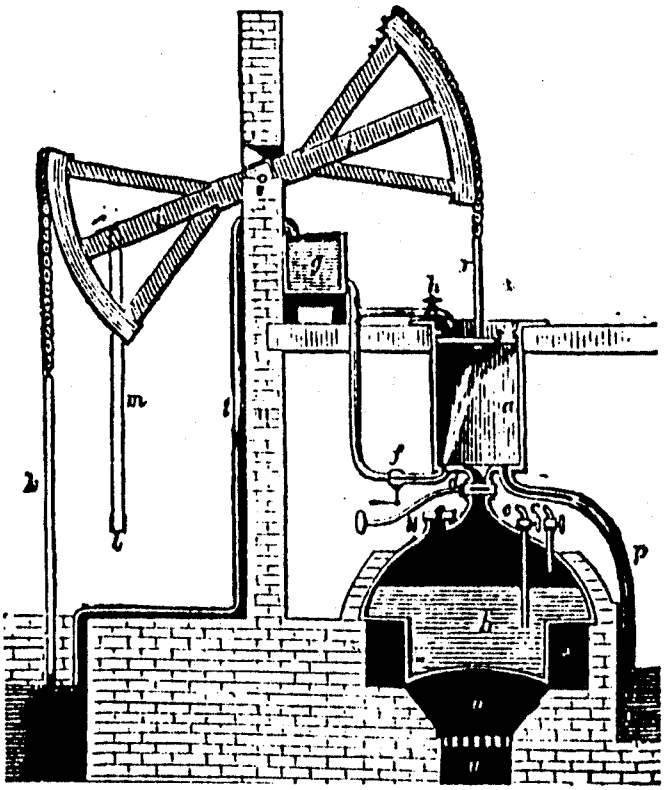
Uranium and Canadian Industrial Development

Philip Ehrensaft



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L'illustration de la page couverture représente la machine à vapeur à pression atmosphérique de l'ingénieur anglais, Thomas Newcomen, utilisée couramment pour pomper l'eau des mines à partir de 1712.

URANIUM AND CANADIAN INDUSTRIAL DEVELOPMENT

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1. Introduction

The center of world uranium production through the 1990's will be Canada.(NUEXCO,1986:18) One-third of the uranium mined in countries outside the Soviet bloc during 1985 was produced in Canada and 85 percent of this production was exported. Uranium prices fell from 1978 onwards and only in recent months has there been a modest upturn. In this "lean and mean" market, the high-grade and easily exploitable uranium deposits in the Western Canadian province of Saskatchewan are among the only mines that can turn a decent profit.[1] In 1984 and 1985, exploration at the Cigar Lake deposit in Saskatchewan revealed the largest high-grade deposit ever discovered. These resources are likely to assure Canada's leadership in the world uranium export market over the next decade.

What are the consequences of this leadership for the industrial and technological development of Canada, and what are the lessons of the Canadian case for other uranium exporters? One possible response is that this leading uranium export role will not have much of a long-term impact in terms of deepening Canada's industrial structure and technological capacity.

In this view, mining is viewed as an enclave and Canada as the world's richest underdeveloped country. Although Canada has a high GDP per capita, the lion's share of its exports are mineral, forestry, and agricultural products which are shipped in raw form or in the first stages of processing (e.g., smelted metals). Capital goods are mainly imported. Hence primary product exports provide a certain amount of foreign exchange, some jobs in sectors characterized by a high ratio of capital to labour, and economic rent collected in the form of taxes or joint ownership of resources between private companies and the government. The resultant revenues provide an internal market for industrialization through import-substitution where industry is characterized by a high degree of foreign ownership and a low capacity to export. When uranium resources are exhausted, one would be left mainly with empty holes and potentially hazardous tailings. The major long-term impact of the mining activity

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[1] More precisely, there is a decent profit in operating existing Saskatchewan mines; it is problematic as to whether current profits would justify the capitalization involved in opening up new mines.

would depend on whether governments utilized rents to meet current expenses or invested the funds in activities which deepen industrial structure and technological development.

An alternative view is that mining has the capacity to generate substantial backward linkages to input industries. In the cases where the class structure of the host country is similar to that of countries in the center of the world economy,[2] or there is a critical mass of skilled persons, the transfer, adoption, and improvement of technologies can "take off." This industrial and technological development may proceed because private capital faces production problems which it finds more profitable to resolve with local resources or on the basis of state intervention. Often these local innovations are not socially visible because they are not major "epoch-making" innovations of the Schumpeterian type. Cumulatively, however, these incremental innovations can yield a dynamic industrial structure which has the capacity to both replace imports and export products and services to markets in the center. (DeBresson, 1986)

When we began our investigation of the Canadian uranium sector, we expected to find a typical case of economic dependency. In the course of this research, we discovered that the basic statistics revealed another situation: uranium exploration and uranium mining, either underground or open-pit, is not fundamentally different than other mining activities. Thus one must examine mining inputs in general in order to understand the inputs into uranium. When we looked at the proportion of mining capital goods supplied by imports, the proportion was high as expected <u>but</u> Canadian exports accounted for a significant proportion of mining equipment production and were growing at a faster rate than imports. These exports were directed towards the countries of the center as well as the periphery. Furthermore, Canada has become the world leader in geophysical exploration techniques.

Mining is not an isolated instance where the facts do not fit the dependency model. Canadian nationalism was on the rise during the 1960's and 1970's. Latin American dependency theory was married to an earlier indigenous theory of the truncated development of primary-product producers, the "staple" theory advanced by Harold Innis and his colleagues during the interwar years. Where the Economic Commission on Latin America divided the world into center and periphery, Innis spoke of "metropole"

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[2] Where the working class historically achieved wages that were equal or superior to the levels prevailing in the European centers of the industrial revolution, proprietors in countries such as Canada had every incentive to adopt new, labour-saving technologies.

and hinterland." During recent years, dependency theory has been called into question by a number of Canadians who began from this perspective, discovered that there were major facts that did not correspond to what was expected, and have consequently advanced new ideas concerning the relation between primary production and industrial development.(Niosi, 1982; Panitch,1981; Ehrensaft and Armstrong,1981; DeBresson,1986).

Our objectives are to present the economic organization of the uranium mining sector of the leading world exporter, Canada, and to examine the backward linkages which are generated by mining. We will also examine the lessons that the Canadian case holds for other exporting nations.

2. World Demand Patterns

Given uranium's dual nature as a military and civilian commodity, it is difficult to assemble a complete profile of uranium prices, production, and resources on a world basis. First, Communist countries do not furnish the basic information used in the standard reference work jointly published by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, Uranium: Resources, Demand, and Production, known throughout the industry as the "Red Book." The Red Book thus provides information on supply and demand for the "WOCA" (World Outside Communist Areas). From geological knowledge, it is probable that civilian and military programs in Communist nations absorb all production from their own uranium mines. Imports from WOCA uranium producers are difficult to trace, but most likely minor. When recorded exports from WOCA countries to Communist countries are on a significant scale, as in the case of Canada, this usually indicates trans-shipment of uranium to the Soviet Union for enrichment with the ultimate consumer being a utility in a WOCA nation.

Thus supply and demand in the world market is largely determined by exchanges among the WOCA group of nations. Within the WOCA group, demand generated by civilian nuclear energy programs dominates the market. The United States built up a large stockpile of highly enriched uranium through the mid-1960's, and has been recycling material from older weapons in order to renew its nuclear arsenal. The government is also estimated to have massive stockpiles of U_3O_8, estimated to be in the range of 150 million pounds. There are immense holdings of depleted UF_6 tailings that could be recycled through gaseous diffusions plants.

Despite these large stockpiles, there are pressures from the military sector to re-enter the uranium market. An estimated 5 to 6 million pounds of uranium are consumed each year for military programs such as nuclear submarines or the manufacture

of plutonium. There are worries that the yellowcake stockpiles might be exhausted sometime in the 1990's. (Haglund, 1986:2-3) If there was a decision to meet all current U.S. military needs from market purchases rather than running down stockpiles, the impact on the world uranium market would be significant but not overwhelming. Estimated WOCA uranium demand is 97 million pounds for 1986. New U.S. military demand would thus increase WOCA total demand by about 6 percent. Including French and British military programs would raise this percentage by a modest amount.

Consequently, we conclude that the military sector does not need a great deal of uranium in order to construct weapons that can annihilate the world several times over. Civilian energy demand is the major component in the world uranium trade.

Civilian demand for nuclear reactors had been slowing down even before Chernobyl. Increasing energy efficiency in the advanced industrial countries subsequent to the energy shocks of the 1970's combined to a world recession impacted upon all energy sectors. In the case of nuclear power, longer than expected lead times for construction plus rising real interest rates increased the capital costs of nuclear plants compared to alternative sources of energy or conservation. In the United States, there are no new reactor orders on the books. Given the abundant coal resources in the United States plus an expressed indifference of the present administration towards controlling emissions which contribute towards acid rain, closing the order books for nuclear makes sense in terms of utilities' balance sheets even before taking account of safety issues and opposition from environmental groups. Even without construction of new nuclear plants, the United States will remain the major world market for uranium for some years to come. Recent protectionist pressures exercised by the American uranium sector could result in measures which will be very disruptive for other uranium-producing nations, as we shall see below.

Japan's ambitious commitment to nuclear energy remains firm despite capital costs and Chernobyl. The same can be said for France. Previous to Chernobyl, environmental concerns resulted in Sweden's decision not to construct new nuclear plants while Austrians voted not to commission a newly constructed facility. Within the rest of Europe, Chernobyl has exacerbated already intense debates on the role of nuclear power.

In terms of future demand for uranium, the key player in this swing group is Germany, which both has the potential to emerge as the technological leader in the next generation of nuclear plants (OTA, 1984) but also has opposition political movements with anti-nuclear stances. Although the Christian Democratic Union/Christian Social Union coalition emerged victorious in the January 25, 1987, elections, the coalition's generally pro-nuclear policies still face important challenges.

State governments which are controlled by the Social Democratic Party have powers which can be used to oppose nuclear energy. The fact that the Social Democrats are strong in the traditional coal-producing regions increases the probability of state governments opposing national pro-nuclear policies. Where the Greens have made a strong showing, the probability of state or municipal goverments using the powers under their jurisdiction to oppose nuclear energy are even higher. (Hibbs, 1987) Chernobyl is an important factor in debates over the future of nuclear energy in Great Britain, Italy, the Netherlands, and Finland. (NUKEM, 1986:6-7) Even if proposed plants are ultimately constructed, there will at least be a significant delay and this will be a damper on the recent but modest upturn in uranium prices.

Within the Third World, a sheer lack of foreign exchange to purchase capital-intensive items on the scale of a nuclear plant compounds the same price considerations which prevail in the advanced industrial countries. Subsequent to Chernobyl, the Philippines decided not to commission a new nuclear plant while Egyptian plans to construct a reactor have come to a halt. The major exceptions are Korea, which has recently announced plans to purchase two plants from the United States, and China, which will purchase plants from France. Overall, the Third World market for nuclear plants will be thin over the coming decade and it will be very much a buyer's market as manufacturers and their governments scramble to move their wares.

This presents a bleak picture for reactor manufacturers during the next 5-10 years. But these manufacturers are mainly large and powerful corporations. The most experienced of these companies, like General Electric, take a very long-term view of the nuclear power business. If they can't make money by selling reactors, they can make it up by servicing ones already sold. Repairs, maintenance, upgrades and fuel supply are now where nuclear profits lie. Utilities are looking for higher burn up from fuel and higher capacity factors to realize more output per unit of invested capital. Leading U.S. European and Japanese nuclear engineering firms are vying for orders for improved plant components and fuel. The leading firms are able to weather rough times, but they have had to close some once-thriving manufacturing facilities and lay off highly skilled staff.(Patterson, 1986:197) In the one case where a major uranium exporter has created forward linkages by supporting an indigenous nuclear reactor sector, Canada's CANDU system, the market downturn has been quite devastating.

Uranium mining and milling companies have had an even rougher time. From peak prices of $43.40 per pound U3O8 in mid-1978 [NUEXCO's exchange price], prices tumbled to 14.25 in April, 1985 (the lowest price since October, 1974) and have risen modestly to $17 as of December, 1985. (NUEXCO, annual Review,

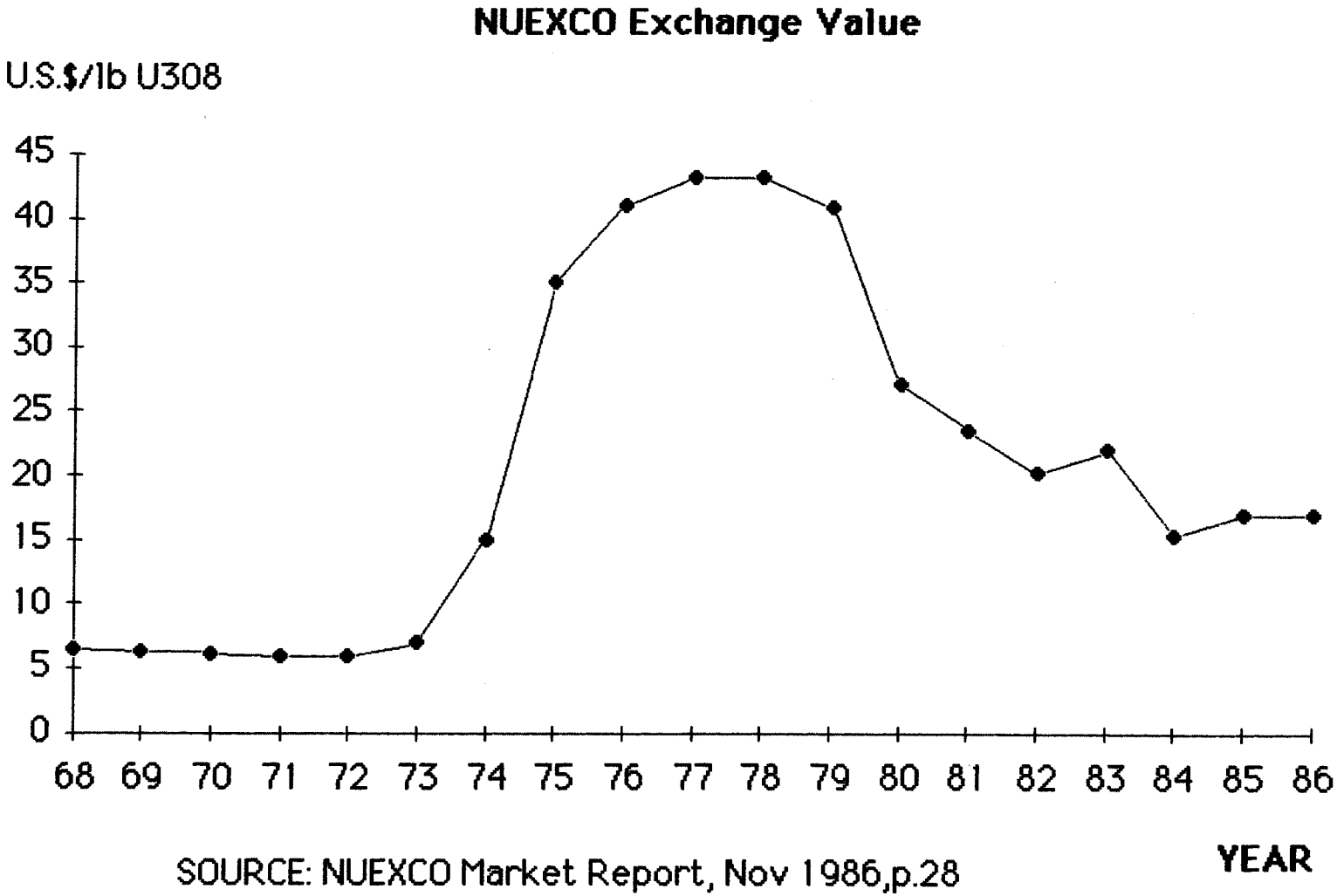
1986). The spot price stayed steady at $17 per pound through August, 1986.(Figure 1) In 1985, however, annual uranium demand exceeded production for the first time since the start of the commercial uranium-use era. (Figure 2) One impact of these tumbling prices has been a drastic decrease in exploration activities. During the 1979-84 period, there was an 80 percent decrease in uranium exploration within the WOCA countries. This may result in a supply crunch towards the end of this century.

Mining and milling companies are composed of several different types of actors, and the impact of falling prices has different consequences for each type of enterprise. For multinational mining companies, uranium mining is one of many types of investments. Many multinationals have long-term contracts with utilities which shelter them in the short-term from tumbling spot prices. Within host countries, national mining companies such as Canada's Denison mines have more of their eggs in the uranium basket, although long-term contracts also offer them temporary shelters---we emphasize temporary because long-term contracts usually have escape clauses for utilities when average spot prices are significantly below contracted prices for a set number of years.

The other actors are state enterprises based in the producing and consuming countries respectively. State enterprises in the host country are often in joint ventures with private capital and act primarily as rent-collectors. Falling prices are likely to push them to increase exploration and development of mines in order to maintain aggregate revenues and employment; private capital is more likely to cut back on these activities in order to maintain profit rates. The second type of state enterprise, or mixed state-private ventures with ties to utilities in consuming countries, have a cushioning mechanism when prices fall: lower profits in a host country such as Canada are compensated by lower fuel prices in the home country reactors. When uranium prices rise, profits can be taken from the mines of the host country as the utility part of the operation faces higher fuel costs.

Finally, this is an industry with both a very long and a very political time perspective. Enterprises, whether state or private or mixed coalitions, must plan their activities on the basis of expectations of increases in the number of new nuclear reactors; reactors involve large chunks of capital and long lead times between the decision to build the reactor and bringing electricity on-line. Uranium companies routinely look at least 15 years ahead in order to plan their activities. Their plans are based as much upon their readings of political opposition to nuclear power and the ability of utilities to overcome this opposition as upon their reading of energy consumption trends and the relative attractiveness of nuclear plants as energy sources. Western Canada is viewed not only as the major world center for

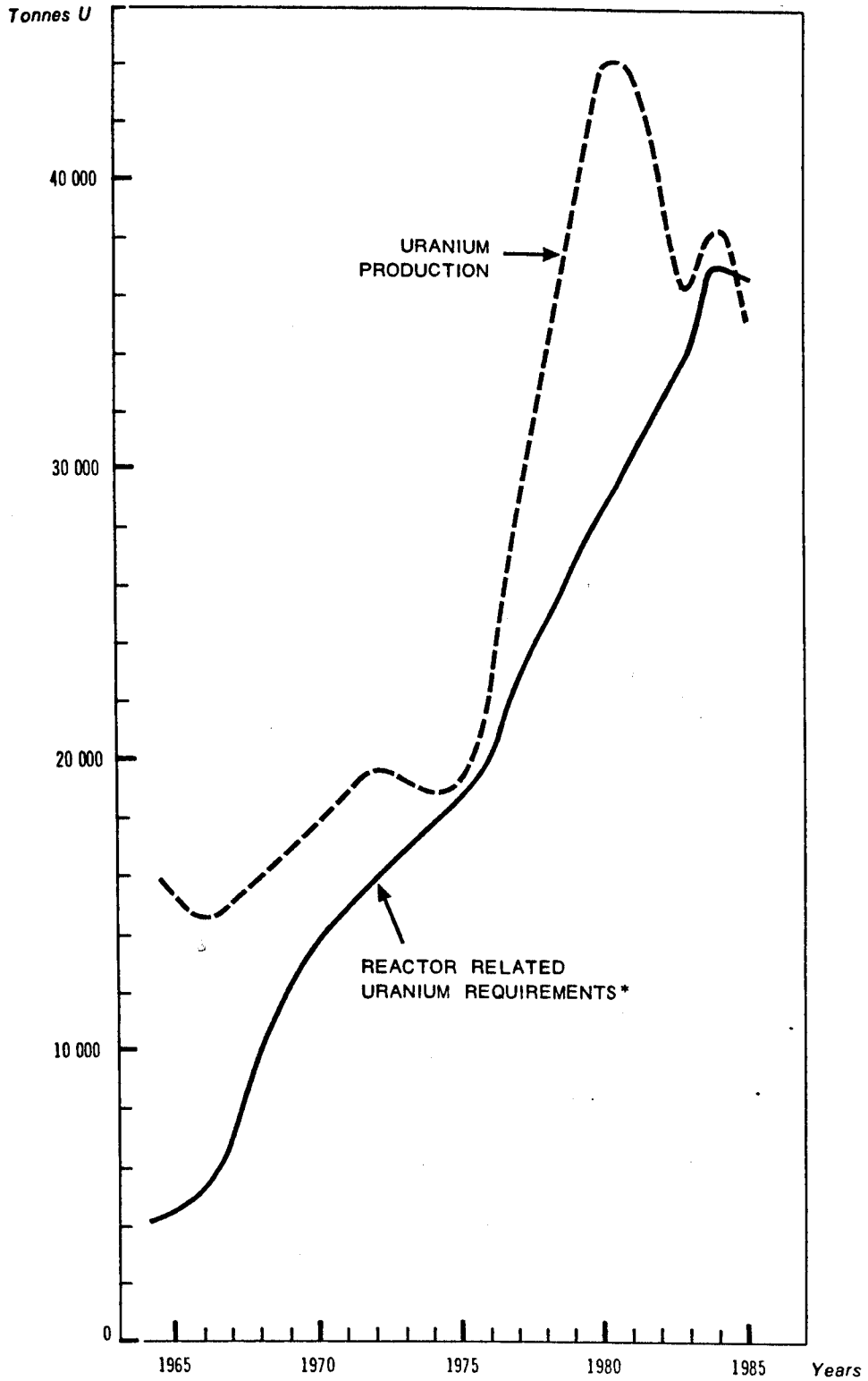
FIGURE I



SOURCE: NUEXCO Market Report, Nov 1986,p.28

FIGURE 2

HISTORICAL URANIUM PRODUCTION AND REQUIREMENTS



* Reactor related requirements as reported in previous Red Books.

high quality uranium deposits with low recovery costs, but also as a region which is politically secure in general and receptive to uranium mining activities by multinational corporations.

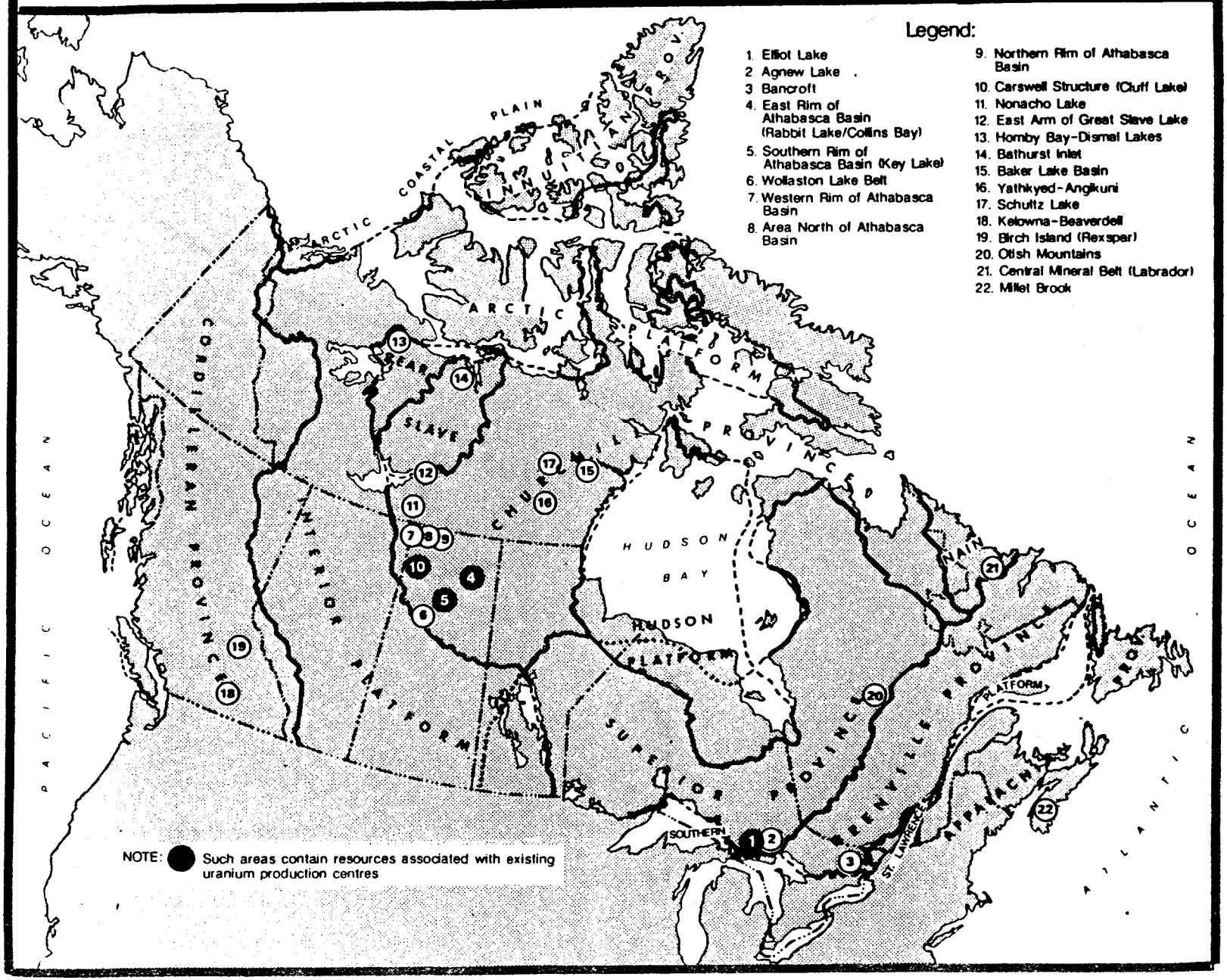
3. A Survey of the Canadian Uranium Sector

The total value of Canadian mineral production, excluding oil and gas, was $14.8 billion. Uranium exports reached a value of $916 million and ranked seventh among Canada's mineral exports. Canadian uranium production is concentrated in two regions, as indicated in Figure 3. The black circle, number 1, represents the older producing region of Elliot Lake in southern Ontario while the black circles 4, 5, and 10 represent the active mines in northern Saskatchewan's Athabasca basin, which is now the leading region of the world uranium economy. Saskatchewan produced 5,928 tonnes U in 1985 with a workforce of 1,034 persons. Ontario produced 4,952 tonnes U with a workforce of 4,299. (Smith and Whillans, 1986:4)

Elliot Lake and the Athabasca Basin are polar opposites in terms of their physical, economic, and demographic characteristics. The eastern mines have underground, low-grade deposits which are labour-intensive and relatively high cost operations. Elliot Lake is a classic mining town of 20,000 people which is located in southern Ontario, which is both Canada's industrial heartland and the major center of nuclear reactor expertise. The mines would likely shut down of the mining companies had to operate on the basis of current spot prices for uranium. Long-term contracts with the state public utility company, Hydro Ontario, and with foreign utilities, yield prices well above spot prices. Escape clauses in these contracts will permit the utilities to begin withdrawing from these contract during the early 1990's. If this option proves attractive, we can probably expect a well-organized political campaign to save the mines and the town.

The Athabasca Basin of northern Saskatchewan is a sparsely populated region with both a high proportion of Amerindians among the local population and a very high rate of unemployment. The mines are high-grade, shallow deposits which are mainly worked by open-pit methods. Operation costs are among the lowest in the world and the mines employ relatively few people. In order to avoid developing mining towns which later become ghost towns, the provincial government moved the companies towards a policy of rotating workers in for intensive 7-day, 12 hours a day stints in the mines. A policy was adopted of reserving a quota of the mining jobs for native people who are flown in from their home communities.

PRINCIPAL AREAS IN CANADA WITH IDENTIFIED URANIUM DEPOSITS



The Saskatchewan uranium mining boom proceeded when a social democratic party, the New Democratic Party, was in power. This party had its roots in agrarian populism and saw uranium, potash, and oil and gas as vehicles to diversify a local economy which rose and fell with international grain prices. The question of opening up the Athabasca Basin for uranium mining created intense conflict within Saskatchewan in general and within the ranks of the NDP. There were concerns with environmental safety and contributing to the proliferation of nuclear weapons. At the same time that the new uranium deposits were discovered, native people's movements were gaining force in Western Canada. They were concerned with the impact of uranium mining on their land and lakes. They were equally concerned to reap economic benefits if mining proceed. After a series of major public hearings, the green light was given and Saskatchewan went on to become the world's most important uranium mining region.

Ownership patterns in the two uranium regions are distinct: in Ontario, private capital owns the mines. Denison Mines (see Table 1) is a Canadian company which has diversified its investments into other mining sectors in recent years. Its contracts are divided between Hydro Ontario and Japanese utilities. Denison's uranium mines would be in difficulty if one of its major contractors exercised it option to withdraw when escape clauses permit because its eggs are in just a few baskets. Rio Algom is a subsidiary of the giant multinational, Rio Tinto Zinc. While it is a high-cost producer like Denison, its contracts are more diversified and thus Rio Algom is less vulnerable to any one company exercising an escape clause.

The Saskatchewan ownership patterns consist of two joint ventures between state enterprises---known as "Crown Corporations" in Canada---and foreign multinationals and one mine owned solely by a crown corporation. The Cluff Lake mine, with a 850 tonnes U capacity, is divided between the French operator, Amok Ltd., with 80 % of the shares, and the Saskatchewan Mining Development Corporation (SMDC), a provincial crown corporation, which has 20 % of the shares. Amok, in turn, is a coalition of three French companies, the state enterprise Cogema (38 % of Cluff Lake's shares), Compagnie Francaise de Mokta (37 %) and Pechiney (25 %).

Rabbit Lake, with a capacity of 1,920 tonnes U, is the sole property of Eldorado Resources, a federal crown corporation. Eldorado has two facilities in Ontario for upgrading U3O8 into UF6 for exports to countries which use enriched uranium in their reactors. The Conservative government now in power in the federal capital is intent on selling off Eldorado and other state enterprises in its privatization campaign. To date, the soft uranium market has discouraged potential buyers.

TABLE 1

OWNERSHIP PATTERNS, CANADIAN URANIUM MINES

Mine	Location	Owners	%Equity	Capacity (tonnes U)
Dension	Ontario	Roman Ltd	36.3	2300
		Others	63.7	
RioAlgom	Ontario	Rio Tinto Zinc	52.8	3580
		Others	47.2	
Cluff Lake	Saskat-chewan	Amok Ltd of which:	80	850
		-Comega	38	
		-CieFr de Mokt	37	
		-Pechiney	25	
		SMDC	20	
Key Lake	Saskat-chewan	SMDC	50	4600
		UEM	33.7	
		Eldorado	16.3	
Rabbit Kake/ Collins Bay		Eldorado	100	1920

SMDC = Saskatchewan Mining Development Corporation
UEM = Uranerz Exploarions and Mining (Germany)

Source: NUKEM Market Report 8/84, 11/84, 12/84, 3/85, 8/85.

Key Lake, with a capacity of 4.6 million tonnes, is the world's largest uranium mine. It is 50 percent owned by SMDC, 33 2/3 % owned by UEM, a wholly owned subsidiary of the privately owned German Uranerzberghau GmbH, and 16 1/3 % owned by Eldorado. Each partner markets their share of annual production independently.

Canada's concern before the Saskatchewan uranium mining boom was that its own domestic nuclear reactor program would run short of uranium. In 1974, policies were instituted which required the Ministry of Energy Mines, and Resources to assure that the domestic reactor network had adequate supplies for the next 30 years before approving export contracts. As we can see from Figure 4, existing production capacity far exceeds domestic Canadian requirements and a high level of production can be maintained through the mid-1990's. In Table 2, we see that Canada's uranium exports are diversified between Japan, the United Sates, and Europe. This stands in contrast to Canada's overwhelming dependence on trade with the United States for many other commodities.

This diversification of trade patterns stands out even more clearly when one looks at exploration expenses. There has been a steady decline in money spent on exploration as uranium prices tumbled. What is striking is the nearly complete exodus of American companies from uranium exploration in Canada. This exodus reflects both the general withdrawal of US petroleum companies from the mining after being burned in the mineral price slide. There is also perhaps a political reluctance to get involved in opening up new, low-cost Canadian mines when the high-cost U.S. uranium mining sector is reeling from imports and crying for protection.(Figure 5) Notice also that the foreign investment in the sector largely involves state enterprises. In Table 3, we see that nearly all of the uranium exploration activity is proceeding in Saskatchewan or the adjacent Northwest Territories.

Finally, we must indicate that although Canada is first in current uranium production and is likely to maintain this position for the next decade, it is not first in terms of known or probable low-cost reserves. Australia and Niger are ahead of Canada on this score, and South Africa and Brazil are not far behind. (Figure 6) On the other hand, there is a significant social distance between knowing uranium is probably in the ground and getting it to market. Exploration and development skills based on past experience with mines, the location of new deposits adjacent to older mines and their transportation infrastructures, plus the political will to export uranium and a reputation as a reliable supplier make a big difference as to whether uranium gets developed or stays in the ground.

CANADIAN URANIUM PRODUCTION CAPABILITY
COMPARED WITH
ESTIMATED DOMESTIC REQUIREMENTS

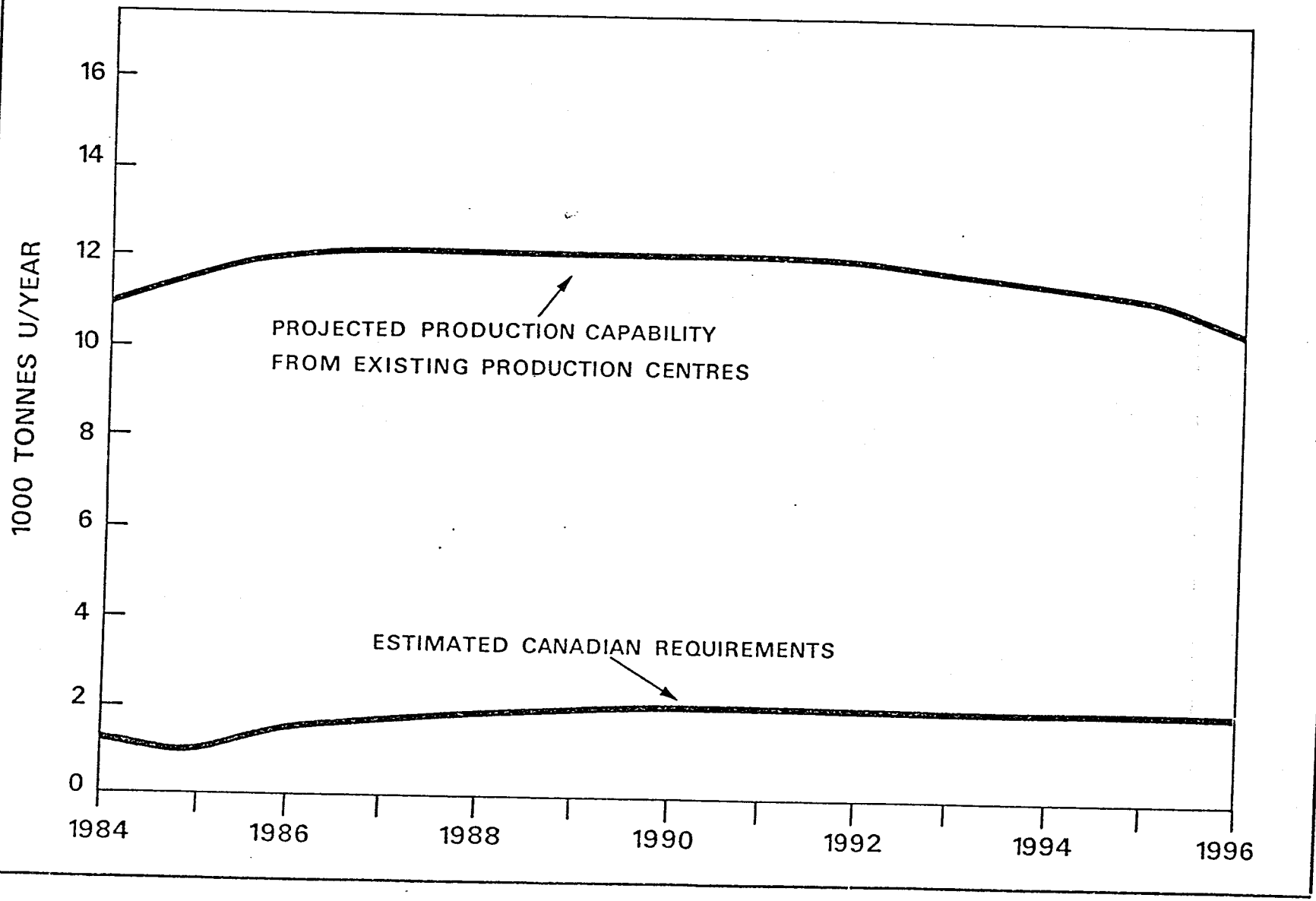


TABLE 2

EXPORTS OF URANIUM OF CANADIAN ORIGIN

Country of final destination	Tonnes of contained uranium[a]		
	1982	1983	1984
Belgium	85	-	121
Finland	96[r]	179	137
France	-	435	525
Italy	143	-	50
Japan	718	663	2436
South Korea	74	94	30
Spain	110	-	-
Sweden	889	613[r]	254
United Kingdom	379	675[r]	692
United States	4852[b]	860[r]	2397
West Germany	471	490	295
Total	7817[r]	4009[r]	6937

[a] Some of this uranium was first exported to intermediate countries, namely France, USA and USSR, for enrichment and then forwarded to the country of final destination.

[b] The bulk of this material represents uranium exchanged by Eldorado Resources Limited in the purchase of the Rabbit Lake operation.

[r] Revised.

Source: Atomic Energy Control Board.

FIGURE 5

Trends In Uranium Exploration Expenditures In Canada

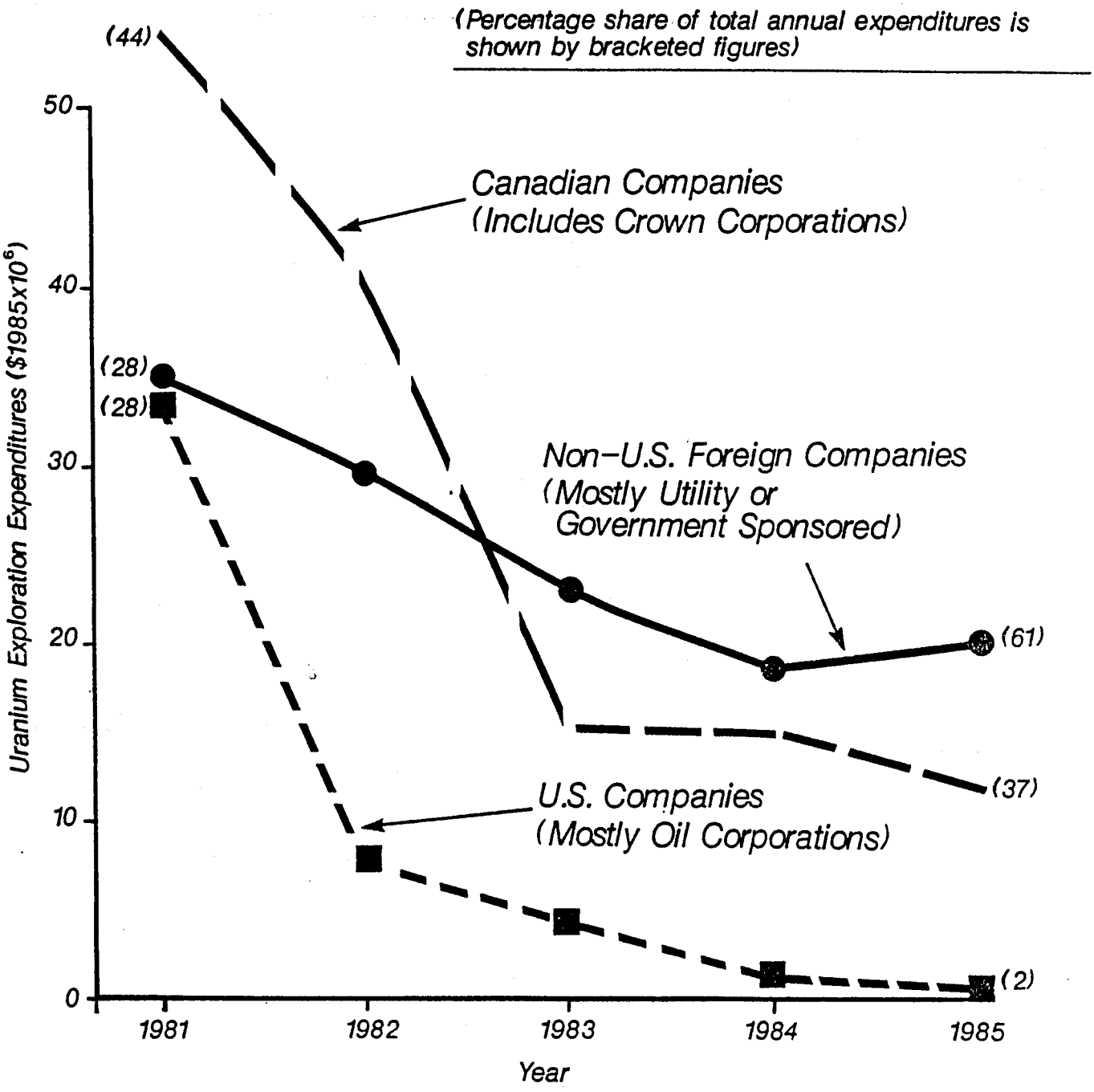


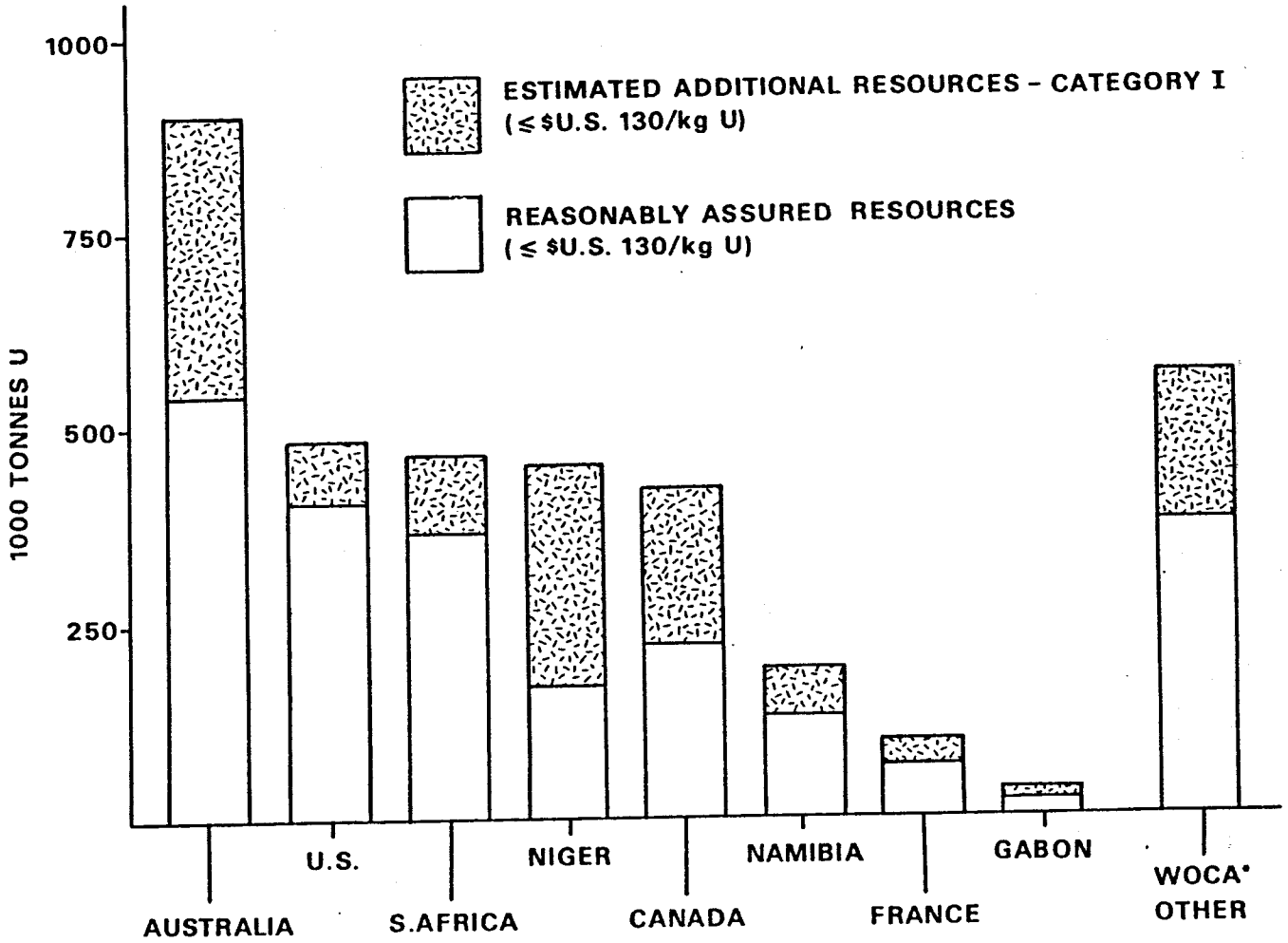
TABLE 3

URANIUM EXPLORATION IN CANADA BY REGION

Province or Territory	YEAR 1978	1979	1980	1981	1982	1983	1984
Sask.	43.6	70.5	77.2	60.8	47.9	27.3	24.8
N.W. Terr.	17	26.4	29.1	23.6	13.2	7.3	6.4
Other	29.4	33.1	21.7	17.6	9.9	6.4	3.8
Total can.	90	130	128	102	71	41	35
Sask+NWT/ Canada	.67	.75	.83	.83	.86	.84	.89

Source: Uranium In Canada: 1984 Assessment of Supply and Requir
Energy Mines and Resources Canada, 1985:33.

DISTRIBUTION OF URANIUM RESOURCES AMONG PRINCIPAL PRODUCING COUNTRIES



SOURCE: NEA/IAEA DECEMBER 1983 "REDBOOK" PLUS 1984 REVISIONS FOR AUSTRALIA, U.S., NIGER AND CANADA

*WORLD OUTSIDE CENTRALLY PLANNED-ECONOMY AREAS

4. Resurgent American Protectionism and Canadian Uranium

Canada and other uranium-exporting countries now face the possibility of a significant part of their export markets due to protectionist pressures that are being exercised both within the U.S. Congress and through legal proceedings instituted by American mining companies. The specter of U.S. import restrictions on foreign uranium stirs up particularly nervous memories in Canada: when the United States Atomic Energy Commission announced in 1959 that it would stop new purchasing of uranium from foreign countries, this wreaked havoc in numerous uranium mining communities which had developed solely to serve U.S. demand. Canada was hit with particular severity because sales of yellowcake to the AEC had become its fourth most important export. (Taylor and Yokell, 1979:33; Neff, 1984:42-43) This was the first of a series of U.S. policy decisions which adversely affected the Canadian uranium sector and motivated Ottawa to join the international uranium cartel of the 1970's.

Canada's uranium exports are now more diversified and while uranium exports are approaching $ 1 billion, they no longer are as important relative to other exports as was the case during the 1950's. Only about a third of Canada's uranium exports are now directed to the United States. From another angle, the United States now imports approximately 30 percent of its uranium needs from Canada. Furthermore, Saskatchewan is the major source of these growing U.S. uranium imports from Canada. Loss of American markets would be a serious blow to the Saskatchewan economy.

The fundamental sources of the growing share of imports in American uranium purchases stems from policy decisions to lift import restrictions from 1974 onwards and the fact that most U.S. deposits are either older mines with declining resources or small, scattered deposits that cannot match the production costs of Western Canadian, Australian, or South African mines. American producers accuse Canada of dumping uranium via purchasing uranium at high prices from the older, high-cost mines in Elliot Lake, Ontario, and directing the low-cost Saskatchewan uranium towards the U.S. The provincial electric utility, Ontario Hydro, as well as Japanese and European corporations, signed long-term contracts with the Ontario mines when world uranium prices were high. It seemed like a good deal at the time and these same companies have the option to pull out of the contracts during the 1990's if world prices are still low. American companies with refining facilities to transform yellowcake into UF_6 also protest against Canada's policy of maximizing uranium processing within Canada. This is a classic case of a conflict between a primary-producing country which seeks to increase value-added within its own economy and processing industries in the central countries of the world economy.

At the heart of the matter are lobbies based in the declining uranium mining regions of the United States. These lobbies are using the national security shibboleth to reinstate import restrictions on uranium imports. The purported worry is that dependence on low-cost foreign suppliers could create a situation where domestic operations would shut down; if foreign suppliers such as Canada refused to sell the United States uranium for military purposes, the United States' security would be in jeopardy. Given the fact that Canada already refuses to sell uranium for military purposes plus the fact that the present stockpile of yellowcake is large relative to annual military needs, forward planning to meet U.S. needs from local production, not to mention a number of willing suppliers, does not present an insuperable problem.

More to the point is that the new Democratic majority in the U.S. Senate will tilt the balance of forces further towards protectionism. A anti-protectionist President who is weakened by "Irangate" will less able to resist legislation introduced by pro-protectionist elements in the Congress. There is a distinct possibility that the world uranium trade will receive a new shock from import restrictions in what is still the largest single market for nuclear fuel. Despite the fact that no new nuclear reactors are on the books, the U.S. will remain the single most important civilian uranium market during the coming decades. A new wave of protectionism would shake the international uranium market in general.

The protectionist thrust is coming from two quarters: legal challenges to the lifting of import restrictions and new legislation. The U.S. Secretary of Energy is required by legislation to issue an annual report on the viability of the domestic uranium industry. In September, the Department of Energy issued a report saying the domestic mining industry was nonviable but declined to issue import restrictions on uranium. Producer groups claimed that the Atomic Energy Act required the DOE to immediately stop enriching non-U.S. uranium for use in domestic reactors. A judge in a lower federal court subsequently ruled in favor of the producer groups. Although the 10th Circuit Court of Appeals issued a judgment in July, 1986, which stayed execution of the early ruling in favor of the producer groups, it is quite possible that the ultimate decision will either be in favor of the U.S. mining companies or that Congress will enact protectionist legislation if the ruling is unfavorable. There is already uncertainty and nervousness in the market; some utilities are already swapping non-U.S. for U.S. uranium stocks at a cost of 50 to 75 cents per pound. (Nuclear Fuel, July 28, 1986:1)

The Canadian uranium sector, and particularly the Saskatchewan uranium sector, has every reason to be nervous in the face of the U.S. producers' lobbying for protectionism. The

shock to uranium mining in Canada would not be as severe as the earlier shock of the late 1950's, but the impact would still be quite serious.

5. Decolonizing Western Canada: the Saskatchewan Mining Development Corporation.

Uranium is not only a highly political commodity in terms of the national development, environmental, and proliferation issues which its discovery and exploitation raise: uranium also raises issues of regional inequalities within national economies. In the cases of Canada and Australia, uranium mining compounds regional inequality issues with issues of ethnic inequality: uranium deposits are frequently located in regions principally inhabited by indigenous, non-European groups that have been increasingly vocal in demanding a fair share of the economic surplus generated by resource projects.

Saskatchewan lies in the heart of the Canadian prairies, a region that was sparsely settled by indigenous peoples and the first wave of European settlers until the 1890's. The upturn of world grain prices after 1896 unleashed the rapid settlement of North America's last agrarian frontier. Within two decades, the "last best west" emerged as one of the world's major grain-exporting regions as well as a major North American ranching region. Through the 1940's, the economy of the Canadian prairies fluctuated up and down with agricultural prices.

Discoveries of oil, gas, uranium, and other minerals after World War II gave the prairies provinces the hope that a diversification of export products would stabilize the region's economy and also generate a surplus which would carry industrialization several steps beyond the small base which existed in the area's principal city, Winnipeg. This desire was quite pronounced in Saskatchewan, where the economy was particularly subject to fluctuations in the prices of its major crop, wheat. In addition to the variability in incomes that this caused, the post-war "green revolution" in North American agriculture had unleashed a process of farm consolidation and an exodus of the rural labour force to other sectors. Some of the ex-farm population found employment in the service industries and the very small local industrial base, but many people left the province. Local wags put up signs on the highways which asked the last person who left Saskatchewan to please turn out the lights.

Mineral and forestry resources were seen as the new element which could stem this tide by sparking local industrialization and thus employment. Through the 1960's, the prairie provinces put their hopes in mega-resource projects which would have "multiplier" effects upon the local economy. Open-door investment policies featured tax incentives, low royalty schemes,

a paucity of environmental regulations, and government guaranteed loans. (Conway,1983:180-81)

Resource policy in Western Canada changed directions during the early 1970's. Agriculture was hit by a severe recession in the late 1960's. Although the diversification of exports through mineral production softened the blow somewhat, the general economy also moved into deep recession. This highlighted the fact that the open-door resource policy of the post-war decades had failed to generate the expected industrialization and job creation.

In Saskatchewan, which is the world's leading exporter of potash, the agricultural recession cut world demand for fertilizers and thus demand for potash. The deep recession in Saskatchewan sparked the 1971 electoral victory of the New Democratic Party, a social democratic party rooted in agrarian populism. Formerly known as the Cooperative Commonwealth Federation, this alliance of family farmers, urban blue collar workers, and middle class professionals had governed Saskatchewan between 1944 and 1964 as the continent's only socialist party in power. Agriculture was still the nucleus of the provincial economy, but farm consolidation meant that farming only accounted for 22 percent of the population in 1971 as opposed to 53 percent at the end of World War II (Archer, 1980:360-61) The new social democratic coalition was tilted more towards the growing urban social classes and determined to introduce basic structural changes in Saskatchewan's vulnerable economy.

This determination was reflected in resources strategies that envisaged both a redistribution of rents towards a higher share for the province and state planning in order to both pace resource development and use the increased revenues in ways that would restructure the economy. This strategy of "province-building" was enhanced by the resource price boom of the early 1970's. Grain prices boomed and this had the added benefit of sparking a consequent rise in potash prices. Western Canada's oil and gas fields are concentrated in the adjacent province of Alberta, but Saskatchewan also has significant deposits which helped swell the treasury during the post-1973 oil boom. At the same time, and for largely independent reasons, uranium prices skyrocketed. Uranium exploration had been proceeding since the late 1960's as the new civilian nuclear energy sector began to take off. By the mid-1970's, it appeared that Saskatchewan had the world's richest, low cost deposits of uranium ore. "With Saskatchewan's conventional oil reserves diminishing, uranium was seen as a key contributor to future provincial revenues." (Gunn, 1982:2) The economic strategists in the NDP now believed they would have the financial resources to transform the agrarian, boom-or-bust provincial economy.

The uranium discoveries sparked an intense debate within the New Democratic Party, parallel to the debate that was to unfold within the Australian Labour Party concerning uranium over uranium mining. Nuclear proliferation questions, the ecological impact of uranium mining, and the fact that the newly discovered deposits were in a region of Northern Saskatchewan mainly populated by Amerindians added up to make the uranium issue a very hot potato. The fervor of the proliferation question was to be understood in the context of the fact that uranium production from the Beaverlodge mines in Saskatchewan helped build the thermonuclear arsenal of the United States during the 1950's. A large fraction of the NDP's members and voters were determined that the Saskatchewan's Cold War role would not be repeated. The uranium debate also became an arena for a basic battle over the nature and future of the NDP: the party elite in power was inclined towards a pragmatic, technocratic strategy in which the word socialism was barely uttered; a significant and vocal part of the rank and file still viewed the party as the vehicle for a radical political movement and fundamental social change.

Today's uranium export figures indicate the outcome of this debate. The NDP of Saskatchewan pursued not prairie socialism but a variant of prairie capitalism. The major vehicles for the new resource strategy were state-owned companies, known as "Crown Corporations" in Canada, which often operated in joint ventures with private capital. This entry of Crown Corporations into direct mineral production happened all across Canada and was initiated by parties occupying all parts of the political spectrum. In the case of the Saskatchewan Mining Development Corporation, legislation passed in 1975 required that any company planning to spend more than $10,000 on mineral properties offer the SMDC the opportunity to invest up to 50 percent in the project. The SMDC had 60 days in which to elect its level of participation; once the option was exercised, it could not be subsequently renewed. The SMDC also had the freedom to seek out its own exploration projects. Joint venture arrangements for the mines now in operation involved each partner taking possession of its share of production and marketing the uranium independently rather than through a common agency.

Before 1970, Crown Corporations were mostly found in infrastuctural activities such as transportation or electricity, "natural monopolies" which required large clumps of capital investment and where excessive prices charged by a private monopoly might damage the profit rates of business in general. State enterprises and joint public-private undertakings in the resource sector were common in both Europe and the Third World by 1970. Within the North American context, this form of direct participation by the state was a break with previous practices and regarded more or less as anathema by most business interests. Rising Canadian nationalism in the face of natural resource ownership by foreign multinational corporations plus regional

nationalism within Canada, directed against the industrial and demographic center in Ontario, created a new wave of crown corporations which participated directly in mineral exploration and production.

In the case of uranium mining, the NDP encountered more opposition within its own ranks than from the private sector in its direct entry into mineral exploration and development. The first factor in this relatively easy acceptance was the heavy involvement of state agencies in the uranium sector since its earliest days because of the military origins of the industry. Canada was the major source of uranium for the Manhattan project. In 1942, Eldorado Gold MInes Limited was asked to reopen their radium mine in the Northwest Territories in order to supply uranium for the atomic bomb project. In 1944, the Canadian government expropriated this mine as well as Eldorado's uranium refinery at Port Hope, Ontario. Eldorado still exists as a federal crown corporation and is one of the major players in the uranium sector in northern Saskatchewan. It is also one of the major world refiners of "yellowcake" (U_2O_8). Another federal Crown Corporation, Atomic Energy of Canada Limited, was founded in 1952 as the major locus of nuclear research in Canada. It has also been one of the major recipients of R and D money in Canada. In 1953, AECL began joint research with Ontario Hydro, a provincial Crown Corporation which supplies electricity in Canada's major industrial region, on a civilian nuclear reactor. This research produced the CANDU reactor, which is fueled by natural uranium pellets and uses heavy water as a moderator.

The second factor in the acceptance by the private sector of the Saskatchewan government's role in uranium production was the relative immaturity of uranium production in the province. When the Saskatchewan Mining Development Corporation was formed in 1974 and given the right to acquire up to 50 percent of newly discovered uranium deposits, companies were involved in exploration rather than production, and their sunk costs were therefore relatively small. (Prince and Doern, 1985:62) The single operating mine in the province at Uranium City was owned by Eldorado Ltd, the federal Crown Corporation. The formation of the SMDC was catalyzed, in fact, by the desire of a private company, Bell Oil, to give up its one-third share in the Key Lake prospecting project. In addition, the province owned virtually all of the land on which the prospecting was taking place, thus avoiding the conflict of expropriation proceedings. This experience in uranium contrasts with the formation of the Potash Corporation of Saskatchewan in 1975, which was part of a protracted and bitter struggle to get higher royalties from the private companies already operating potash mines in the province.

Third, most uranium companies active in Saskatchewan were foreign owned (German, French, and Japanese), and either

government-owned companies themselves, private companies accustomed to having government joint-venture partners, or companies that were already joint government-private ventures. Federal foreign ownership restrictions on uranium ventures already required Canadian partners for foreign companies. (Prince and Doern, 1985:62) Thus it was not a major step for European or Japanese companies to acquire a Canadian partner that was a Crown Corporation.

Increased uranium production in Saskatchewan contributed to lower world prices, which benefited the integrated European and Japanese producers by lowering the cost of fuel at home. Between fuel savings at home and returns on invested capital after sharing output with the Saskatchewan Mining Development Corporation and paying royalties to the provincial treasury, M.E. Fulton estimates the rate of return for the integrated producers to be in the 50-100 percent range. (1985:51)

The royalty system that was instituted required a basic royalty of 3 percent of gross sales plus a graduated royalty on the producer's rate of return to invested capital. Since the companies pay the graduated royalty only after they have recovered their full capital investment, which would have taken about ten years in the high price context of the 1970's, the royalties did not cause undue concern. (Gunn, 1982:89-90) The post-1978 uranium price slide has meant that Saskatchewan's royalty take has been quite meager.

Saskatchewan was consequently viewed by European and Japanese multinational corporations not as a socialist menace but as a secure environment in which to explore for and exploit rich uranium deposits which could be mined by low-cost, open pit methods. The entry of Crown Corporations into the sector was probably viewed as offering certain advantages: first, provincial participation provided a source of capital; second, provincial participation was useful in overcoming local opposition to uranium mining.

If the Crown Corporation "backing in" to the sector was not particularly threatening to the multinationals, and even potentially useful, let us look at things from the other side to see what benefits the new resource policy brought to Saskatchewan and indirectly to other regions of Canada. In order to evaluate Saskatchewan's resource policy, we must also examine its objectives and achievements in the context of the policy objectives of the two other major players, the federal capital in Ottawa and the older uranium producing province, Ontario, which is also the heart of the Canadian nuclear reactor industry.

From Ottawa's point of view, the objectives of its uranium policy are the following: 1) ensure adequate supplies of uranium for the domestic nuclear reactor program and for exports of CANDU

reactors; 2) increase information on reserves in order to have a better bargaining position with respect to private mining companies and approval of export contracts; 3) maximize the processing of yellowcake into UF_6 by Canadian plants; 4) increase returns from exports; 5) assure "orderly" development and marketing of uranium in world trade, i.e., attempt to coordinate major suppliers in a way that will raise the price paid for uranium; 6) tie to uranium exports to adherence to the international non-proliferation regime; 7) given the amount of foreign ownership, acquisition of sufficient information to block transfer payments as a way of effectively lowering the price paid for uranium in Canada.(Campbell, 1984:53)

Saskatchewan's uranium policies were largely congruent and supportive of national objectives. Conflicting policy objectives occurred mainly between Saskatchewan and the older, high-cost producing region of Ontario, where Canada's yellowcake processing plants are also located.

Saskatchewan's intervention both speeded up the development of mines in the Athabasca Basin and probably increased the amount of uranium produced in the new mines than might have been the case if they were controlled solely by private capital. When Ottawa instituted uranium export control policies in 1974, its main concern had been over the adequacy of future supplies at an economic cost. Thus domestic reactor programs had to be assured of a 30-year supply of uranium before export contracts were approved, and these contracts were limited to a 15-year period. The uranium boom in Saskatchewan removed the uncertainty over future supplies and also enable Atomic Energy of Canada to offer low-cost uranium as a sweetener in its attempts to market CANDU reactors at home and abroad.

In terms of getting information on reserves and acquiring enough knowledge of day-to-day functioning of the industry to block transfer pricing, the joint venture strategy worked in the interests of both Saskatchewan and Ottawa. Deeper knowledge concerning reserves also enhanced promotion of Canada as a reliable source of uranium during the next two decades. Given the ownership of the Rabbit Lake mines by a federal Crown Corporation, Eldorado, and also Eldorado's joint participation in the Key Lake mine, Ottawa was also supportive of Saskatchewan's strategy to accelerate and increase uranium sales. The main complaint came from the two private corporations which owned mines in the older producing region of Elliot Lake, Ontario. They objected to government support of new and large supplies of low-cost uranium coming onto the market when world uranium prices were already tumbling. This objection was voiced with particular emphasis by the Canadian company, Denison, which is both more dependent on Elliot Lake production than the other producer, Rio Algom, and has a narrower range of contracts which are subject to cancellation by utilities during the 1990's.

The major potential conflict between Ottawa and Saskatchewan lies in the federal policy of imposing processing requirements on export contracts. If Eldorado is a miner in Saskatchewan, it is also a processor in Ontario. Its plant at Blind River, Ontario, has to capacity to convert yellowcake to UO_3 at the rate of 18,000 tonnes per year. The UO_3 can then be shipped for further processing into UF_6 for export at the rate of 9,000 tonnes U per year at Port Hope, Ontario. Port Hope also processes UO_3 into UO_2 for CANDU reactor fuel. Canadian processing policies can potentially lose export sales for Saskatchewan, since foreign customers may be faced with domestic processing policies within their own countries or may find it cheaper to process elsewhere. This is especially dicey in the case of U.S. utilities, which may be tied into processing contracts with the U.S. Department of Energy. The Canadian processing clause may also be used as a pretext to introduce protectionist measures in the United States, as we saw above.

Our reading of the balance of forces is that Canada's role as the world's leading uranium exporter, i.e., Saskatchewan's role, will take precedence over domestic processing policies. This policy tilt is reinforced both by Eldorado's ability to make money as a miner in Saskatchewan as well as a processor in Ontario and by the Ontario nuclear reactor establishment having a greater interest in abundant and cheap supplies of uranium as opposed to having processing plants operating at full capacity.

In terms of distribution of rent revenues from uranium mining in Saskatchewan, European and Japanese corporations are willing to live with the province taking a higher cut. Even with the elimination of transfer pricing as a vehicle for increasing the returns to private capital, the multinationals and state companies operating in Saskatchewan had ample opportunities to take profits upstream in the nuclear fuel cycle. Uranium exported in the form of UF_6 takes only a minor share of value-added and profits in the commodity chain which stretches from mines to the consumption of electricity or byproducts such as medical isotopes. In particular, the cost of electricity generated from nuclear energy depends more on the capital cost of reactors than on the cost of nuclear fuel. (Fulton, 1985:47)

There was a potential conflict between Ottawa and Saskatchewan because provincial Crown Corporations are exempt from federal royalty payments under present constitutional arrangements. This conflict was muted by other converging interests plus the fact that Ottawa already had good revenue opportunities via Eldorado's mining interests in Saskatchewan.

Finally, with respect to the objective of "orderly marketing," it is difficult to tell whether Canada is still participating with other non-U.S. producers to restrict output,

i.e., to know whether the uranium cartel of the 1970's is still operating. The governments of Canada and Australia have similar orientations towards marketing, and these two market leaders are likely to avoid price competition. (Campbell, 1984:60)

In terms of Saskatchewan's specific economic objectives with respect to "province-building," three goals must be evaluated: 1) the multiplier effects of exploration, development, and operation of uranium mines in Saskatchewan and other regions of Canada; 2) royalty revenues which can be used for economic diversification; 3) participation of Amerindians in the mining boom. The multiplier goal will be treated in the following sections of the paper. We will focus here on royalty revenues and Amerindian participation.

Uranium royalty payments into the Saskatchewan treasury have been modest, given falling uranium prices and the policy of allowing private investors to recover invested capital before collecting graduated royalty payments. For the fiscal year1981-82, uranium payments totaling $30 million were paid into the Saskatchewan Heritage Fund, which was only 3.6 percent of total SHF revenues (the oil industry contributed 64 percent). Seventy percent of the SHF's revenues were paid into the provincial government's Consolidated Fund in order to help finance current expenditures. (Campbell, 1984:81-82) Uranium royalties fell to $24.4 million in 1982-83 and $11.1 million in 1983-84; in the latter fiscal year, uranium provided only 1.4 percent of SHF revenues. (SHF, 1984:4-6) On the basis of price expectations in the early 1980's, it was projected that the uranium industry would generate royalties of $224 million in constant 1980 dollars by the year 2000 and $522 million in 1980 constant dollars by the year 2020, thus replacing payments from dwindling oil resources. (Campbell, 1984:81) Given current price trends, this is likely to be quite over-optimistic. Our conclusion is that uranium has and will contribute much less to the provincial Heritage Fund than expected. In any event, the Heritage Fund has been used much more to meet current expenses than for "province building."

When the uranium boom took hold in northern Saskatchewan during the mid-1970's, this sparsely settled region had a population of 25,000 persons. Thirty percent of the population lived in the three principal urban centers and was principally of European origins. The 8,600 "status" Amerindians [3] and 10,000

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[3] Status Indians are people who are legally recognized by the Federal government as being Indians and thus eligible for program benefits. Non-status Indians and Metis, the latter being the descendants of intermarriage between French fur traders and indigenous people, are people who are not legally recognized and thus ineligible for benefits.

"non-status" Amerindians and Metis[4] make up 94 percent of the remaining population, which is scattered in small settlements. Previous resource projects in the northern Amerindian regions of the prairie provinces and the adjacent Northwest Territories had provided very little in the way to economic spinoffs to the local population, which suffers from severe levels of unemployment and poverty. During the 1970's, Amerindian nationalist movements mobilized to reverse this pattern when new resource projects were proposed for their regions.

Amerindians in northern Saskatchewan demanded but did not achieve an ownership role in the uranium industry or the earmarking of a specific portion of royalty payments for development projects in their region. What emerged were two new programs: 1) agreements that 50 percent of the operating staff at the Cluff Lake and Key Lake mines would be northerners, i.e., Amerindians. 2) policies to encourage the formation of new companies by northern entrepreneurs who would provide supplies and services to uranium mines. These latter policies included preferential clauses in contracting, invitational bids, non-tendered awards of work, and payment of higher leasing rates to the fledgling companies. These policies have resulted in the rise of a small class of Amerindian entrepreneurs who are cashing in on mining industry contracts. (Gunn, 1982:131-34) Given the scale of uranium operations in northern Saskatchewan, however, there is a far larger potential role for the sector in overcoming the severe local poverty than has been realized by existing programs.

6. The Multiplier Effect: Jobs and Indirect Revenues

Uranium exploration and open-pit mining are highly capital-intensive activities. In terms of direct job creation, the impact of the industry is relatively limited. On the basis of an econometric model of the Saskatchewan uranium sector, M.E. Fulton estimates that five jobs are generated for every $1 million spent on exploration and approximately 80 jobs for every million pounds of product produced. (1985:14) The peak year for uranium exploration in Saskatchewan was 1980, when $77 million was spent on exploration. This works out to approximately 385 jobs. By 1985, exploration expenditures fell to $23.5 million, with a corresponding decline in employment. In terms of employment in uranium mining, we remind the reader that Saskatchewan produced 5,928 tonnes of Uranium with a workforce of 1,034 persons in 1985.

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[4] The descendants of intermarriage between French fur traders and indigenous people. The Metis are not legally recognized as Amerindians and are thus ineligible for the benefits of government programs directed at indigenous groups.

The employment impact of the uranium sector is thus to be sought not so much in terms of direct employment but in terms of the direct and indirect income flows generated by uranium mining and the impact of these income flows on the indirect creation of employment in Saskatchewan and other regions of Canada. Statistics Canada's input-output models of the Canadian economy have been employed by G.W. Holman (1982) in order to estimate the direct and indirect income and employment effects of uranium exploration, development, and exploitation. Let us examine his results.

For the peak exploration year in Saskatchewan, 1980, Holman estimates that the income and employment multipliers from uranium exploration activities in Canada as a whole were 1.9 and 2.1 respectively. In other words, for every dollar of income generated directly from exploration, another dollar is created when companies or individuals who make money from exploration spend their incomes on purchases from other sectors and thus increase incomes outside the exploration sub-sector. A similar ratio holds for job creation: for every job created in exploration, another job is created outside. But when the multiplier is examined on a regional basis, we see a different pattern: Saskatchewan, the Northwest Territories, and the Yukon accounted for 78 percent of direct impacts from uranium exploration, but the local multiplier effects were only 1.3 for income and 1.4 for jobs in the case of Saskatchewan. On the other hand, "other provinces," meaning mainly the central industrial region of Ontario, accounted for only 22 percent of direct impacts but the multipliers were 3.8 for income and 4.4 for jobs. (Holman, 198254-55) Ontario provides much of the equipment and services which support exploration, and thus captures approximately one-half of the total incomes and jobs from exploration which takes place mainly in Western Canada.

The development phase of open-pit uranium mining generates more employment than the operating phase. The direct income effect of developing a 1000 ton annual output capacity in Saskatchewan as of 1980 were estimated at $24 million and the indirect effect at $64 million while central Canada (Ontario and Quebec) would gain $40 million in indirect income. An estimated 6000 persons would be employed directly in mine development in Saskatchewan while another 1200 would indirectly gain employment in the province. Central Canada would indirectly gain an estimated 1,670 jobs from the mine development work taking place in Saskatchewan. (Holman, 1982:47-49) In terms of total jobs, nearly the same number of new jobs would be created in Canada's industrial heartland as would be created in the region where mining development was proceeding. These estimates put Western Canada's desires to use resource revenues as a vehicle for financing economic diversification into perspective.

Once established, open-pit mining operations have low income and employment multipliers. Mine operations can generate high levels of direct income flows which accrue to government, industry, and labour. Indirectly, mine operations do not generate a large amount of income and employment because of the small proportion of material, service, and labour costs as a proportion of total revenues. (Holman, 1982:58) However, generation of high levels of direct income flows is dependent on favorable uranium prices, which has not at all been the case in recent years. Let us examine the potential direct income flows which can result from uranium mining when prices are high. This will explain why the Saskatchewan government had such high expectations with respect to the sector's contribution to restructuring the provincial economy.

The employment, value-added, and royalties generated per $ million of shipments for uranium as compared to other minerals during the 1977-80 period are compared in Table 4. Uranium and oil are quite comparable in that they have high ratios of value-added to shipments, i.e., few intermediate inputs are purchased outside the sector once development is over and thus little indirect income is generated. Oil is the low end of employment per $ million shipments while the mid-range figure for uranium is the result of averaging Ontario's labour-intensive underground mines with Saskatchewan's open-pit mines, which have very low labour requirements. What is most striking is that uranium generates even more royalties per dollar of shipments than is the case for oil.

TABLE 4
Comparison of Direct Operating Impacts of Selected Extractive and Energy Industries Per Unit of Output
($ million per $ million of annual shipments unless otherwise specified)

	Number Employed	Value Added	Royalties/ Taxes
Uranium(1980)	8.9	.89	.46
	8.3	.75	.11
Other Mining(1978)	18.7	.67	.015
Iron(1977)	11.2	.60	.037
Nickel(1977)	14.8	.54	na
Oil,gas(1977)	1.9	.97	.30

Source: Holman, 1982:61

These figures explain the enthusiasm of the Saskatchewan government in appropriating a large share of the rent from uranium mining and applying this surplus to restructuring its agrarian economy. If sliding uranium prices have frustrated these hopes, one can reply that hindsight is always easier than foresight. Even with today's low prices, Saskatchewan's rich and easily recoverable uranium deposits still yield profits on current operations. Current profits are probably not sufficient, however, to justify the heavy capital investments necessary to develop other known deposits in Saskatchewan. If and when prices do turn up again, Saskatchewan's uranium mines do have the potential to generate a large economic surplus which, if properly invested, could make a very important contribution towards restructuring the province's economy.

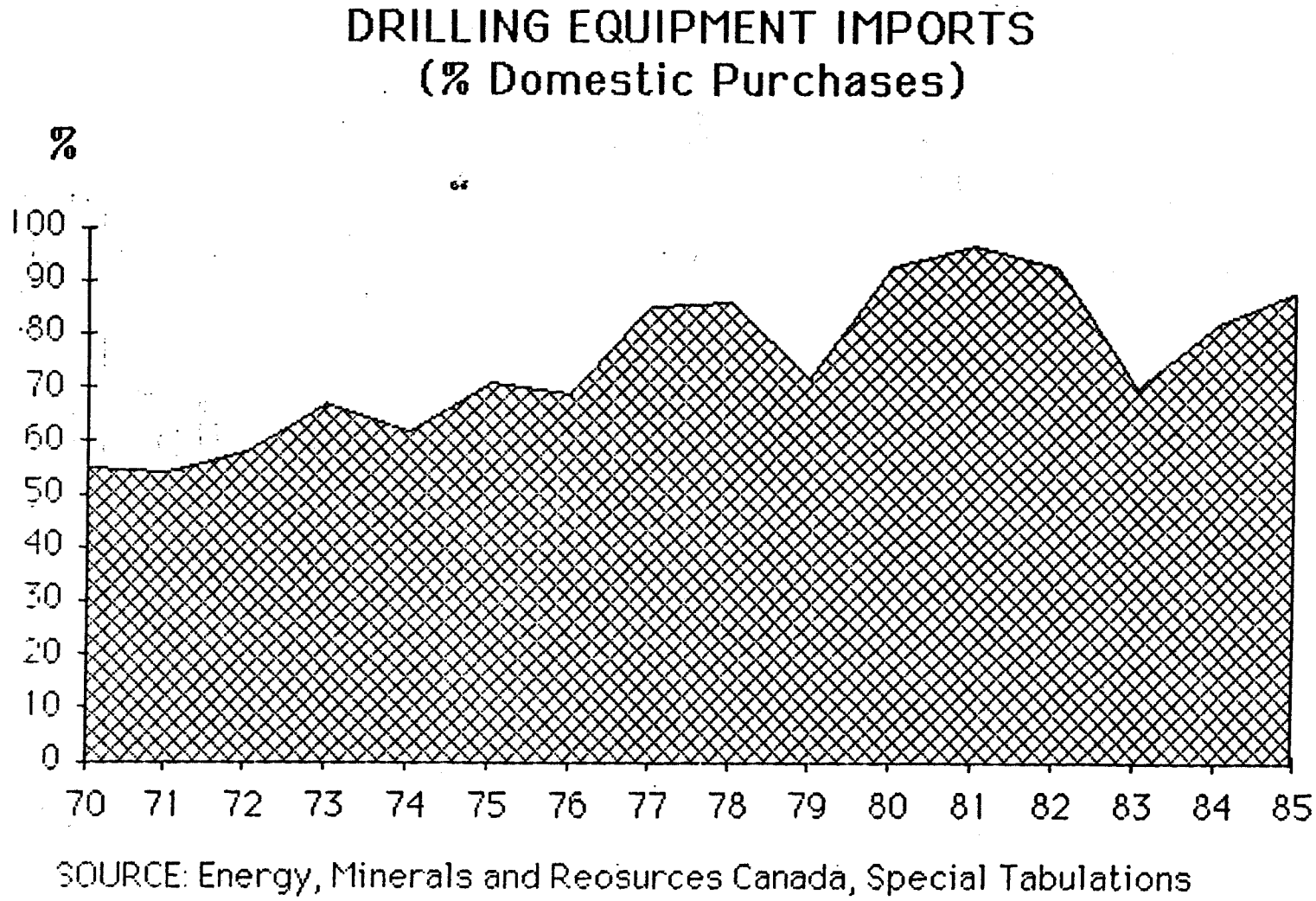
7. Backward Linkages: the Mining Equipment Sub-sector

Uranium exploration, development, and production involves inputs and technological processes which are fundamentally the same as hard-rock mining for other minerals. Existing data bases do not permit us to distinguish purchases of mining equipment and services which emanate from the uranium sector as opposed to purchases emanating from other sectors. Consequently, the manner in which uranium mining does or does not create backward linkages to Canadian suppliers of mining equipment and services must be inferred from the linkages generated by hard-rock mining as a whole.

The extent to which the Canadian mining sector depends upon imported inputs is indicated in Figures 7 and 8 for rock drilling equipment and mining and ore processing equipment respectively. One gets the impression that the Canadian mineral boom of the 1970's was associated with an increased dependence upon imported equipment. This only looks at only one side of the coin, however. Exports of Canadian equipment were quite vigorous during the 1970-85 period: in fact, the growth rate for exports of both classes of mining equipment surpassed those for imports. (Figure 9). In absolute terms, the ratio of the value of exports to imports as measured in $ 1985 increased from .41 to .75 in the case of rock drilling equipment and from .23 to .38 in the case of processing equipment. (Ministry of Energy, Mines, and Resources: special tabulations, 1986).

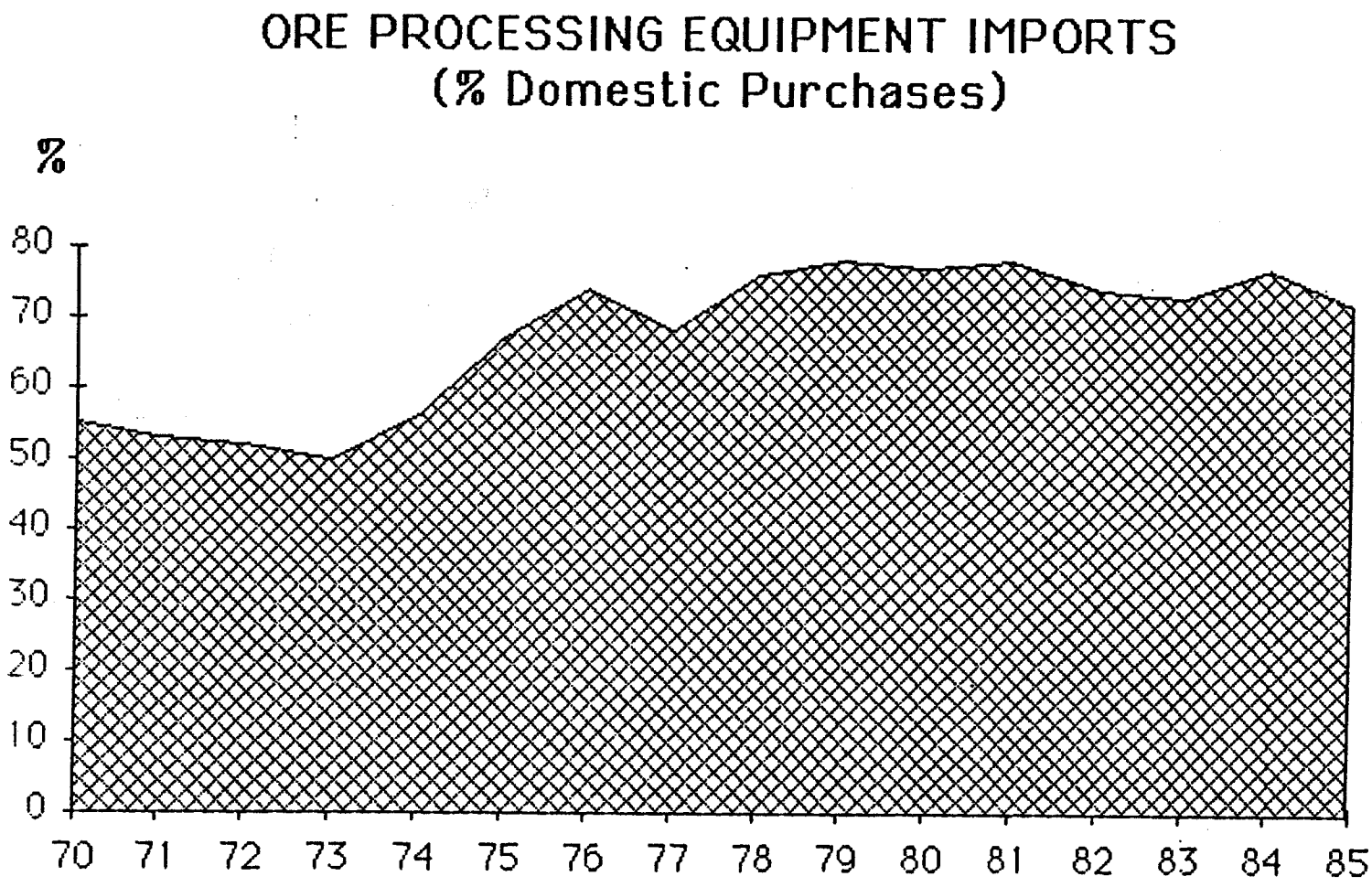
Very much the same kind of equipment was being imported into Canada as was being exported. Both imports and exports of equipment grew, with the export growth exceeding that of imports. Why not simply purchase locally made equipment rather than resorting to imports? For example, foreign and Canadian drill bits are virtually identical. The motive for a foreign country to import a Canadian drill bit and for Canada to import a drill

FIGURE 7



SOURCE: Energy, Minerals and Reosurces Canada, Special Tabulations

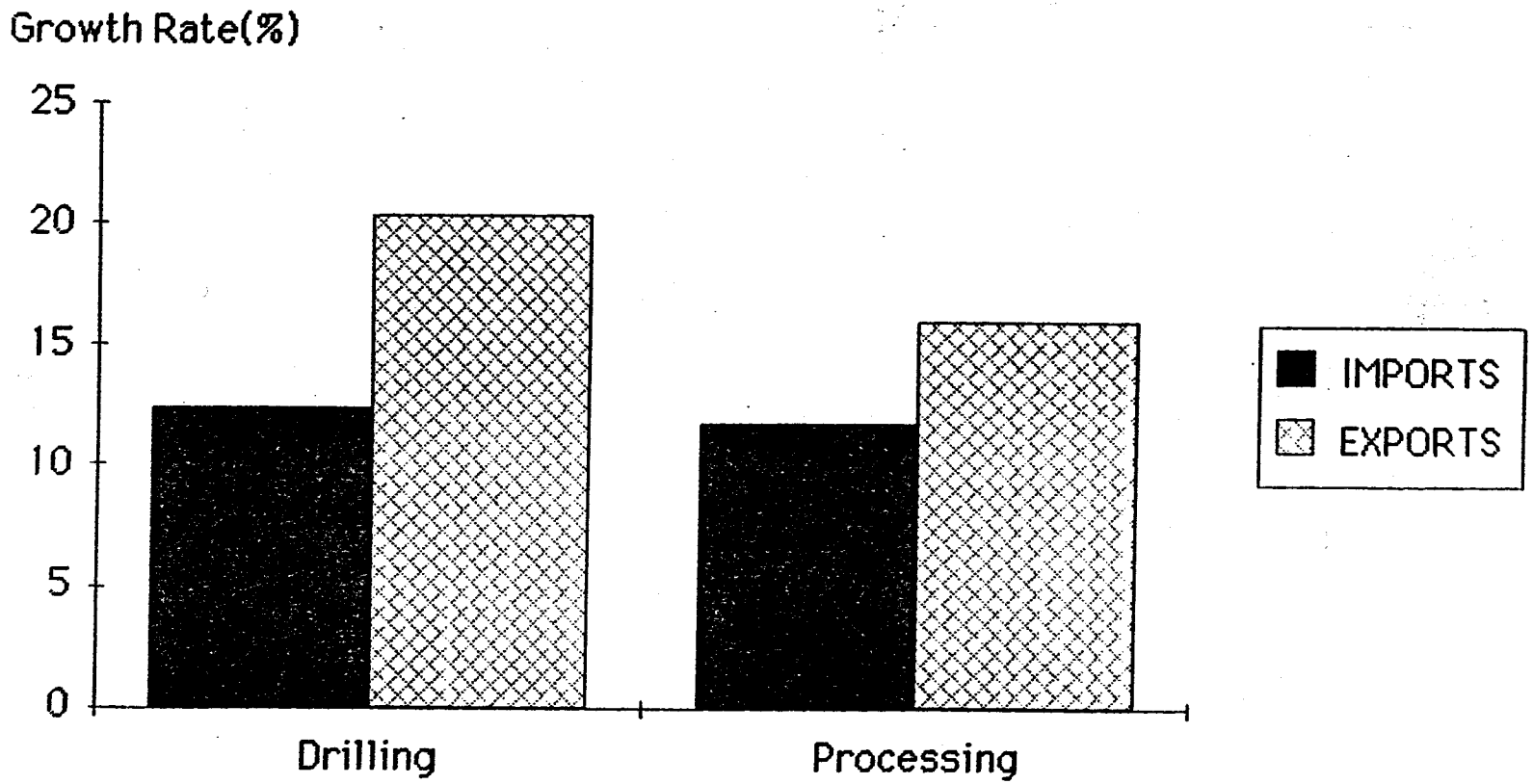
FIGURE 8



SOURCE: Energy, Minerals and Reosurces Canada, Special Tabulations

FIGURE 9

GROWTH RATES, IMPORTS AND EXPORTS, MINING EQUIPMENT, 1970-85



SOURCE: Energy, Mines,and Resources Canada, Special Tabulations

bit from that same foreign country probably lies in export credit subsidies which are not covered by GATT. If a company operating in Canada buys a drill bit locally, it borrows money to do so at the local prime rate plus 1 percent. If it imports the drill bit, it will pay the exporting country's prime rate less , for example, 2 percent because of export credit subsidies. In addition, Canada has a relatively high prime rate to begin with because Canadian interest rates are usually set above those of the United States in order to attract capital into the country. The money saved more than covers the cost of transportation.

Canada's increasing capacity to export mining equipment belies the image of the country as a hewer of wood and drawer of water. The main market for Canadian mining equipment exports was the United States, which absorbed 62 percent of Canada's $512 million exports in 1985. But Canada has also succeeded in exporting its equipment to Western Europe, Japan, Australia,and Eastern Europe. Taken together, the countries at the "center" of the world economy generally absorb three-quarters of Canadian mining equipment exports. Canada has also established itself as the world leader in geophysical mineral exploration services and equipment and is in the top ranks with respect to geochemical techniques.

Aside from export credit subsidies, which are modest in Canada compared to those furnished by other countries, this export growth resulted largely from private firms, both Canadian and foreign branch companies, following market opportunities. Our hypothesis is that the exporting activities would have proceeded at an even more rapid rate if systematic policies requiring mining companies to buy inputs locally had been instituted, as in Brazil or Australia. We also expect that the participation of foreign firms in exports of mining equipment from Canada (Table 5) reflects a product mandate from the home office to produce for both the Canadian and American markets. By the fact that exports have succeeded without this policy support, we infer that these policies would have accelerated and deepened the development of the mining input sector in Canada that was competitive on the world market.

In summary, hardrock mining, of which uranium is one sub-sector, has generated dynamic backward linkages to the production of mining equipment. The process could be even more dynamic with the introduction of appropriate forms of state intervention. Canada's world leadership in mineral exploration technology would be difficult to imagine without the substantial support given to mineral research and the Geological Survey of Canada within the Ministry of Energy, Mines, and Resources. A deregulation and privatization approach does not appear to be the most efficient way to generate backward linkages within mineral-exporting countries.

TABLE 5

COMPANIES EXPORTING MINING AND EXPLORATION EQUIPMENT
CANADA, 1980-85

OWNERSHIP	NUMBER OF COMPANIES WITH EMPLOYEES <100		NUMBER OF COMPANIES WITH 100+ EMPLOYEES	
Canadian	170		86	
%		66		34
Foreign				
American	42		72	
%		37		63
Non-American	10		15	
%		40		60

SOURCE: Energy Mines and Resources Canada, Special Tabulations; Dunn and Bradstreet, 1986; Canadian Trade Index, 1986; Scott's Index, 1986.

8. Conclusion

Canada has become the world's leading exporter of uranium and is likely to maintain this position through the early to mid-1990's. It will be in the top ranks of world exporters through the early decades of the twenty-first century. In terms of economic and technological development, the question is whether the sector has operated as a mineral enclave which will leave behind mainly radioactive tailings or whether backward and forward linkages have been established which have diversified and deepened Canada's economic structure.

First, the exploration, development, and exploitation process in uranium mining employs technologies which are basically the same as those employed in other hardrock mining sectors. Canada's vast pre-Cambrian Shield holds one of the world's most diversified and richest source of mineral deposits. Backward linkages to the mining equipment sector have been established such that Canada has become a world-class equipment exporter. This has occurred despite modest levels of government support. With more aggressive policies, such as those adopted by Brazil, Canada would capture more long-term technological benefits and create more employment as mining becomes increasingly capital-intensive. In the area of exploration equipment and services, Canada has become a world leader, and the world leader in geophysical technologies. Government programs have been a key element in creating this leadership.

The important goal is not merely to replace imports but to create equipment and services which can compete on the world market---to the extent that one can really speak of a world "market" for mining inputs. Non-GATT trade barriers and credit subsidies are the rule rather than the exception for mining inputs. It will take a major round of international negotiation to create anything looking like a "level playing field." Until then, the most rational strategy for mineral-exporting countries attempting to create backward linkages may be to act as crazy as everyone else and thus match existing subsidies.

Secondly, the dynamic backward linkages flowing from the new world uranium production center, Saskatchewan, appear to have flowed mainly to Canada's central industrial region, Ontario. As a region with a highly educated but small population of one million people and a limited industrial base, Saskatchewan does not appear to have benefited greatly to date in terms of creating a mining equipment and service sector. While it would be unrealistic to think that the province would develop a wide-ranging mining input sector, "buy local" policies do not appear to have exhausted the range of the possible in identifying viable products that could be manufactured locally and making local purchases a condition of mining licenses. The trickle-down

effect, or "learning by doing," appears to require planning and intervention if it is to be actualized.

In terms of industrial planning, Saskatchewan achieved more of its goals in supporting the creation of new supply and construction firms run by Amerindian entrepreneurs. The government was also more successful in reserving mining jobs for Amerindians. Its policy of flying workers in and out of their own communities to work on 7-day shifts avoided the problem of creating mining towns which will become ghost towns if aging mines are closed. Third World uranium producers with relatively small populations can draw some valuable insights from Saskatchewan's local uranium policies in the Athabasca Basin.

Third, royalties from uranium were limited due to the post-1978 price slide and the policy of limiting royalty rates until multinational partners in joint ventures recovered their initial capital investments. Furthermore, uranium's minor contributions to the Saskatchewan Heritage Fund as well the Fund's budget in general has been used largely to finance current government expenses rather than being invested in long-term economic development projects. Earnings by the Saskatchewan Mining Development Corporation have been mainly retained for reinvestment in the uranium sector.

Reinvestment in uranium and maintaining high levels of production in the face of falling prices may be viewed either as an inopportune use of wasting resources or a future-oriented policy in which Saskatchewan's reputation as a reliable supplier through thick and thin is a valuable economic asset. (Fulton, 1985:8) Our view is that the policy is future-oriented and will encourage the opening of new mines in Saskatchewan and in the adjoining Northwest Territories. Canada is first in production but not in reserves. However, the evaluation of reserves involves more than just the quantity of ore in the ground. It also involves a risk assessment relative to producing in a given country. In terms of international competition for mining investment, reliability as a supplier during a time of falling prices enhances the value of reserves.

Fourth, the National Democratic Party's policy of compulsory options of joint venture participation by the Saskatchewan Mining Development Corporation in new uranium discoveries appears to have been quite acceptable to European and Japanese corporations. When the newly elected Conservative Party government in Saskatchewan cancelled the compulsory participation clause in 1983, it gave away an unnecessary concession. What made the multinationals more nervous was the potential re-election of a more radicalized NDP which might impose a moratorium on uranium mining. The narrow electoral victory of the Conservative Party in the autumn, 1986, elections was good news for the nuclear industry because it assured that Saskatchewan would have an open

door for uranium development during the next five years. An open door conditional on joint ventures was acceptable to multinationals. The joint venture strategy, as we explained above, appears to have achieved its goals of accelerating uranium development and getting a window on the industry in order to drive a better bargain with multinationals.

Finally, our analysis of the political economy of Canadian uranium has restricted its analysis to a commodity perspective. A complete analysis must start with the question as to whether conservation or increased production of uranium, petroleum, gas, or hydroelectric dams constitute the most efficient energy strategies. Even within the commodity perspective, uranium is not a commodity like any other because it is used to make bombs. Canada adheres quite strictly to the non-proliferation regime in terms of its uranium exports. To this one must add the fact that Canada has long had the capacity to make nuclear weapons but has refrained from doing so. What is at question is the efficacity of the international arrangements in enforcing nonproliferation. Canada's responsibility here is dual: we are both the world's major uranium exporter and also the exporter of a nuclear reactor technology that is particularly well-suited creating fissionable material to be used in bombs (the CANDU does not have to be shut down for refueling and thus detecting nonproliferation violations can be more difficult than with a LWR reactor). Uranium mining has environmental risks that must be evaluated in an economic analysis of the sector. The next phase of our research involves integrating a commodity analysis of uranium with the dimensions of nonproliferation and environmental impact.

From the perspective of whether uranium in particular and minerals in general have functioned as a shallowly rooted enclave or a dynamic sector generating linkages to the rest of the economy, Canadian mining appears to be a "pole de croissance" that has deepened the country's economic and technological structure. State intervention has been a key factor when deepening has occurred and lack of state intervention appears important when the deepening process has not gone further. Privatization and deregulation do not appear to be appropriate strategies for a mineral-exporting country which wishes to reap the full long-term benefits from its mines.

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A l'origine de ce regroupement se situe le programme dit des «Actions structurantes» du Ministère de l'éducation supérieure, de la science et de la technologie du Québec, destiné à favoriser l'essor de la recherche dans le secteur prioritaire de la maîtrise technologique. En vertu de ce mandat et des fonds qui lui ont été attribués, le Centre est appelé à se pencher sur l'étude de la maîtrise et du transfert de la technologie canadienne dans le domaine stratégique de l'énergie. Il s'agit d'un ensemble de recherches d'une durée prévue de cinq ans impliquant la participation de professeurs réguliers, professeurs-chercheurs, d'étudiants de deuxième et troisième cycle.