SECTOR COMPETITIVENESS FRAMEWORKS

INDUSTRIAL CHEMICALS INDUSTRY

PART 1 – OVERVIEW AND PROSPECTS

Industry Sector
Advanced Materials, Chemicals and Plastics

Secteur de l'industrie
Matériaux de pointe, produits chimiques et produits en matière plastique

Canada

INDUSTRIAL CHEMICALS INDUSTRY

PART 1 – OVERVIEW AND PROSPECTS

PREPARED BY:
ADVANCED MATERIALS,
CHEMICALS AND PLASTICS BRANCH

This *Overview and Prospects* is the first of two companion documents on the Canadian industrial chemicals industry in the **Sector Competitiveness Frameworks** series, which is being produced by Industry Canada in collaboration with Canada's key stakeholders in the industry. *Part 2 — Framework for Action* will be prepared in coming months, based on discussions with major industry stakeholders, following study and review of the *Overview and Prospects*.

The **Sector Competitiveness Frameworks** series focusses on opportunities, both domestic and international, as well as on challenges facing each sector. The objective is to seek ways in which government and private industry together can strengthen Canada's competitiveness and, in doing so, generate jobs and growth.

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FOREWORD

The new Canadian marketplace is expanding from national to global horizons and its economic base is shifting increasingly from resources to knowledge. These trends are causing Canadian industries to readjust their business approaches, and government must respond with new tools to help them adapt and innovate. Industry Canada is moving forward with strategic information products and services in support of this industry reorientation. The goal is to aid the private sector in what it is best qualified to do — create jobs and growth.

Sector Competitiveness Frameworks are a series of studies published by Industry Canada to provide more focussed, timely and relevant expertise about businesses and industries. They identify sectors or subsectors having potential for increased exports and other opportunities leading to jobs and growth. They will cover 28 of Canada's key manufacturing and service sectors.

While they deal with "nuts and bolts" issues affecting individual sectors, the Sector Competitiveness Frameworks also provide comprehensive analyses of policy issues cutting across all sectors. These issues include investment and financing, trade and export strategies, technological innovation and adaption, human resources, the environment and sustainable development. A thorough understanding of how to capitalize on these issues is essential for a dynamic, job-creating economy.

Both government and the private sector must develop and perfect the ability to address competitive challenges and respond to opportunities. The Sector Competitiveness Frameworks illustrate how government and industry can commit to mutually beneficial goals and actions.

The Sector Competitiveness Frameworks are being published sequentially in two parts. An initial *Overview and Prospects* document profiles each sector in turn, examining trends and prospects. The follow-up *Framework for Action* draws upon consultations and input arising from industry–government collaboration, and identifies immediate to medium-term steps that both can take to improve sectoral competitiveness.

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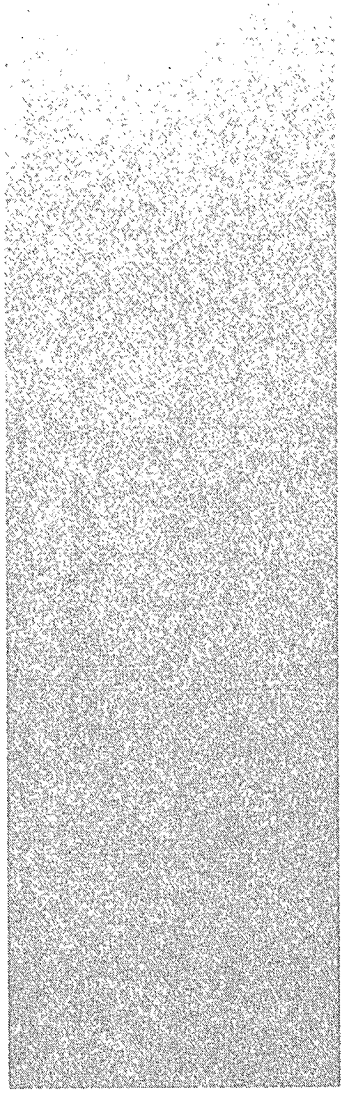


1 HIGHLIGHTS

Canada's chemical manufacturing industry is part of an expanding sector that provides high-quality jobs and generates wealth for Canadians. Many products that Canadians take for granted and use daily depend on chemicals. In manufacturing the family car, for example, over $3 000 worth of chemical derivatives are used to help to create a better and more fuel-efficient vehicle.

- Chemical production is a globally driven, high-tech, high-skill activity. Using advanced technology processes, chemical companies upgrade natural resources such as natural gas, oil and minerals to produce a broad range of high-value-added chemicals and chemical products for domestic and export markets.

- Chemicals and chemical products comprise Canada's fourth largest manufacturing sector in terms of sales, and third largest in terms of value-added. In 1995, the industrial chemicals industry represented 43 percent of the overall chemicals and chemical products sector (up from 35 percent in 1985) and comprised 300 establishments, generated $14.4 billion in shipments and directly employed 23 148 people.

- Plants are regionally concentrated in Ontario, Quebec and Alberta, with current expansion occurring primarily in Alberta and Quebec. Canadian producers have been largely geared to supplying the North American market, but new western capacity is being added to supply rapidly growing market demand in Southeast Asia as well.

- Industrial chemical production provides an important stimulus to other sectors of the economy. Primary suppliers to the industry include other chemical industries, the distribution and storage industry, the feedstock and energy sectors, business services, materials and supplies, construction, equipment and services of various kinds. Leading consumers of industrial chemicals are manufacturing industries that make plastic products, transportation equipment, electrical and electronic products, and paper and allied products, among others.

1.1 Competitiveness and Trade

- An indicator of the industry's international competitiveness is its high proportion of exports; over 63 percent of shipments are destined for export markets. Productivity in the industrial chemicals industry is two and a half times the total Canadian manufacturing sector average. Annual wages for the industry's small but highly skilled work force average almost $55 000 (Table D-2), which is about 45 percent above the average for the total manufacturing sector.

- New investment to expand capacity and develop downstream product synergies with existing refinery/petrochemical complexes in Alberta, Ontario and Quebec is key to the continued growth of this industry. It adopts high standards in controlling the impact of its activities on health, safety and the environment. Its accident rate is less than half the national average for all manufacturing industries, and performance continues to improve year by year. Plant emissions are declining, and the industry is committed to continuous improvement in its environmental record.

- Many of Canada's major industrial chemical producers are subsidiaries of U.S. multinationals. Through the restructuring and rationalization of North American production that has occurred over the past decade, Canadian producers have become more fully integrated into the operations of these global corporations. The low Canadian currency exchange rate in recent years has greatly facilitated this process. Product specialization for the North American market has allowed Canadian firms to realize the gains that come from increased economies of scale.

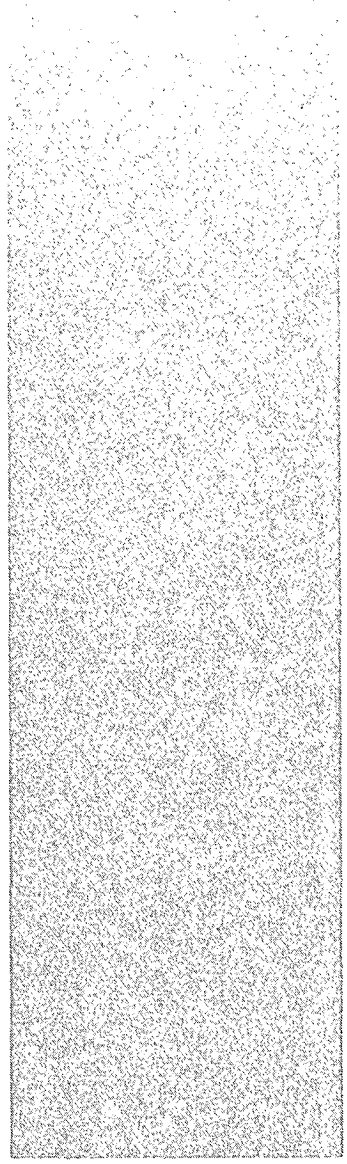
1.2 Major Trends

- Canada is well positioned to benefit from the expected long-term growth in North American demand for ethylene derivatives and other petrochemical products. Canada has an ample supply of the hydrocarbons used as inputs to petrochemical products and, relative to the U.S. Gulf Coast, is closer to Asian markets.

- Although some constraints remain to be addressed, the prospect is excellent for attracting major new investment in Canada in industrial chemicals and downstream products.

1.3 The Bottom Line

- Canada's natural resource wealth and skilled human resources are the underlying strengths of this country's industrial chemicals industry. To remain globally competitive, however, it is necessary to build on these strengths. In particular, continuous attention must be devoted to cost control and product innovation. While Canada is very well positioned to attract investment, there is a need for ongoing review and assessment of certain factors that have an important influence on the competitiveness of Canadian-based activities relative to operations in the U.S., notably, construction costs, electricity costs, labour costs and environmental regulations.



2 KEY POINTS ABOUT THIS INDUSTRY

Industry comprises 2 major subsectors: inorganic and organic

This *Overview and Prospects* focusses on the two main subsectors comprising the industrial chemicals industry: inorganic chemicals, and organic chemicals including plastics and synthetic resins. Excluded from this study are pharmaceuticals, formulated chemical products and fertilizers, which are qualitatively different and serve different end-use markets.

Industrial chemicals are essential inputs to the production of a wide range of manufactured products for both industries and consumers. Commodity chemicals are typically sold in bulk and at world market prices to other manufacturing industries and to other segments of the chemicals and chemical products sector. Specialty chemicals, often packaged in small units and commanding higher prices, are designed for specific applications, including their use in pharmaceuticals.

The chemical industries in industrialized countries draw on a combination of elements, which include substantial capital, advanced process technology, research capacity, management skill, and highly skilled and technically competent workers.

Inorganic chemicals from non-carbon minerals have many industrial uses

Inorganic chemical companies produce chemicals from basic minerals and materials that do not contain carbon as a principal element. Examples of inorganic chemicals are sulphuric acid, soda ash, phosphorus, chlorine, caustic soda and titanium dioxide. Inorganic chemicals are used directly or indirectly in virtually all industrial processes, such as bleaches, detergents, absorbents, dyes and disinfectants.

Organic chemicals from hydrocarbons serve as inputs to other industrial and consumer products . . .

Organic chemical companies produce primarily petrochemicals from hydrocarbons such as crude oil and natural gas but also chemicals from animal fats and vegetable oils. Most of the following analysis of organic chemicals relates to the petrochemical subsector. These chemicals are used in both resource and manufacturing industries. Some are used as intermediates to produce other chemicals, and others are important ingredients in many common consumer goods, such as cosmetics, foods, paints, plastic and rubber products, and pharmaceuticals.

. . . and command higher value per unit, which can support world-scale plants

Since petrochemicals have a higher value per tonne and can support the costs of shipping more easily, they are traded on international markets more than inorganic chemicals. Petrochemicals are also subject to more volatile investment swings, since they are directly linked to both hydrocarbon feedstock prices, which tend to be rigid, and to industrial and consumer demand for plastics and other industrial end products, which are more sensitive to income changes. Investment in new petrochemical production capacity is being increasingly geared to the establishment of

world-scale plants, either close to growing markets such as Southeast Asia, or in countries with hydrocarbon resources, such as Canada, Mexico and the Middle East. Such large new plant investments tend to follow periods of strong demand growth and high profitability.

2.1 Global Context

While every nation is engaged in the trade of industrial chemicals or chemical products, a handful of nations account for most of the world's output of chemicals and chemical products, which have a total estimated value of US$1.5 trillion. In 1995, the top 10 producers together accounted for about 74 percent of world production of all chemicals, including pharmaceuticals, with the U.S., Japan and Germany accounting for over half the world total. It is estimated that industrial chemicals account for approximately 41 percent of total chemical production, based on the commodity composition of world chemical exports in 1995. Assuming the world industrial chemical market is worth about US$630 billion, Canada is a small player, with about 1.7 percent of the total in 1995.

World output is concentrated in 10 producers, 3 countries

Canada is small player

During the past decade, a number of developing nations have embarked on ambitious programs to develop globally competitive chemical sectors. This group includes several of the newly industrialized countries (NICs) of Asia such as Singapore, Republic of Korea, Taiwan and Thailand. Many of the larger economies of Latin America (Argentina, Brazil, Mexico and Venezuela) also have made large investments in their chemical industries.

NICs invest in chemical sector to sustain their development

Since the 1960s, chemical markets have become increasingly globalized. The industry now is characterized by multinational enterprises with geographically dispersed facilities and markets, and prices are set by global supply and demand. These developments reflect the influence of world economic growth, largely due to the rapid development of the newly industrialized world, falling tariff and non-tariff trade barriers, and technological advances that have substantially reduced telecommunications and transportation costs. American and European chemical companies were at the forefront of this globalization process during the 1980s.

Freer trade, world economic growth drive global industry with widely dispersed production facilities and markets

An increasing share of Canadian production is directed to export markets. In 1995, exports accounted for 63 percent of shipments, with most of this going to the U.S., but a significant share was destined for rapidly growing markets in Southeast Asia. Canada's share of world exports fell over the latter half of the 1980s but subsequently increased and is now back to just over 3 percent of the world total.

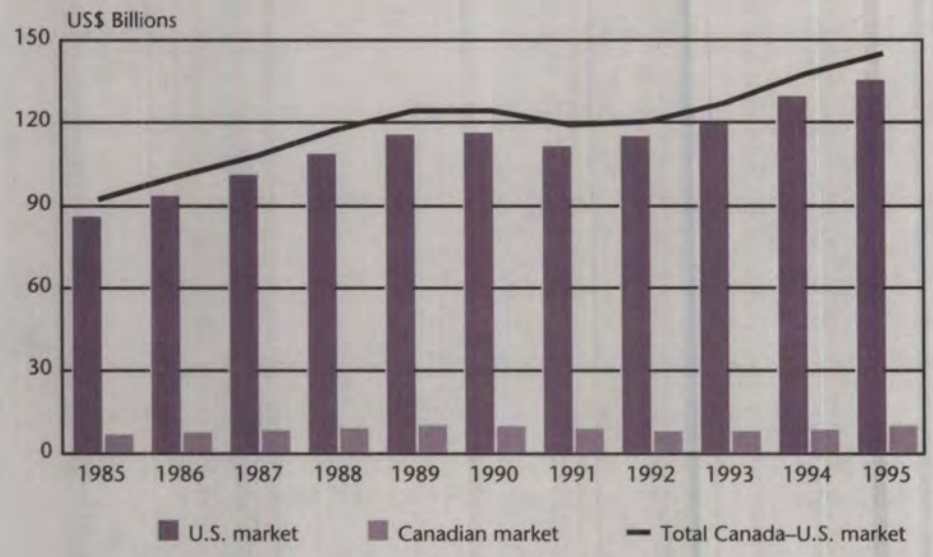
Exports account for major share of Canadian shipments

2.2 North American Context

U.S. accounts for 90% of NA market

The combined Canada–U.S. industrial chemical market reached US$145 billion in 1995. Over the past decade, market growth has been about the same in Canada (4.9 percent per year) and the U.S. (4.7 percent). However, trends have been dominated by developments in the U.S., which accounts for over 90 percent of North American sales (Figure 1).

Figure 1. North American Industrial Chemical Market



Source: Statistics Canada/Industry Canada Business Integrated Database; U.S. Department of Commerce, *Census of Manufactures* (Washington, D.C.: GPO, 1992 and updates).

Canada–U.S. exchange rate since 1991 favours Canadian expansion and growth of exports to U.S.

During implementation of the Canada–U.S. Free Trade Agreement (FTA) beginning in 1989, followed by implementation of the North American Free Trade Agreement (NAFTA) in 1994, some chemical companies became concerned about the erosion of the Canadian manufacturing base that seemed to be taking place and about its impact on their domestic sales. The high Canada–U.S. exchange rate in 1989 and 1990 forced production adjustment on the domestic industry. Since 1991, a major depreciation in the Canadian dollar against the U.S. dollar greatly assisted the growth of exports to the U.S. and the expansion of domestic production.

NA market rationalization boosts Canada–U.S. trade growth

At the same time, the chemical industry has itself gone through a major restructuring. The effects of this can be partly seen in the trade data; both Canadian exports to and imports from the U.S. have increased at average annual rates of over 10 percent over the past decade as the industry has increasingly rationalized to a North American market orientation (Annex Table D-1).

Recent trade growth rates between Canada, the United States and Mexico have been impressive, rising 12.4 percent annually between 1990 and 1995. While much of this activity is accounted for by the increase in Canada–U.S. trade, Mexico's exports are growing strongly from their low base. In recent years, Mexican exports of petrochemical products to the U.S. and Canada have risen by about 25 percent per year. The Mexican government has announced its intention to privatize the petrochemical industry, and this should further boost development. Canadian imports from Mexico have risen more rapidly than Canadian industrial chemical exports to Mexico, due in part to the recent devaluation of the peso. Both Canada and Mexico are important markets for the U.S. chemical industry, which exported US$5.2 billion to Canada and US$2.8 billion to Mexico in 1995.

Mexico's exports in chemicals grow

2.3 Canadian Industry Snapshot

The industrial chemicals, plastics and synthetic resins industry in 1995 employed 23 148 workers and generated total revenues including resales of over $16.7 billion. Among Canada's 22 major manufacturing groups, chemicals and chemical products is fourth largest, as measured by manufacturing shipments, and third largest in terms of manufacturing value-added. The industry ranks sixth in terms of manufacturing exports.

23 148 workers help generate revenues of $16.7B in 1995

Industry Output and Structure

Table 1 lists the major chemical products of the two industry subsectors, based on the value of their output in 1992 (the most recent year for which complete data are available). These products are inputs to other manufacturing industries.

Table 1. Main Industrial Chemical Products, Canada, 1992

Product	Share of total value	Product	Share of total value
	(percent)		(percent)
Inorganic chemicals		**Petrochemicals**	
Caustic soda	14	Ethylene polymers	13
Sodium chlorate	8	Other polymers	12
Other salts	7	Ethylene	11
Chlorine	6	Other hydrocarbons	6
Oxygen	5	Vinyl chemicals	5
Pigments and dyes	3	Benzene, toluene, xylene	5
Ammonia	2	Other alcohols and derivatives	2
Sulphuric acid	1	Butadiene	1
Other	54	Other	45

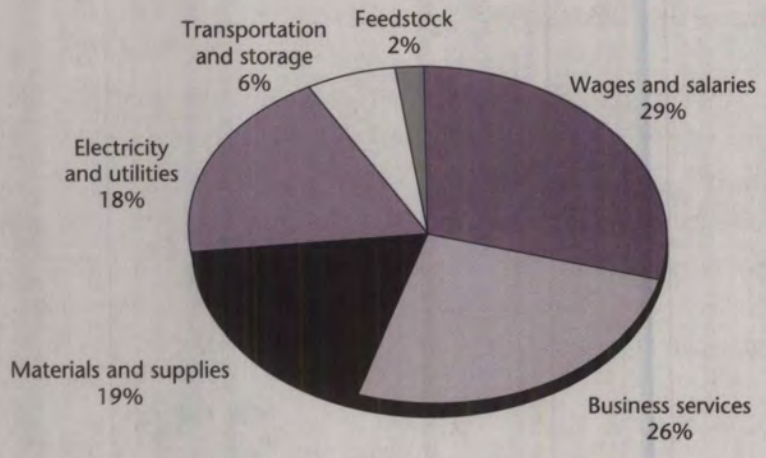
Source: Statistics Canada, Input-Output Division.

Chemical outputs become inputs to wide range of manufacturing industries

The plastic products and transportation equipment industries consume half the value of industrial chemical output. Other major consumers are other chemical industries (14 percent), other manufacturing industries (14 percent), electrical and electronic products (7 percent), and paper and allied products (4 percent).

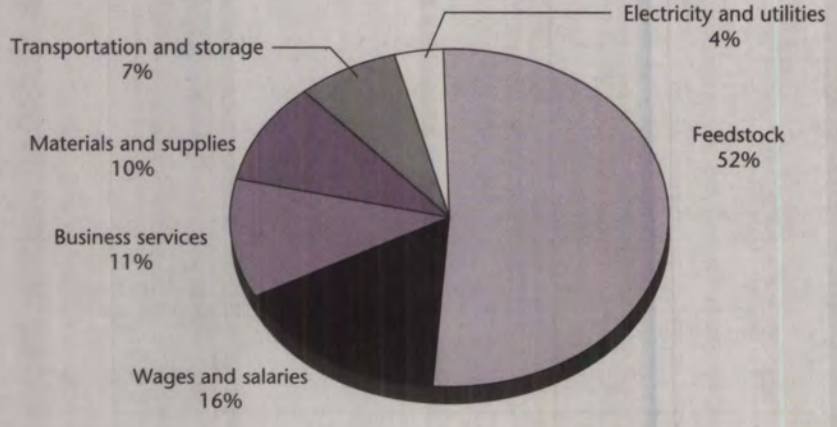
Input use by the two subsectors differs: while feedstock prices have an important influence on costs for petrochemical producers, electricity rates are an especially significant cost determinant for producers in the inorganic segment (Figures 2 and 3).

Figure 2. Cost of Inputs, Inorganic Industrial Chemicals, 1992



Source: Statistics Canada, Input-Output Division.

Figure 3. Cost of Inputs, Petrochemicals, 1992



Source: Statistics Canada, Input-Output Division.

There are significant differences between petrochemicals and inorganic chemicals at both the subsector and plant levels. Ownership in the petrochemical subsector is relatively concentrated, with the four largest firms accounting for 56 percent of shipments in 1991 (most recent available data). The situation is very different in inorganic chemicals, where the eight largest firms operated 20 percent of the establishments and produced only 54 percent of subsector shipments.

4 largest firms make up 56% of petrochemical shipments; concentration is much less in inorganic subsector

Industrial chemicals are among the most capital-intensive industries in the economy and, through backward linkages to the oil and gas and mining industries, are supplied by similarly capital-intensive production. This makes this industry highly sensitive to changes in technology and borrowing costs.

Industry is sensitive to changes in interest rates and technology

Petrochemical establishments are larger, with employment averaging almost twice that of inorganic chemical plants. The value of shipments per worker is about 65 percent greater in petrochemical than in inorganic establishments. Average salaries in each subsector are comparable and are significantly above the average for the total manufacturing sector.

Petrochemical plants support higher employment

Foreign-controlled firms in 1991 (most recent available data) represented about three quarters of establishments and production and over 80 percent of the employment and employment income in the inorganic chemical subsector. Foreign control was somewhat lower in petrochemicals, accounting for 64 percent of production in the same year.

Ownership is mainly foreign-controlled

Regional Distribution

While the number of industrial chemical plants increased in every region between 1985 and 1994 (most recent available data), employment declined everywhere except Alberta. Ontario still accounts for half of industry employment as well as wages and salaries, but activity has become somewhat less concentrated in Ontario in recent years (see Annex Table D-3).

Half of industry employment, wages are accounted for by Ontario

In **inorganic chemicals**, Ontario's market share has declined in recent years. While Ontario's share of industry shipments declined from 53 percent to 37 percent between 1985 and 1994, Quebec's share increased from 21 percent to 35 percent. The new production capacity built in Quebec in recent years is largely due to the very competitive electricity rates in that province (see Annex Table D-4).

Quebec posts gains in inorganic subsector shipments

In **petrochemicals**, new investment in Alberta, attracted by the availability of natural gas feedstock, has pulled production westward. Over the 1985–94 period, Ontario's share of manufacturing shipments fell from 60 percent to 50 percent, while Alberta's share increased from about 25 percent to 35 percent (see Annex Table D-5).

Natural gas feedstock pulls organic production west

North American Rationalization

Canadian plants specialize in specific products to supply NA market . . .

As part of the rationalization of industrial chemical production in North America, Canadian plants have been restructured to specialize in specific product lines. By producing a specialized group of products for the continental market, Canadian plants are able to achieve greater economies of scale and scope. This restructuring has been reflected in employment patterns.

. . . focus on production

The proportion of production workers to total employment rose from 60 percent to 69 percent over 1990–95 as restructuring brought about a reduction in the number of Canadian head office functions. With rationalization, management jobs have been concentrated in corporate or regional headquarters, which in many cases are in the United States.

Canadian production is tied to growth in NA market

As a result of restructuring, Canadian production is tied less closely to the growth of the Canadian market and is more dependent on the growth of the North American market. Both imports and exports increased sharply. While Canadian shipments of all industrial chemicals over the past decade have kept pace with the growth in the Canadian market, the experiences of firms in the organic and inorganic segments have been quite different.

Growth in domestic inorganic market is mostly supplied by imports

In inorganic chemicals, Canadian shipments have not kept up with the expansion of the Canadian market. Over the past 10 years, the U.S. market, the principal destination of Canadian output, has grown at an annual average rate of 2.8 percent, which is only a little more than half the growth rate of the Canadian market (5 percent). As a result, Canadian export growth could not compensate for the strong growth in imports of inorganic chemicals not made in Canada (over 10 percent per year) (see Annex Table D-6).

Canadian petrochemical exports expand to meet growing U.S. needs, outpacing strong growth in imports of products not made in Canada

Canadian imports of petrochemical products also have increased rapidly, with U.S. producers capturing an increasing share of the domestic market. However, in this segment, the growth in exports has more than compensated for the strong growth in imports. Canadian petrochemical exports to the U.S. increased by an average 15 percent per year over 1985–95, and Canadian producers' share of the U.S. market rose from 1.4 percent to 3.3 percent over this period. As a consequence, the growth in shipments of Canadian petrochemicals outpaced domestic market growth, unlike the situation for inorganic chemicals (see Annex Table D-7).

2.4 Performance

Trade Performance

Despite substantial demand growth, benefit has been restrained

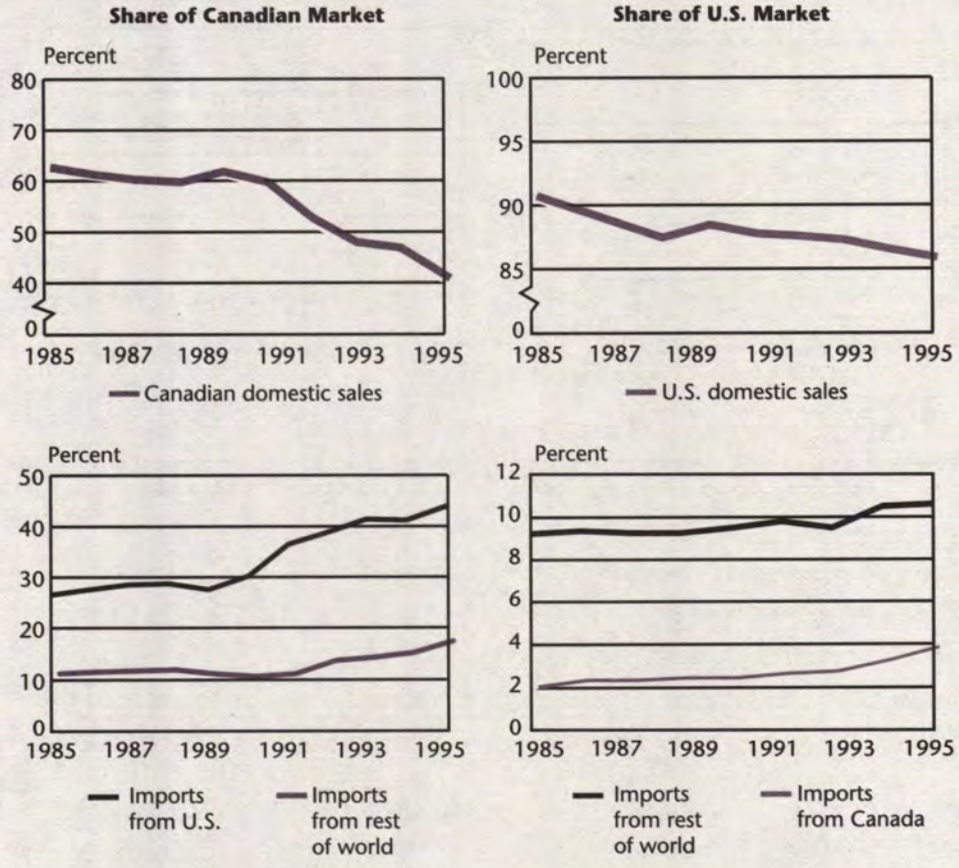
Both world exports and North American demand for industrial chemicals have grown substantially over the past decade, although rates of growth have varied significantly from year to year due to the cyclical nature of the markets. The ability of Canadian producers to benefit from growing

demand has been greatly influenced by the rationalization that has been under way in North American production, by the downturn in demand resulting from the 1990–92 recession and by the limited number of products manufactured in Canada.

U.S. plants increase Canadian market penetration; Canadian exports increase as exchange rate falls

Canadian producers have gone through a difficult period. As the FTA took effect and as U.S. markets softened in 1990, U.S. producers intensified their efforts to sell in Canada and increased their share of the Canadian market from 30 percent in 1990 to 44 percent by 1995 (Figure 4). Imports from the rest of the world also increased their share over the same period, but not to the same extent. As previously noted, the high Canadian exchange rate in the late 1980s played a significant role in the early domestic adjustments, whereas a lower Canadian dollar has assisted the growth of exports and production in recent years.

Figure 4. Share of Industrial Chemicals,[a] Canadian and U.S. Markets



[a] Including plastics and synthetic resins.

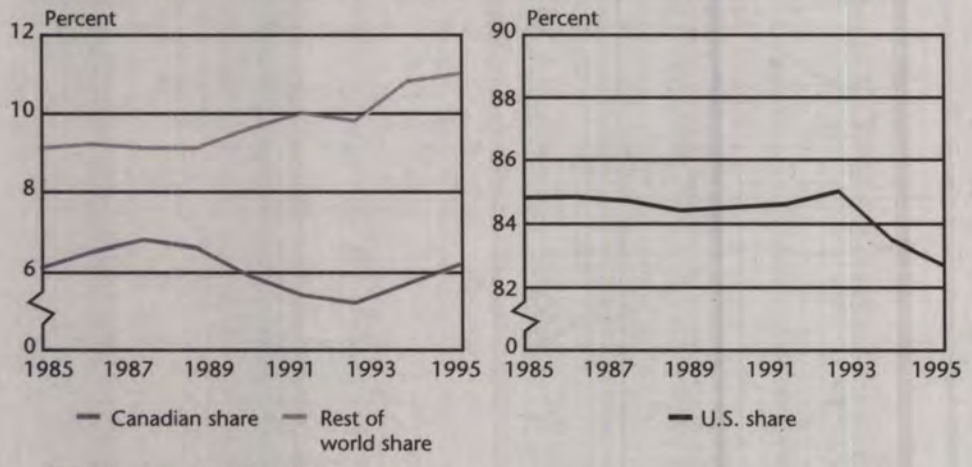
Source: Statistics Canada/Industry Canada Business Integrated Database; U.S. Department of Commerce, *Census of Manufactures* (Washington, D.C.: GPO, 1992 and updates).

On the other hand, Canada's penetration of the U.S. domestic market also rose, doubling from 2 percent in 1985 to 4 percent by 1995 (Figure 4). Imports from the rest of the world also increased their share over the same period, but at a lower rate of growth.

Canada's share of NA market recovers to 1985 levels

The percentage decline of domestic producers' share of the Canadian market is quite large, and the size of the Canadian share of the U.S. market (notwithstanding a doubling) appears quite small. But because the U.S. market is so large, the Canadian industry in fact has not done badly in absolute terms. Its share of the combined Canada–U.S. market did decline for awhile but, since 1993, it has rebounded and, at just over 6 percent, once again stands at about where it was 10 years ago. Indeed, it is the U.S. that has lost share in the combined markets to offshore producers (Figure 5).

Figure 5. Share of Industrial Chemicals,[a] Combined Canada–U.S. Market



[a] Including plastics and synthetic resins.

Source: Statistics Canada/Industry Canada Business Integrated Database; U.S. Department of Commerce, *Census of Manufactures* (Washington, D.C.: GPO, 1992 and updates).

Canadian inorganic chemicals enjoy upswing in exports in 1990s

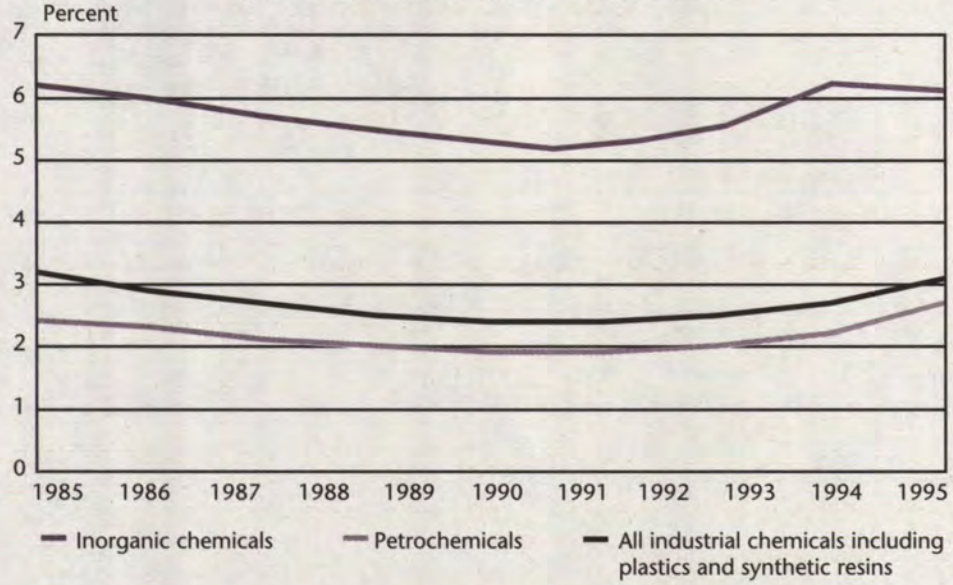
With regard to **inorganic chemicals**, Canada runs a substantial trade surplus with the U.S., and Canadian penetration of the U.S. market had risen to 5.9 percent by 1995. The Canadian share of the combined Canada–U.S. market was around 7 percent or higher throughout the 1985–95 period. After declining in the late 1980s, the Canadian industry's share of world exports of inorganic chemicals has rebounded to its 1985 level of 6.2 percent (Figure 6).

Export growth reduces Canadian trade deficit with U.S. in petrochemicals

Canada's share of the North American market in **petrochemicals** also has been on the rise recently, going from 4.7 percent in 1993 to 6.0 percent in 1995. Exports of petrochemicals increased sharply in 1995 as production capacity in western Canada came on stream. Export growth is expected to lead to continued reductions in Canada's trade deficit in petrochemicals with both the U.S. and the rest of the world.

After slipping in the late 1980s, Canada's share of world export demand for industrial chemicals has been restored to the 1985 level of about 3.1 percent. It should be noted that this is 3.1 percent of a market that has grown by an average of 9.8 percent per year in the period from 1985 to 1995.

Figure 6. Canada's World Trade Shares



Source: Chemical Manufacturers Association, *U.S. Chemical Industry Statistical Handbook 1994* (Washington, D.C.: CMA, 1994).

Efficiency Indicators

Labour output and value-added per worker have increased significantly since 1991 for both inorganic and petrochemical production in Canada. This is partly attributable to recent North American restructuring. In the petrochemical subsector, however, since labour costs represent less than 5 percent of the value of shipments (in 1994, most recent available data) and since output prices vary with market forces and hydrocarbon feedstock costs, output per employee is not a reliable indicator of overall performance.

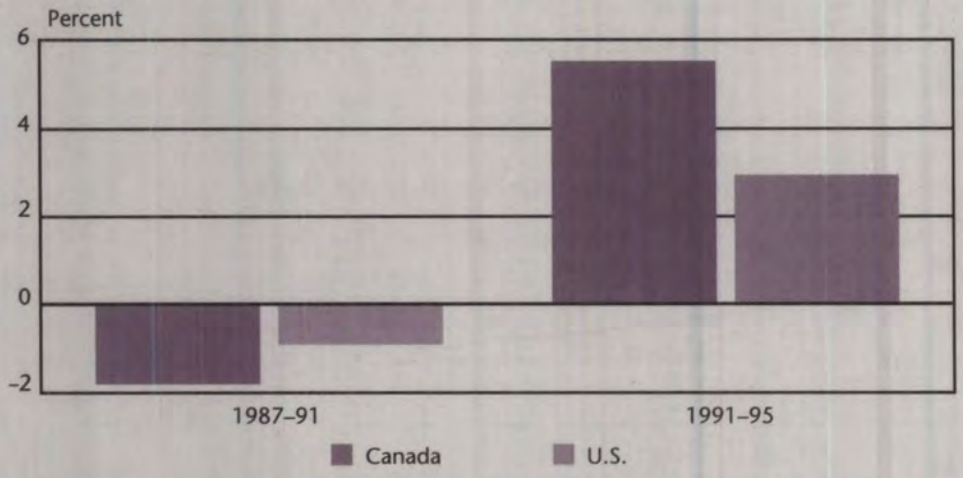
Labour output and value-added per worker rise for both inorganic and petrochemical subsectors

Canada–U.S. Efficiency Comparisons

For the sector as a whole, Canadian labour productivity typically has been lower than that in the U.S. over the years. However, after declining more rapidly than in the U.S. industry going into the last recession, labour productivity growth in the Canadian industry since 1991 has been almost double that of its U.S. counterpart (Figure 7). Growth in constant-dollar shipments per employee, however, is not a measure of the absolute levels of Canadian or U.S. productivity.

Rate of Canadian industry labour productivity growth surges

Figure 7. Annual Growth in Labour Productivity,[a] Canada and the U.S.



[a] Compound average annual rates of growth of shipments divided by number of employees, expressed in constant national currency units.

Source: Statistics Canada/Industry Canada Business Integrated Database; U.S. Department of Commerce, *Census of Manufactures* (Washington, D.C.: GPO, 1992 and updates).

Profitability

Despite facing greater swings, Canadian industrial chemical producers' average profitability exceeds U.S. rate

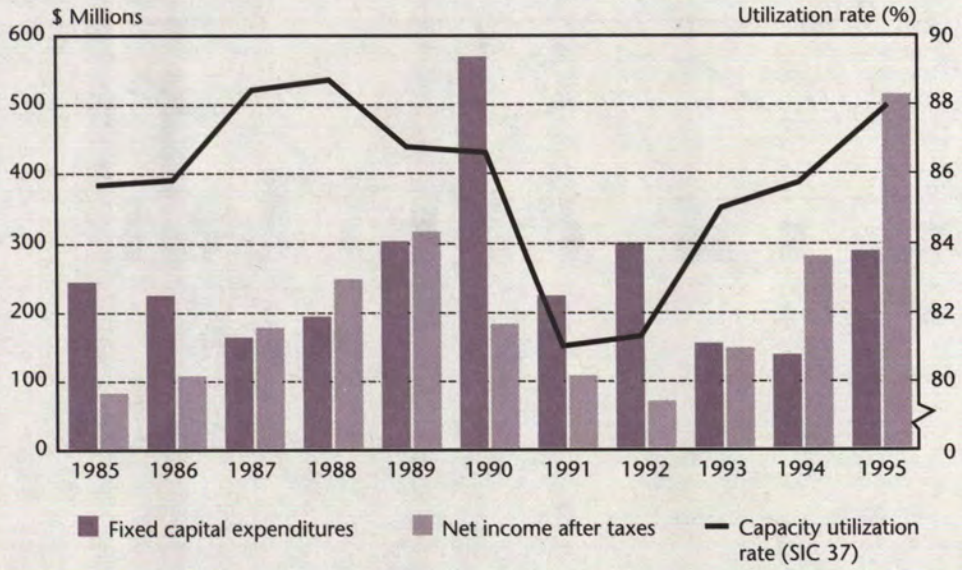
Domestic prices tend to be less volatile than export prices. The U.S. industrial chemical industry has 79 percent of production going to the domestic market, and a larger percentage of higher-priced specialty chemicals than Canada. Its profitability record shows lesser fluctuations than those of the Canadian sector, where only 37 percent of production, most of which is of commodity chemicals, goes to the domestic market. Over the 1985–95 period, however, the Canadian industry still averaged net earnings after taxes and write-offs of 6.2 percent, compared with 4.1 percent for U.S. firms.

Investment and Profits

Inorganic chemicals are poised for expansion

For inorganic chemicals, high capacity utilization rates and rising profits in the mid-1980s triggered major capital investment in new plant capacity in the 1988–90 period (Figure 8). The recession in the early 1990s subsequently led to lower net income (net profit/loss after taxes, interest and special write-offs) and reduced capital investment. More recently, rising capacity utilization rates and profits suggest that the business cycle has returned to a point where capital expansion is again likely.

Figure 8. Investment and Profits, Inorganic Chemical Subsector

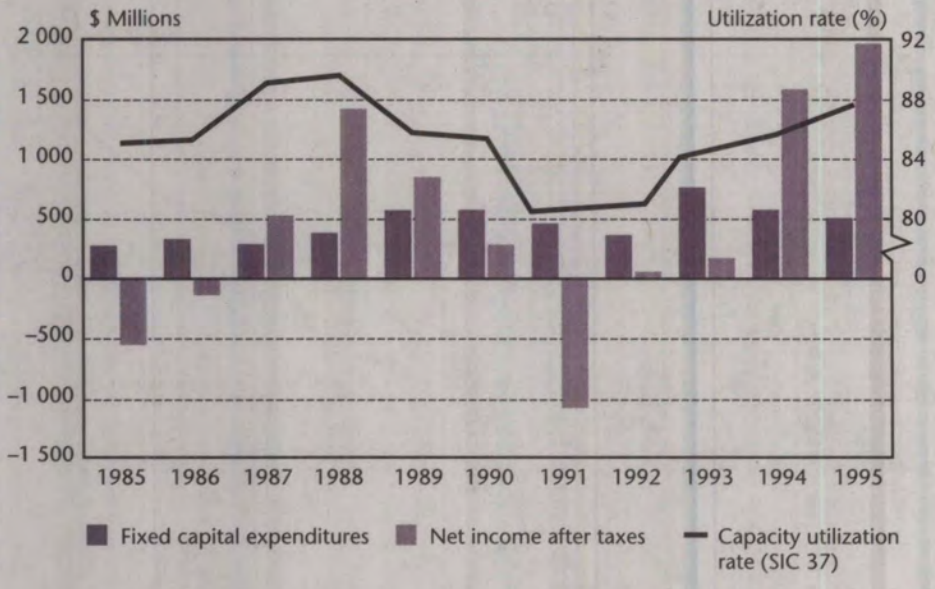


Source: Industry Canada estimates, based on financial data provided by the Canadian Chemical Producers' Association and capacity utilization rates provided by Statistics Canada.

Renewed capital investment gets under way for petrochemicals in Alberta

In the petrochemical subsector, the sharp decline in capacity utilization at the start of the 1990s was a consequence of the major loss in North American market share by Canadian petrochemical producers (Figure 9). Weak sales combined with weak prices resulted in the poor financial results of the 1990–93 period. In recent years, however, utilization rates have again approached capacity limits, and a new round of major capital investment is under way, largely in Alberta.

Figure 9. Investment and Profits, Petrochemical Subsector



Source: Industry Canada estimates, based on financial data provided by the Canadian Chemical Producers' Association and capacity utilization rates provided by Statistics Canada.

Asian prospects open attractive growth possibilities for western petrochemicals

Given recent excellent returns in upstream energy, "oil sands" tax regime changes and heavy exploration activity in western Canada, a supply-side advantage is emerging. Western Canada has a clear freight advantage over the U.S. Gulf Coast in shipping bulk petrochemicals to the rapidly growing markets of Asia Pacific. This offers attractive growth prospects for the medium term.

3 CHANGING CONDITIONS AND INDUSTRY RESPONSE

3.1 General

Alberta, Quebec gain jobs, shipments, value-added; Ontario loses ground but still dominates

The geographic distribution of the industrial chemicals industry has shifted substantially since 1985. Alberta has gained petrochemical jobs, while Ontario and Quebec have lost some. In the inorganic subsector, only Quebec has not lost jobs. In spite of its losses, Ontario continues to dominate the industrial chemicals industry (see Annex Table D-3).

Quebec has low electricity costs; Alberta has ample feedstocks

Electricity costs in Ontario accelerated rapidly in the early 1990s and, to remain competitive with the U.S. producers, manufacturers built new inorganic chemical capacity in provinces with lower electricity costs, most notably Quebec. In 1994, Alberta started to attract substantial new ethylene production capacity because of its ample supply of ethane.

In recent years, the electricity rate advantage of Quebec has come under pressure from such factors as the trend toward utility deregulation, co-generation from natural gas sources, and other factors such as the NAFTA provision that places electricity pricing on a "continental basis."

Investment prospects are attractive due to Canadian corporate tax policy

Canada reformed its corporate tax system in the late 1980s in line with the reforms implemented in other countries. The tax base was substantially broadened and, in turn, corporate taxes were reduced. The removal of most investment tax credits and the replacement of a three-year capital cost allowance formula for machinery and equipment with a 25-percent declining balance methodology was particularly detrimental to the petrochemical sector. At the same time that Canada had made its capital cost allowance formula less attractive, the U.S. had given preferential treatment to its petrochemical sector with an accelerated five-year capital cost allowance.

Federal and provincial tax changes in 1992 reversed some of the disincentives in the Canadian tax regime and now, for the petrochemical industry in Alberta, Ontario and Quebec, the corporate tax systems are competitive with those in the competing U.S. states of Texas and Louisiana.

3.2 Research and Development and Innovation

Human resources, tax treatment favour R&D

The industrial chemicals industry benefits from a favourable environment for R&D in Canada. The primary underlying factors are an ample supply of well-qualified new graduates, favourable tax treatment for R&D expenditures and the lowest cost per researcher (on a common currency basis) among the Group of Seven most industrialized countries. The government's emphasis on industrial collaboration means that Canadian universities and government laboratories are increasingly open to partnership research activities. As well, the Natural Sciences and Engineering Research Council of Canada (NSERC) has dedicated a significant portion of its funding to the support of university–industry cooperative research partnerships

Provincial R&D tax treatment is additional incentive

In addition to the very favourable federal R&D tax treatment, firms benefit from provincial R&D tax incentives that are generally more attractive than those in competing U.S. states. The benefits of the Canadian tax policies accrue directly to Canadian companies. If, however, funding is supplied by a non-Canadian parent through its Canadian affiliate, all of the tax benefits can be achieved by the Canadian affiliate, thus benefiting the global business. Canada's R&D tax treatment represents one of the most generous incentive systems available internationally.

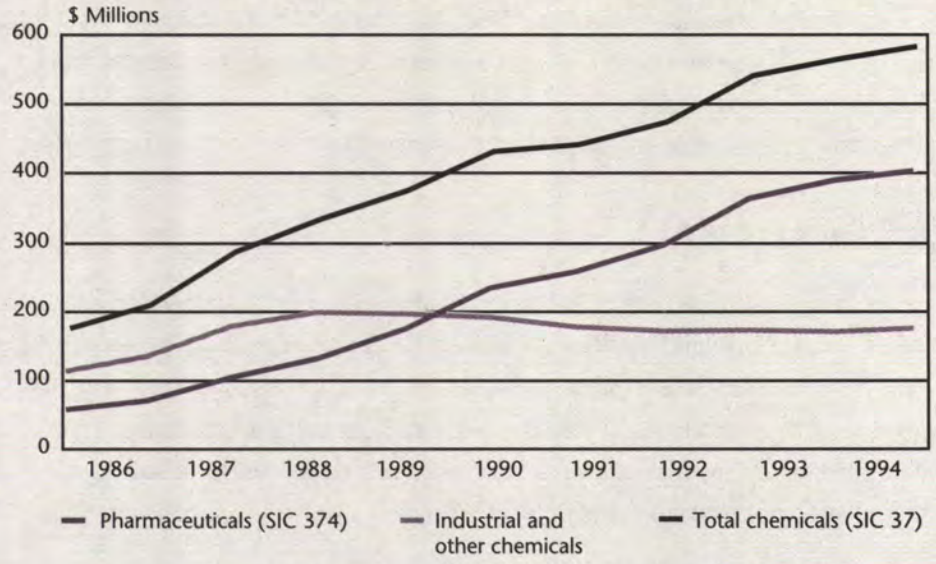
Canadian firms benefit from innovations of foreign parents

Canadian firms that are affiliates of U.S. enterprises are also able to benefit from their privileged access to new technology developed in other parts of the organization. In the inorganic chemical subsector, which is subject to a high degree of foreign control, Canadian firms can take advantage of the innovations of their U.S. parents that lead to new industrial chemical products, new process technology or increased efficiency in marketing, financing or distribution.

Industry ranks 3rd in R&D expenditures, 2nd in ratio of R&D to sales

A review of 1993 Statistics Canada data (*Industrial Research and Development in Canada*, Catalogue No. 88-202, annual) ranks the chemicals and chemical products industry, which includes pharmaceuticals, third after the electrical and electronics industry and the transportation equipment industry in R&D expenditures, and second in R&D expenditures as a percentage of sales. When R&D spending is considered over time, total chemicals (SIC Major Group 37: Chemicals and Chemical Products Industry) show a steady increase from $176 million to $583 million from 1985 to 1995. Industrial and other non-pharmaceutical chemicals represented more than half of this in 1985, but less than one third in 1995. Industrial chemical R&D spending has been essentially flat over the past five years (Figure 10). These data suggest that, despite the positive environment for attracting R&D investment, industrial chemicals in recent years have not managed to attract the level of investment that one might expect.

Figure 10. R&D Spending, Chemicals and Chemical Products, Canada



Source: Statistics Canada, *Industrial Research and Development*, Catalogue No. 88-202, annual.

R&D has contributed to success of many Canadian firms . . .

With a view to better understanding the R&D environment in Canada for companies in this industry and with the objective of promoting awareness of the benefits of doing R&D in Canada, Industry Canada has compiled a number of success stories including 14 case histories, all available on the Internet at the department's *Strategis* web site (http://strategis.ic.gc.ca). Six are summarized in Annex C.

. . . in becoming world-class suppliers

Although each of the companies started from a different base and faced different competitive challenges, the solution was often similar: specialize and focus on a niche market and strive to become a world leader in that market. This is exemplified by Cytec Canada with phosphine derivatives, DuPont Canada with its specialty fibres, Sterling Pulp Chemicals with chlorine dioxide technology, and others. All are leading suppliers of their special product to world markets. These success stories examine how the R&D/innovation conducted by these companies contributed to their success as world-class suppliers and illustrate the factors that encouraged conducting of the R&D in Canada.

3.3 Trade

Canada's share of U.S. market nearly doubles

As noted in Section 2.4, Canadian firms have experienced growing success in recent years in the U.S. market. Canada's share of the U.S. market has increased from 2.0 percent in 1985 to 3.8 percent in 1995. Canada's production share of the Canada–U.S. market has recovered from its recessionary lows, recording a particularly strong increase in 1995. In this regard, it is interesting to note that 1 percent of the U.S. market represents US$1.3 billion, which is equivalent to about 15 percent of the Canadian market in 1995.

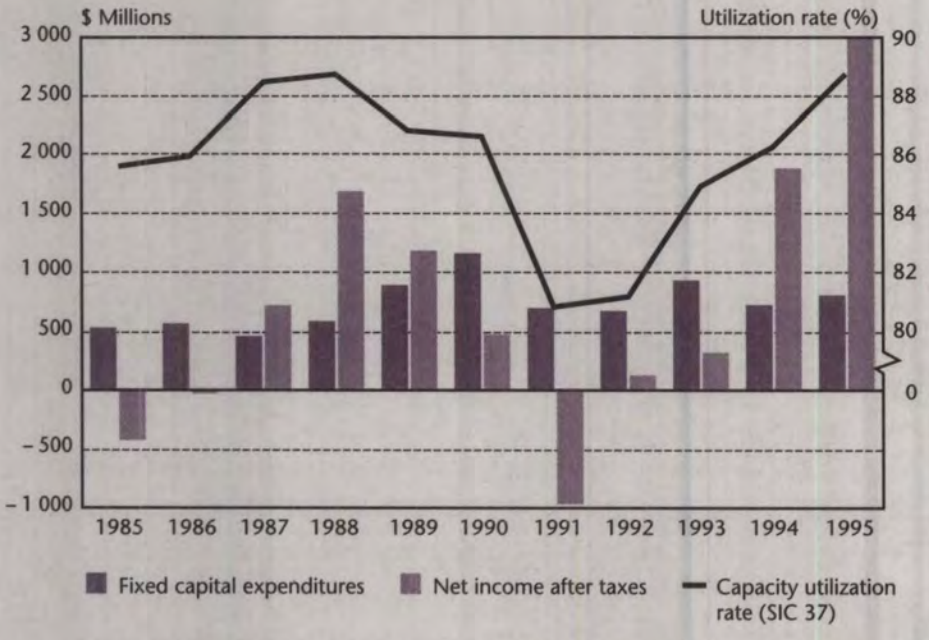
Increase in world demand is twice NA rate

World export demand for industrial chemicals increased at 9.8 percent per year during 1985–95, which was more than twice the growth rate of North American demand. World markets are being fuelled by demands from the rapidly growing economies of Southeast Asia, particularly Taiwan, Republic of Korea, China, Thailand, Malaysia and Singapore. Canada has participated in the growth of world exports, achieving an estimated 3.1 percent share of the world market in 1995.

3.4 Investment

The federal government has recently announced a national investment strategy initiative that includes a special marketing unit named Investment Partnerships Canada, administered jointly by Industry Canada and the Department of Foreign Affairs and International Trade. This initiative seeks to make Canada the NAFTA location of choice for investment, and the industrial chemicals industry has been identified as one of the target sectors for this initiative. Figure 11 illustrates the recent capital investment cycle of the Canadian industrial chemicals industry.

Figure 11. Capital Investment and Profits, Industrial Chemicals, Canada

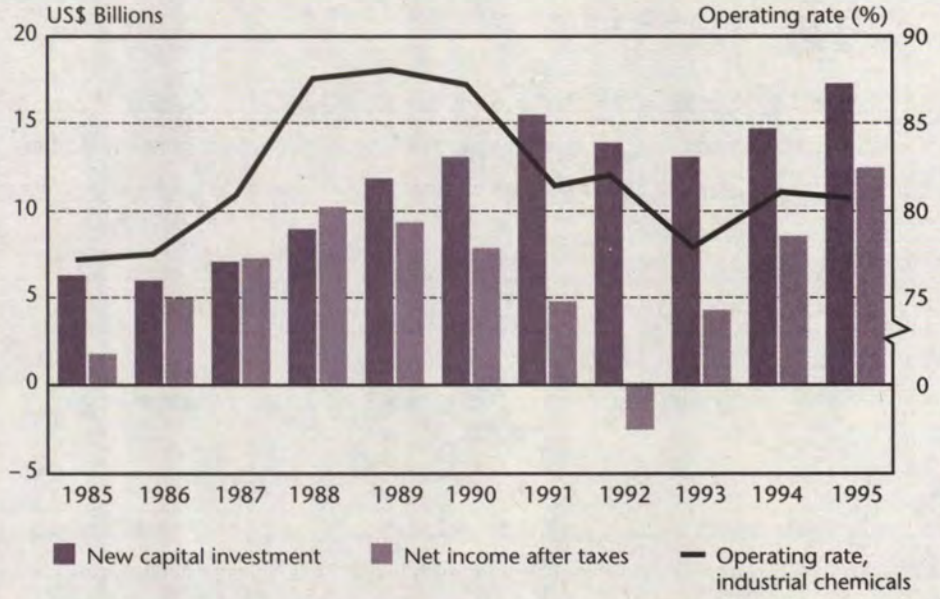


Source: Industry Canada estimates, based on financial data provided by the Canadian Chemical Producers' Association and capacity utilization rates provided by Statistics Canada.

It is interesting to compare the Canadian experience with the investment cycle of the U.S. sector (Figure 12). U.S. firms experienced the effects of the recent recession, but the downturn lasted longer than in Canada and operating rates fell lower. Since the U.S. industry invests primarily for the U.S. market, investment in the U.S. industry declined only moderately in the early 1990s. In the mid-1990s, with plants operating at 80 percent or better, investment to expand plant capacity is again on the increase. In Canada, operating rates generally approach 90 percent before investments are attracted.

Impact of recession lasted longer in U.S.

Figure 12. Capital Investment and Profits, Industrial Chemicals, U.S.



Source: U.S. Department of Commerce, *Census of Manufactures* (Washington, D.C.: GPO, 1992 and updates); Chemical Manufacturers Association, *U.S. Chemical Industry Statistical Handbook 1994* (Washington, D.C.: CMA, 1994).

With the continued strength of its investment (about $16 billion per year), the U.S. is maintaining a large, modernized production base to serve the North American market. This increases the need to maintain a favourable investment climate within Canada and to regularly monitor the relative efficiency of Canadian plants and equipment.

Canada requires favourable investment climate to stay competitive in NA market

3.5 Sustainable Development

A healthy economy and a healthy environment are essential to well-being. This is particularly the case for Canada, where rich natural resources have been a primary source of wealth and jobs.

Sustainable development is both a concept and a process that provide the framework for the integration of environmental objectives and development strategies. It acknowledges the necessity of development to satisfy human needs and improve the quality of life, while recognizing that development must be based on the efficient and environmentally responsible use of all our resources — natural, human and economic.

Industry affects, and is affected by, environmental agenda of many sectors

It should be noted that this industry both sells to and buys from industries at the heart of virtually every environmental agenda. As a result, significant developments on the environmental front, both domestically and internationally, will affect this industry on both the demand and cost sides.

Canada has made considerable progress in many areas by working on a collaborative basis to improve environmental quality. Examples of recent federal environmental policy and program initiatives include the *Canadian Environmental Assessment Act*, the Toxic Substances Management Policy, the Pollution Prevention Strategy and the *Canadian Environmental Protection Act*.

Commitment to voluntary emission controls results in significant reductions

For the industrial chemicals industry, the principles of sustainable development are given expression through a broad range of environmental initiatives, including emission reduction/elimination, comprehensive waste management and recycling, the product life cycle management approach and various corporate activities. The industry has demonstrated a strong commitment to effective voluntary approaches, and has supported international standards and approaches to both establishing and achieving environmental goals. For example, air emissions were reduced by 50 percent by 1994, in keeping with a commitment made in 1992 by members of the Canadian Chemical Producers' Association (CCPA). Projected air emissions for 1999 are for only 28 percent of 1992 emissions. Water emissions were reduced to 16 percent of 1992 levels by 1994.

Responsible Care® sets industry-wide guidelines

The CCPA in 1985 created the Responsible Care® initiative, which affirms the commitment of member companies to operate according to standards that meet the health, safety and environmental needs of society. As a condition of CCPA membership, companies formally sign, at the top management level, the "Statement of Responsible Care® and Guiding Principles," which includes specific moral obligations for the responsible management of chemicals and products.

®Responsible Care is a registered trademark of the Canadian Chemical Producers' Association.

Under Responsible Care®, the association compiles and reports key performance data annually. Managers are also expected to be proactive in bringing their company's performance to the attention of employees, communities, governments and other stakeholders. The CCPA annually reports on all emissions in the National Emissions Reduction Master (NERM) plan and on progress in meeting the five-year commitments toward continuous improvement.

Managers take proactive approach toward continuous improvement

The CCPA Chemical Referral Centre provides product information and a company contact to answer public enquiries. Through TransCAER, a component of Responsible Care®, companies assist communities potentially at risk, through community meetings, chemical risk awareness, emergency planning and first aid response training. Companies must have the capacity either in-house or through alternative arrangements (like the CCPA Transportation Emergency Assistance Plan) to respond promptly to transportation emergencies.

In addition, Responsible Care® companies are committed to work with governments and are expected to participate in and support various Memoranda of Understanding directed at environmental improvement, report designated substance emissions to the secretariat of the Accelerated Reduction and Elimination of Toxics (ARET) program and, with regard to climate change issues, to commit to the federal Voluntary Challenge and Registry (VCR). In Ontario, companies are strongly encouraged to participate in the provincial government's Pollution Prevention Pledge Program, drawing on their NERM data and ARET submissions.

Public–private sector participation helps set pollution prevention goals

Responsible Care® is a *bona fide* Canadian industry success story, recognized internationally and commended by the United Nations Environmental Programme. Following the CCPA example, industry associations in over 40 countries have adopted Responsible Care® for their own use.

Responsible Care® is adopted in 40 countries

4 GROWTH PROSPECTS FOR THE INDUSTRY

4.1 Demand Outlook

Countries with substantial capacity and hydrocarbon feedstocks will benefit from growth in demand for petrochemicals

The world market for **petrochemicals** and resins is growing rapidly. Total world exports of petrochemicals increased at an average annual rate of 10.8 percent during 1985–95. Since petrochemical plants are world-scale operations, requiring long lead times for construction, countries with substantial capacity already in place will be the main beneficiaries of expanding opportunities over the short to medium term. The economics of petrochemical production also depend on feedstock supply and prices, giving an advantage to countries with ample supplies of hydrocarbon resources.

Rapidly growing SE Asian petrochemical markets are overtaking Americas, western Europe

The major growth markets for petrochemicals are in the rapidly expanding economies of Southeast Asia. It is forecast that by 2005 the Asia Pacific nations will account for 62 percent of the gross domestic product of the world's 25 largest economies, compared with 38 percent in 1994. The share of the Americas is projected to fall from 38 percent in 1994 to 22 percent in 2005, and that of western Europe from 25 percent to 16 percent. China has become a major importer of petrochemicals. While major increases in production capacity are also planned by China over the next decade, demand growth is expected to outstrip the increase in capacity that can be brought on stream over this period.

Canada anticipates investments to meet rising world demand

In Canada, industry analysts anticipate that potential new investments in petrochemicals to meet North American and offshore markets could approach $4–6 billion in western Canada over the years to 2005. Investments in eastern Canada could be on a similar scale, although the mix of petrochemicals, resins and other downstream products would be more varied there. In eastern Canada particularly, the scale of investment depends very much on addressing issues of construction costs, utility deregulation and environmental permitting processes.

Inorganic chemical production is more stable; investment cycles are less volatile

Prospects for the **inorganic chemical** industry are tied more closely to the growth of the North American market. Freight costs represent a relatively high proportion of product value per tonne, and this limits the geographic trading area for many products. While more dependent on the North American market, inorganic chemicals are less affected than petrochemicals by the ups and downs of the North American business cycle. Moreover, since demand tends to be relatively stable and since plants can be expanded in stages to meet demand growth, investment cycles are less volatile than in the hydrocarbon-based petrochemical sector.

4.2 Current Industry Strengths

Canada has a number of advantages as a producer of industrial chemicals. We have abundant natural resources and ample supplies of the raw materials required by industrial chemical producers. Trade agreements provide firms with largely unrestricted access to the entire North American market. The country has a skilled work force and, at current exchange rates, labour costs are relatively low in comparison with other industrialized nations. Canada provides favourable tax treatment to R&D investment and, with the exception of British Columbia, the industry views the provincial corporate tax systems for petrochemicals as competitive with the tax systems in competing U.S. states such as Texas and Louisiana.

Strengths include ample feedstocks, more liberal NA trade, R&D investment

Canada presents a model for collaboration between government and industry in the area of regulation to address environmental concerns. Through voluntary standards, the chemical industry generally has encouraged its members to come up with cost-effective approaches to reducing harmful plant emissions and to work to redress environmental degradation arising from industry activities.

Industry–government collaboration stimulates search for cost-effective environmental solutions

Canada's quality of life and standard of living, which are among the highest in the world, support positive work force attitudes. The education system produces quality graduates, many of whom receive additional training from their employers. The chemical industry views its highly skilled work force as a source of its competitive strength. It has established relations with universities and community colleges in order to ensure that it continues to benefit from the availability of well-trained recruits.

Highly skilled work force is competitive strength

Canada's unit labour costs (measured in U.S. dollars), a key indicator of competitiveness, have declined since 1992, reflecting the effect of the continuing decline in wages and a decline in the value of the Canadian dollar. In addition to this advantage in terms of wage costs, Canada benefits from Canadian workers' generally high level of job satisfaction. In the chemical industry, this has translated into minimal losses of production time due to labour disputes.

Exchange rate gives Canadian firms labour cost advantage

Managers in Canadian chemical companies exhibit a strong commitment to quality and customer service. Generally, Canadian managers have more experience than their U.S. counterparts with flexible manufacturing systems and smaller production runs to meet diverse demands. The industry appears to be well positioned for the age of "nimble manufacturing." Some companies are taking advantage of this by placing mandates for niche products in Canada.

Canada adapts readily to diverse demand changes of niche markets

Companies restructure with heavy investments in plants, equipment

During the major restructuring that has occurred over the past 10 years, companies have invested heavily in new plants and equipment. Companies have added capacity, lowered production costs, added advanced technology, and introduced process improvements to meet or exceed health, safety, environmental and energy conservation goals. But Canada accounts for less than 1.7 percent of the world's estimated $1.5 trillion worth of industrial chemical outputs. As a small player with a small domestic market, Canada needs to outperform others in order to command the attention of international investors.

4.3 Current and Anticipated Competitiveness Challenges

An analysis of performance and outlook and extensive collaboration with stakeholders reveals a range of key issues affecting the competitiveness of the Canadian industrial chemicals industry.

Lower exchange rate helps reduce construction cost disadvantage

Construction costs, relative to those in competing locations, can have a significant influence on investment decisions. While Canadian construction costs have fallen relative to those in the U.S., recent analysis by Industry Canada in cooperation with industry representatives suggests that this change is due not so much to improvements in productivity and changes in labour practices as to a lower exchange rate for the Canadian dollar. This element of capital cost continues to be of concern.

Government is responsive to firms' need for smooth approvals process

While **regulation** is generally regarded as a major cost of doing business in Canada, the chemical sector recognizes that the Canadian environmental approvals process tends to work better than those in other countries, including the U.S. and Europe. Governments in Canada are responsive and pragmatic in comparison with other countries. Regulatory reform in Canada has been ongoing for 20 years, and governments are committed to a continuing process of regulatory review.

To provide a firmer basis for the favourable view that many have of Canada's regulatory approach, Industry Canada and the CCPA undertook a comparative analysis of plant environmental approvals systems in four Canadian jurisdictions and a range of competing U.S. locations. This study identifies and attempts to promote a number of best practices that can guide the design and implementation of regulatory processes (summarized in Annex B — *Regulatory Requirements Best Practices*). The complete findings of the study are available on the Internet at Industry Canada's *Strategis* web site (http://strategis.ic.gc.ca).

Electricity cost is important to inorganic chemical investment

Depending on the product, **electricity costs** can represent less than 5 percent to 60 percent of the variable operating cost of a chemical manufacturing facility. Because these costs can be readily compared between jurisdictions, electricity costs impact on investment decisions,

particularly when they represent a large component of total operating costs, as in many inorganic chemical processes. To attract new investment and stay competitive in domestic and international markets, the industry — particularly the inorganic subsector — must have options for sourcing electricity.

Despite generous tax incentives for **research and development**, the availability of skilled research talent, and a climate that is conducive to university–industry collaboration, Canada's level of R&D investment has been disappointing. These advantages may not be sufficiently appreciated by corporate decision makers, or they may be overridden by other factors. Another factor may be increased centralization of certain corporate functions such as R&D to head office locations, as subsidiaries become more integrated into global operations. Industry Canada's examination of R&D successes (Annex C) serves as both illustration and demonstration of best practices in this area.

R&D investment needs to be increased to meet global market challenges

Both industry and government have given considerable attention to improving environmental performance. Over the past decade, **sustainable development** has become a key principle governing federal government policy. The industrial chemicals industry recognizes that the principles of sustainable development are fundamental to its future and to the future of Canada's economy, and is responding to these challenges through the Responsible Care® initiative. More information on Responsible Care® can be found in Annex A.

Improved environmental performance assists sustainable development

4.4 Future Opportunities

The industry faces two major challenges with respect to **inorganic chemicals**. The first is to encourage the investment needed to support expansion. To this end, industry and government must continue to monitor the subsector's competitive health on a variety of fronts, including electricity and fuel costs, the regulatory environment and operating costs. The second challenge for Canadian firms is to increase exports by acquiring the expertise, technology, know-how and mandate needed to participate in emerging opportunities in foreign markets.

Inorganic chemicals need to contain energy costs, expand exports

Canadian **petrochemical** producers have an exceptional opportunity to export from their western Canada bases to booming Southeast Asian markets. Over the longer term, opportunities will emerge (through joint ventures, technology transfer arrangements and other mechanisms) to participate in developing the production capacity of these newly industrializing countries. Recent investments in new ethylene capacity in Alberta (Nova-Union Carbide and Dow) position the industry as a North American low-cost producer ready to export ethylene derivatives to expanding Asian and U.S. markets. This new capacity also creates opportunities for new downstream product lines.

Petrochemicals become poised to tackle boom in SE Asian market

4.5 The Bottom Line

Canadian chemicals depend on world markets

With a small domestic market for industrial chemicals, Canada is dependent on its ability to attract investment and remain competitive in global markets in general and in the U.S. market in particular. Canada compares favourably with other countries in terms of a number of competitiveness factors, especially its abundant supply of natural resources. As a result of recent trade agreements, Canada has relatively free access to the U.S., along with the Mexican markets. The quality and stability of Canada's work force and this country's relatively low labour costs at current exchange rates provide significant competitive advantages.

Industry competitiveness helps Canadian firms integrate with global MNEs . . .

While the industry is well positioned for the new, more intensely competitive environment, globalization of the industrial chemical market nonetheless has had a profound effect on Canadian producers. Canadian-owned companies no longer can rely on a protected domestic marketplace. For multinationals, the days of the separately managed, self-contained Canadian subsidiary are gone. Today, the Canadian branches of most multinational chemical companies have been fully integrated into their global corporations.

. . . to become full partners in global structures

The challenge for Canadian producers is to become full partners in these increasingly global structures and to demonstrate to their parent companies the opportunities and benefits of investing in Canada. The challenge for government is to ensure a competitive investment environment through stable and supportive policies and by working with industry to effectively promote Canada's advantages.

For further information concerning the subject matter contained in this Overview, please contact:

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Annex A
RESPONSIBLE CARE®

The following material is summarized from the booklet Responsible Care®: A Total Commitment *by the Canadian Chemical Producers' Association (Ottawa: CCPA, September 1992).*

Guiding Principles

With a formal commitment to Responsible Care®, which comes from the chief executive, each CCPA member company subscribes to the following guiding principles:

- ensure that its operations do not present an unacceptable level of risk to employees, customers, the public or the environment
- provide relevant information on the hazards of chemicals to its customers, urging them to use and dispose of products in a safe manner, and make such information available to the public on request
- make Responsible Care® an early and integral part of the planning process leading to new products, processes or plants
- increase the emphasis on the understanding of existing products and their uses and ensure that a high level of understanding of new products and their potential hazards is achieved prior to and throughout commercial development
- comply with all legal requirements which affect its operations and products
- be responsive and sensitive to legitimate community concerns
- work actively with and assist governments and selected organizations to foster and encourage equitable and attainable standards.

Responsible Management of Chemicals

On the foundation of these guiding principles, all CCPA companies commit to meeting the requirement of the Responsible Care® codes of practice. The six codes cover:

- community awareness and emergency response
- research and development
- manufacturing
- transportation
- distribution
- hazardous waste management.

These codes are based on "life cycle management"; that is, managing each chemical responsibly from initial concept through R&D, manufacturing, shipping, usage and ultimate disposal. Each code of practice consists of:

- a code statement defining what is expected of a member company
- criteria by which the company can evaluate progress and results including identification of the areas, frequency and the means by which progress reports can be made to the association
- implementation assistance, which includes seminars, printed materials and references on external resources.

In addition, member companies are also expected to work with customers, transporters, distributors and other parties in the application of the codes to their operations.

Annex B
REGULATORY REQUIREMENTS BEST PRACTICES

Industry Canada and the Canadian Chemical Producers' Association in August 1996 completed a comparison study of environmental approval processes in four Canadian provinces and three U.S. states for a range of industrial chemical facilities. The purpose of the study was to quantify the competitive advantage that the process in Canada could contribute to a chemical project, including differences in time required for the approvals process, fees, equipment/process requirements and other associated costs. The results were shared with participants and reviewed by a CCPA Working Group on Plant Permitting. From the findings, the following list of best practices was compiled.

Recommended "Best Practices" in Regulatory Permitting

- Initiate the permitting process with a pre-application meeting, based on a one-page project description. Have the official responsible for each potential permit requirement for the project represented at the meeting be prepared to outline required information and commit to a probable or usual time frame.
- Assign a project leader from government as the contact, a single-window account manager for the duration of the permitting process of a project. The account manager should have responsibility for final permitting sign-off or approval(s).
- **Process:**
  - Generate a decision-tree schematic of the approval process which clearly highlights the relevant areas for the project based on the pre-meeting;
  - Clearly identify who the decision makers are; the consultative process should have direct access to decision makers;
  - An issues resolution process must be in place with capacity to quickly escalate to decision makers;
  - Where standards have not been established, and must be developed as part of the permitting process, those responsible for standards-setting decisions must be accessible to the consultative process, directly interacting with the proponent.
- Establish on-line access to allow the proponent to identify project status. This permits the proponent to identify where the project approvals package is at any given time. Is the process waiting for data, undergoing analysis or at a decision point?

- Explore the notion of classifying types of projects. Develop screening or fast-track treatment by regulators for non-controversial or routine projects. For well-known technologies, use experience from other jurisdictions. As far as practicable, push the process down the decision-tree. Only use proponent or government resources when there are information gaps, i.e., develop a process template based upon collective experience.
- Establish a database for environmental standards and related regulatory rationale used in establishing standards and unique requirements which might apply to a particular location in the various jurisdictions. This will allow a potential investor to understand what may be involved in getting a permit and to use that information in making an investment decision.
- Coordinate federal, provincial/state and municipal permitting where there is a potential risk of overlap. Ensure various jurisdictions work together, including sharing studies and data to assess similar projects. Promote sharing of data on probable environmental impacts, best available technologies and design safeguards for similar projects, perhaps through on-line access.
- Undertake public meetings only where there are serious, substantiated, unresolved public concerns by the affected community.
- Consider eliminating the need to conduct a review of project engineering. The proponent is responsible for developing a project design proposal and signing off on the project. The proponent is accountable for employing its best available technology and meeting its Responsible Care® commitments.
- For an environmental assessment process generally and plant permitting specifically, the design of the process should be based on protection of the environment as outlined below:
  - Environmental objectives/goals should be established for each jurisdiction. This would not be the sole responsibility of the regulators, but a broader stakeholder exercise.
  - Permitting officials could then assess, on a periodic basis, the contribution of the regulatory process to achieving the objectives.
  - There should be ongoing review of both the objectives and regulatory performance, with a view to continuous improvement and the objectives of delivering a sustainable development regulatory environment.
  - Jurisdictions should commit to continuous improvement and benchmark process and performance with other jurisdictions.

Annex C
RESEARCH AND DEVELOPMENT SUCCESS STORIES IN THE INDUSTRIAL CHEMICALS INDUSTRY

The following case histories are condensed from Industry Canada's examination of how selected Canadian companies have benefited from R&D collaborations. The full text of 14 case histories is available on the Internet at the department's Strategis *web site (http://strategis.ic.gc.ca).*

Bayer Rubber Inc.

This success story presents an example of **industry/university R&D collaboration** at its best.

Bayer Rubber Inc. (formerly Polysar) produces a range of synthetic rubber-based materials for transformation into industrial and consumer products by an array of manufacturing industries. It currently employs approximately 1 300 people at its Sarnia, Ontario, plant and has annual sales in the $400 million range. Beginning in 1982, it contracted the research assistance of Prof. Garry Rempel of the University of Waterloo on the development of a high-performance elastomer for use in automotive parts. The result was the rapid development and commercialization of an end product to meet market needs.

In order to meet standards for emission control and fuel efficiency, automotive engines operate at high temperatures and in small engine compartments. The result is a short life span for polymer-based engine parts such as belts, hoses and gaskets as they are attacked by oxygen, oils and other automotive fluids. The elastomer of choice in the late 1970s, nitrile butadiene rubber (NBR), was reaching its thermal resistance limits. Facing the potential loss of a huge market, Polysar moved quickly in 1982 to form a group to develop a heat and oil resistant rubber that would maintain its properties at 150°C for more than 1 000 hours. Concurrently, Polysar signed a research contract with Prof. Rempel to investigate and develop a catalyst system for the hydrogenation of NBR to form H-NBR. The close collaboration between both parties resulted in the invention of a unique, precious-metal catalyst system that was patented worldwide in 1983.

A grant from the National Research Council assisted with scale-up testing. A pilot plant was designed and constructed in order to develop a commercial process for the catalytic hydrogenation of nitrile rubber. Meanwhile, collaboration with the university continued in the search to find less expensive materials and to refine the process. Pilot plant samples were supplied to

selected clients, who confirmed that H-NBR was a viable product. The Polysar–Waterloo catalytic technology captured the Canada Gold Award for Business Excellence in 1987. The collaborative efforts were further recognized in September 1995 by a University–Industry Synergy R&D Partnership Award from the Natural Sciences and Engineering Research Council of Canada and the Conference Board of Canada. To date, the work has resulted in 12 patents filed worldwide. The technology proved to have great commercial application, and H-NBR is now used in automotive seals, gaskets, belts and hoses, oil well seals and valve linings, and in many industrial applications such as roll covers, textile belts and heat exchanger gaskets.

Cytec Canada Inc.

Based in Niagara Falls, Ontario, Cytec operates the only phosphine and phosphine derivatives plant in North America. Its success is largely based on research conducted by the Cytec R&D group and its development of a broad range of products derived from phosphine chemistry. Much of this research was supported by **research tax credits** and by **grants** from the National Research Council of Canada's Industrial Research Assistance Program (IRAP).

Cytec employs about 90 people in the Niagara area and has sales estimated to be in the area of $20–30 million. The plant in Niagara Falls is the world's largest phosphine production facility. Products include intermediates and catalysts used in pharmaceuticals, flame retardants used in military and industrial clothing, and electronic grade phosphine used in the production of semiconductor chips. About 80 percent of all production from the Niagara Falls facility is currently exported.

Cytec's R&D group currently consists of three PhD's, two MSc's, two chemical technologists and several chemical technicians. The research projects are technology-driven and market-focussed. The following products are examples of the technology developed by Cytec Canada.

- **Flotation promoter:** This product is a sulfide mineral flotation reagent used in the recovery of metals from mining ore. The promoter, AEROPHINE® 3418A, was developed under an IRAP grant. Since its introduction in the late 1970s, AEROPHINE® 3418A has become the promoter of choice at a number of locations throughout the world because it gives higher recovery rates, has greater selectivity, can be used in smaller doses and does not form hazardous decomposition products. This is the largest product by volume of the Niagara Falls facility, with sales reaching $7 million per year, of which 80 percent is exported.
- **Solvent extraction reagent:** This development project also was sponsored by an IRAP grant. The two major successes to date are the development of CYANEX® 272, a phosphinic acid, and CYANEX® 923, a liquid phosphine oxide. Cytec manufactures and supplies the chemicals and also develops new processes for utilization. The chemists and metallurgists

at Cytec who developed CYANEX® 272 designed an extraction process to separate cobalt and nickel, a notoriously difficult task. The first plant was designed around the properties of CYANEX® 272, and this process became operational in 1985. Since then, six more custom-designed installations have been constructed around the world using the CYANEX® 272 process.

- **Ultraviolet photo initiator:** This product is used primarily in the new and growing market of environmentally attractive ultraviolet-cured coatings. It can be used in applications involving thick coatings and opaque coatings. All production is currently exported.

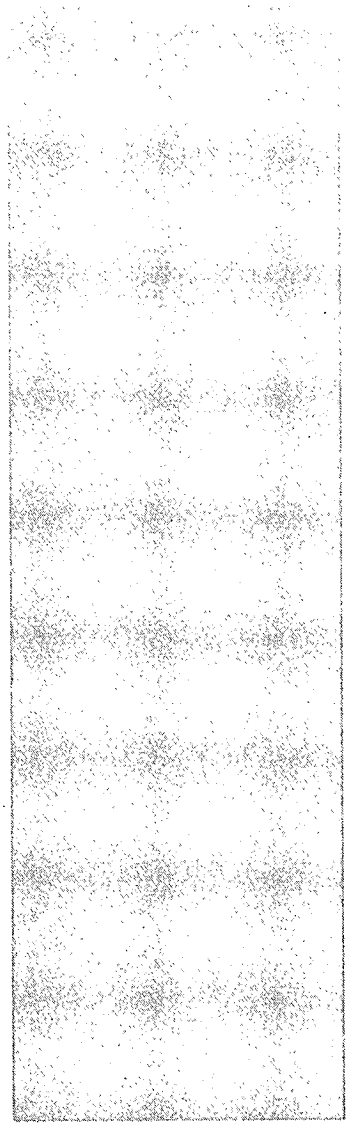
DuPont Canada Inc.

The cost competitiveness of conducting R&D in Canada, due in part to **scientific research tax credits**, was instrumental in attracting an important research project on developing automobile airbags to DuPont's Kingston, Ontario, facility. Another significant factor in attracting this research project was the **"receptor capacity"** that existed in Kingston, consisting largely of the skill and reputation of the technical personnel already in place there.

DuPont Canada Inc. is a large diversified company serving customers in every Canadian province and in over 35 countries around the world. It has annual sales of approximately $1.7 billion and employs about 3 700 people. DuPont operates three main businesses: fibres, specialty chemicals, and specialty plastics and film. More than 65 percent of the product manufactured in Canada is for export.

The fibres used in the manufacture of airbags require special properties. Airbags are housed in very confined spaces for a long period — up to 25 years. They must retain their strength while experiencing temperatures ranging from well below freezing to over 150°F (65°C). Then, at any time, they must withstand the force of an explosion that inflates the bags in microseconds. They must also be available in a broad range of shapes and sizes depending on the car model, the bag design and the bag location within the car. Hence, the fibre has to be lightweight, very strong, high-quality, reasonably priced and with the heat capacitance necessary to survive the inflation technology.

In the 1980s, the ideal fibre did not yet exist. DuPont determined that what was needed was a blend of the best properties of an apparel fibre (lightweight, efficient processing) and an industrial fibre (strength and durability). The DuPont Canada R&D facility in Kingston took on the project to create a new generation of fibres to meet this end use.



The Kingston facility was selected for a variety of reasons. The DuPont Canada R&D capability already had a proven track record and had earned the mandate within DuPont for developing lightweight, high-strength nylon fibres for sewing threads and industrial fabrics. The cost of conducting research in Canada, including the research tax credits, meant R&D costs were as much as 50 percent lower than in the U.S. In addition, DuPont Canada was structured and sized to be more flexible and to offer a greater breadth of product. There was also a corporate desire to establish DuPont Canada as a world-class company to allow it to compete successfully outside Canada.

Ultimately, the R&D group successfully developed a new generation of fibre to meet the exacting demands of this market. In response to the explosive market growth in airbags, DuPont has invested over $50 million in capital in the Kingston facility, creating jobs, job stability and future viability. The Kingston facility is now the largest supplier of these fibres to the global airbag market. All of the product is exported; there are no airbag fabric weavers in Canada!

Nacan Products Limited, Resin Division

This division's research team has been supported in part by a variety of **government-sponsored programs** as well as through the **commercialization** of the products developed by the team.

Nacan Products Limited is a leading Canadian supplier of adhesives, resins and starches to a wide variety of markets. The Resin Division supplies resins and specialty chemicals to the paint, paper, construction, adhesive and cosmetic industries, to name a few. Nacan Products is part of the National Starch and Chemical Company, which has over 8 500 employees worldwide and annual sales of almost $2.5 billion.

Beginning in the latter half of the 1980s, Nacan decided to support more development work in Canada. Its Brampton laboratory now is the North American centre for paint and coatings research for the parent company, National Starch.

Much of the recent work at the Brampton facility has been on the development of resins for use in solvent-free paints. Traditional water-based house paints contain some coalescing solvents and glycols. Although the total may be only about 4 percent, the quantity of water-based house paints sold in a year in North America contributes over 100 million pounds (45 000 tonnes) of volatile organics to the atmosphere. Nacan's goal was to develop new polymers without solvents that still give equivalent performance properties to the old.

As a result of the technical expertise that has been developed in Canada, the Brampton laboratory became Nacan's North American R&D Centre for paints and coatings. Several government grants allowed Nacan to accelerate its development work. Nacan has had two IRAP grants, uses co-op students in conjunction with NSERC grants and makes extensive use of university expertise. Nacan is a member of the Institute of Polymer Research at Waterloo as well as the McMaster Institute of Polymer Process Technology. The combination of tax credits and grants has allowed Nacan to add new young talent (graduating students) and steadily increase its research personnel over the past 10 years. This technical expertise has also allowed it to capitalize on export opportunities that promise to be a real growth market in the future. In fact, new products developed in the past four years currently represent 50 percent of Nacan's sales.

Sterling Pulp Chemicals Ltd.

This Canadian company, with plants in Alberta, British Columbia, Ontario and Quebec as well as the United States, is a leading world supplier of sodium chlorate, a feed chemical for on-site production of chlorine dioxide, which is used for bleaching wood pulp. Part of the development of the technology for producing sodium chlorate resulted from the **collaborative R&D efforts** of Sterling Pulp Chemicals and the University of Toronto. The closeness of both Sterling and university personnel to the marketplace has enabled the company to identify and develop the appropriate technology required by the pulp industry.

Environmental concerns over the use of elemental chlorine in the pulp and paper industry and the development of a more efficient bleaching process using chlorine dioxide have led to a growing demand for chlorine dioxide over the past 20 years as a replacement for chlorine. Because chlorine dioxide cannot be transported, it must be generated on-site. Sterling's forte is the design and installation of chlorine dioxide generators, and Sterling now accounts for over 60 percent of the chlorine dioxide generators in the world. These generators have the combined capacity to produce 5.4 million pounds (2 430 tonnes) of chlorine dioxide *per day*.

Much of the fundamental technology for the use of chlorine dioxide in the bleaching of pulp was developed jointly by W. H. Rapson of the University of Toronto and Sterling (then called ERCO). The joint research work has continued from 1970 to the present day, with the university's activities becoming focussed on bleaching and the company's on chlorine dioxide process development. Considerable synergy resulted from this close collaboration. For example, the development of cost-effective and environmentally acceptable bleaching sequences utilizing increasing amounts of chlorine dioxide as a replacement for chlorine was studied by university personnel both in the laboratory and in field trials. This has contributed to the development of an elemental chlorine free (ECF) kraft pulp bleaching process, which is widely practised both in Canada and abroad.

Today, Sterling's collaboration with the University of Toronto is on three levels: it is a founding member of the Pulp and Paper Centre, formed in 1987; it participates with other companies in consortia formed by the centre to research specific industry problems; and it supports directed proprietary research. Additionally, key university personnel have provided their expertise, via consultancies, to address technical issues at specific mills. They also provide training and advice to a broad cross-section of the industry via workshops and seminars sponsored by Sterling. Sterling also provides resource personnel to assist students in their project assignments.

Uniroyal Chemical Ltd.

This company's development process on fungicides started with pure research, progressed to pilot plant studies and finally resulted in full **commercialization**, all taking place within Canada but having worldwide impact. This story illustrates the benefits of government support through specific **grants** and **research tax credits**. It is also an example of the joint efforts of Canadian and American scientists to commercialize products.

Uniroyal Chemicals Ltd., with its head office and manufacturing facility in Elmira, Ontario, and its research laboratories in Guelph, Ontario, has about 325 employees across Canada. It is an international leader in the production of crop protection chemicals, rubber chemicals and polymers as well as specialty chemicals and polyurethanes. Its parent company, Uniroyal Chemical Co. Inc. of Middlebury, Connecticut, has about 2 700 employees worldwide and has annual sales of over $1 billion.

Development of the carboxanilide class of fungicides began in the 1960s as a joint project of Canadian and American research teams. The Guelph laboratory had expertise in organic synthesis, and the U.S. labs had developed a screening process to detect systemic fungicidal activity. Two products were found to be particularly active against several fungus species: 5,6-dihydro-2-methyl-N-phenyl-1,4-oxathiin-3-carboxamide (Vitavax®) and its sulphone analog (Plantvax®). These were especially active in controlling plant pathogenic fungi such as wheat leaf rust, bean rust and loose smut of barley. The basic synthesis was done in Canada, and the U.S. labs supplied screening tests, toxicological studies and environmental chemistry studies necessary for commercialization. Much of the work in Canada was made possible by one of the original IRAP grants, and Uniroyal maintained these grants from 1962 to 1984.

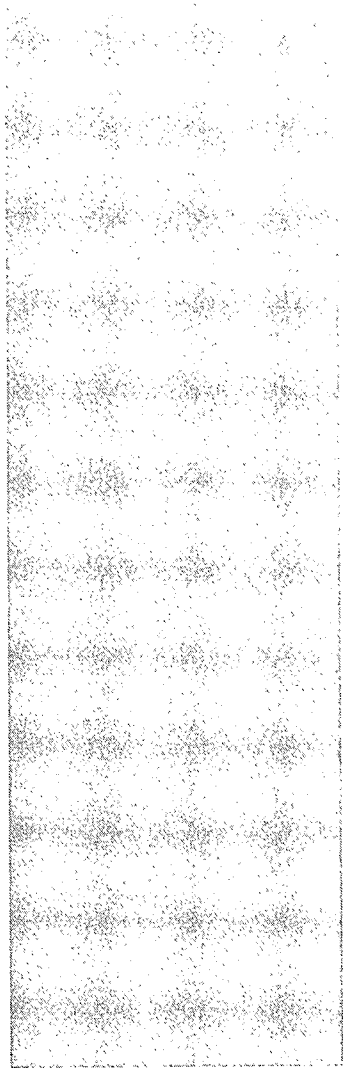
Following field trials, the next major hurdle was the development of a manufacturing process. The chemists, working in conjunction with the process development group in Elmira, overcame a host of problems. Scale-up in Elmira was completed as a pilot in 1968, and commercial production began in 1969. Uniroyal continued research over the years to improve the manufacturing process and develop new formulations. Formulations for powder and liquid form, in combination

with contact fungicides, with colour added to detect treated seed, etc., were all developed and refined to attack specific problems on a wide variety of crops.

The net impact after initial product introduction was vast market acceptance, resulting in an additional manufacturing plant being built, also in Elmira. All product is now made in Elmira and sold worldwide. Total sales have reached $500 million, of which 40 percent has been exported.

Uniroyal has been able to achieve a unique position in the crop protection industry in Canada: it is the only company doing research in new active ingredients, the only company doing formulation invention and development, and the only company manufacturing the active ingredients.

At the time of the original development, the Uniroyal chemical laboratory in Guelph was a small part of the total corporate crop protection research program. This lab is now the sole supplier of new crop protection chemicals for Uniroyal on a worldwide basis, and the IRAP grants from 1962 to 1984 were a large contributor to developing this strength and reputation.



Annex D
SELECTED INDUSTRY STATISTICS

Table D-1. Estimated North American Market, Industrial Chemicals (SIC 3711, 3712 and 3731: Industrial Chemicals and Plastics and Synthetic Resins)

	1985	1988	1989	1990	1991	1992	1993	1994	1995	Annual growth 1985–95
					(US$ millions)					(%)
U.S. shipments	88 967	114 856	123 674	124 076	120 947	123 379	128 662	138 306	145 194	5.0
U.S. imports	9 405	12 246	12 185	13 092	13 195	14 193	14 675	17 601	19 361	7.5
U.S. exports	12 953	19 312	21 133	21 772	23 615	23 429	23 689	27 243	29 967	8.7
U.S. apparent market[a]	85 419	107 789	114 725	115 396	110 527	114 143	119 648	128 664	134 588	4.7
Canadian shipments	6 492	9 218	9 748	9 597	8 428	7 694	7 570	8 941	10 480	4.9
Canadian imports	2 323	3 448	3 603	3 724	3 929	3 859	4 119	4 805	6 096	10.1
Canadian exports	2 635	4 147	3 979	4 154	4 081	4 186	4 259	5 171	6 582	9.6
Canadian apparent market[a]	6 180	8 519	9 372	9 167	8 275	7 367	7 429	8 575	9 994	4.9
Sales to Canadian customers (shipments minus exports)	3 858	5 071	5 769	5 443	4 347	3 508	3 311	3 770	3 898	0.1
Canadian imports from the U.S.	1 640	2 449	2 578	2 770	3 024	2 869	3 075	3 531	4 392	10.4
Canadian exports to the U.S.	1 729	2 531	2 631	2 768	2 686	3 016	3 289	4 102	5 133	11.5
Total Canada–U.S. market	91 599	116 308	124 097	124 563	118 802	121 509	127 077	137 239	144 582	4.7
World exports (SITC 51, 52 and 58)	82 000	143 000	149 900	165 100	169 900	173 600	168 400	190 707	209 778	9.8
					(percent)					
Canadian penetration of U.S. market	2.0	2.3	2.3	2.4	2.4	2.6	2.7	3.2	3.8	
Canadian production share of Canada–U.S. market	7.1	7.9	7.9	7.7	7.1	6.3	6.0	6.5	7.2	
Canadian share of domestic market	62.4	59.5	61.6	59.4	52.5	47.6	44.6	44.0	39.0	
Rest of world share of Canada–U.S. market	9.1	9.2	8.5	9.1	9.6	10.0	9.8	10.8	11.0	
Canadian exports share of world exports	3.2	2.9	2.7	2.5	2.4	2.4	2.5	2.7	3.1	

[a] Apparent market = shipments plus imports less exports.

Source: Statistics Canada/Industry Canada Business Integrated Database; U.S. Department of Commerce, *Census of Manufactures* (Washington, D.C.: GPO, 1992 and updates); Chemical Manufacturers Association, *U.S. Chemical Industry Statistical Handbook 1994* (Washington, D.C.: CMA, 1994).

Table D-2. Selected Statistical Performance Indicators, Industrial Chemicals (SIC 3711, 3712 and 3731: Industrial Chemicals and Plastics and Synthetic Resins)

	1985	1988	1989	1990	1991	1992	1993	1994	1995	Annual growth 1985–95
										(%)
Establishments (number)	247	293	302	310	293	283	286	300	—	—
Total revenue, including resales ($ millions)	10 234	13 074	13 416	13 144	11 703	11 354	12 228	14 130	16 656	5.0
Manufacturing shipments ($ millions)	8 865	11 344	11 541	11 198	9 656	9 299	9 766	12 210	14 383	5.0
Manufacturing shipments (constant 1986 dollars)	8 739	9 246	9 402	9 788	8 693	8 803	9 036	10 111	10 369	1.7
Manufacturing shipments as a share of chemicals and chemical products (%)	48.5	49.8	48.8	48.4	45.3	43.3	43.2	47.7	50.4	
Apparent domestic market (shipments plus imports less exports) ($ millions)	8 439	10 485	11 246	10 918	9 437	9 302	10 244	12 773	14 197	5.3
Manufacturing value-added ($ millions)	2 750	5 377	5 185	4 582	3 504	3 604	3 797	5 033	5 904	7.9
Total employment (number)	26 083	27 589	27 406	29 373	28 197	27 346	25 587	24 500	23 148	–1.2
Total salaries and wages ($ millions)	990	1 196	1 237	1 385	1 352	1 334	1 297	1 307	1 278	2.6
Energy costs ($ millions)	824	709	793	887	863	805	803	880	1 021	2.2
Cost of materials and supplies ($ millions)	5 263	5 346	5 588	5 809	5 172	4 918	5 208	6 262	7 419	3.5
Production workers as a share of total employment (%)	58.6	58.5	59.3	59.1	58.0	58.5	63.0	63.2	69.2	
Energy costs as a share of total operational costs (%)	11.6	9.8	10.4	11.0	11.7	11.4	11.0	10.4	10.2	
Industrial product price index (1986 = 100)	101.5	122.7	122.7	114.4	111.1	105.6	108.1	120.8	138.7	3.2

Source: Statistics Canada/Industry Canada Business Integrated Database.

Table D-3. Regional Statistics, Industrial Chemicals (SIC 3711, 3712 and 3731: Industrial Chemicals and Plastics and Synthetic Resins)

	1985	1988	1989	1990	1991	1992	1993	1994	Annual growth 1985–94	Share of Canada 1985	Share of Canada 1994
									(%)	(%)	(%)
Establishments (number)											
Alberta	28	41	42	46	37	36	37	37	3.1	11.3	12.3
Ontario	114	132	136	141	132	121	122	128	1.3	46.2	42.7
Quebec	54	65	65	69	68	72	73	76	3.9	21.9	25.3
Other provinces	51	55	59	54	56	54	54	59	1.6	20.6	19.7
Canada	247	293	302	310	293	283	286	300	2.2	100.0	100.0
Employees (number)											
Alberta	3 296	3 394	3 364	3 866	3 906	3 936	3 983	3 645	1.1	12.6	14.9
Ontario	15 431	16 653	16 422	17 204	16 358	16 250	15 057	13 990	–1.1	59.2	57.1
Quebec	4 946	5 386	5 510	6 301	5 818	5 270	4 756	4 867	–0.2	19.0	19.9
Other provinces	2 410	2 156	2 110	2 002	2 115	1 890	1 791	1 998	–2.1	9.2	8.2
Canada	26 083	27 589	27 406	29 373	28 197	27 346	25 587	24 500	–0.7	100.0	100.0
Manufacturing shipments ($ millions)											
Alberta	1 840	2 724	2 763	2 552	2 326	2 239	2 454	3 602	7.8	20.8	29.5
Ontario	5 106	5 909	5 964	5 912	4 891	4 854	4 906	5 720	1.3	57.6	46.8
Quebec	1 357	2 011	2 113	2 184	1 857	1 631	1 726	2 122	5.1	15.3	17.4
Other provinces	563	700	702	550	583	575	680	767	3.5	6.4	6.3
Canada	8 865	11 344	11 541	11 198	9 656	9 299	9 766	12 211	3.6	100.0	100.0
Census value-added (manufacturing) ($ millions)											
Alberta	619	1 457	1 494	1 208	994	965	1 054	1 670	11.7	22.5	33.2
Ontario	1 533	2 698	2 526	2 312	1 654	1 751	1 718	2 139	3.8	55.7	42.5
Quebec	372	847	799	803	571	600	644	817	9.1	13.5	16.2
Other provinces	226	375	366	260	285	288	380	406	6.7	8.2	8.1
Canada	2 750	5 377	5 185	4 582	3 504	3 604	3 796	5 033	6.9	100.0	100.0
Total wages and salaries ($ millions)											
Alberta	139	150	157	189	208	219	235	230	3.8	14.0	17.6
Ontario	605	753	769	828	787	787	744	745	2.4	61.1	57.0
Quebec	159	204	214	281	262	236	228	223	3.8	16.1	17.1
Other provinces	86	89	87	126	95	91	89	108	2.5	8.7	8.3
Canada	990	1 197	1 237	1 385	1 352	1 334	1 296	1 306	3.1	100.0	100.0
Manufacturing shipments per employee (thousands of constant dollars, based on IPPI 1986 = 100)											
Alberta	548	635	650	568	526	534	523	777	4.0		
Ontario	326	288	295	299	269	282	288	342	0.5		
Quebec	272	309	319	309	293	299	324	377	3.7		
Other provinces	231	291	290	247	250	286	330	331	4.1		
Canada	335	335	343	333	308	322	335	413	2.3		

Source: Statistics Canada/Industry Canada Business Integrated Database.

Table D-4. Regional Statistics, Inorganic Chemicals (SIC 3711: Inorganic Chemicals)

	1985	1988	1989	1990	1991	1992	1993	1994	Annual growth 1985–94	Share of Canada 1985	Share of Canada 1994
									(%)	(%)	(%)
Establishments (number)											
Alberta	12	20	21	18	16	15	16	16	3.2	11.2	10.7
Ontario	36	52	55	55	56	49	48	53	4.4	33.6	35.6
Quebec	21	27	26	30	29	32	34	36	6.2	19.6	24.2
Other provinces	38	40	45	40	40	38	37	44	1.6	35.5	29.5
Canada	107	139	147	143	141	134	135	149	3.7	100.0	100.0
Employees (number)											
Alberta	974	592	495	506	618	653	560	502	–7.1	9.4	6.1
Ontario	5 246	5 695	5 286	5 764	5 470	5 056	4 748	3 958	–3.1	50.4	47.8
Quebec	2 301	2 618	2 458	3 014	3 087	2 662	2 497	2 476	0.8	22.1	29.9
Other provinces	1 881	1 595	1 544	1 347	1 418	1 230	1 230	1 353	–3.6	18.1	16.3
Canada	10 402	10 500	9 783	10 631	10 593	9 601	9 035	8 289	–2.5	100.0	100.0
Manufacturing shipments ($ millions)											
Alberta	224	273	267	258	258	286	253	244	1.0	10.2	9.1
Ontario	1 151	1 289	1 366	1 353	1 256	1 160	1 099	979	–1.8	52.6	36.6
Quebec	451	583	644	814	719	703	698	934	8.4	20.6	34.9
Other provinces	361	458	483	346	371	362	444	516	4.0	16.5	19.3
Canada	2 187	2 603	2 759	2 771	2 604	2 511	2 495	2 674	2.3	100.0	100.0
Census value-added, manufacturing ($ millions)											
Alberta	111	183	184	180	171	194	157	173	5.1	9.8	12.4
Ontario	642	727	747	712	683	649	614	477	–3.2	56.7	34.2
Quebec	228	305	329	422	326	351	338	444	7.7	20.2	31.8
Other provinces	151	260	283	189	197	202	271	301	7.9	13.3	21.5
Canada	1 132	1 474	1 543	1 502	1 377	1 397	1 380	1 395	2.3	100.0	100.0
Total wages and salaries ($ millions)											
Alberta	38	22	20	24	31	34	31	28	–3.3	9.5	6.5
Ontario	212	256	239	267	257	239	230	212	0.0	53.3	49.3
Quebec	80	104	106	133	142	126	123	125	5.0	20.1	29.0
Other provinces	68	66	64	59	63	56	57	66	–0.4	17.0	15.2
Canada	398	449	429	483	493	456	441	431	0.9	100.0	100.0
Manufacturing shipments per employee (thousands of constant dollars, based on IPPI 1986 = 100)											
Alberta	227	443	491	469	384	411	415	435	7.5		
Ontario	217	217	236	216	211	215	213	221	0.2		
Quebec	194	214	239	248	214	247	257	337	6.4		
Other provinces	190	275	285	236	240	276	332	341	6.7		
Canada	208	238	257	240	226	245	254	288	3.7		

Source: Statistics Canada, *Annual Survey of Manufactures.*

Table D-5. Regional Statistics, Organic Chemicals (SIC 3712 and 3731: Organic Chemicals and Plastics and Synthetic Resins)

	1985	1988	1989	1990	1991	1992	1993	1994	Annual growth 1985–94	Share of Canada 1985	Share of Canada 1994
									(%)	(%)	(%)
Establishments (number)											
Alberta	16	21	21	28	21	21	21	21	3.1	11.4	13.9
Ontario	78	80	81	86	76	72	74	75	–0.4	55.7	49.7
Quebec	33	38	39	39	39	40	39	40	2.2	23.6	26.5
Other provinces	13	15	14	14	16	16	17	15	1.6	9.3	9.9
Canada	140	154	155	167	152	149	151	151	0.8	100.0	100.0
Employees (number)											
Alberta	2 322	2 802	2 869	3 360	3 288	3 283	3 388	3 143	3.4	14.8	19.4
Ontario	10 185	10 958	11 136	11 440	10 888	11 194	10 286	10 032	–0.2	65.0	61.9
Quebec	2 645	2 768	3 052	3 287	2 731	2 608	2 292	2 391	–1.1	16.9	14.7
Other provinces	529	561	566	655	697	660	586	645	2.2	3.4	4.0
Canada	15 681	17 089	17 623	18 742	17 604	17 745	16 552	16 211	0.4	100.0	100.0
Manufacturing shipments ($ millions)											
Alberta	1 616	2 451	2 496	2 294	2 068	1 953	2 201	3 358	8.5	24.2	35.2
Ontario	3 955	4 620	4 598	4 559	3 635	3 694	3 807	4 741	2.0	59.2	49.7
Quebec	906	1 428	1 469	1 370	1 137	928	1 028	1 188	3.1	13.6	12.5
Other provinces	202	242	219	204	212	213	236	250	2.4	3.0	2.6
Canada	6 678	8 741	8 782	8 427	7 052	6 788	7 271	9 537	4.0	100.0	100.0
Census value-added, manufacturing ($ millions)											
Alberta	508	1 274	1 310	1 028	823	770	897	1 497	12.8	31.4	41.1
Ontario	891	1 972	1 779	1 600	971	1 102	1 104	1 662	7.2	55.1	45.7
Quebec	144	542	470	381	245	249	306	373	11.2	8.9	10.3
Other provinces	75	115	83	71	88	86	109	106	3.8	4.7	2.9
Canada	1 618	3 903	3 642	3 080	2 127	2 207	2 416	3 637	9.4	100.0	100.0
Total wages and salaries ($ millions)											
Alberta	101	128	137	165	177	185	204	202	8.1	17.1	23.1
Ontario	393	497	530	561	530	548	514	533	3.4	66.4	60.9
Quebec	79	100	118	148	120	110	105	98	2.4	13.3	11.2
Other provinces	18	23	23	67	32	35	32	42	10.0	3.0	4.8
Canada	592	748	808	902	859	878	855	875	4.5	100.0	100.0
Manufacturing shipments per employee (thousands of constant dollars, based on IPPI 1986 = 100)											
Alberta	682	675	678	583	553	559	534	832	2.2		
Ontario	383	325	323	342	298	313	319	389	0.2		
Quebec	340	398	383	364	382	351	394	418	2.3		
Other provinces	378	334	304	268	270	306	338	310	–2.2		
Canada	420	395	391	386	358	364	375	476	1.4		

Source: Statistics Canada/Industry Canada Business Integrated Database.

Table D-6. Estimated North American Market, Inorganic Chemicals (SIC 3711: Inorganic Chemicals)

	1985	1988	1989	1990	1991	1992	1993	1994	1995	Annual growth 1985–95
					(US$ millions)					(%)
U.S. shipments	18 183	19 345	21 085	23 487	23 572	23 902	23 086	24 214	25 397	3.4
U.S. imports	4 104	4 266	4 216	4 319	4 283	4 185	4 049	4 692	5 162	2.3
U.S. exports	3 618	4 281	4 680	4 723	5 101	5 178	4 944	5 348	5 883	5.0
U.S. apparent market[a]	18 669	19 330	20 621	23 083	22 754	22 909	22 191	23 558	24 676	2.8
Canadian shipments	1 602	2 115	2 331	2 375	2 273	2 078	1 934	1 958	2 203	3.2
Canadian imports	414	640	714	720	688	754	779	970	1 115	10.4
Canadian exports	1 042	1 370	1 327	1 326	1 296	1 352	1 318	1 548	1 733	5.2
Canadian apparent market[a]	974	1 385	1 717	1 768	1 664	1 480	1 395	1 380	1 584	5.0
Sales to Canadian customers (shipments minus exports)	560	745	1 003	1 048	977	726	616	410	469	–1.7
Canadian imports from the U.S.	311	441	492	524	543	554	599	707	809	10.0
Canadian exports to the U.S.	817	1 041	1 126	1 116	1 084	1 122	1 140	1 323	1 457	6.0
Total Canada–U.S. market	19 643	20 715	22 338	24 851	24 419	24 389	23 586	24 938	26 260	2.9
World exports (SITC 52: Inorganic Chemicals)	16 800	23 900	24 100	24 700	25 200	25 200	23 600	25 267	27 794	5.2
					(percent)					
Canadian penetration of U.S. market	4.4	5.4	5.5	4.8	4.8	4.9	5.1	5.6	5.9	
Canadian production share of Canada–U.S. market	7.0	8.6	9.5	8.7	8.4	7.6	7.4	6.9	7.3	
Canadian share of domestic market	57.5	53.8	58.4	59.3	58.7	49.1	44.1	29.7	29.6	
Rest of world share of Canada–U.S. market	17.3	16.5	14.8	13.7	13.7	13.4	13.1	14.6	15.3	
Canadian export share of world exports (SITC 52)	6.2	5.7	5.5	5.4	5.1	5.4	5.6	6.1	6.2	

[a] Apparent market = shipments plus imports less exports.

Source: Statistics Canada/Industry Canada Business Integrated Database; U.S. Department of Commerce, *Census of Manufactures* (Washington, D.C.: GPO, 1992 and updates); Chemical Manufacturers Association, *U.S. Chemical Industry Statistical Handbook 1994* (Washington, D.C.: CMA, 1994).

Table D-7. Estimated North American Market, Organic Chemicals (SIC 3712 and 3731: Organic Chemicals and Plastics and Synthetic Resins)

	1985	1988	1989	1990	1991	1992	1993	1994	1995	Annual growth 1985–95
					(US$ millions)					(%)
U.S. shipments	70 784	95 511	102 589	100 589	97 375	99 477	105 576	114 092	119 796	5.4
U.S. imports	5 300	7 980	7 969	8 774	8 912	10 008	10 626	12 909	14 200	10.4
U.S. exports	9 335	15 032	16 453	17 049	18 514	18 251	18 746	21 894	24 084	9.9
U.S. apparent market[a]	66 750	88 459	94 105	92 313	87 773	91 234	97 457	105 106	109 912	5.1
Canadian shipments	4 891	7 103	7 417	7 223	6 155	5 616	5 636	6 983	8 277	5.4
Canadian imports	1 909	2 808	2 889	3 004	3 241	3 105	3 339	3 835	4 981	10.1
Canadian exports	1 593	2 777	2 651	2 828	2 785	2 834	2 941	3 623	4 849	11.8
Canadian apparent market[a]	5 206	7 134	7 655	7 399	6 611	5 887	6 034	7 195	8 410	4.9
Sales to Canadian customers (shipments minus exports)	3 298	4 326	4 766	4 395	3 370	2 782	2 695	3 360	3 428	0.4
Canada imports from the U.S.	1 329	2 007	2 087	2 246	2 481	2 315	2 477	2 823	3 583	10.4
Canada exports to the U.S.	911	1 490	1 505	1 653	1 602	1 894	2 148	2 780	3 676	15.0
Total Canada–U.S. market	71 956	95 593	101 760	99 712	94 384	97 120	103 491	112 301	118 322	5.1
World exports (SITC 51 and 58)	65 200	119 100	125 800	140 400	144 700	148 400	144 800	165 440	181 984	10.8
					(percent)					
Canadian penetration of U.S. market	1.4	1.7	1.6	1.8	1.8	2.1	2.2	2.6	3.3	
Canadian production share of Canada–U.S. market	5.8	6.1	6.2	6.1	5.3	4.8	4.7	5.5	6.0	
Canadian share of domestic market	63.3	60.6	62.3	59.4	51.0	47.2	44.7	46.7	40.8	
Rest of world share of Canada–U.S. market	6.9	7.6	7.1	7.9	8.5	9.2	9.0	9.9	10.1	
Canadian share of world exports (SITC 51 and 58)	2.4	2.3	2.1	2.0	1.9	1.9	2.0	2.2	2.7	

[a] Apparent market = shipments plus imports less exports.

Source: Statistics Canada/Industry Canada Business Integrated Database; U.S. Department of Commerce, *Census of Manufactures* (Washington, D.C.: GPO, 1992 and updates); Chemical Manufacturers Association, *U.S. Chemical Industry Statistical Handbook 1994* (Washington, D.C.: CMA, 1994).