The existence of wage premia in these non-resource sectors (Copithorne 1979a) is the likely reason for the omission of rent-in-wages from the Economic Council's earlier rent estimates (Economic Council 1982).

Table 5

Provincial Government Resource Revenues
Per Cent of Total Revenues 1987-88

	Forests	Mines	Oil and Gas	Total
Atlantic Provinces	0.3	0.4	neg.	0.8
Quebec	0.3	0.0*	0.0	0.5
Ontario	0.2	neg.	neg.	0.7
Manitoba	neg.	0.7	0.3	1.9
Saskatchewan	neg.	2.2	8.7	11.3
Alberta	0.2	0.1	28.9	29.4
British Columbia	5.0	0.5	1.7	9.2
Territories	neg.	0.0	0.0	0.1
Total Canada	0.7	0.2	3.8	5.2

Notes: *Quebec's mining tax revenues negative in 1987-88 due to tax rebates on mining investment incentives.

Total revenue includes revenues from hydroelectric power, fish and game liciences, and miscellaneous resources revenue.

neg. = negligable.

Sources: Statistics Canada: Public Institutions Division.
Statistics Canada: Provincial Economic Accounts, 1984-88, 13-213.

2.3 *Are Resource Rents the Whole Story?*

The message that economic rent magnitudes, no matter how difficult they may be to measure accurately, capture the full effect of the resources sector on GNP was opened to question by the early 1980s. The impetus came from international trade theory as a result of the impacts of North Sea oil discoveries and rising energy prices on the economies of northern Europe. The response of the Netherlands economy acted as a kind of case study: the increased size of the petroleum sector placed obvious upward pressure on Dutch wages in the late 1970s. The Dutch manufacturing sector became less competitive as a result and contracted to make room for the booming oil-related sectors - the so-called 'Dutch disease'. New theoretical models identified the natural resources sector as the 'booming sector' with deindustrialization in manufacturing (the 'lagging sector') as the logical consequence of wage increases and increases in domestic expenditure driven by the resources boom (Corden and Neary 1982; Corden 1983, 1984). A 'booming sector' framework was used by Norrie and Percy (1982,1984) to construct a multisector calibrated model of the Alberta economy. These 'booming sector' models of the early 1980s were designed to examine the immediate consequences of sudden shocks in resources sectors. They do, however, contain the potential for long-run application to an NRE.

The key to long-run application of the 'booming sector' notion lies in relaxing the restrictive treatment of the manufacturing sector in the Chambers-Gordon model. In the CG model, the resource sector is allowed to expand or contract without influencing domestic wage rates because of the assumption that capital is internationally mobile and the assumption that domestic manufactures are perfect substitutes for imported manufactures. This results in the perfectly-elastic supply curve of labour to the R-sector (SS) shown in Figure 5. If the perfect-substitutes assumption in the M-sector is dropped, substitution of imported manufactures for domestic manufactures in consumption requires an increase in the prices of domestic manufactures relative to the prices of foreign manufactures (Lewis 1975).

Econometric evidence for the US suggests that demand elasticities for imported manufactures imply a 1 to 2 percent increase in import volumes for each 1 percent increase in domestic prices relative to import prices (Goldstein and Khan 1985; Brookings 1987). The assumption that imports are imperfect substitutes for domestic goods in consumption is common in single-country general equilibrium modelling (Norrie and Percy 1982,

1984; Shoven and Whalley 1992, chaps. 4 and 9). Supply-side issues may be a more important issue in the long-run. Canada's long-run manufacturing wage relative to the U.S. (adjusted for exchange rates) is likely to depend importantly on the locational issues that formed the heart of the Wonnacotts' analysis of the impact of Canada-U.S. free trade on Canadian wages in the late 1960s (Wonnacott and Wonnacott 1967). In this vein, Krugman has recently argued that relative exchange-adjusted manufacturing wages in domestic and foreign markets may be much more closely linked in the long-run than in the short-run (Krugman 1989). The reason lies in firms' long-run locational decisions. A fall in the domestic manufacturing wage relative to the foreign wage should induce footloose manufacturing firms to prefer a domestic location over a foreign location. This locational entry-exit process tends to tie long-run exchange-adjusted manufacturing wages together in a kind of 'locational equilibrium' (see also Anderson 1988, chap. 2). Such a supply-side substitution approach can be argued to be closer to the spirit of the CG model than the notion that domestic and foreign manufactures are perfect substitutes in demand.

Assuming *some* degree of imperfect substitution in the traded manufactures sector, movement of labour out of the M-sector into the R-sector implies an increase in the prices of domestic manufactures relative to imported manufactures and an accompanying rise in the exchange-adjusted domestic wage rate relative to foreign wages. The R-sector's labour supply curve is upward-sloping as shown in Figure 6 rather than perfectly elastic. In the jargon of trade theory, expansion of the R-sector increases the domestic economy's real exchange rate. Further, the assumption of imperfect substitution between Canadian and foreign non-resource goods also unleashes domestic expenditure effects that would otherwise spill out into imports under perfect substitution and these expenditure effects contribute to the increase in domestic wages as the R-sector expands.

In contrast to the CG model, the domestic wage now becomes a function of what is happening in the resources sector. The upward-sloping SS curve in Figure 6 says that long-run wages in Canada could not be as high as they are in the absence of natural resources. Without the R-sector, exchange-adjusted Canadian wages would have to fall relative to wages abroad to reduce Canada's dependence on imports of foreign manufactured goods and to expand Canada's exports of manufactured goods. In this model, productivity gains and terms-of-trade improvements in the R-sector have the potential to raise domestic real wages as well as resource rents.

The message of the CG dichotomy was that Canadian real wages are determined by the terms-of-trade and productivity in the manufacturing sector while conditions in the R-sector, given the wage determined in the

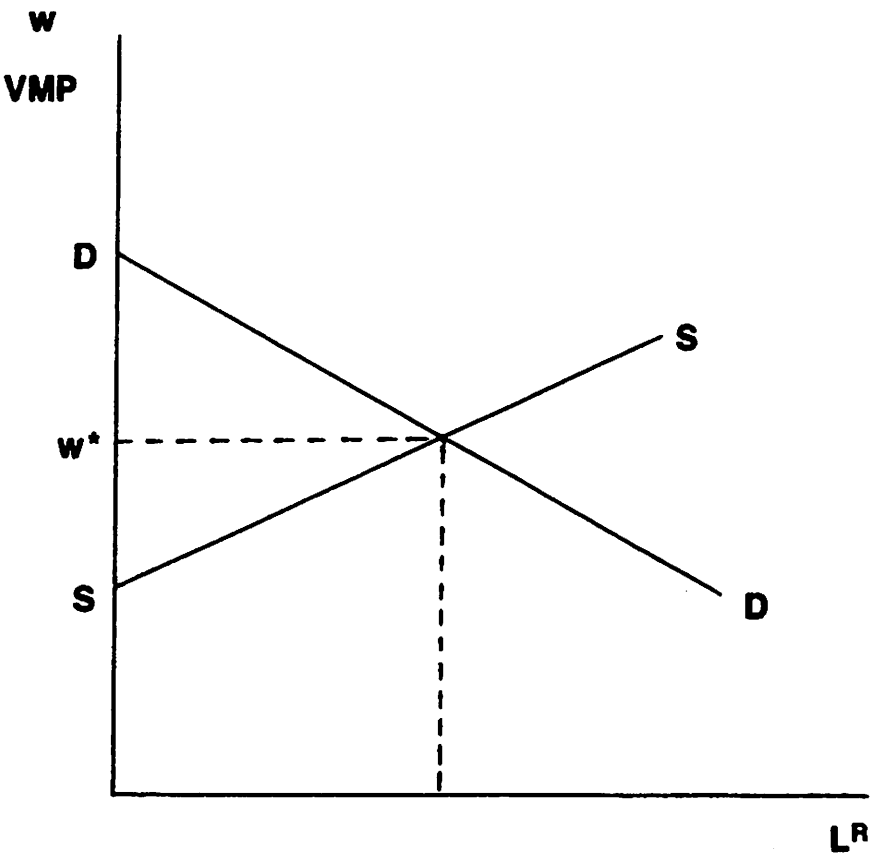


Figure 6

Generalized NRE Model

M-sector, serve to determine resource rents. When domestic wages depend on the demand for labour in resources sectors, this dichotomy no longer holds. An increase in the demand for labour in the R-sector due to improved terms-of-trade for resources goods or improved R-sector productivity shifts DD upward in Figure 6. The expected result is an increase in both resource rents and wages. The wage increase affects both resource and non-resource sectors and is in addition to any increase in average wages that may occur because R-sectors pay wage premia relative to non-resource sectors (section 2.2). In contrast to the CG representation of an NRE, resource rent magnitudes fail to capture the full domestic impact of resources on GNP. As a corollary, the slow growth or decline in employment in the resources sectors noted in section 1.3 can have adverse implications for economy-wide real wages.

2.4 *Implications of the NRE Framework*

From an empirical viewpoint the problems surrounding rent measurement described in the section 2.2 are compounded by the need to estimate the impact of resource sector shocks on overall labour market equilibrium in a general equilibrium NRE. As noted above, some fairly strong assumptions are needed to completely insulate labour markets from developments in resources sectors. If the simple CG representation is to be a reasonably close approximation to the structure of Canada's NRE, long-run national labour market integration must be supplemented by long-run integration of Canadian and U.S. manufacturing sectors. The latter will only be the case if exchange-adjusted manufacturing wages in Canada are closely tied to U.S. manufacturing wages in the long-run through the locational decisions of a subset of footloose manufacturing firms willing to shift capital freely within a North American free-trade regime.

In the absence of the strong integration assumptions characteristic of the CG approach, Canadian real wage levels are partially dependent on the terms-of-trade, employment and productivity performance in resources industries. If resource sector shocks transmit real shocks to domestic labour markets, Canada's natural rate of unemployment is also dependent on long-run resources sector performance. Resources rents no longer capture the full impact of resources sectors on Canadian GNP and welfare once labour-market effects are introduced. General equilibrium short-run models of regional NREs (Norrie and Percy 1982,1985 for Alberta and Percy 1986 for British Columbia) have already been developed in this vein. Some suggestive results were also reported by Boadway and Treddenick (1977) in their analysis of the economic impact of the Canadian mining sector in the 1970s.

3. Public Policy Issues

3.1 *Market Failure Arguments*

The NRE models of the previous section are designed to capture the broad outlines of the impact of natural resources sectors on overall equilibrium in an open economy. Under assumptions of price-taking behaviour with well-defined property rights, the equilibrium outputs of resources goods correspond to welfare-maximizing outputs. Much of what might be referred to as conventional public policy arguments in the theory of resources utilization and trade theory consists of exceptions to the view that private sector equilibrium automatically leads to the correct mix of resources-producing activities and other activities in general equilibrium - what is usually referred to as *market failure*. These market-failure arguments have at least three characteristics: first, there are a fairly large number of them; second, they are often difficult to quantify; and, finally, their individual effects on resource sector outputs often point corrective policy in divergent directions. Without attempting to provide an exhaustive list, the following arguments are often advanced in support of public policy to modify NRE equilibria to account for alleged market failure.

The *terms-of-trade argument* from international trade theory suggests that a reduction in Canadian resources exports could improve domestic welfare by increasing world prices received for resource exports. Competitive Canadian resource firms generate external benefits to foreign consumers of resource products in the form of low prices at the expense of domestic profits. The potential increase in domestic profits from export restrictions is a net benefit to Canadians provided the increase in profit accrues to Canadians and the costs to foreigners due to higher prices is of no concern to Canadians. Canada produces large enough world-market shares of some resources goods to lead to sensitivity of world prices to Canadian export levels. Some observers have argued that Canada's long-term potential for monopolistic control over world prices is too limited to be of any real policy significance (e.g.: Caragata 1984). For specific mineral commodities, such as nickel, potash and uranium, monopoly or cartel activities have influenced Canadian supply decisions. The imposition of an export tax on Canadian lumber shipments to the U.S. in the late 1980s may have provided modest gains to Canada in the form of higher U.S. lumber prices (Boyd and Krutilla 1987). An important cost of export restrictions is the threat of foreign retaliation (Webb and Zacher 1988). Both GATT rules and the rules of the FTA constrain the use of export taxes or other export restrictions to improve Canadian welfare at the expense of the welfare of foreign consumers.

Observed *wage differentials* between Canadian resources sectors and other domestic sectors (sections 1.3 and 2.2) point in the opposite direction to the terms-of-trade argument (see also Gera and Grenier 1991). In this case, the marginal social cost of expanding resources sectors is less than marginal private cost owing to an assumed rent component in resource sector wages. Aggregate social returns from resources activities could be increased by subsidizing labour inputs in Canada's R-sectors. This argument has been advanced as part of a strategic trade policy under which export or production subsidies could be used to shift rents into the domestic economy (Katz and Summers 1989; Harris 1989) and has a close affinity with now well-known second-best arguments that an individual traded goods sector subjected to a regulated wage is too small and can be expanded by a subsidy policy (e.g.: Krugman 1991, 250-52). The subsidy policy is used to compensate for the domestic labour market distortion that transforms resources rents into wage differentials. This species of market failure argument has had no discernible impact on Canadian policy and international trade obligations may again prevent any policy action.

The natural resources and environmental economics literature contributes further market-failure arguments that can be added to those from trade theory. The present-value optimizing stucture (mentioned at the beginning of section 2.2) that has driven the development of the intertemporal theory of resource extraction since the late 1960s contains arguments that private-sector extraction rates will tend to exceed optimal extraction rates. In this case, the market failure centres on vagueness in *property rights* and the absence of coordinated supply decisions through *incomplete forward markets* that lead to a bias in favour of present over future extraction (see Anderson 1991, chap. 2 and references; Pearse 1988). No real body of evidence has been assembled to support the idea that Canadian exhaustible resources are being extracted at excessively high rates, however. The absence of well-defined property rights in *environmental* stocks also produces a theoretical bias to current use. In this case, instances of external costs are easy enough to find and are ubiquitous in the revival of environmental policy issues since the mid-1980s. The current conflict between forests as sources of timber inputs and as sources of environmental amenities, for example, asks whether or not the true social costs of timber harvesting are adequately reflected in prices paid by the private harvesting sector for wood supplies and how available stocks of forest land should be allocated between timber and non-timber uses (e.g.: Haley and Leitch 1992). Social welfare, measured by present-valued returns to resources from all uses, can be improved by restricting resource sector production below its current level, either through quantitative controls or through taxes on environmental depletion or degradation.

Technological externalities provide a final example of market-failure arguments applied to resources sectors. The property rights component again plays a prominent role. Exploration activities and research and development expenditures frequently convey benefits to firms other than those initiating the activities in question. The argument is quite general, though, and so applies to knowledge-enhancing activities across all sectors. If knowledge-enhancing activities are subsidized to bring about correspondence between marginal social costs and benefits, the implications for the levels of production in resources sectors is uncertain. If such externalities are most pronounced in non-resource sectors, for example, subsidization of research and development will expand the non-resources sectors at the expense of resources sectors and *vice-versa*.

The upshot of conventional market-failure arguments for the size of resources sectors is uncertain. Terms-of-trade and resource depletion arguments often imply an optimal decrease in the size of R-sectors. The wage differentials argument points in the reverse direction while the technological externalities result could go either way. The common thread in all the market failure arguments is their appeal to the existence of divergences between private and public net benefits in specific resource-related activities and the policy dictum that such divergences can be corrected by using tax-subsidy or quantitative ("command and control") techniques to expand (contract) those activities or sectors in which the allocation of society's productive resources in private-sector equilibrium generates positive (negative) marginal net benefits.

3.2 *Capturing Resource Rents*

The search for appropriate mechanisms to transfer resource rents from the private sector to the provincial public sector dominated policy discussions in Canada's minerals sectors in the 1970s. There are at least two reasons to think that the rent capture issue is less important in the 1990s. First, although consensus on the 'right' way to transfer resource rents to the public sector is not complete, a great deal has been learned about the mechanics of rent capture at the theoretical level. Second, as described in section 2.2, resource rents cannot now be very large. The massive increases in mineral prices - particularly energy prices - that drove the rent capture debate are history.

Resource rents can be transferred from the private to the public sector using either *ex-ante* techniques or *ex-post* techniques. *Ex-ante* rent-capture techniques involve the estimation of resource rent prior to extraction while *ex-post* techniques allow rent magnitudes to emerge from the actual revenues and costs incurred by the private sector in the

process of extraction. The *ex-ante* category includes public appraisals of the prospective value of resources as well as private appraisals translated into market measures of resource values through bidding mechanisms in which publicly-owned resources are auctioned off to private developers.

Ex-post transfer mechanisms take the form of resource taxes. To ensure that resource taxes actually fall on resource rents rather than on pre-production and extraction costs, efficient resource rent tax mechanisms must isolate the *ex-post* rent magnitude and then use this magnitude as the base for a resource rent tax (Garnaut and Clunies-Ross 1975,1979). This efficiency-based model of resource rent transfer has been described as cash flow taxation (e.g.: Boadway, McKenzie, and Mintz 1989) or as a system of net value royalties (Bradley and Watkins 1987). In essence, the tax base is the net present value of the resource but the actual measurement of NPV is retrospective. Investment costs are incurred by the private sector in the pre-production phase (exploration and development) of a resource project and net operating revenues are realized during the subsequent extraction phase. Negative cash flows in the pre-production phase are carried forward and grossed-up using a pre-determined rate-of-return on investment. The excess of the extraction phase net operating revenues over the investment costs carried forward defines (*ex-post*) resource rent subject to the resource rent tax.

The choice between *ex-ante* and *ex-post* resource rent transfer systems is influenced by at least three central issues. First, the presence of risk and uncertainty ensures that prospective rent estimates will diverge from the rent results actually realized. Second, the cost-efficiency with which resource development and rent transfer activities are actually carried out is not independent of the choice of transfer system. Finally, the decision to use *ex-post* transfer very often leads to the implementation of an inefficiently designed resource tax system. These three issues can crop up separately or in combination.

Consider first the risk and uncertainty issue in the absence of the other cost and efficiency issues. Suppose the Province of Alberta can either auction off petroleum exploration leases to a perfectly competitive collection of equally-efficient potential resource developers or (somehow) select a single developer and levy a cash-flow tax (at a rate of 100 percent) on the results of the single developer's resource project. If there is no disagreement among potential resource developers concerning the likely outcomes of resource development and all have the same attitude to risk, the winning bid represents the certainty-equivalent NPV for the project. If developers are risk-averse, the certainty-equivalent bid lies below the mean NPV of the project. If the province is risk-neutral it will

choose the *ex-post* rent capture approach over bidding since the present value of the province's *ex-post* returns (equal to the mean NPV) is larger than the winning bid. This choice efficiently allocates risk to the party (the province) for which risk matters least. Of course the risk preference assumptions are crucial here. If, for example, some prospective developers are also risk-neutral or even enjoy risk, then the province can do at least as well, if not better, by auctioning off the development rights. And the resource-owner may do even better if some prospective developers have especially optimistic expectations of the project's range of returns.

Turning to the cost side, it is difficult to imagine a pure *ex-post* transfer mechanism without efficiency implications. If, realistically, prospective developers differ in the cost-efficiency with which they discover, develope, and extract resources, how can the resource owner choose the least-cost producer without some form of *ex-ante* payment for development rights? And even if the low-cost producer could be identified under a pure *ex-post* transfer system, extraction of a large fraction of the realized surplus from a resources project through taxation reduces the private sector's incentive to minimize costs since the same large fraction of any realized cost savings accrue to the public owner as increased resource tax revenue. This type of disincentive is absent from the *ex-ante* system since the *ex-ante* appraised value of the resource or its bid-price is a sunk cost for the winner. The cost of administering rent transfer systems may also be a consideration. No province other than British Columbia expends the substantial public resources needed to appraise standing timber stocks (Haley and Luckert 1990). In all likelihood, the administrative costs of detailed and regular appraisals in other provinces would exceed the rents thus measured.

Finally, the decision to capture resource rent using taxes is no guarantee that the tax regime chosen will conform to the ideal rent-based principle. Canada's provincial resource tax systems, viewed in the absence of other taxes on resources industries, often work against the extraction of rent-bearing resources. Most provinces with commercial timberlands collect stumpage on the basis of scaled harvest volume or weight and/or index timber revenues to forest products prices. Alberta levies royalties on wellhead and field prices of oil and gas. At the margin, these kinds of taxes discourage production from economic resources. When combined with the corporate tax system, however, the impact of *overall* resource taxes can go the other way. Using the mid-1980s federal-provincial tax regime, Boadway, McKenzie and Mintz (1989) have shown that combined corporate and mining tax systems for Canada's non-fuel minerals sectors contain sufficiently strong capital expenditure incentives at all stages from exploration though the installation of mining equipment and structures to cause uneconomic (negative rent) projects to be accepted.

Reform of Canada's existing rent-capture systems should take the form of a combination of *ex-ante* and *ex-post* approaches. In addition, as Boadway, Mintz, and McKenzie have argued, existing capital spending incentives for minerals sectors embedded in the corporate tax system need to be removed. Provincial governments can share risk with the private sector by capturing part of resource rents using rent-based cash flow taxation while using appraisal and bidding techniques to transfer the remaining expected rents prior to project development (Watkins 1987). In the forestry and non-fuel minerals sectors, the use of bidding techniques for the allocation of resources remains rare. Useful gains may be available from the use of auctions as a method of allocating resources to new entrants.

As industry representatives have stressed, Canada's rent capture systems need to be responsive to fluctuations in rent since the residual nature of rents implies that such fluctuations can be significant. It is equally important to maintain stability in the set of government rules that comprise the transfer mechanism itself. Stability of the transfer rules reduces private sector risk associated with resource projects. The overall welfare significance of reforms to the resource taxation system are unlikely to be large, however, despite the contribution that resources revenues make to provincial fiscal positions in Alberta and British Columbia (Table 5).

3.3 *The Productivity Nexus*

Canada's international competitive position in resources and prospects for continued growth are not clear cut (section 1). Productivity growth in the resources industries over the 1970-87 period has been mixed. Growth of exports, as measured by aggregate export volume indicators, has been slower than the rate of growth of final product export volumes and the absolute level of employment in the resources sectors has been essentially static over the past twenty years. In part, the relatively slow growth of exports reflects worldwide changes in the relative importance of final demand for resources goods compared to final goods and services. To gain a larger share of world markets for resources goods, Canada's resources sectors would require faster productivity growth combined with slower rates of growth in labour compensation.

Is there any coherent role for public policy addressed to productivity issues in the natural resources sectors? On one side of any such discussion, a pure *laisser-faire* model of public policy would simply leave productivity-improving decisions entirely to free market forces, relying on incentives within the resources industries to produce results that are beneficial or otherwise in the long-run. Clearly the private sector has been

eminently successful in maintaining Canada's competitive position in many sectors. Recent productivity improvements in the logging sector, wood products, primary metals, and and petroleum/coal products have been strong. In some other sectors, productivity and unit cost performance have been much less satisfactory. The pulp and paper sector, particularly newsprint, is an example of the latter and some of the subsequent discussion in this section will focus on this case.

Supporters of the *laisser-faire* model can argue that the best that can be done in the private sector is already being done. There is obviously a large element of truth in this view. Overall market growth has in fact focused on non-resource sectors and will continue to do so. In the main, resources industries that are declining in relative importance are declining because the dynamics of productivity advance and market growth have shifted to high technology end-products. This is a process that seems destined to continue with the result that Canada's economic structure will continue to shift away from resources as comparative advantage moves to secondary manufacturing and traded services. The consumer electronics sector is continuing to enjoy rates of productivity advance that cannot be duplicated by resources products. From the pure *laisser-faire* perspective, putting time and effort into promotion of Canada's natural resources sectors is just backing the wrong horse. If any form of activist public policy is to be pursued, it should be directed to the sunrise industries of the future not the sunset resources sectors of the staples-driven past.

Alternative to a *laisser-faire* policy for resources industries is a more interventionist approach to resources sectors. When intervention in resource sector performance has seemed critical, the traditional Canadian response has been to turn to subsidization or tax policies. Corporate tax incentives built into the mineral industry tax system, for example, have been noted in the last section. Attempts to improve productivity in the pulp and paper sector in the late 1970s and early 1980s led to joint federal-provincial subsidies directed to modernizing pulp and paper mills and enabling existing plants to upgrade their environmental controls to meet new federal and provincial standards. The results of the 1979-84 Pulp and Paper Modernization Program provide a useful cautionary tale (Anderson and Bonsor 1985; de Silva 1988). The subsidization policy failed to address fundamental issues of comparative advantage or basic microeconomic issues of firm efficiency. As a result of its concentration on the productivity problems experienced by existing older plants in the Ontario-Quebec sector of the industry (notably newsprint producers) in the late 1970s, the impact of the program was a stop-gap at best and, at worst, may well have delayed fundamental changes. By focusing public funding on the least progressive elements of the industry, the program generated the justified perception that firms that had successfully

modernized were being penalized relative to grant recipients. Grant recipients were not encouraged to examine the option of large scale replacement of aging facilities with state-of-the-art plants. A more comprehensive approach to the industry's problems would have revealed that state-of-the-art investments were capable of providing competitive rates of return relative to capital costs and relative to the U.S. locations that were placing competitive pressure on the Canadian industry without public subsidies. The underlying problem of commitment on the part of management and labour to productivity improvement and cost containment were never examined by the program and there is no evidence that the cash infusion route proved effective in producing a long-run commitment to competitive performance within the industry. Such industry-specific subsidization models also conflict with Canada's commitment to avoid export subsidies under both GATT and FTA rules and have the potential to provoke costly countervail responses under US trade law.

The pulp and paper modernization case not only indicates the wrong way for the public sector to pursue productivity improvements, it also presents a puzzle and a possible constructive public policy response that may already be a feature in some other sectors such as mining. While it should be admitted that the aggregate labour productivity and TFP information in section 1.2 does not offer much in the way of a detailed understanding of productivity and cost development in individual industries, more detailed examination of the pulp and paper case reveals that overall productivity advance has been slower in Canada than elsewhere in this sector. The Canadian industry has been reluctant to modernize, with or without grants. At the very least, public policy research into the reasons for this behaviour is warranted and the questions that arise are necessarily microeconomic in content. The puzzles are detailed ones. Why have some firms failed to keep up on the productivity front over the past two decades by installing new kinds of pulping techniques and larger, faster paper machines? What are the characteristics of those firms that have maintained state-of-the-art facilities relative to those that have not done so? Why have some firms moved away from standard newsprint grades into other product lines while others continue to produce standard grades with older plants? What methods are being used by successful producers to meet U.S. newsprint recycling requirements and to what extent does location matter for recycled newsprint plants? Turning this sector of the pulp and paper industry into a dynamic 'cluster' (to use the term coined by Michael Porter in his recent analyses of industrial competitiveness), turns on the answers to these kinds of questions which, in turn, depend on the details of newsprint markets, technology, and management abilities in the pulp and paper sector.

In such a detailed arena successful policy intervention is obviously difficult at best Very specific issues are involved requiring specialized knowledge in industrial organization and management. Can anything useful be done? One possible approach would be to establish or utilize ongoing sector-centred groups that can draw on expertise from industry, government, and universities to study the detailed economic and technological performance of key resource industries. The Centre for Resource Studies at Queen's University, focused on the Canadian minerals sector, provides an interesting prototype of the research benefits that accrue from an industry focus. The Centre's research program identifies problems of concern to the industry and to public policy and sponsors research projects accordingly. Continuing interaction of mining industry decision-makers with academics and public officials through the CRS suggests that the benefits to the mining industry are perceived to be significant. The existence of such an institution in the pulp and paper industry would almost surely have produced more knowledge on the industry's productivity problems in the context of comparative international studies of the industry's major sectors in the 1970s and 1980s together with discussion of the private and public sector actions alternative to the chosen policy instrument of modernization subsidies.

4. Summary and Conclusions

Viewed from the perspective of employment and export growth over the past two decades, natural resources sectors no longer occupy the key position in Canadian economic development that they once did. Like other developed economies, changing economic structure will continue to emphasize growth in end-products manufacturing and services. From a North American perspective, this transition was accomplished much earlier in the US, probably by the end of World War II (Wright 1990). Overlaid on these long-run structural changes in employment and output have been the more recent "productivity slowdown" issues that began to attract attention in public policy discussions in the 1970s and 1980s in the US. The productivity evidence reviewed in section 1.2 of the present paper leads to a mixed picture of the "productivity slowdown" for Canadian extractive and primary manufacturing activities. As suggested by Figures 3 and 4, slow productivity growth in resource-linked sectors relative to the Canadian manufacturing average is evident prior to the 1980s (in terms of both labour productivity and multi-factor productivity measures). Resource-sector productivity performance has improved since the late 1970s, however, both relative to other manufacturing sectors in Canada and relative to counterpart industries in Japan and the US (Denny, Bernstein *et al* 1992). Canadian productivity growth in aggregate manufacturing has continued to slow throughout the 1970s and 1980s

(Tables 2 and 3) so there is no room for complacency on this score. But the evidence for the 1980s does not support the view that resources sectors *in toto* present a special dynamic efficiency problem relative to other sectors. For those resource sectors that have experienced persistent lagging productivity growth - pulp and paper is an obvious example - the previous section has suggested that formalization of ongoing research into sectoral performance involving academic, industry, and government expertise along lines similar to the work of the Centre for Resource Studies for the minerals sector.

The impact of ongoing resource sector developments on the economy depends crucially on how the Canadian NRE is assumed to work. Prior to the 1980s, the Chambers-Gordon paradigm (section 2.1) dichotomized the long-run general equilibrium effects of resource sector shocks by assuming perfectly elastic supplies of non-resource inputs to resources sectors. This dichotomy had the effect of confining the impact of R-sector terms-of-trade and productivity shocks to resources rents and thus helped to validate the almost exclusive attention to rents that was characteristic of resource sector discussions in the 1970s. The "rent question" has now somewhat faded from prominence, partly because rents, though hard to measure with any precision, are certainly much smaller in the late 1980s and 1990s as a result of falling resource commodity prices over the past decade. In addition, the advent of booming-sector models in the early 1980s laid the groundwork for a more complex, but as yet empirically unspecified, approach to the long-run structure of NREs. This newer, more general, approach (section 2.3) includes long-run real wage and employment effects as well as rent effects among the impacts of resource sector shocks.

Placing somewhat stronger emphasis on generalized NRE modelling and on the dynamic efficiency aspects of productivity in Canadian resources sectors does not imply that the rent capture issue will, or ought to, disappear from the public policy menu. Much has been learned on the subject of efficient rent collection since the mid-1970s (section 3.2) and there are still static efficiency payoffs to be had from nudging existing rent capture systems in the direction of combined bidding and cash-flow taxation regimes. But the payoffs here will not be large given the limited significance of rents.

While recognizing the potential for improved environmental tradeoffs, one might also surmise that there are few large static efficiency gains to be exploited from correction of the other types of market failure catalogued in section 3.1. In some cases (terms-of-trade manipulation or the wage-differentials argument), institutionalized international constraints stand in the way of corrective tax-subsidy moves. In other cases, notably

technological externalities and optimal timing considerations, as yet not enough is known to warrant definitive conclusions for public policy action.

References

Anderson, F. (1979) "Ontario Reforestation Policy: Benefits and Costs" *Canadian Public Policy*, 5, 336-47.

_____ (1988) *Regional Economic Analysis: A Canadian Perspective* Toronto: HBJ Holt.

_____ (1991) *Natural Resources in Canada: Economic Theory and Policy* Toronto: Nelson.

Anderson, F. and Bonsor, N. (1985) *The Ontario Pulp and Paper Industry: A Regional Profitability Analysis.* Toronto: Ontario Economic Council

Bank of Nova Scotia. (1992) *Scotiabank Commodity Price Indices.*

Benson, C. (1988) "A Need for Extensive Forest Management" *The Forestry Chronicle*, October, 421-30.

Bernard, J-T. (1982) "La rente des ressources naturelles." *Canadian Public Policy*, 8, 297-99.

Boadway, R., McKenzie, K. and Mintz, J. (1989) *Federal and Provincial Taxation of the Canadian Mining Industry.* Kingston: Centre for Resource Studies, Queen's University.

Boadway, R. and Treddenick, J. (1977) *The Impact of the Mining Industries on the Canadian Economy.* Kingston: Centre for Resource Studies, Queen's University.

Bowers, B. and Kutney, R. (1989) "Trends in Crude Oil and Natural Gas Reserves: Additions Rates and Marginal Supply Costs for Western Canada" *The Journal of Canadian Petroleum Technology*, 28, 88-94.

Boyd, R. and K. Krutilla (1987) "The Welfare Impacts of Trade Restrictions against the Canadian Softwood Lumber Industry" *Canadian Journal of Economics*, 20, 17-35.

Bradley, P. and Watkins, G.C. (1987) "Net Value Royalties - Practical Tool or Economist's Illusion?" *Resources Policy*, December, 279-88.

Brookings Institution (1987) *Workshop on the US Current Account Imbalance.* Brookings Discussion Papers in International Economics Number 58.

Caragata, P. (1984) *National Resources and International Bargaining Power: Canada's Mineral Policy Options.* Kingston: Centre for Resource Studies, Queen's University.

Chambers, E. and Gordon, D. (1966) "Primary Products and Economic Growth: An Empirical Measurement" *Journal of Political Economy*, 74, 315-22.

Copithorne, L. (1977) "A Neo-classical Perspective on Natural Resource-Led Regional Economic Growth" Economic Council of Canada. Discussion Paper 92. Ottawa.

_____ (1979a) *Natural Resources and Regional Disparities.* Ottawa: Economic Council of Canada.

_____ (1979b) "Natural Resources and Regional Disparities: A Skeptical View" *Canadian Public Policy*, 5, 181-94.

Corden, M. (1983) "The Economic Effects of a Booming Sector" *International Social Science Journal*, 35, 441-454.

_____ (1984) "Booming Sector and Dutch Disease Economics: Survey and Consolidation" *Oxford Economic Papers*, 36, 359-80.

Corden, M. and Neary, P. (1982) "Booming Sector and Deindustrialization in a Small Open Economy" *Economic Journal*, 92, 825-848.

Crane, D. (1992) *The Next Canadian Century.* Toronto: Stoddart.

Demers, M. (1992) "Responding to the Challenges of the Global Economy: The Competitiveness Agenda" in F. Abele (ed.) *How Ottawa Spends: The Politics of Competitiveness.* Ottawa: Carleton University Press.

Denny, M., J. Bernstein, M. Fuss, S. Nakamura and L. Waverman "Productivity in Manufacturing Industries, Canada, Japan, and the United States, 1953-1986: was the productivity slowdown reversed?" *Canadian Journal of Economics*, 25, 584-603.

Dertouzos, M., Lester, R. and Solow, R. (1989) *Made in America: Regaining the Productive Edge.* New York: Harper.

de Silva, K. (1988) "Pulp and Paper Modernization Grants-An Assessment" Economic Council of Canada Discussion Paper 350. Ottawa.

Devarajan, S. and A. Fisher (1981) "Hotelling's 'Economics of Exhaustible Resources': Fifty Years Later." *Journal of Economic Literature*, 19, 65-73.

Drushka, K. (1985) *Stumped: The Forest Industry in Transition.* Vancouver: Douglas and McIntyre.

Economic Council of Canada (1982) *Financing Confederation Today and Tomorrow.* Ottawa: Supply and Services.

_____ (1990) *Good Jobs, Bad Jobs: Employment in the Service Economy.* Ottawa: Supply and Services.

_____ (1992) *Pulling Together. Productivity, Innovation, and Trade.* Ottawa: Supply and Services.

Energy, Mines and Resources Canada *Canadian Minerals Yearbook* (various).

Forestry Canada. (1991) *Selected Forestry Statistics - Canada - 1990* Ottawa: Supply and Services.

Friedman, B. (1992) "Productivity in Crude Oil and Natural Gas Production" *Monthly Labor Review*, March.

Garnaut, R. and Clunies-Ross, A. (1975) "Uncertainty, Risk Aversion, and the Taxing of Natural Resource Projects" *Economic Journal*, 85, 272-87.

_____ (1979) "The Neutrality of the Resource Rent Tax" *Economic Record*, 55, 193-201.

Gera, S. and Grenier, G. (1991) *Interindustry Wage Differentials and Efficiency Wages: Some Canadian Evidence* Ottawa: Economic Council of Canada, Working Paper 19.

Goldstein, M. and M. Khan (1985) "Income and Price Effects in Foreign Trade" in R. Jones and P. Kenen (eds.) *Handbook of International Economics.* Amsterdam: Elsevier.

Green, A. (1984) *Productivity and Price: The Case of Gold Mining in Ontario.* Kingston: Centre for Resource Studies, Queen's University.

Haley, D. (1980) "A Regional Comparison of Stumpage Values in British Columbia and the US Pacific Northwest" *The Forestry Chronicle*, October, 225-30.

Haley, D. and J. Leitch (1992) "The Future of Our Forests-Report of the British Columbia Forest Resources Commission: A Critique." *Canadian Public Policy*, 18, 47-56.

Haley, D. and Luckert, M. (1990) *Forest Tenures in Canada: A Framework for Policy Analysis.* Forestry Canada Information Report EX43.

Halliwell, J. (1991) "Mapping the Parameters of Canadian Competitiveness" *Science Bulletin*, May.

Harris, R. (1989) "The New Protectionism Revisited." *Canadian Journal of Economics*, 22, 751-78.

Hotelling, H. (1931) "The Economics of Exhaustible Resources". *Journal of Political Economy*, 39, 137-75.

Katz, L. and L. Summers (1989) "Can Interindustry Wage Differentials Justify Strategic Trade Policy" in R. Feenstra (ed.) *Trade Policies for International Competitiveness.* Chicago: University of Chicago Press.

Krugman, P. (1989) "Differences in Income Elasticities and Trends in Real Exchange Rates". *European Economic Review*, 33, 1031-54.

_____ (1991) *International Economics: Theory and Policy.* New York: Harper-Collins.

Lewis, F. (1975) "The Canadian Wheat Boom and Per Capita Income: New Estimates" *Journal of Political Economy*, 83, 1249-57.

Mackenzie, B. and Bilodeau, M. (1979) *Effects of Taxation on Base Metal Mining in Canada.* Kingston: Centre for Resource Studies, Queens University.

Norrie, K. and Percy, M. (1982) "Energy Price Increases, Economic Rents, and Industrial Structure in a Small Regional Economy". Economic Council of Canada. Discussion Paper 220. Ottawa.

_____ (1984) "Province-building and Industrial Structure in a Small Open Economy" in D. Purvis (ed.) *Economic Adjustment and Public Policy in Canada.* Kingston: Queens University.

Pearse, P. (1974) *Timber Appraisal - Second Report of the Task Force on Crown Timber Disposal.* Vancouver: British Columbia Forest Service.

_____(1988) "Property Rights and the Development of Natural Resource Policies in Canada" *Canadian Public Policy*, 14, 307-20.

Percy, M. (1986) *Forest Management and Economic Growth in British Columbia.* Ottawa: Economic Council of Canada.

Porter, M.E. (1990) *The Competitive Advantage of Nations.* New York: Free Press.

_____ (1991) *Canada at the Crossroads: The Reality of a New Competitive Environment.* Minister of Supply and Services.

Rao, P. and T. Lempriere (1992) "A Comparison of the Total Factor Productivity and Total Cost Performance of Canadian and US Industries". Economic Council of Canada, Working Paper 45. Ottawa.

Scott, A. (1976) "The Cost of Compulsory Log Trading" in W. McKillop and W. Mead (eds.) *Timber Policy Issues in British Columbia* Vancouver: UBC Press.

Shoven, J. and J. Whalley (1992) *Applying General Equilibrium.* Cambridge, UK: Cambridge University Press.

Watkins, G. (1987) "Postscript: Canadian Policy Perspectives" in A. Kemp: *Petroleum Rent Collection Around the World.* Halifax: Institute for Research on Public Policy.

Webb, M. and M. Zacher (1988) *Canada and International Mineral Markets: Dependence, Instability, and Foreign Policy.* Kingston: Centre for Resource Studies, Queen's University.

Wonnacott, R. and P. Wonnacott (1967) *Free Trade Between the United States and Canada.* Cambridge, Mass.: Harvard University Press.

Wright, G. (1990) "The Origins of American Industrial Success, 1879-1940." *American Economic Review*, 80, 651-68.