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How Much Could Canada Gain from Free Trade?

In the current debates about trade liberalization, whether in the current Uruguay Round of the General Agreement Of Tariffs and Trade (GATT) talks or the negotiations leading to the North American Free Trade Agreement (NAFTA), free trade arguments collide with protectionist arguments, leaving the non-specialist quite perplexed (*see* the excellent discussion of protectionism in Bhagwati 1988).

Our intention in this paper is to provide a list of the benefits in order of magnitude Canada could reap from free trade, and at the same time to pinpoint the areas in which Canada would have to specialize in such a free trade world order.

Theoretical Background to the Free Trade Debate

Traditional economic theory says that each country should specialize in the products where it has a comparative advantage and then exchange those products against other products in which some other country has a competitive edge. In so doing everybody would be better off by sharing each other's strengths.

To explain the notion of comparative advantage, take two countries, Canada and Israel, and two products, cigarettes and oranges. Suppose, for the sake of argument, that the two products require only labour as a factor of production. Canada can produce four units of cigarettes or two units of oranges per hour; Israel can produce six units of cigarettes or twelve units of oranges per hour. Notice that Israel is more efficient in both lines of production; it has an absolute advantage in both commodities. However, if Canada shifted one hour of labour from the production of oranges to that of cigarettes, it would reduce the output of oranges by two units and

increase the output of cigarettes by four units. Conversely, if Israel shifted half an hour from cigarettes to oranges, it would increase its output of oranges by six units and reduce its output of cigarettes by three units. Hence if Canada specialized a bit more in cigarettes and Israel a bit more in oranges, both countries could, to their mutual benefit, raise the production of oranges by four units and that of cigarettes by one unit. So Canada is said to have a comparative advantage in producing cigarettes and Israel a comparative advantage in producing oranges.

In terms of real prices or opportunity cost, one unit of oranges sells for two units of cigarettes in Canada and for half a unit of cigarettes in Israel. Hence the price of oranges in terms of cigarettes is lower in Israel; conversely the price of cigarettes in terms of oranges is lower in Canada. Thus the location of comparative advantage can be revealed by the domestic prices in this simple example with only one input. Of course, for both countries to gain from specializing and trading with each other, the trading price (the so-called terms of trade) has to lie in between the two domestic prices.

There can be several sources of comparative advantage. The domestic prices can differ because of differences in technology (the Ricardian theory), differences in factor endowments (the Hecksher-Ohlin theory) and differences in taste. The taste-endowment-technology trio constitutes the classical foundation of comparative advantage and...the consequent benefits from free trade.

The new theory of international trade emphasizes the notions of returns to scale, imperfect competition, product differentiation and strategic behaviour. Differences in domestic prices, and hence incentives to trade, can be due to economies of scale, be they internal to the firm (i.e., related to its size) or external to the firm (such as economies of proximity), to differences in market structure (more monopoly power and hence higher prices in one country than in the other one), to differences in quality (product differentiation), to government intervention in the form of taxes, tariffs, subsidies or to strategic aspects such as dumping (i.e., exporting abroad at prices that lie below marginal cost) or research and development (which can alter the direction of comparative advantage in the long run). Some of these differences, notably in market structure, are related to the fundamentals of the economy—endowments, technology and preferences—in other branches of the economic literature.

The Model

Our analysis concentrates on the traditional sources of comparative advantage directly, i.e., those that a country derives from its endowments, its

preferences and its technology as compared to the rest of the world.

We take the Canadian economy as it was in 1980, dividing it up into 29 sectors and 92 commodities and recognizing three primary inputs (labour, capital and the prevailing deficit in the balance of trade). We exploit the rich information contained in the input-output tables of the Canadian economy, and in particular we pay explicit attention to the interindustry flows of goods and services. Each sector can be active in the production of various commodities. Hence, contrary to the usual input-output analysis, we do not assimilate sectors with commodities, although at our level of aggregation there is a correspondence between the two (Table 1). Commodities are

Table 1
Sector and Commodity Aggregation

	29 sectors	50 sectors	92 commodities
1.	Agricultural and related services	1	1–3
2.	Fishing & trapping	2	5, 6
3.	Logging and forestry	3	4
4.	Mining, quarrying and oil wells	4–7	7–12, **13**
5.	Food	8	14–22
6.	Beverage	9	23, 24
7.	Tobacco products	10	25, 26
8.	Plastic products	12	29
9.	Rubber and leather products	11, 13	27, 28, 30
10.	Textile and clothing	14, 15	31–35
11.	Wood	16	36–38
12.	Furniture and fixtures	17	39
13.	Paper and allied products	18	40–42
14.	Printing, publishing and allied	19	43,**44**
15.	Primary metals	20	45–49
16.	Fabricated metal products	21	50–52
17.	Machinery	22	53, 54
18.	Transportation equipment	23	55–57
19.	Electrical and electronic products	24	58, 59
20.	Non-metallic mineral products	25	60, 61
21.	Refined petroleum and coal	26	62, 63
22.	Chemicals and chemical products	27	64–67
23.	Other manufacturing	28	68, 69
24.	Construction	29	**70–72**
25.	Transportation and communication	30–33	73–77
26.	Electric power and gas	34	78, **79**
27.	Wholesale and retail trade	35, 36	80, **81**
28.	Finance, insurance and real estate	37–40	82, 83
29.	Community, business, personnel serv.	41–50	84–87,**88**,89,90,**91,92**

Source: Statistics Canada. 1987, M-classification.
Note: Figures in bold represent non-tradables.

produced to satisfy the demand for intermediate inputs from the various sectors and to meet the domestic and foreign final demands. The technologies of production of the various commodities by the various sectors are explicitly given by the observed flows of outputs and purchases of inputs across sectors. The preferences are given by the observed commodity composition of domestic final demand (consumption plus investment) or, alternatively, by the commodity composition of domestic consumption or domestic investment. The endowments of the Canadian economy in the three primary inputs are given by the total labour force (measured in terms of yearly person-hours), the sum of the sectoral capital stocks available and the overall trade deficit in 1980.

The potential efficiency gain from free trade is measured by the percentage increase in domestic final demand that Canada could achieve by specializing in the production of certain commodities and allocating its inputs optimally across sectors. In doing so, the central planners would have to keep in mind that they cannot use more than Canada's available stocks of labour and capital (which are supposed to be perfectly mobile across sectors and immobile across national boundaries), that they cannot import more than allowed by the prevailing trade deficit (in a fixed-exchange-rate world, one could think of a constraint in the availability of foreign currencies) and that the production of each commodity has to be sufficient to meet the various demands for it. The variables the planners can influence to attain these objectives are the activity levels in each sector and the net exports of all tradable commodities. A formal presentation of the model is contained in the appendix, together with a brief description of the data sources.

The reader should notice that we perform a so-called activity analysis, that is, we allow for an expansion or a contraction of all activities in a given sector (e.g., a 10 percent increase of all commodity productions and purchases and of all primary input uses in a given sector) but exclude any output or factor substitutions. The advantage of this approach is that we do not have to make any particular assumptions regarding the technology of production of a certain commodity or in a given sector in order to construct an input-output coefficient matrix that circumvents negative technical coefficients. Moreover, we are not bound to have as many sectors as commodities. The reason is that we do not work with coefficients but directly with commodity flows.

The objective is to increase all domestic final demand components by the same percentage. To allow for alternative representations of preferences, we also perform the analysis by maximizing domestic final demand and

keeping fixed the structure of domestic consumption or domestic investment. We make the assumption that Canada is a small, open economy, implying that it cannot manipulate the world prices. The assumption is probably not too severe overall for a country like Canada, although for particular commodities Canada might have some monopoly power on the world stage. As a consequence of this assumption, the world prices are exogenous—not affected by the solution of our problems. Whatever pattern of trade Canada decides to adopt, it will not affect the prices it faces on the world market. For simplicity, we assume the exchange rate between the Canadian dollar and all foreign currencies to be equal to one.

The model of this paper is similar to the one used in ten Raa and Mohnen (1994), with one major difference. There the objective was to maximize foreign earnings, domestic final demand being exogenous. Here the objective is more realistic, namely maximizing the amount of domestic final demand, making it endogenous by the same token. Since the new objective is domestic final demand, a balance of trade constraint has to be added to prevent the unrealistic solution of infinite imports in order to maximize today's well-being.

The approach we pursue combines the general equilibrium analysis of input-output models with the neoclassical feature of resource substitution. The substitution is the result of intersectoral shifts of labour and capital. The optimal increase in final demand that we obtain under free trade is due to the absence of any trade barrier but also to an optimal allocation of resources across sectors and to the fullest possible utilization of available resources within sectors. However, as we proved in ten Raa and Mohnen (1994), the 1980 Canadian economy cannot boost or maintain its net exports in all commodities simultaneously. This condition also holds in the present case. Hence, Canada is a truly open economy that cannot improve its efficiency without changing its prevailing trade structure.

Interpretation of the Results

The resolution of our model determines simultaneously the activity levels of each sector, the percentage increase in the objective function, the commodity net exports and the shadow prices of each constraint in the problem. The shadow prices of commodities and factor inputs would prevail under ideal conditions of perfect competition. In Table 2 we present the activity levels and in Table 3 the shadow prices under the three preference structures we consider. These three preference structures correspond to three scenarios. In each case we maximize domestic final

Table 2
Activity Levels in Three Alternative Free Trade Scenarios

Sector	Preference structure		
	domestic absorption	domestic consumption	domestic investment
1.	0.00	0.00	0.00
2.	0.00	0.00	0.00
3.	0.00	0.00	0.00
4.	**5.80**	**5.67**	**2.93**
5.	0.00	0.00	0.00
6.	0.00	0.00	0.00
7.	**30.65**	**37.87**	0.00
8.	0.00	0.00	0.00
9.	0.00	0.00	0.00
10.	0.00	0.00	0.00
11.	0.00	0.00	0.00
12.	0.00	0.00	0.00
13.	0.00	0.00	0.00
14.	1.45	1.51	1.25
15.	0.00	0.00	0.00
16.	0.00	0.00	0.00
17.	**14.81**	**12.07**	0.00
18.	0.00	0.00	0.00
19.	0.00	0.00	0.00
20.	0.00	0.00	0.00
21.	0.00	0.00	0.00
22.	0.00	0.00	0.00
23.	0.00	0.00	0.00
24.	1.60	1.62	2.79
25.	0.00	0.00	0.00
26.	1.10	1.13	**1.96**
27.	1.46	1.52	1.06
28.	1.47	1.53	**5.73**
29.	1.45	1.51	1.25
domestic absorption (actual)	1.47 (1.00)	1.09 (0.71)	0.80 (0.29)

Note: The actual sectoral activity levels = 1.

demand, but each time we operate under a different commodity composition of final demand. In the first scenario, we increase in the same proportion the domestic final demand for each commodity; in the second scenario, we increase in the same proportion the domestic consumption for each commodity, keeping the domestic investments at their prevailing levels; in the third scenario, we increase the domestic investment for each commodity in the same proportion, keeping the domestic consumptions at their

prevailing levels. In Table 4 we report the optimal net exports generated by our model.

The numbers in Table 2 indicate the optimal activity levels in each sector and in the objective function for each of the three scenarios. Notice that the actual levels of sectoral activity correspond to a value of one, whereas for the objective function the actual level is one for the first scenario and 0.71 and 0.29 for the other two scenarios, corresponding respectively to the shares of consumption and investment in domestic final demand. By a theorem of linear programming, we know that there will be as many active sectors as binding constraints. Binding constraints are characterized by non-zero shadow prices in Table 3. In the first two scenarios, there are seven binding non-tradability constraints, reflecting the impossibility to satisfy the domestic (final and intermediate) demand for the non-tradables via imports. In the last scenario there are five non-tradability constraints. In all three cases the endowment constraints on the three primary inputs (labour, capital and the foreign trade balance) are binding. Hence, we have ten active sectors (including domestic absorption) in the first two scenarios and eight in the third scenario. The first two scenarios yield similar qualitative and quantitative results. As we shall see, those of the third scenario are somewhat different.

Table 3
Shadow Prices in Three Alternative Free Trade Scenarios

Non-tradable Commodity	Preference structure		
	domestic absorption	domestic consumption	domestic investment
13.	0.00	0.00	0.00
44.	1.48	1.20	1.77
70.[1]	0.00	0.00	3.05
72.	6.57	5.31	0.00
79.	11.10	8.98	15.83
81.	2.04	1.65	2.14
82.	0.42	0.34	0.00
88.	2.68	2.17	0.00
91.	0.00	0.00	0.00
92.	2.47	2.00	5.52
wage ($/hour)	1.53	1.24	1.28
rental rate	0.18	0.15	0.27
PPP[2]	1.04	0.84	0.97

[1] Commodity constraint 71, being perfectly collinear with commodity constraint 70, has been dropped.
[2] PPP=purchasing power parity, i.e. domestic price/foreign price.

In addition to the sectors producing non-tradables, mining, quarrying and oil wells (4), tobacco products (7) and machinery (17) are active in the first two scenarios. The same result was found in ten Raa and Mohnen (1994). Those sectors, in bold print, primarily produce the commodities in which Canada turns out to have a comparative advantage (see Table 4); in other words, those in which Canada would specialize in a free trade world and from which it would earn the foreign exchange needed to import all the other commodities it needs in order to maximize its objective function. For example, if Canada was maximizing its domestic final demand, it would increase its 1980 production of all commodities by six times in sector 4, by 30 times in sector 7 and by 15 times in sector 1. These figures are big. But remember, in a perfectly competitive world it would specialize in only a few tradable commodities and produce those for itself and for the rest of the world. Under the investment structure of preference, again sector 4, but now also sectors 26 (transportation and communication) and 28 (finance, insurance and real estate), display a much higher activity than the prevailing one. Sector 24 cannot be considered a sector of comparative advantage, since it only produces non-tradables. And, as will become clearer when we examine table 4, sectors 27 and 29 are also active mostly because of their non-tradable commodities. We notice that the number of sectors of specialization equals the number of primary inputs. Indeed, the economy will need three sectors to use up its labour, capital and allowed trade deficit. Since imports below the allowed deficit can increase final demand at no cost, the deficit will always reach its upper boundary.

In 1980, Canada could have increased by 47 percent the value of its domestic absorption in a free trade world. By comparing the value of the objective function under the three scenarios, we see that a lower efficiency is obtained by concentrating only on consumption (an increase of 38 percent in the value of domestic absorption) and a higher efficiency by concentrating only on investment (a comparable increase of 51 percent). Hence, of the two, the preference structure implicit in investment is more conducive to growth.

The numbers in Table 3 indicate the shadow prices of the relevant constraints under free trade. As can be shown from the so-called complementary slackness conditions of linear programming (*see* ten Raa and Mohnen 1994) on one hand, the shadow price of each constraint equilibrates the supply and demand corresponding to that constraint and, on the other hand, a sector will be active only when at the equilibrium shadow prices it breaks even. In other words, a shadow price indicates how much more the economy could consume and invest (in fixed ratios) and hence

would be ready to pay to have one additional unit of the item under constraint. Non-tradables have to be produced at home and require resources to be put aside for their production. According to our model, in 1980 Canada would have paid $1.48 to have one additional unit of "services to mining," $6.57 for "repair construction," $11.10 for "other utilities" and so on. If there was no secondary production in the sectors producing those goods, these shadow prices would correspond to their unit cost of production.

The shadow price of the labour constraint reveals that one more hour of labour would only fetch a wage rate of $1.53 in the first scenario and even less in the other two. One dollar of capital would be worth a rental rate of 18 cents in the first scenario, but 27 cents in the last scenario. The shadow price of the balance of trade reflects the domestic price of one additional dollar of deficit. Since world market prices are exogenous, the domestic prices of all tradables must equal their world prices, converted in purchasing power parity. Since consumption and/or investment must increase in fixed ratios, additional consumption and/or investment implies additional production of non-tradables and hence diversion of resources from the production of tradables. Therefore the value of the tradables can differ from one. From the so-called dual constraints of linear programming, it can be shown that the weighted sum of all commodity prices equals one, the weights being the shares of each commodity in final demand (consumption or investment respectively). The shadow price of the balance of trade constraint can thus be interpreted as the purchasing power parity (PPP) of all tradable goods in Canada vis-à-vis the rest of the world; in other words, the average Canadian price over the average world price for those goods. If all commodities were tradable, domestic prices would have to match world prices for all commodities and the PPP would be equal to one. Our results indicate that the Canadian PPP in 1980 was higher for investment goods than for consumption goods.

In Table 4, we report the actual and optimal net exports by commodity under the first and the last scenarios only. The optimal net exports under the second scenario are very close to those under the first one and are therefore not reported. The commodities where optimal net exports exceed their actual level by a substantial margin are those in which Canada has a comparative advantage—those in which it would specialize under free trade given its endowment, technology and preferences as of 1980. They are indicated in bold print. Those are the tradable commodities produced by the sectors in bold print in Table 2 (the first scenario), the products of mining (7 to 12), tobacco (25, 26) and machinery (53, 54), and in the last

Table 4
Net Exports in Three Alternative Free Trade Scenarios
(millions of dollars)

Commodity	Actual net exports	Preference structure	
		domestic absorption	domestic investment
1. Grains	3764.2	654.3	1281.1
2. Live animals	169.0	-993.0	-653.8
3. Other agricultural products	-287.8	-11034.8	-2670.4
4. Forestry products	10.1	-210.0	-176.2
5. Fish landings	55.0	-61.3	-24.4
6. Hunting and trapping products	-3.2	-0.1	-0.1
7. Iron ores and concentrate	879.3	**9150.4**	**4433.3**
8. Other metal. ores and concentrates	-3014.7	**28975.3**	**12209.6**
9. Coal	-328.4	**4064.9**	**1282.1**
10. Crude mineral oils	-4974.2	**55776.0**	**27997.0**
11. Natural gas	3775.6	**31904.4**	**15360.5**
12. Non-metallic minerals	733.3	**9364.6**	**4182.5**
13. Services incidental to mining	0.0	10258.2	382.4
14. Meat products	292.5	-8577.9	-6316.9
15. Dairy products	73.8	-5035.0	-3533.0
16. Fish products	-320.3	-2200.2	-1487.6
17. Fruits and vegetables preparations	-401.6	-2855.5	-1957.0
18. Feeds	42.1	-426.5	-338.1
19. Flour, wheat, meal and other cereals	-29.7	-472.0	-368.7
20. Breakfast cereal and bakery products	4.7	-2715.1	-1936.3
21. Sugar	3.3	-390.7	-317.1
22. Misc. food products	-512.2	-4040.9	-2740.3
23. Soft drinks	-10.7	-1368.0	-961.3
24. Alcoholic beverages	22.8	-2876.1	-1855.7
25. Tobacco processed unmanufactured	26.0	**2255.9**	-139.7
26. Cigarettes and tobacco mfg.	-15.7	**26406.7**	-901.1
27. Tires and tubes	-170.0	-249.3	-242.3
28. Other rubber products	-199.0	-2862.2	-1315.9
29. Plastic fabricated products	-435.6	-2144.3	-2962.9
30. Leather and leather products	-449.0	-1677.1	-1092.0
31. Yarn and man-made fibres	-329.9	-56.6	-4.7
32. Fabrics	-781.7	-482.6	-337.4
33. Other textile products	-316.0	-2208.7	-2404.2
34. Hosiery and knitted wear	-347.7	-1870.5	-1294.0
35. Clothing and accessories	-456.1	-5588.2	-3679.6
36. Lumber and timber	3090.7	-1084.6	-1794.0
37. Veneer and plywood	109.6	-674.5	-1125.3
38. Other wood fabricated materials	367.7	-2457.7	-4136.4
39. Furniture and fixtures	-90.5	-3471.3	-3449.8
40. Pulp	3570.9	138.9	122.3
41. Newsprint and other paper stock	3975.9	-2378.1	-1741.8
42. Paper products	-328.4	-6442.7	-2765.1
43. Printing and publishing	-583.5	-761.4	-412.4

44.	Advertising, print media	0.0	0.0	0.0
45.	Iron and steel products	417.0	-13621.0	-4336.6
46.	Aluminum products	-424.4	-3240.1	-1502.7
47.	Copper and copper alloy products	903.4	-503.7	146.0
48.	Nickel products	1038.9	-460.6	-725.1
49.	Other non-ferrous metal products	999.3	232.2	688.3
50.	Boilers, tanks and plates	-24.1	-989.7	-1547.1
51.	Fabricated structural metal products	147.6	-3354.2	-5180.1
52.	Other metal fabricated products	-1678.0	-8131.7	-10486.2
53.	Agricultural machinery	-1208.5	**13692.0**	-6124.0
54.	Other industrial machinery	-5535.0	**31548.1**	-24791.7
55.	Motor vehicles	923.9	-11475.5	-15765.6
56.	Motor vehicle parts	-3795.4	-3527.0	-605.2
57.	Other transport equipment	89.6	-4233.3	-6745.4
58.	Appliances and receivers, household	-1465.9	-2176.4	-3332.9
59.	Other electrical products	-1692.7	-8158.7	-15864.3
60.	Cement and concrete products	94.7	-2537.5	-4205.0
61.	Other non-metallic mineral products	-637.9	-3120.4	-3910.2
62.	Gasoline and fuel oil	326.2	-13529.1	-10959.7
63.	Other petroleum and coal products	1271.0	5106.8	1683.4
64.	Industrial chemicals	-2038.5	-4047.4	-2878.8
65.	Fertilizers	-64.1	4386.1	1929.7
66.	Pharmaceuticals	-300.5	-1643.3	-1217.0
67.	Other chemical products	-1157.9	-5654.4	-4637.7
68.	Scientific equipment	-1806.6	-3965.9	-4111.5
69.	Other manufactured products	-295.7	-3971.4	-3343.3
70.	Residential construction	0.0	1860.6	0.0
71.	Non-residential construction	0.0	3785.2	148.6
72.	Repair construction	0.0	0.0	2384.2
73.	Pipeline transportation	153.6	-865.0	-710.9
74.	Transportation and storage	610.2	-27321.5	-22233.5
75.	Radio and television broadcasting	-10.1	-1991.1	-1626.4
76.	Telephone and telegraph	-48.7	-8324.5	-8785.7
77.	Postal services	14.8	-1811.1	-2047.2
78.	Electric power	807.5	-1080.7	**7711.7**
79.	Other utilities	0.0	0.0	0.0
80.	Wholesale margins	2170.6	3093.0	-7010.8
81.	Retail margins	0.0	0.0	0.0
82.	Imputed rent owner occupied dwellings	0.0	0.0	93610.2
83.	Other finance, ins., real estate	-753.9	-20307.2	**143124.1**
84.	Business services	-1205.1	-3015.1	-10978.0
85.	Education services	32.6	34.0	229.8
86.	Health services	-16.5	-135.6	1494.0
87.	Amusement and recreation services	-150.3	22.0	621.9
88.	Accommodation and food services	0.0	0.0	2877.3
89.	Other personal and misc. services	-90.9	2424.8	5269.0
90.	Transportation margins	3413.0	7223.6	6625.6
91.	Supplies for office, lab. and cafeteria	0.0	808.5	1203.1
92.	Travel, advertising and promotion	0.0	0.0	0.0

Note: Figures in bold print locate comparative advantages.

scenario, the commodities of the mining industry (7 to 12); electric power (78); and finance, insurance and real estate (83). The other commodities with net exports in excess of actual exports are either non-tradables or by-products of non-tradables. For all other commodities either there is a slight net export (lower than actual) or a substantially larger trade deficit than observed in 1980. Because of the assumed absence of output substitution, some non-tradable commodities (e.g., commodity 13) get produced beyond demand. For those commodities there is a slack and hence a zero shadow price (see table 3). In 1980, Canada was far away from its optimal trade pattern, which explains the magnitude of potential efficiency it could achieve. Of course, in actuality there are many constraints we have not incorporated in our analysis and, moreover, decisions are taken at an individual level and not by a central planning bureau.

Conclusion

New trade theorists can come up with strong arguments for protectionism, to give the domestic industry a head-start advantage or increase it to enable it to compete with economies of scale on the world stage (*see* Krugman 1987). But the same features emphasized by the new trade theory (imperfect competition, economies of scale and strategic behaviour) can also be used to make a strong case for free trade. The extension of the market will allow firms to specialize within sectors and reap economies of scale and the increased competition from foreign producers will decrease the producers' monopoly power and push prices down.

In this paper, we abstract from these modern arguments for free trade, without denying their pertinence. Our view is simply that the basic elements of taste, endowment and technology are important on their own and should not be swept under the carpet. While we recognize that certain hypotheses we have made regarding technology and market structure are unrealistic, we want to point out that some of these hypotheses are likely to yield conservative estimates of the gains from free trade. The absence of economies of scale, of product heterogeneity, of factor and output substitution and of international factor mobility only add more rigidity to the system, which would otherwise be able to yield even bigger efficiency gains. True, as Harris and Cox (1984) have shown for the Canadian economy, the existence of returns to scale and monopoly power would produce a different picture of specialization. Nevertheless, we found it worthwhile to find out what specialization would occur in Canada in a

world of perfect competition, where proper account is taken of the demand for intermediate inputs and the existence of secondary products.

We have conducted an intersectoral, general equilibrium, open economy analysis of the benefits from free trade and the identification of Canadian comparative advantage. Similar studies have been conducted by Williams (1978) and ten Raa and Mohnen (1994). In contrast to Williams (1978), we do not casually classify commodities as import–competing or exportable, but rather let the analysis reveal their identity. Compared to our previous study, we here allow the level of consumption to be endogenous.

We conclude that under conditions of perfect competition and on the basis of its endowments, its technology and the preferences revealed by its domestic final demand or consumption structure, in 1980 Canada had a comparative advantage in mining, quarrying and oil wells, in tobacco and in machinery. Under the preferences implicit in its investment structure, the comparative advantage would have been in mining, electric power and finance, insurance and real estate. In free trade, it could have increased its total final demand by 46 percent. This estimate of the gains from free trade is bigger than those generally reported in the literature. Of course, it only pertains to the year 1980. It would be interesting to examine how much the results would differ over time. *A priori*, we do not believe that 1980 was such an exceptional year in terms of production or final demand structure, nor that the endowments, the preferences and the technology change rapidly over time.

Appendix

A. The Formal Model

Formally, the basic model underlying our analysis is the following linear problem:

$$\max_{t,s} \quad e'ft \tag{A1}$$

$$\text{s.t.} \quad (V'_{NT} - U_{NT})s \geq tf_{NT} \tag{A2}$$

$$L's \leq N \tag{A3}$$

$$K'\hat{c}s \leq K'e \tag{A4}$$

$$\pi'[(V'_T - U_T)s - tf_T] \geq BT \tag{A5}$$

$$s \geq 0 \tag{A6}$$

where

- U = (mnx) use table, m being the number of commodities and n the number of industries, showing the commodity purchases by the various sectors;
- V = (nxm) make table, showing the commodity composition of sectoral production; hence (V'-U) represents the net output table;
- f = (mx1) vector of domestic final demand;
- e = unity vector of appropriate dimension;
- t = scalar;
- s = (nx1) scale or activity vector;
- L = (nx1) vector of sectoral labour employment;
- K = (nx1) vector of sectoral capital stocks;
- N = total labour force;
- $\hat{c}$ = (nxn) diagonal matrix of capacity utilizations;
- π = vector of world prices of tradable commodities;
- BT = total balance of trade with the rest of the world;
- T (NT) = index denoting tradable (non-tradable) commodities. A vector or a matrix indexed T (NT) is restricted in its line dimension to the tradable (non-tradable) commodities.

The objective function in this basic model is the maximization of total domestic final demand. Notice that t=1 corresponds to the observed level of domestic absorption. Notice also that the objective is just a matter of increasing the overall level of domestic final demand, keeping its commodity composition constant. The first set of inequality restrictions (A2) states that, for each non-tradable commodity, production has to be sufficient to

meet domestic intermediate and final demand. Constraints (A3) and (A4)state that the sum of all sectoral employments (capital stocks) cannot exceed the total labour force (capital stock). Notice that all the inputs, labour, capital and intermediate input commodities, are homogeneous and perfectly mobile across sectors. The (A5) constraint states that the sum, over all tradable commodities, of their trade balances must exceed a certain minimum, in this case the observed total trade balance. This last constraint implies a ceiling to total net imports.

When the objective is to maximize domestic final demand by keeping fixed the structure of domestic consumption (domestic investment), then f in the above model represents the vector of consumption (investment) divided by the share of domestic consumption (investment) in domestic final demand and t becomes t times that same share. The observed level of domestic final demand now corresponds to t = the observed share of consumption (investment). The remainder of domestic absorption is exogenously added to the RHS of (A2) and the total value of its tradables at world prices to the RHS of (A5).

B. The Data

We studied the Canadian economy of 1980. The use, make and final demand tables are directly taken from Statistics Canada (1987). For the sources and constructions of the sectoral labour flows, the total labour force, the sectoral capital stocks and capital utilization rates, we refer to ten Raa and Mohnen (1991; 1994). All data are expressed in millions of 1980 Canadian dollars or in thousands of person-hours. The economy is disaggregated into 92 commodities and 29 sectors using the concordance contained in table 1. We are constrained to a 29 sectoral classification by the unavailability of sectoral capital stocks at a finer level of disaggregation. Net exports are given by the sum of columns 26 to 28 of the final demand table of Statistics Canada's input-output tables. Domestic investment is the sum of columns 14 to 23 of the same table. Domestic consumption is measured as the difference between the column total of final demand (column 29) and the sum of domestic investment and net exports. Those commodities that display no net exports are considered non-tradables.

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