OPPORTUNITIES FOR FOREIGN TRADE AND THE EXTENT OF SUBOPTIMAL CAPACITY IN CANADIAN MANUFACTURING INDUSTRIES

by

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This thesis is dedicated

to

my loving parents, David and Kanimah Rawana,

my wife, children, brothers, sisters and

all my in-laws

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ABSTRACT

This dissertation examines the impact of trade barriers on suboptimal capacity in Canadian manufacturing industries in 1968, 1970 and 1979. Suboptimal capacity (i.e., failure to realize scale economies) is a frequent explanation of persistent low productivity levels in Canada relative to the US.

The basic question addressed in this thesis is whether small markets prevent scale efficiency in Canada, and if so, how? In this regard a model of the determination of plant scale in a homogeneous goods industry protected by tariffs is developed. The model allows for free entry and the solution concept is Cournot-Nash Equilibrium.

Three hypotheses are tested: the small market hypothesis, the trade liberalization hypothesis, and the Eastman-Stykolt hypothesis. The trade liberalization hypothesis predicts that US-Canadian trade barriers promote scale inefficiency by separating a small Canadian market from the large US market. The Eastman-Stykolt hypothesis predicts that the interaction of small Canadian market size and high trade barriers should lead to more scale inefficiency. These hypotheses are tested on data supplied by the US International Trade Commission and Statistics Canada.

The thesis confirms the importance of small markets in explaining scale inefficiency. US-Canadian nominal tariff protection and Canadian Non-Tariff Barriers (NTBs) seem to be closely associated

with scale inefficiency in Canada. There is some support for the Eastman-Stykolt effect.

The thesis concludes that Canadian producers would realize economies of scale if Canadian trade protection and US tariffs are reduced. Many studies have documented these effects but our study is the first to explicitly deal with NTBs. The key contributions are: (a) improved modelling of the effect of trade barriers on plant scale, and (b) improved test of the Eastman-Stykolt hypothesis.

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As usual, all errors and omissions remain the responsibility of the author.

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DIAGRAMS

CHAPTER 1

INTRODUCTION

Output per man-hour in Canadian manufacturing industries has been persistently low and has continued to lag behind the level in the United States. Canadian average productivity, for example, was approximately 28 percent below that of the United States' level in 1983[1]. One explanation of this lagging productivity level, is the failure of Canadian plants to realize all potential economies of scale of single product firms. The concept of economies of scale, which will be defined formally later, is useful in assessing the economic efficiency of market structures. An industry which contains many manufacturing plants with each producing at minimum efficient scale is referred to as being scale efficient; otherwise, the industry exhibits some degree of scale inefficiency or suboptimal capacity. This thesis has examined the impact of trade barriers on two measures of scale efficiency: suboptimal capacity (the fraction of industry shipments originating from plants below minimum efficient scale), and relative plant scale (the ratio of the average size of Canadian largest plants to the minimum efficient plant scale).

One early examination of scale economies in the Canadian manufacturing sector was performed by Eastman and Stykolt (1967). In what has become known as the "Eastman-Stykolt Hypothesis", they conjectured that the prevalence of inefficiently operated production units in Canada is the result of imperfect competition in small Canadian markets which are separated from larger foreign markets by Canadian and foreign trade barriers. In this context, small market size means that the output of a single plant of minimum efficient scale is a large fraction of domestic output. The "Eastman-Stykolt Hypothesis" has been prominent in Canadian discussions of trade policy and has been tested with respect to Canadian tariffs in a number of studies (see Muller, 1982). Nevertheless, previous studies have not developed a formal description of the theory underlying the proposition, the tariff has not been demonstrated to have a strong independent effect on plant scale, and little empirical attention has been given to the effects of non-tariff barriers and foreign tariffs.

The Eastman-Stykolt hypothesis basically states that the interaction of small market size and trade barriers prevent scale efficiency from being realized. Eastman and Stykolt (1967) hypothesized that efficiency would be reduced in Canada especially in oligopolistic industries for which sellers might collude and systematically construct suboptimal plants.

Previous authors have empirically tested the Eastman and Stykolt propositions on the assumption that the oligopolistic behaviour of firms could be approximated by a four-firm concentration ratio (the percentage of industry shipment accounted for by the largest four-firm). Later in this thesis, we argue that the concentration ratio variable is partly determined by the dependent variables and therefore should be omitted from the set of explanatory variables.

The basic question addressed in this thesis is whether barriers to foreign trade promote suboptimal capacity in Canada , and if so, how? Great concern has recently been expressed by the Royal Commission on the Economic Union and Development Prospect for Canada (MacDonald Commission, Vol. I, 1985, 312) on the use of trade barriers on a wide range of manufactured goods. There are four types of trade barriers to consider: Canadian tariffs, foreign tariffs, Canadian-nontariff barriers, and US non-tariff barriers. Besides US trade protection which affect Canadian export opportunities, there are other foreign trade barriers including Japan and member countries of the European Economic Community. However, in this thesis, we will consider only the US trade protection because (a) the US has been Canada's major export market and has continued to play a dominant role in our trade policy discussion, and (b) we are interested in comparing Canadian productivity levels with levels in the US.

In trading with the US, the commissioners (1985, 312) cited 'contingent protection' and 'laws' as the most basic measures of US non-tariff barriers affecting Canadian exports. According to the Commissioners, a free trade arrangement with the US would result in improved productivity and the realization of plant scale economies.

None of the previous studies of the Eastman-Stykolt hypotheses, however, have incorporated measures of non-tariff barriers in an equation explaining scale efficiency. Furthermore, none of the studies found empirical support for the Canadian tariff as being responsible for the disparity in the US and Canadian labour productivity level. This dissertation was motivated by the possibility that this lack of support for the tariff might be due to the weak theoretical modelling in testing of the Eastman-Stykolt hypothesis, and to the omission of foreign tariff and both Canadian and foreign non-tariff barriers from empirical work.

Hence, the purpose of this thesis is two-fold: i) to construct a formal model of the effect of Canadian tariffs on relative plant scale and then generalize the model in intuitive fashion to the effect of other variables (chapter 4) and ii) to test the theory using a variety of data sources, including a set of measures of non-tariff barriers which have never been used for this purpose before.

The major contribution of this thesis can be summarized as: a) progress in formally modelling the effect of trade barriers on scale, and b) an improved test of the Eastman-Stykolt hypothesis (improved because the regression model is better specified as the result of formal modelling, and because of the use of US tariff, US non-tariff barriers and Canadian non-tariff barriers).

The thesis is organized into eight chapters as follows: Chapter 2 describes the productivity gap between Canada and the US and examines several explanations including inadequate expenditure on Research and Development (R&D), poor management and the failure to realize economies of scale (suboptimal capacity). Chapter 2 also defines the minimum efficient scale output and economies of scale. The impact of trade barriers were tested on two measures of scale efficiency: (a) suboptimal capacity, and (b) relative plant scale. The final section documents the wide prevalence of scale efficiency in Canada.

Chapter 3 reports on studies of the determinants of suboptimal capacity. Prominent explanations of suboptimal capacity are Canadian market size, US trade barriers and Canadian trade barriers are examined. Empirical work has found strong support for market size and concentration ratio variable in explaining scale efficiency in Canada. However, none of the previous studies confirm the deleterious effect of the Canadian tariff on scale inefficiency. The role of Canadian non-tariff barriers and foreign trade barriers in preventing scale efficiency received virtually no attention in the empirical studies.

Chapter 4 builds a model of the determinants of relative plant scale in which we analyze the impact of the Canadian tariff, Canadian small market size and the Eastman-Stykolt effect on scale efficiency. Three hypotheses are examined. The small market size hypothesis is that Canadian small market size promotes suboptimal capacity or low relative plant scale independently of the tariff.

The trade liberalization hypothesis is that trade barriers are responsible for Canadian inefficient plant scale (and hence low productivity levels) regardless of market size. The Eastman-Stykolt hypothesis is that the interaction of small market size and trade barriers is the chief determinant of scale inefficiency and relative plant scale in Canada.

Chapter 5 gives a brief survey of the literature on non-tariff barriers: a) the 'counting' method, and b) tariff equivalence. It also introduces a set of data on US tariff and US Canadian non-tariff barriers which were supplied by the US International Trade Commission.

Chapter 6 specifies a regression model designed to test the three hypotheses developed in chapter 4. The model is linear though it incorporates interaction terms. The hypotheses developed in chapter 4 are tested on data available for three different years: 1968, 1970 and 1979. Data for the 1968 dependent variable (suboptimal capacity) are available from Gupta and Fuss (1979) for 79 Canadian manufacturing industries. Data for the 1970 and 1979 variables were supplied by P. Gorecki (Economic Council of Canada). In both cases the data were supplemented by data on Canada and US trade barriers provided by US International Trade Commission (1975).

Chapter 7 presents and discusses the Ordinary Least Squares regression results for a) suboptimal capacity across 79 Canadian manufacturing industries in 1968, and b) relative plant scale across 120 Canadian manufacturing industries in 1970 and 1979. Also, the F-tests and best-fit equations in the sense of maximum adjusted R-squared are presented. The 1968, 1970 and 1979 Data Sets confirm the small market size hypothesis rather well. The data also support the trade liberalization hypothesis that US tariffs, Canadian tariffs and Canadian non-tariff barriers (NTBs) prevent scale efficiency in Canada. Finally, the importance of the Eastman-Stykolt hypothesis is seen to be declining over time.

Chapter 8 gives a summary and main conclusions of this study. The thesis suggests that a reduction in US-Canadian tariffs and Canadian NTBs would encourage Canadian producers to operate in the large North American market and accordingly realize economies of scale.

FOOTNOTE

Chapter 1

1. Handbook of Labor Statistics, US Department of Labor, Bureau of Labor Statistics (June 1985, Table 129, 425).

   Also, see chapter 2, Table 2.2 in this thesis for a comparison of Canada-US output per hour in total manufacturing.

CHAPTER 2

DETERMINANTS OF LAGGING CANADIAN PRODUCTIVITY LEVELS

The productivity gap between Canada and the US is significant[1]. There are several lines of explanation including a) weakness of management[2], b) lack of Research and Development (R&D)[3], and c) suboptimal capacity[4]. Weakness of management and lack of R&D, as will be described later in this chapter, are insufficient or incomplete explanations of Canada's lagging productivity level. Suboptimal capacity is considered a particularly important factor accounting for the disparity in the productivity gap. This chapter is organized into three broad sections. Section 2.1 describes the existence of a gap and the various ways of measuring it, while section 2.2 presents the explanations of the productivity gap. The last section describes the measurement of suboptimal capacity and its prevalence in Canada.

2.1 EXISTENCE OF A GAP

The productivity gap, as used in this study, refers to the discrepancy in the productivity level between Canada and the US. This section describes the existence of the gap and its various ways of being measured.

2.1.1 MEASURES OF PRODUCTIVITY

There is a considerable literature on productivity measurement. Denny and Fuss (1982, 3-9), Silver (1984, 1) and Kendrick (1977, 12) have defined productivity as a measure of the relationship between the flow of output and the input resources used to generate the flow of output. The theoretical and empirical problems involved in measuring the flow of output and aggregating the input resources have been emphasized by Denny and Fuss (1982). The partial or average productivity of a factor is a commonly used measure of productivity in the literature. Following (Silver, 1984, 9) we specify a Cobb-Douglas production function

(1) $$Q = AL^{\alpha}K^{\beta}$$

where Q denotes output; A is a technical shift factor; L and K represent services of labour and capital input; α and β are elasticities of output with respect to L and K.

From (1), the partial labour and capital productivities are

(2) $$Q/L = AL^{\alpha-1}K^{\beta}$$ Labour Productivity

(3) $$Q/K = AL^{\alpha}K^{\beta-1}$$ Capital Productivity

In the case of a well defined output and input, the task of measuring (Q/L) or (Q/k) is quite straightforward. However, the interpretation of either partial measure is usually unclear because it is not a good indicator of the efficient utilization of resources to generate flows of output. Increased output per man-hour could emanate from a more capital intensive production process or technical change other than the contribution of labour (Denny and Fuss, 1982, 7).

An ideal measure of productivity should account for the relationship between the flow of output and all inputs used to generate the flow of output. From equation (1), a possible measure of this total factor productivity is[5]

(4) $$A = Q/L^{\alpha}K^{\beta}$$

In measuring 'A' one must find an appropriate method to aggregate quantities of labour and capital used for a given production activity into a single aggregate quantity. Denny and Fuss (1982, 9) argued that the task of measuring total factor productivity is not simple and that there has been a "considerable discussion during the last decade" in developing methods to aggregate the various inputs.

2.1.2 LABOUR PRODUCTIVITY GAP

The partial labour productivity in Canadian manufacturing industries relative to matching US industries is recorded in Table 2.1. This partial labour productivity level comparison between the US and Canada has been updated using Canadian price weights as described by Donald J. Daly (1979, Table 12, 37). Annual estimates obtained for Canada, from the US Handbook of Labor Statistics (1985, 425) are

TABLE 2.1

Output Per Hour in Total Manufacturing, United States, Canada and Canada/United States. (U.S. 1977 = 100)

Year	U.S.	Canada	Canada/US
1950	49.4	25.7	52.0
1951	51.1	26.7	52.0
1952	52.0	27.4	52.7
1953	52.9	28.4	53.7
1954	53.7	29.6	55.1
1955	56.4	31.6	56.0
1956	56.0	32.8	58.6
1957	57.1	33.1	58.0
1958	56.9	34.3	60.3
1959	59.6	36.1	60.5
1960	60.0	37.4	62.3
1961	61.6	39.4	64.0
1962	64.3	41.5	64.5
1963	68.9	43.0	62.4
1964	72.3	44.9	62.1
1965	74.5	46.6	62.6
1966	75.3	48.2	64.0
1967	75.3	49.7	66.0
1968	78.0	53.1	68.1
1969	79.3	56.2	70.9
1970	79.1	57.1	72.2
1971	83.9	61.1	72.8
1972	88.2	63.9	72.4
1973	93.0	67.8	72.9
1974	90.8	69.4	76.4
1975	93.4	67.6	72.4
1976	97.5	71.5	73.3
1977	100.0	74.3	74.3
1978	100.8	75.3	74.7
1979	101.5	77.4	76.3
1980	101.7	75.8	74.5
1981	105.3	77.7	73.8
1982	106.5	75.8	71.2
1983	113.1	81.0	71.6

Sources: Handbook of Labor Statistics, U.S. Department of Labor, Bureau of Labor Statistics (June 1985, Table 129, 425): 1950-83.

TABLE 2.2

Total Factor Productivity Relative to the US (US = 100.0 in each year)

Year	Canada
1950	82.0
1951	80.4
1952	84.0
1953	84.1
1954	81.7
1955	83.2
1956	87.6
1957	85.9
1958	86.0
1959	84.1
1960	84.3
1961	83.8
1962	83.6
1963	84.6
1964	85.1
1965	85.9
1966	86.4
1967	85.9
1968	87.3
1969	86.8
1970	91.4
1971	91.6
1972	90.9
1973	90.7

Source: Denny and Fuss (1982, 39) who obtain them from Christensen, Cummings and Jorgenson (1980).

multiplied by the US-Canada level comparison for 1979. The US-Canada level comparison is obtained from Daly (1979, 37). The updated labour productivity reported in Table 2.1 is almost identical to those obtained by Daly who used 1967 instead of 1977 as the base year for the US.

Also, Table 2.1 shows that Canadian industrial productivity has been persistently below that of the US. The partial labour productivity is about 52 per cent of the US level in 1950. By 1973 this productivity gap has been narrowed and has since remained relatively unchanged at about 29 per cent below the US level.

2.1.3 TOTAL FACTOR PRODUCTIVITY GAP

The total factor productivity gap in Canada relative to the US for 1950 through 1973 is recorded in Table 2.2 (Denny and Fuss, 1982, 29). For comparison purposed, they have set the US productivity to an index of 100 for each year. The total factor approach to measure productivity indicates that Canadian productivity was about 18 per cent below the US level in 1950. By 1973, the gap declined to about 10 per cent below the US level.

Clearly, Table 2.1 and 2.2 shows that there is a productivity gap between Canada and the US. This difference in output per employed person between the two countries reflects the differences in output in relation to total factor inputs rather than the magnitude of other factor inputs (Daly and Watters, 1972, 285). Usually in capital-intensive industries we would expect labour productivity to be relatively high when they are compared to countries with less capital intensive industries (Kravis; 1976, 37). However, this line of argument does not find support by Daly (1983, 21). More specifically Daly (1983, 21) argued that Canadian "low productivity levels in manufacturing occur in spite of higher levels of capital stock in relation to employment and output than in the United States".

2.2 EXPLANATIONS OF THE GAP

As mentioned earlier there are several lines of explanation for the productivity gap including, a) weakness of management; b) lack of R&D, and c) suboptimal capacity.

2.2.1 WEAK MANAGEMENT

The weakness of management view towards the explanation of the productivity gap has been advanced by Daly (1983, 22) and MacCharles (1983, 14). Daly (1983, 22) argued that a high proportion of Canadian management with a university degree is less than in the US and accordingly is "less open to change". This weakness of Canadian management argument, however, offers an insufficient or incomplete explanation for the gap. For instance, the weakness of management view lacks a formal model explaining how increases in the stock of personnel and knowledge would affect output per man-hour which in turn, determines the productivity gap. Furthermore, the shortage of managerial expertise view of the gap emanates largely from the observation that the proportion of Canadian managers with university degree is small, compared to that of the US[6]. Moreover, with free flow of managers for most of the period, why would Canadian firms not hire US managers?

2.2.2 LACK OF RESEARCH AND DEVELOPMENT (R&D) EXPENDITURE

Insufficient expenditure on R&D is an often mentioned factor responsible for the lagging Canadian productivity level (Daly, 1981, 5). This lack of R&D was repeatedly emphasized in The Weakest Link: A Technological Perspective on Canadian Industrial Underdevelopment (Britton and Gilmour, 1978, 81). However, Daly (1983, 21-23) and MacCharles (1983, 14) argue that R&D expenditure is not a good proxy for adaptation of new technology, given the widespread foreign ownership of industry in Canada. Specifically, the level of research will be determined partly by the size of the market, so that the fundamental determinant of lagging productivity level may be the limited market size.

2.2.3 SUBOPTIMAL CAPACITY

Suboptimal capacity (defined as the fraction of industry output produced in plants below MES) has drawn a great deal of attention and lies behind the view that there are gains from free trade with the US. In their 1967 study, the Wonnacotts emphasized the importance of scale economies in Canadian manufacturing industries and concluded that a free trade arrangement with the US would result in potential benefits as large as 7-10.5 per cent of gross national product. The potential benefits to Canada are based on a declining Canadian price level and rising money wages following the exploitation of scale economies[7]. In their more recent 1975 and 1982 studies they have revised their estimates downward because some of the potential gains have been realized as a result of the Kennedy and Tokyo rounds of tariff cuts. In short, the Wonnacotts claim that free trade would reduce the productivity gap associated with small scale production and that Canadian productivity performance might accordingly, rise to the average US level.

Harris and Cox (1984) constructed a general equilibrium trade model of 29 Canadian manufacturing industries (in the mid-70s) to analyze the ongoing issue of free trade, especially with the US. Some interesting features of their simulation general equilibrium trade model are the incorporation of imperfect competition and potential scale economies in 20 industries. The remaining 9 are perfectly competitive constant cost industries. In their policy simulations Harris and Cox (1984, 146) concluded that multilateral free trade would yield gains in real income to Canada on the order of 8 to 10 per cent of gross national product. Also, "Canadian real wages would rise on the order of 20 to 27 per cent with gains in labour productivity of similar magnitudes". With respect to unilateral free trade, the gains are estimated to be much lower somewhere in the neighbourhood of 2 to 5 per cent. A large proportion of the unilateral free trade gain would rise from the competitive effect of import competition which would force the domestic industries to rationalize their productive capacities and achieve greater production efficiency.

In a more recent review of the Canadian-US trade relations, the MacDonald Commission (1985) recognized the Canadian scale problem and recommended that free trade with the US would result in productivity improvements in Canada. After reviewing the literature on scale inefficiency, most notably, the work of the Wonnacotts (1967, 1975, 1983) and Harris-Cox (1984), the MacDonald Report (1985, 330) concluded that:

> "there is a high probability that Canada would experience significant gains from free trade with the United States. The long-term gains suggested by these studies lie in the range of 4 to 10 per cent of Canadian GNP".

2.3 THE MEASUREMENT OF SUBOPTIMAL CAPACITY IN CANADIAN MANUFACTURING

This section describes two different ways of measuring suboptimal capacity: a) the Gupta-Fuss approach, and b) Baldwin-Gorecki relative plant scale. Each approach has been used extensively in the literature on scale inefficiency. Also, this section shows that there is a considerable amount of suboptimal capacity in Canada.

2.3.1 DEFINITIONS AND MEASUREMENT

Before documenting the wide prevalence of suboptimal capacity in Canada, the following definition of terms are required:

2.3.1.1 ECONOMIES OF SCALE AND MINIMUM EFFICIENT SCALE

The reduction in unit cost of production associated with increases in the scale of production is referred to as economies of scale and is reflected in the downward slope of the long run average cost curve. When the lowest attainable unit costs of production is realized, the plant is described as being scale efficient. The smallest output at which minimum average cost is achieved is called the minimum efficient scale (MES) plant. Bailey and Freidlander (1980, 1028) measured scale efficiency as the ratio of average cost (AC) to the marginal cost (MC) of production. Economies of scale arise whenever the ratio of AC to MC exceeds unity, since unit production cost will decline as firms increase their level of production from its current values.

There are four empirical techniques for estimating the minimum efficient plant scale: Stigler's (1958) survivor techniques; the engineering technique; the statistical cost analysis method, and a measure based on the top 50 per cent of the industry shipments. The advantages and disadvantages of each approach to estimate unit cost/scale relationship have been well documented (Sheppard, 1958, 117-117; Scherer, 1980, 92-95; Gorecki, 1976, 19-23), and we simply review them briefly here.

2.3.1.2 SURVIVOR TECHNIQUE

According to the survivor technique, all plants in an industry are classified by employment size class, and the shares of the industry output belonging to each size class are computed between two-time-periods. If that size class records an increase in relative share of the industry output overtime, it is described (in the survivor sense) as being relatively efficient. Conversely, size classes with declining market shares are deemed inefficient.

2.3.1.3 STATISTICAL COST ANALYSIS

The statistical cost analysis is a direct method for estimating the long run average cost curve and hence the minimum efficient plant size[8]. Historical data on unit production costs, output, variable inputs, equipment age and differences in factor prices are assembled for each plant size class. Once the relevant cost-output observations on plant sizes are obtained, standard statistical techniques are employed to estimate the cost-scale relationship, ceteris paribus[9]. A major drawback of the statistical approach is the paucity of data, especially when economies of scale are large relative to the size of the market[10].

2.3.1.4 THE ENGINEERING APPROACH

The engineering approach to cost scale measurement problem estimates the unit cost of production by varying the scale of output.

In estimating the MES plant, engineers assume adoption of the best available technology and assume "constant relative factor prices, supply conditions, product homogeneity, location and so forth" (Haldi and Whitcomb, 1967, 374). This engineering approach to studying economies of scale is useful in that it embodies assumptions consistent with those underlying the envelope curve.

3.3.1.5 PROXY MEASURE OF MES

Besides the survivor, statistical and engineering methods, there are surrogate or proxy measures of MES that are less expensive to estimate. One such proxy method is the Top 50 per cent measure. Scherer (1980, 95) defined the Top 50 per cent as the average size of the largest plants" comprising the upper half of the scales or employment size distribution". It was initially suggested by W.S. Commanor and T.A. Wilson (1967) in their study of advertising, concentration and profitability.

2.3.1.6 GUPTA AND FUSS MEASURE OF SUBOPTIMAL CAPACITY

Gupta and Fuss (1979) measured suboptimal capacity as the fraction of industry output originating from plants below MES level. They pooled cross-section data which are grouped according to plant size class for four years (1965, 1968, 1969, 1970) and then computed an MES plant using the statistical cost analysis approach. Initially, Gupta and Fuss estimated the long-run average cost curve and identified the MES plant as that plant size at which average cost is one per cent higher than the estimated average cost at the largest efficient plant scale. Given their statistical cost estimates of MES plant, they obtained the fraction of industry output originating from plants below MES. In addition to estimating suboptimal capacity, they derived estimates of the cost disadvantage ratio at 1/2 of MES and the ratio of MES plant to industry shipment (small market size) for ninety-one 3 and 4 digit Canadian manufacturing industries. Gupta and Fuss results are scaled in ratio form and are reported in Table 2.3

2.3.17 BALDWIN AND GORECKI MEASURE OF RELATIVE PLANT SCALE

Baldwin and Gorecki (1983c, 12-13) make use of the Commanor and Wilson proxy measure of MES to construct an index of relative plant scale in 120 Canadian manufacturing industries in 1970 and 1979. Unlike Gupta-Fuss estimate of suboptimal capacity, relative plant scale is an indirect measure of scale efficiency. Specifically, relative plant scale refers to the ratio of the average Canadian plant size accounting for 50 per cent of industry shipment to an estimate of MES[11]. The MES estimate in Canadian industries is derived from data in comparable US manufacturing industries. This use of the matched Canadian and US manufacturing industries to estimate MES is based on the assumption that either factor-proportions are fixed or factor prices are constant in Canadian and corresponding US industries. Although these assumptions might not hold precisely, many others including Caves et. al. (1980, 29)

TABLE 2.3

Gupta and Fuss Data on MES Plants, Small Market Size, Cost Disadvantage Ratio at 1/2 of MES, and Suboptimal Capacity in 91 Canadian Manufacturing Industries, 1968*

SIC 1960 Code	Industry	MES $'000	Small Market Size	Cost Dis-advantage Ratio	Suboptimal Capacity
1010	Slaughtering and Meat Processing	22886.3	.0129	.0372	.4748
1030	Poultry Processors	4948.0	.0196	.0470	.3934
1050	Dairy Product	219.5	.0002	.0001	.0708
1110	Fish Product	853.6	.0026	.0150	.1994
1120	Fruit and Vegetable Canners	2678.1	.0053	.0024	.3757
1230	Feed Manufacturers	6976.1	.0001	.0001	.0515
1240	Flour Mills	4262.9	.0187	.0032	.0758
125	Breakfast Cereals	6937.5	.1331	.0760	.0239
128	Biscuits	4197.1	.0335	.0118	.1448
129	Bakeries	4081.5	.0084	.0423	.4788
1410	Soft Drinks	2898.3	.0095	.0478	.4595
1430	Distilleries	29941.4	.0995	.0928	.5367
1450	Breweries	30916.6	.0885	.0979	.7383
1470	Wineries	2198.2	.0713	.0335	.5148
1510	Leaf Tobacco Processing	2079.4	.0117	.0005	.0237
1530	Tobacco Products	43457.4	.1313	.0235	.5566
1630	Rubber Tire and Tube	14842.5	.0459	.0275	.1485
1690	Other Rubber Products	9362.2	.0452	.0189	.3542
1720	Leather Tanneries	558.9	.0088	.0237	.0316
1740	Shoe Manufacturers	160.3	.0007	.0001	.0465
1750	Leather Gloves	459.5	.0294	.0165	.3743
1792	Boot and Shoe Findings	310.8	.0176	.0445	.0643
17990	Other Leather Products	2213.8	.0354	.0121	.6930
1830	Cotton Yarn and Cloth Mills	2681.7	.0090	.0013	.0215
1930	Wool Yarn Mills	1341.9	.0560	.0163	.2180
1970	Wool Cloth Mills	1119.3	.0105	.0232	.0971
2010	Synthetic Textiles	13027.3	.0287	.0084	.3716
2310	Hosiery Mills	2639.9	.0250	.0129	.5105
2390	Other Knitting Mills	409.4	.0015	.0002	.1254

....continued

SIC 1960 Code	Industry	MES $'000	Small Market Size	Cost Dis-advantage Ratio	Suboptimal Capacity
2441	Women's Clothing	1276.4	.0027	.0233	.0812
2442	Women's Clothing Contractors	488.9	.0173	.1753	.9356
2460	Fur Goods	2306.6	.0331	.0211	.7588
2480	Foundation Garments	4294.9	.0692	.0226	.3561
2511	Shingle Mills	2124.9	.0487	.0306	.4630
2513	Sawmills and Planning Mills	10357.1	.0088	.0661	.6875
2520	Veneer and Plywood	1122.3	.0039	.0199	.0538
2541	Sash, Door and Other Millwork	2713.9	.0100	.0499	.7095
2542	Hardwood Flooring	858.5	.0394	.0020	.2916
2560	Wooden Boxes	1381.4	.0296	.0098	.8644
2610	Household Furniture	2062.5	.0059	.0184	.6673
2640	Office Furniture	509.2	.0071	.0006	.1038
2660	Other Furniture	437.7	.0020	.0007	.3866
2710	Pulp and Paper Mills	12049.0	.0049	.0194	.1505
2720	Asphalt Roofing	3089.2	.0527	.0372	.1896
2731	Folding Cartons and Set-up Boxes	2186.0	.0131	.0159	.3034
2732	Corrugated Boxes	2712.2	.0113	.0257	.0600
2733	Paper and Plastic Bags	1908.5	.0112	.0190	.1613
2740	Other Paper Converters	703.3	.0021	.0005	.1380
2860	Commercial Printing	2403.5	.0039	.0262	.5671
2870	Plate-making Type-Setting, etc.	423.4	.0051	.0283	.4155
2890	Publishing and Printing	7256.7	.0135	.0347	.3472
2910	Iron and Steel	100330.5	.0734	.0162	.1454
2920	Steel Pipe and Tube	13405.2	.0495	.0585	.3669
2940	Iron Foundries	1496.6	.0080	.0276	.1985
3010	Boiler and Plate Works	4416.1	.0271	.0125	.2710
3020	Fabricated Structural Metal	2207.7	.0060	.0011	.1530
3030	Ornamental and Architectural Metal	2318.1	.0095	.0301	.5548
3040	Metal Stamping, Pressing, etc.	2259.8	.0029	.0197	.3545
3050	Wire and Wire	2492.2	.0064	.0282	.2521
3060	Hardware, Tool and Cutlery	4599.4	.0190	.0124	.6902
3070	Heating Equipment	6805.3	.0592	.0127	.5323
3110	Agricultural Implements	2181.1	.0081	.0250	.1748
3160	Commercial Refrigeration and Air Conditioning	2051.0	.0324	.0505	.2708

....continued

SIC 1960 Code	Industry	MES $'000	Small Market Size	Cost Dis-advantage Ratio	Suboptimal Capacity
3210	Aircraft and Parts	45470.3	.0695	.0233	.3902
3230	Motor Vehicles	345736.8	.1152	.0138	.0308
3240	Truck Body and Trailers	3240.5	.0181	.0836	.5109
3250	Motor Vehicle Parts and Accessories	2582.3	.0022	.0158	.0913
3310	Small Electrical Appliances	8365.6	.0587	.0254	.6635
3320	Major Appliances	6563.0	.0224	.0146	.0535
3340	Household Radio and TV Receivers	4374.5	.0220	.0409	.0700
3350	Communication Equipment	3207.2	.0048	.0003	.1463
3360	Industrial Electrical Equipment	4050.4	.0093	.0021	.2639
3370	Battery Manufacturers	2011.0	.0332	.0246	.0935
3410	Cement Manufacturers	6321.5	.0419	.3361	.0632
3470	Concrete Products	309.7	.0015	.0004	.3003
3480	Ready-Mix Concrete	1786.5	.0068	.3684	.4677
3511	Clay Products (from domestic clay)	1894.0	.0387	.0242	.4215
3512	Clay Products (from imported clays)	4740.7	.1197	.0535	.2471
3561	Glass Manufacturers	8973.9	.0684	.0953	.2815
3562	Glass Products	1075.2	.0110	.0146	.1960
3651	Petroleum Refining	17709.2	.0109	.0165	.1152
3652	Lubricating Oils and Grease	3469.7	.0982	.0206	.4132
372	Mixed Fertilizers	765.3	.0098	.0239	.0494
3740	Pharmaceuticals and Medicines	4800.4	.0147	.0323	.3174
3570	Paints and Varnish	4591.5	.0195	.0504	.3527
3760	Soap and Cleaning Compounds	10514.3	.0437	.0264	.4298
3770	Toilet Preparations	7288.7	.0574	.0270	.5981
3820	Jewellery and Silverware	1550.9	.0137	.0356	.4626
3830	Broom, Brush and Mop	2885.6	.0778	.0101	.6219
3931	Sporting Goods	2329.5	.0367	.0167	.4602
3932	Toys and Games	312.7	.0047	.0132	.0796

* denotes MES/Industry size; Cost Disadvantage Ratio and suboptimal Capacity are scaled in ration.

Source: Gupta and Fuss (1979, 17-24).

argued that since "the US economy is larger, certain statistics pertaining to the US industry are better proxies for underlying conditions than the comparable statistics for the Canadian industry". Also, Baldwin and Gorecki (1983) used the Top 50 per cent measure, as discussed by Scherer (1980, 95) to approximate MES plant in Canadian industries with US data.

2.3.2 THE EXTENT OF SUBOPTIMAL CAPACITY IN CANADA

This section will focus on studies which have documented the wide prevalence of scale inefficiency in Canada. Eastman and Stykolt (1967), for example, examined a sample of 16 manufacturing industries and claimed that many industries were scale inefficient. Table 2.4 shows that the markets for Electric Refrigerators and Electric Ranges were insufficient to accommodate even one MES plant. Nevertheless, many industries were overcrowded with plants of less than MES. For example, in the Refrigeration and Electric Range industries, there were 10 and 23 plants, respectively. Clearly, the average size of these plants was much less than MES.

In a smaller sample of 12 industries across 6 Western economies, Scherer (1973, 135) also concluded that Canadian plants are small relative to those of other countries. Table 2.5 shows that average Canadian plant size is 57 per cent of US plants in 1967.

TABLE 2.4

Smallest Efficient Plant Size, Canadian Market Size, and Related Statistics, 1967

% of Efficient Plant Size Industry	Smallest Efficient Plant Size	Market Size	Ratio of Market Size to MES	# of Actual Plants	%age of industry capacity that was of efficient plant size
Fruit Canning	$4.3 million	$22 million	4	13	0
Vegetable Canning, 1958	$7.5 million	$180 million	24	43	50
Cement 1957	$2 M barrels	34.6 M barrels	17.8	18	80
Container Board 1960	120,000 tons p.a.	560,000 tons	4.66	10	57
Shipping containers, 1958	254 million square feet	7,104 million square feet	28	37	72
Solid Detergents 1958	22 M. lbs.	156.2 million lbs.	7	3	100
Liquid Detergent	1 Million lbs.	48.7 million lbs.	49	?	75
Electric Refrigerators 1960	500,000 units	310,000	.6	10	0
Electric Ranges, 1960	250,000 units	222,000	.9	23	0
Wringer Washing Machines	25,000 units	210,000	8	14	58
Newsprint 1958	200,000 tons	7,230,000	36	39	80
Meat Packing 1959	100,000 head a wk.	157.5 thousand weekly	16	45	9
Petroleum Refining	100,000 barrels/day	706,000	7	40	0
Primary Steel 1955	1 million tons	4.5 million tons	4	4	0
Rubber Tires 1959	5,000 a day or 125 Million p.a.	9 million	7	9	20

# denotes number

MES denotes Minimum Efficient Plant Scale

% denotes percentage

Source: Eastman and Stykolt (1967), various pages.

TABLE 2.5

Index of Average Plant Size, Six Industrial Countries, 1967

Country	Range of Indices	Mean Plant Size Index
German Federal Republic	27-426	121
United Kingdom	21-340	111
US	100-100	100
France	11-131	68
Sweden	10-209	61
Canada	12-117	57

Source: Scherer (1973, 135).

In his studies on Economies of Scale and Efficient Plant Size in Canadian Manufacturing Industries, Gorecki (1976, 13-14) compared the association between average plant size and the percentage of output produced at suboptimal scale for 9 Canadian-US manufacturing industries in 1967. Table 2.6 describes Gorecki's comparison of average plant size and the percentage of industry output produced at suboptimal scale. The index of suboptimal capacity was derived from the ratio of US Top 50 per cent plant sizes as a percentage of US MES to Canadian Top 50 per cent plant sizes as a percentage of Canadian MES as:

$$\frac{\text{US TOP 50/US MES}}{\text{Canada Top 50/Can MES}}$$

A value above unity implies that Canadian average plant sizes are suboptimal relative to comparable US average plants. For example, Table 2.6 shows that US industries are more scale efficient than comparable Canadian industries, except for Portland Cement which has a value below unity.

TABLE 2.6

A Comparison of Average Plant Size and the Percentage of Industry Output Produced at Suboptimal Scale: 9 Canadian-US Manufacturing Industries, 1967

Industry	Ratio of Average Plant Size: US/Canada	Ratio of an Index of Suboptimal Capacity: US/Canada
Non-Rubber shoes	2.01	1.00
Breweries	1.66	3.08
Refrigerators and Freezers	1.06	7.69
Automobile Storage Batteries	1.03	1.59
Portland Cement	0.98	0.83
Petroleum Refining	0.96	2.55
Integrated Steel	0.81	1.09
Paint and Varnish	0.75	1.72
Cigarettes	0.65	3.23

Source: Gorecki (1976, Table 2.2, 13).

Using an extensive data base of 125 4-digit manufacturing industries, Baldwin and Gorecki (1983c, 19) have shown that Canadian average plant size is "not only substantially but dramatically below"

US plant size. They considered the average size of large Canadian plant relative to the average size of large US plants size. Specifically, their variable EFF1T is the ratio of Canadian average plant size accounting for 50 per cent of industry employment to US average plant size accounting for 50 per cent of industry employment. Table 2.7 shows that in 23 of the 125 industries Canadian plant size exceeded US plant size by approximately 71 per cent in 1970. The remaining 102 industries have plant size less than US MES plant. The suffix 70 or 79 indicates the year 1970 or 1979. A value above unity implies that Canadian average plant size is scale efficient; otherwise, it is scale inefficient.

TABLE 2.7

Mean Size of Relative Plant Scale Across 125 Canadian Manufacturing Industries in 1970 and 1979

Index of Relative Plant Scale	Number of Industries	Mean Size
EFF1T > 1		
EFF1T70	23	1.710
EFF1T79	26	1.630
EFF1T < 1		
EFF1T70	102	.461
EFF1T79	99	.541

Source: Baldwin and Gorecki (1983c, 19)

There is a debate about whether the scale problem lies in the fact that Canadian plants are smaller than US plants or in the fact that they produce a wider variety of products. The debate in Canada differentiates between product specific and plant spceific economies of scale[13]. Product specific scale economies refer to changes in cost per unit output associated with greater volume and longer lengths of run for a particular product. Plant specific economies of scale refer to cost savings from operating plants of different size, which produce a distinct product or group of products in the same industry[14]. A greater product diversity within a plant implies: a) shorter production run, b) more frequent changeover from one product to another, and c) higher unit production costs[15]. If Canadian plants rationalize their production capacities and concentrate on producing fewer items in larger volume, economies of scale would be realized. The product diversity explanation of the productivity gap, however, does not find support from Baldwin and Gorecki (1983c, 19). Hence, in this study, we will concentrate on explaining plant size, because, a) of its increased relative importance over product diversity, and b) data on plant size is available.

FOOTNOTES

Chapter 2

1. Looking Outward, ECC, 1975: 26-28; Daly (1979, 37).
2. See, for example, D.C. MacCharles (1983, 14) and D.C. MacCharles (1982 , 7).
3. See, for example, John N.B. Britton and James M. Gilmour (1978, 81). They argued that "Canada's R&D performance is about the worst of the Western world!.
4. Baldwin and Gorecki (1983c, 1)
5. See, for example, M.S. Silver (1984, 15).
6. Daly (1983, 22).
7. P. Wonnacott and R. Wonnacott (1982, 413).
8. F.M. Scherer (1980, 93).
9. Goldschmid et. al., eds. (1974, 18).
10. Goldschmid et. al., eds. (1974, 18).
11. Baldwin and Gorecki (1983c 12-13).
12. Baldwin and Gorecki (1983c, 10-11).
13. Gorecki (1976, 10).
14. Daly (1979, 23).
15. Scherer (1980, 81).

CHAPTER 3

STUDIES OF THE DETERMINANTS OF SUBOPTIMAL CAPACITY

The previous chapter has documented the wide prevalence of suboptimal capacity in Canada as the chief explanation of Canadian lagging productivity levels. This chapter examines the determinants of suboptimal capacity (Section 3.1) and then proceeds to give a brief survey of the various empirical studies of suboptimal capacity (Section 3.2). The last section summarizes the discussion of suboptimal capacity.

3.1 EXPLANATIONS OF SUBOPTIMAL CAPACITY

Theoretical studies have suggested a number of variables which may cause suboptimal capacity. These include (i) Market Size; (ii) domestic trade barriers, and (iii) foreign trade barriers.

3.1.1 MARKET SIZE

Market size refers to the number of MES plants that could be accommodated in the market. The larger the size of the market the more MES plants the industry could accommodate. Small market size, however, as used in this thesis, refers to the ratio of MES plants to industry output -- that is, the reciprocal of the number of MES plants that would satisfy the market.

The theoretical relationship between market size and a measure of scale efficiency has been well developed. Adam Smith (Skinner, 1973, 121) initially stressed the importance of market size as a limiting factor on the extent of specialization and the division of labour. Large markets provide greater opportunities for entrepreneurs to specialize their productive equipment and to save on labour costs as a result of less frequent switching from one product line to another.

Friedman (1983, 192-193) formulated a more explicit relation between market size and firms' production capacity under conditions of free entry and fixed cost. Using Sylos-Labini's example of fixed cost and entry, Friedman demonstrated that a potential entrant at the MES level would avoid entry if the resulting industry output would depress price considerably. Instead, a potential entrant would "come in on a small scale" presumably below MES level.

In instances where optimum plant size is a small fraction of industry output, one would expect a large number of plants to take advantage of all available economies of production. As the size of the market becomes infinitely large the emerging type of market structure would approximate a competitive outcome. In a purely competitive long-run equilibrium, no suboptimal capacity should exist at all[1]. Therefore, the larger is the ratio of domestic consumption to the output of an MES plant, the smaller is the fraction of industry output predicted to originate from suboptimal plants. Conversely, if the optimum plant size constitutes an abnormally large fraction of the industry output, one would expect an oligopolistic type of market structure in which sellers recognize their pricing and strategic interdependence. Under this type of market structure, oligopolists are more inclined to build suboptimal instead of MES plants so as to avoid the depressing influence of the added output on industry price[2]. Hence, the smaller the size of the market relative to the output of an efficient plant size, the greater is the degree of suboptimal capacity.

3.1.2 DOMESTIC TRADE BARRIERS

Domestic trade barriers include not only Canadian tariff protection but also subsidy and other non-tariff barriers.

3.1.2.1 CANADIAN TARIFF PROTECTION

The Canadian tariff protection plays a dual role in promoting suboptimal scale plants in Canadian manufacturing industries. First, the tariff separates the small domestic market from the larger world market and allows firms to compete among themselves[3]. In the absence of efficient import competition, domestic firms "adopt a parochial view towards their domestic market" and build suboptimal scale plants (Scherer et. al., 1975, 137). The higher unit cost incurred by operating at less than efficient scale of production is covered by the higher price permitted behind the tariff wall. Eastman and Stykolt (1967, 24) emphasized that Canadian tariff reductions would "oblige Canadian producers who were operating at inadequate scale to improve the efficiency of their operation if they were to remain in existence.

Secondly, in a small open economy such as Canada's, the landed price of imports is equal to the foreign price plus the full amount of the tariff. This tariff limit price encourages producers to enter protected industries that they would not otherwise have entered. Firms which contemplate entry in protected industries could either enter at optimal or at an inefficient scale. If entry occurs at the inefficient scale one would expect both the number of inefficiently operated units and the degree of suboptimal capacity to increase. Next, if entry occurs at MES level, the output of every producer is expected to decrease. Producers who previously operate scale efficient plant are now in a situation of suboptimal capacity. Hence, Eastman and Stykolt (1967, 106) argued that tariff limit price results in excessive entry and inefficient plant scale.

3.1.2.2 SUBSIDIES

Subsidies are defined as government expenditure policies such as loans and grants which result in reducing a producer's cost of supplying output relative to other producers [4]. Harris and Cox (1984, 53) claimed that these government policies are intended to encourage the employment of some factors and to afford domestic producers a cost advantage over foreign competitors [5]. By reducing the production cost in some industries, national subsidy policy could affect the extent to which firms exhaust all available economies of scale..

The theoretical relationship between subsidies and economies of scale was examined at length by Harris and Cox (1983, 53). They considered various kinds of government subsides ranging from factor input to export subsidies and concluded that the overall effect of subsidies on inefficiency depends on entry in response to positive profit that is created by the subsidy. First, Harris and Cox (1984, 57) considered the impact of subsidies on scale inefficiency under condition of fixed cost and free entry. On one hand, a capital subsidy results in positive profit for existing firms and at the same time encourages entry. If "all firms face constant-elasticity perceived demand curves ...." capital subsidies would affect neither marginal cost nor price and hence industry output would remain unchanged. With the output of the industry unchanged, and the number of firms become larger than the market could possibly accommodate at the MES level, each firm would be operating a suboptimal scale plant. Thus, a positive relationship is hypothesized between subsidy and suboptimal capacity.

On the other hand, if the assumption of a zero profit condition is dropped and barriers to entry are assumed to exist, capital subsidy could encourage firms to exploit economies of scale. For example, if capital subsidies yield positive profit which would not be eroded by potential entrants, existing firms would be encouraged to take advantage of available economies of scale by cutting prices and increasing output. Thus, a negative association is predicted between suboptimal capacity and subsidies. So the impact of subsidies on suboptimal capacity is ambiguous.

3.1.2.3 CANADIAN NON-TARIFF BARRIERS

Non-Tariff Barriers (NTBs) refer to the types of trade protection other than tariffs which serve to insulate the small domestic market from the larger foreign market. These protectionist NTBs include import quotas, voluntary export restraints, custom valuation, government procurement policies and subsidies affecting particular industries which are usually subsumed under the general heading 'new protectionism'[6]. Following the Kennedy and Tokyo rounds of average tariff reductions on a wide range of manufactured goods, these NTBs have become quite visible and relatively more important than tariff barriers in restricting foreign competition. In instances where NTBs operate through quantitative restrictions, such as import quotas, their impact on plant economies of scale are measured in an analogous manner to that of tariff protection. A more detailed account of the different approaches and measurements of NTBs is provided in chapter 5.

Stern (1973, 872) compares the similarities and differences between quantitative restrictions and tariff protection and concludes that quantitative restrictions (like tariff protection) result in higher domestic prices via the physical limitations on imports. The greater the degree of protection from efficient foreign competition, the more likely firms will compete among themselves in a small domestic market and produce output levels below the level at which unit production cost attains its minimum level.

3.1.3 FOREIGN TRADE BARRIERS

Like Canadian trade barriers, US trade barriers include both US tariff protection and US NTBs.

3.1.3.1 US TARIFF PROTECTION

US tariff protection is expected to influence suboptimal capacity in the Canadian manufacturing sector. The role of US tariff protection in promoting scale inefficiency has been repeatedly emphasized by Eastman (1960, 437-8), Eastman and Stykolt (1967, 21), Wonnacott and Wonnacott (1982, 413), Harris and Cox (1983, 21), and more recently, by the MacDonald Commission (1985, 324-327). A common theme reiterated by these authors on trade liberalization is the importance of securing a large unrestricted market for Canadian exports. The presence of the US tariff, however, separates the small Canadian market from the larger US market "by lowering the maximum price at which Canadian producers can export" (Eastman and Stykolt, 1967, 21). By restricting Canadian producers to serve Canadian market, Eastman (1960, 438) argued that "firms are less inclined to enter an industry with plants of large and efficient size, or if already established in the industry, they are less inclined to add to capacity by large increments". In fact, as is pointed out by the Wonnacotts (1967), the chief cause of Canada's inefficient manufacturing sector is the presence of high US tariff protection.

In their 1982, study, however, the Wonnacotts suggested that a lower US tariff might not encourage Canadian producers to realize economies of scale through access to the large US market. Unless there is a "commitment on the US part to keep tariff down" in the future, Canadian producers would be reluctant to reorganize their plants to exhaust economies of scale (Wonnacotts, 1982, 414).

3.1.3.2 US NON-TARIFF BARRIERS

In recent years, although average US tariff rates have been continuously declining on a wide range of goods, US NTBs are expected to play an important role in explaining Canadian inefficient plant scale. The MacDonald Commission (1985, 312) mentioned two main types of US

NTBs that might influence Canadian exports: a) measures of contingent protection, and b) laws or regulations. Like tariff protection, the impact of US NTBs on suboptimal capacity is not known a priori. On one hand, US NTBs reduce Canadian market size and promote scale inefficient operation; on the other, a lowering of US NTBs would not necessarily ensure the rationalization of Canadian plants to serve the large US market and to exhaust all available economies of scale. Canadian producers would continue to compete among themselves in the small domestic market and to build suboptimal scale plants, unless there were a strong commitment on the US part to keep NTBs down[7]. A full discussion of NTBs is postponed to chapter 5.

3.1.4 CONCLUSION

Many studies have often mentioned the importance of market size in explaining scale efficiency and repeatedly stressed the increasing use of NTBs in protecting inefficient industries. However, none of these studies have formally modelled these effects on suboptimal capacity. For instance, in their model of intra-industry trade in identical commodities, Brander and Spencer (1981) emphasized the importance of Cournot strategic interaction among firms in explaining the simultaneous exports and imports of commodities of the same industry in a country. They were particularly interested in explaining the presence of intra industry trade in homogeneous goods. Although their model incorporates increasing returns to scale it does not explicitly consider the impact of trade barriers on suboptimal capacity.

3.2 EMPIRICAL STUDIES

Empirical work on scale efficiency in Canadian manufacturing industries primarily focuses on testing the Eastman and Stykolt hypothesis which basically states that small market size induces scale inefficient operation. The ratio of an MES plant to the industry size is referred to as the small market size.

3.2.1 EARLY STUDIES

Muller (1982), in The Eastman-Stykolt Hypothesis Reconsidered, reviewed a number of empirical studies ranging from Eastman-Stykolt to Dickson and Caves. In his review article, Muller pointed out the importance of the Eastman-Stykolt hypothesis in trade policy discussions but emphasized that the theory itself has not been adequately formulated. Furthermore, he noted that none of the studies find a strong positive impact of tariff protection on inefficiency. He also criticized the statistical significance attached to the coefficient of the concentration ratio variable because of its partial correlation with the dependent variable. The material described in Section 3.2.1.1 below is the material Muller discussed in his review article.

3.2.1.1 A SURVEY OF RECENT LITERATURE

An initial comprehensive examination of the Canadian industrial structure and is relation to trade barriers was performed by Eastman and Stykolt (1967). Using the engineering technique, they estimated suboptimal capacity as the percentage of capacity of efficient size for 16 Canadian manufacturing industries based on 1960 SIC cross-section data. Although they stressed the significance of the concentration ratio and of US-Canadian trade barriers (tariff, non-tariff barriers and transportation cost), no account was taken of these influences in their equation explaining suboptimal capacity. They regressed suboptimal capacity on market size, a capital requirement barrier, product differentiation and growth in demand. Their empirical work showed that market size had a positive impact on scale efficiency and was statistically significant.

In his work on 12 identically defined industries across 6 industrialized countries, Scherer (1973, 135) employed the engineering technique and estimated scale efficiency as the ratio of the top 50 per cent (of industry's culumative output or employment) measure to the minimum efficient plant scale. This proxy measure of scale efficiency has been criticized by Gupta (1979, 506), Baldwin and Gorecki (1983c, 6) and Davies (1980, 287), and (Allen, 1983, 6), on the basis that it reflects more of a 'hybrid' measure of concentration ratio rather than scale efficiency.

Despite the criticisms levelled against the use of proxy measures, Scherer (1973, 141-43) regressed scale efficiency on unit transportation cost, market size, cost disadvantage ratio, and market density which interacts with three-firm concentration ratio variable.

The market variable, defined as population density multiplied by per capita income, becomes statistically significant only when it interacts with the three-firm seller concentration ratio variable. This high significance in the interaction term which includes market density and concentration ratio variables, occurred because the latter variable is partly determined by the dependent variable. With respect to the other variables, Scherer found some evidence that unit transportation costs and the cost disadvantage ratio are important in some countries but not in Canada. Finally, the market size variable is statistically significant across all specifications of the regression equation.

A remarkable feature of published studies is the lack of significance of trade variables: a) tariff measures, and b) export/import exposures in the equation explaining the measures of scale efficiency. Export/import exposures refer to the percentage of industry shipments that are exported or imported, respectively.

In an attempt to capture foreign influences on the ratio of actual plant size to MES, Gorecki (1976, 56-59) examined Canadian effective tariff and export measures for 13 Canadian industries. The Canadian tariff protection variable has the expected and negative impact on the ratio of actual plant size to MES but is statistically insignificant. The export exposure variable, however, seems to affect the realization of scale economies.

Dickson (1979) employed a large sample of 1966 cross-section data on 70 Canadian manufacturing industries and estimated three measures of scale efficiency using survivor techniques: a) the fraction of industry value added originating from plants of minimum efficient scale; b) the ratio of average cost of scale efficient plants to the industry average, and c) the top 70 per cent index which refers to the average size (measure in terms of value added) of the smallest number of the largest plants accounting for 70 per cent of industry value added. These three measures of the dependent variable were regressed alternatively on measures of market size, Canadian effective rate of tariff protection and other elements of market structure such as capital requirement barriers. Like Scherer, Dickson (1979, 214-275) found strong support for the hypothesis that large market size promotes scale efficiency in Canada by encouraging firms to rationalize their plants and to achieve long production runs.

The impact of Canadian tariff protection, however, on the various measures of scale efficiency is ambiguous. In some equations, the coefficient of Canadian tariff protection has the wrong sign and is statistically insignificant. Only when the dependent variable is measured as the ratio of average cost of scale efficient plants to the industry average does the coefficient of Canadian tariff protection have the expected sign and is statistically significant at the 10 per cent level in some equations.

Gupta (1979) also employed a large sample of Canadian industries to examine the determinants of suboptimal capacity. Using the statistical cost analysis method, Gupta estimated suboptimal capacity from a cross-section of 67 manufacturing industries in 1979. Like Dickson, Gupta (1979, 510) failed to find an empirical effect of the Canadian tariff on the extent to which plants realized scale economies. Specifically, in Gupta's empirical work, the coefficient of the Canadian tariff variable has the expected impact on suboptimal capacity but is statistically insignificant.

Caves et. al. (1980, 29) estimated the percentage of industry output at efficient scale by using the mean size of large US plants to approximate MES in Canadian industries. Their sample consists of 84 Canadian and corresponding US industries in 1980. Unlike previous studies, Caves et. al. have tested the influence of tariff protection on scale efficiency when it (the tariff) interacts with Canadian small market size. In this way, they found tariff protection to be statistically significant.

3.2.2. BALDWIN AND GORECKI

In a more recent study of suboptimal capacity, Baldwin and Gorecki (1983C, 55-57) constructed an index of relative plant scale across 120 Canadian manufacturing industries in 1970 and 1979. The average size of large US plants was used to approximate MES plants in Canadian industries, since the American plants are assumed to operate at MES level.

Although their study includes a large sample, Baldwin and Gorecki did not find empirical support for the tariff in explaining relative plant scale. In fact, they argued that when MES plant scale is small relative to industry size, the influences of both the tariff and concentration ratio variables on relative plant scale are negligible and that firms are more inclined to add to capacity MES plants. Conversely, when the MES plants constitute a large fraction of the industry size, the tariff becomes important in explaining relative plant scale. Hence, in their empirical work, they specified the Eastman and Stykolt hypothesis as a composite variable, that is, the interaction of tariff protection and concentration ratio variable or the interaction of tariff protection, concentration ratio and large market size variable (the reciprocal of MES plants to industry size).

Baldwin and Gorecki's work on relative plant scale is the first to utilize an extensive data base of Canadian industries. However, it seems difficult to interpret their interaction term of high tariff, concentration and large market size to represent the Eastman and Stykolt effect on relative plant scale. A proper specification of the Eastman and Stykolt hypothesis should omit the concentration ratio variable which jointly interacts with tariff and market size variable. In our model of the determinants of relative plant scale developed in chapter 4, we argue that the concentration ratio variable is partly determined by the dependent variable and consequently the resultant estimates of the interaction term which describes the Eastman and Stykolt effect are likely to be statistically biased. A full discussion of the high collinearity between concentration ratio and a proxy measure for scale efficiency has been provided by Davies (1980).

3.2.3 CONCLUSION

A brief survey of the recent empirical work on measures of scale efficiency in Canadian manufacturing industries shows that further research is required in the following areas: First, a formal investigation of the role of opportunities for foreign trade in determining relative plant scale and suboptimal capacity is required. Such a formal model would facilitate adequate comparative static analysis of these measures of scale efficiency on the effect of market size, tariff and an interaction term representing the Eastman and Stykolt hypothesis. In this thesis, we refer to the interaction of small market size with trade barriers as the Eastman and Stykolt effect on relative plant scale.

Second, empirical studies have confirmed the role of small market size but have not established the significance of tariffs and non-tariff barriers. In fact, none of the studies has accounted for Canadian non-tariff barriers and US trade protection. In recent years, non-tariff barriers have become quite important and must be explicitly accounted for in explaining Canadian industrial efficiency. Formal models explaining scale efficiency would be mis-specified if Canadian and US trade protection are omitted.

Also, empirical evidence on the role of the Canadian tariff in preventing scale efficiency is almost nonexistent. In the survey, none of the studies found a statistically significant effect of tariff protection on scale efficiency. Dickson, however, found effective tariff protection to be statistically significant in explaining the average cost of scale efficient plants relative to industry average. In more recent studies of Caves et. al. and Baldwin-Gorecki, tariff protection becomes significant when defined as a composite variable (i.e., interacting with other variables). Baldwin and Gorecki justified such a composite variable on the grounds that scale inefficiency is more pronounced in industries that are subject to high concentration and high tariff. In other words, the tariff, per se, does not matter.

However, the proposition advanced by Baldwin and Gorecki that a tariff, per se, is irrelevant does not find support in our formal trade model developed in chapter 4. In a simple model of the determinants of relative plant scale, the tariff will be seen to have a negative effect on relative plant scale. In fact, the model's predictions confirm Eastman's hypothesis that the tariff barrier has an effect on scale efficiency that is independent of other entry barriers.

3.3 SUMMARY

Empirical work on scale efficiency in Canadian manufacturing industries primarily focuses on testing the Eastman-Stykolt hypothesis. Eastman and Stykolt argued that the tariff has a more deleterious effect on scale inefficiency when the output of a scale efficient plant becomes a large fraction of the industry output. The hypothesis has been empirically tested by regressing measures of scale efficiency on various explanatory variables which are defined over an industry sample ranging from six (Scherer, 1973, 135) to one-hundred-and-twenty four-digit SIC industries (Baldwin and Gorecki, 1983c, 55-57). These studies employ variables measuring various aspects of market structure to explain industry performance such as suboptimal capacity and relative plant scale. We conclude that the literature is deficient because: (i) it lacks a formal modelling of the effects of trade barriers on scale efficiency, and ii) it ignores the increasing importance of US-Canadian non-tariff barriers and US tariffs on the extent to which economies of scale are realized in Canada.

FOOTNOTES

Chapter 3

1. L. Weiss (1976, 124)

2. Eastman and Stykolt (1967, 19); Scherer (1973, 140).

3. Eastman and Stykolt (1967, 102).

4. Mutti (1979, 9); Moroz (1984, 23).

5. Harris and Cox (1984, 53).

6. Stern (1973, 872); Harris and Cox (1984, 53); Balassa (1973, 414).

7. Wonnacotts (1982, 414).

CHAPTER 4

A MODEL OF THE DETERMINANTS OF RELATIVE PLANT SCALE

In chapter 3 we have illustrated the deficiencies of the literature in the following areas: a) the lack of a formal model to explicitly investigate the relationship between trade barriers and suboptimal capacity; b) the Eastman and Stykolt hypothesis has not been adequately formulated; and c) the failure to account for the increasing importance of non-tariff protection on scale efficiency. This chapter addresses problems a) and b), leaving c) for chapter 5. It is organized into four broad sections. Section 4.1 presents the basic model of the determination of relative plant scale in the presence of trade barriers. Section 4.2 describes the comparative statics of tariff protection, market size, and the Eastman-Stykolt effect on relative plant scale. Section 4.3 discusses the implications for testing the Eastman-Stykolt hypothesis while Section 4.4 describes the expected signs of additional variables.

4.1 THE BASIC MODEL

The basic model extends von Weizsacker's (1981) analysis of the welfare effect of barriers to entry. Unlike von Weizsacker's, our model allows for explicit consideration of tariff protection on the firms' Cournot equilibrium output. First, we will consider the model's assumptions and then proceed to analyze its equilibrium.

4.1.1 ASSUMPTIONS

Market Demand Function

In von Weizsacker's presentation, the market demand function is linear and in the absence of imports would take the form:

(1) $$P = H(Q) = A - gQ$$

where $A > 0$ and $g > 0$; P and Q respectively denote price and output of a homogeneous industry. The industry output, Q, is the sum of the outputs of all domestic firms. Let q_i be the output of a representative firm, q_i' denote the output of the remaining firms and n be the total number of firms. Hence, industry output becomes

(2) $$Q = q_i + q_i'$$

In equilibrium the remaining firms' output is specified as $q_i' = (n-1)q_i$. Substitution for q_i' into (2) yields

(3) $$Q = nq_i$$

The restrictions placed on the demand function are that H(Q) is a linear function of Q such that $A > 0$ and $g > 0$. For simplicity we express the market demand function in terms of relative market size, S, (industry output relative to the most efficient plant scale) and price elasticity of demand at the competitive output $(h > 0)$[1].

Under these assumptions and using the definition of elasticity, the market demand function (1) becomes[2]

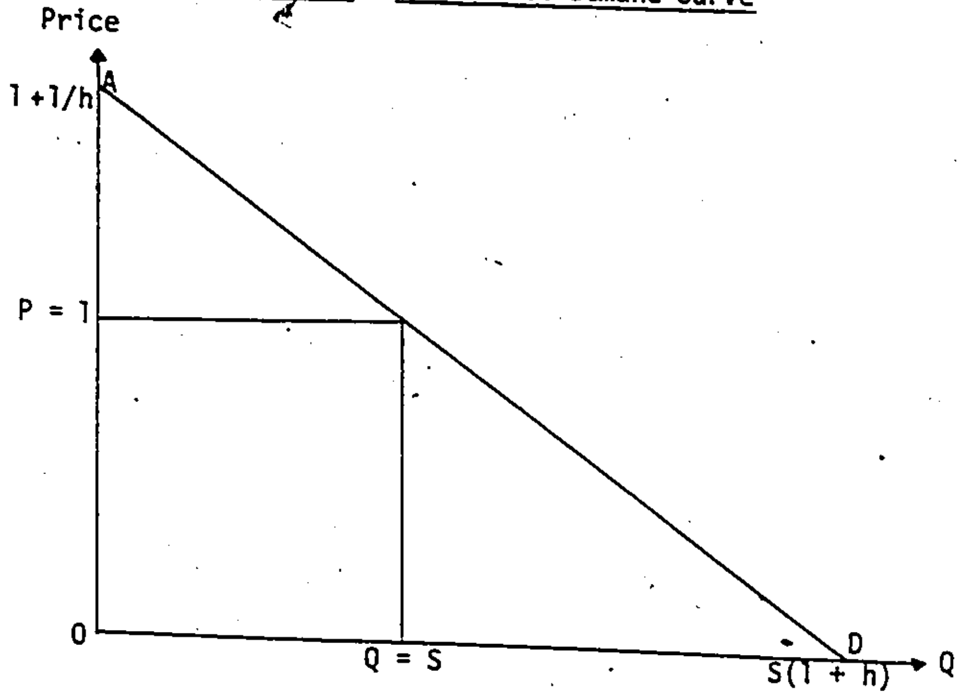
(4) $$P = 1 + \frac{1}{h} - \frac{Q}{hS}$$

Substitution for $Q = nq_i$ into (4) yields the industry demand function in equilibrium

(5) $$P = 1 + \frac{1}{h} - \frac{nq_i}{hS}$$

The size of the Canadian market (S) is indicated by the demand curve at the quantity where the price equals unity as illustrated in diagram 4.1.

DIAGRAM 4.1: The Market Demand Curve



AD denotes the market demand curve.
S denotes the Canadian market size at price, p equals unity.
Q denotes industry output.
h denotes the price elasticity of demand.

Cost Function

Each supplier is assumed to operate under an identical cost function.

$$(6) \qquad TC = F + aq_i + \frac{1}{2} bq_i^2$$

where F, the initial set-up cost, is assumed constant across firms; q_i represents the output of supplier i and 'a' and 'b' are parameters greater than zero. From the total cost function (TC) in (6), the marginal cost (MC) and average cost of production (AC) are

$$(7) \qquad MC = a + bq_i$$

$$(8) \qquad AC = F/q_i + a + \frac{1}{2} bq_i$$

The average cost minimizing output level is $q = \sqrt{2F/b}$ and minimum average cost is $TC/q = a + \sqrt{2Fb}$. By assumption, minimum average cost occurs where q = 1 such that 2F = b. When q equals unity average and total cost also equals unity. Then the condition that b and q equals 2F and unity, respectively implies that a = 1 - 2F. Finally, the cost function in 6 can be expressed in terms of fixed cost as follows:

$$(9) \qquad TC = F + (1 - 2F)q + Fq^2$$

The marginal and average costs are

(10) $MC = (1 - 2F) + 2Fq$

(11) $AC = F/q + (1 - 2F) + Fq$

These relationships are illustrated in diagram 4.2 The minimum efficient plant (at which average cost is unity) is denoted by q(MES) where MC intersects the average cost curve (AC). Diagram 4.2 also shows that economies of scale are assumed to exist up to q(MES) over the range where $dAC/dQ < 0$ and MC is less than AC.

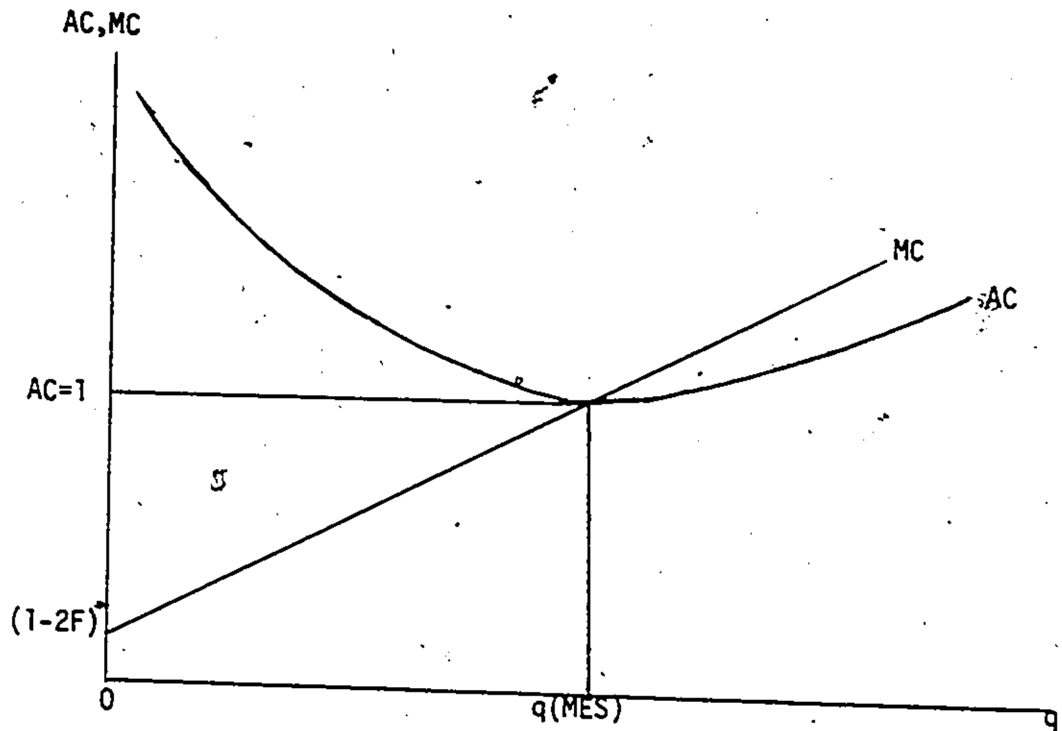


DIAGRAM 4.2: MINIMUM EFFICIENT PLANT SIZE WHEN AVERAGE COST IS UNITY

MC denotes Marginal Cost
AC denotes Average Cost
q(MES) denotes minimum efficient plant scale when average cost (AC) is unity.

Imports

It is assumed that the elasticity of import supply is infinite at a world price of P_W (at the Canadian border) and that imports and domestically produced goods are perfect substitutes. Under these circumstances, the maximum price which the Canadian producer can charge is $P^* \equiv P_W + t_c$, where t_c is the Canadian tariff. The price P^* will be referred to as the tariff limit price. These assumptions imply that above P^* the demand curve facing Canadian producers has infinite elasticity, while at prices below P^* it is less elastic. The impact of the Canadian tariff (and hence P^*) on the market demand function is illustrated in diagram 4.3.

Let the demand corresponding to P^* be Q^* in diagram 4.3. Then the market demand curve P^*XD that faces Canadian producers is kinked at the output Q^*. For $Q < Q^*$ price equals P^*, since for prices above P^* Canadian consumers would switch to foreign suppliers. P^*XMN is the discontinuous marginal revenue corresponding to the demand curve P^*XD; OP_W is the price at which MES Canadian producers could sell in the world market; OP^* is the price at which foreigners are willing to supply in the Canadian market.

We wish to analyze the role of Canadian tariff, Canadian market size, and their interaction on plant scale relative to MES. Since units have been chosen so that AC = 1 at MES, relative plant scale equals absolute plant scale (q) and it suffices to examine the effect of changes in: a) tariffs, b) market size, and c) the interaction of a) and b) on plant scale. The interaction of a) and b) will be

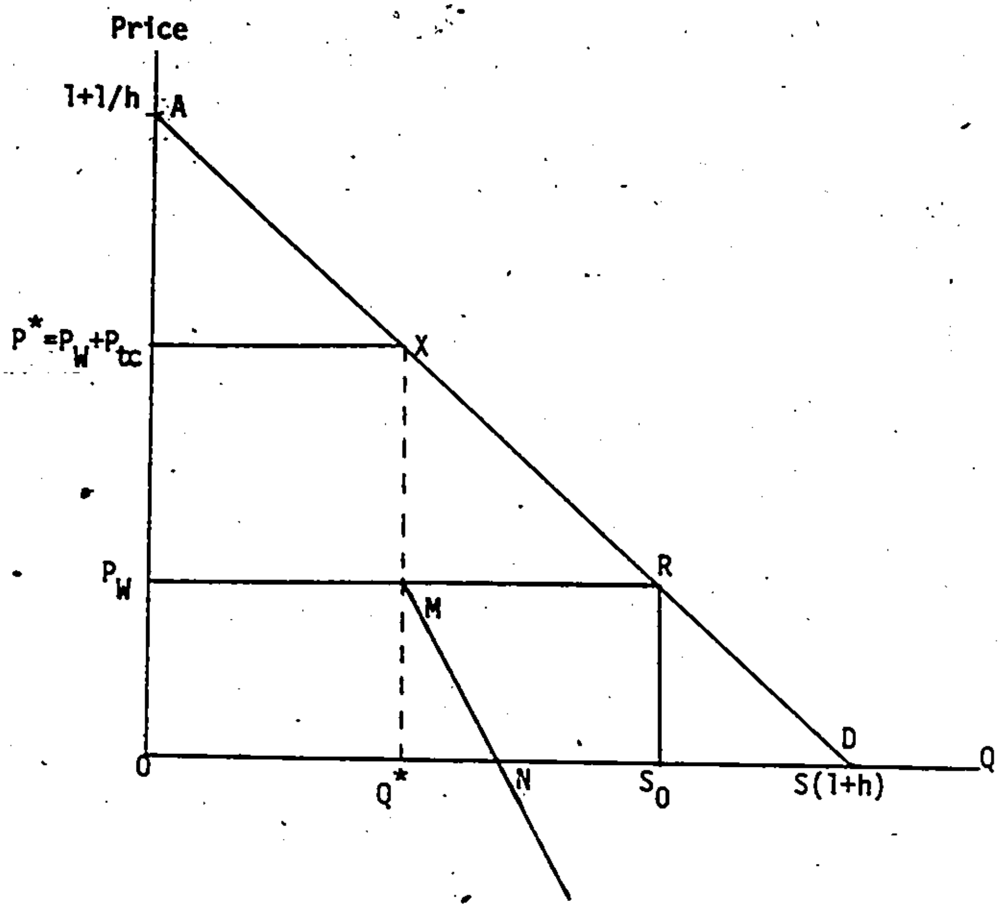


DIAGRAM 4.3: KINKED DEMAND CURVE AND CANADIAN TARIFF PROTECTION

AD	denotes the Market Demand Curve.
P^*XMN	denotes the Marginal Revenue Curve
Q*	denotes industry output at the tariff limit price, P^*
P_W	denotes the world price in the absence of the tariff.

referred to here as the Eastman-Stykolt (1967) effect. As we saw in Chapter 2, Eastman and Stykolt (1967) argued that in industries where the output of a minimum efficient plant constitutes a large fraction of the industry output, we would expect many firms to operate scale inefficient plants. Moreover, they argued that the prevalence of inefficiently operated manufacturing units is further encouraged by trade barriers which serve to separate the Canadian market from larger world markets.

To adequately capture the effect of tariff changes and Canadian market size on plant scale, we have interpreted the cross partial derivative of relative plant scale (q) with respect to market size and tariff protection as the Eastman-Stykolt effect.

In our empirical work, q will be measured by the ratio of the average size of large Canadian and corresponding US plants. Since the US plants are assumed to operate at minimum efficient scale, we will often refer to q as the size of Canadian plants relative to MES. We proceed by defining an industry equilibrium and then deriving expressions for $\partial q/\partial P^* \equiv \partial q/\partial t_C$, $\partial q/\partial S$ and $\partial^2/\partial P^*\partial S$. These expressions will be interpreted as the impact of tariff, market size and the Eastman-Stykolt effect on q, respectively.

4.1.2 SHORT-RUN EQUILIBRIUM WITH NO ENTRY

To define equilibrium, we adopt as our solution concept the Cournot-Nash equilibrium in which no firm can independently increase profits by adjusting its output. The equilibrium can occur on either segment of the demand curve or at the kink in diagram 4.3. We distinguish three cases: 1) Import Competition; 2) Tariff Limit Pricing, and 3) Domestic Oligopoly. For each case, the equilibrium is derived when the number of firms is fixed. The case of entry is discussed in Section 4.1.3 below.

CASE 1: IMPORT COMPETITION AND NO ENTRY

Under Case I where the tariff limit price prevails and industry output lies below the output Q^* corresponding to the kink at X, the demand function is infinitely price elastic at P^*, in diagram 4.3. Regardless of the output of the remaining firms, the representative firm maximizes profits by setting $P^* = MC$. Substitution into (10) yields the best response function:

(12) $$q = \frac{P^* - (1 - 2F)}{2F} \quad ; \quad \text{provided } Q < Q^*$$

CASE 2: TARIFF LIMIT PRICING AND NO ENTRY

In Case 2, the tariff limit price continues to prevail and the industry output Q equals Q^* at the kink in diagram 4.3. Substitution of the tariff limit price into (4) yields

(13) $$Q^* = hS[1 + 1/h - P^*]$$

At the kink, the combined output of all firms is $Q^* = q_i' + q_i$, where q_i is the output of the i^{th} firm and q_i' the output of remaining firms. Thus, substitution of $q_i' + q_i$ for Q^* in (13) we obtain

(14) $$q = S[h(1 - P^*) + 1] - q'$$

It forms the boundary between Cases 1 and 3. Later we will argue that (14) can be interpreted as a reaction function.

CASE 3: DOMESTIC OLIGOPOLISTS AND NO ENTRY

Under Case 3, domestic oligopolists charge below the tariff limit price and there are no imports in this regime, and the reaction function is obtained directly from the profit maximization for Cournot oligopolists. From the market demand function (4) and the cost function (9), the profit function for the i^{th} firm is

$$\Pi = Pq - TC$$

$$= (1 + 1/h)q_i - 1/hS(q_i^2 + q_i q_i') - (F + (1 - 2F)q_i + Fq_i^2)$$

Profit maximization requires

$$(1 + 1/h) - \frac{2q_i}{hS} - 1/hs\ q_i' - (1 - 2F) - 2Fq_i = 0$$

(15) $$\therefore\ q_i = \frac{S[1 + 2Fh]}{2(1 + FhS)} - \frac{q'}{2(1 + FhS)} \quad \text{provided } q_i + q_i' > Q^*$$

Symmetric equilibrium requires $q_i = q_j$ and $q_i' = (n - 1)q_i$ in equilibrium. Therefore, in equilibrium, substitute $q_i' = (n - 1)q_i$ in (15) to obtain

(16) $$q = \frac{S(1 + 2hF)}{(n+1) + 2FhS}$$

A simple description of the reaction function and Cournot firm equilibrium output level are illustrated in diagram 4.4. Line MX, in diagram 4.4, is the reaction function given by equation (15).

Line OR illustrates the condition of symmetric equilibrium, namely $q_i' = (n - 1)q_i$. In the special case of n = 2, OR becomes the 45 degree line though in general it will be $(n-1/n) \times 90^o$. The intersection of OR and MX is the Case 3 equilibrium. In this case each firm produces $\frac{S(1 + 2hF)}{3 + 2FhS}$ units of output.

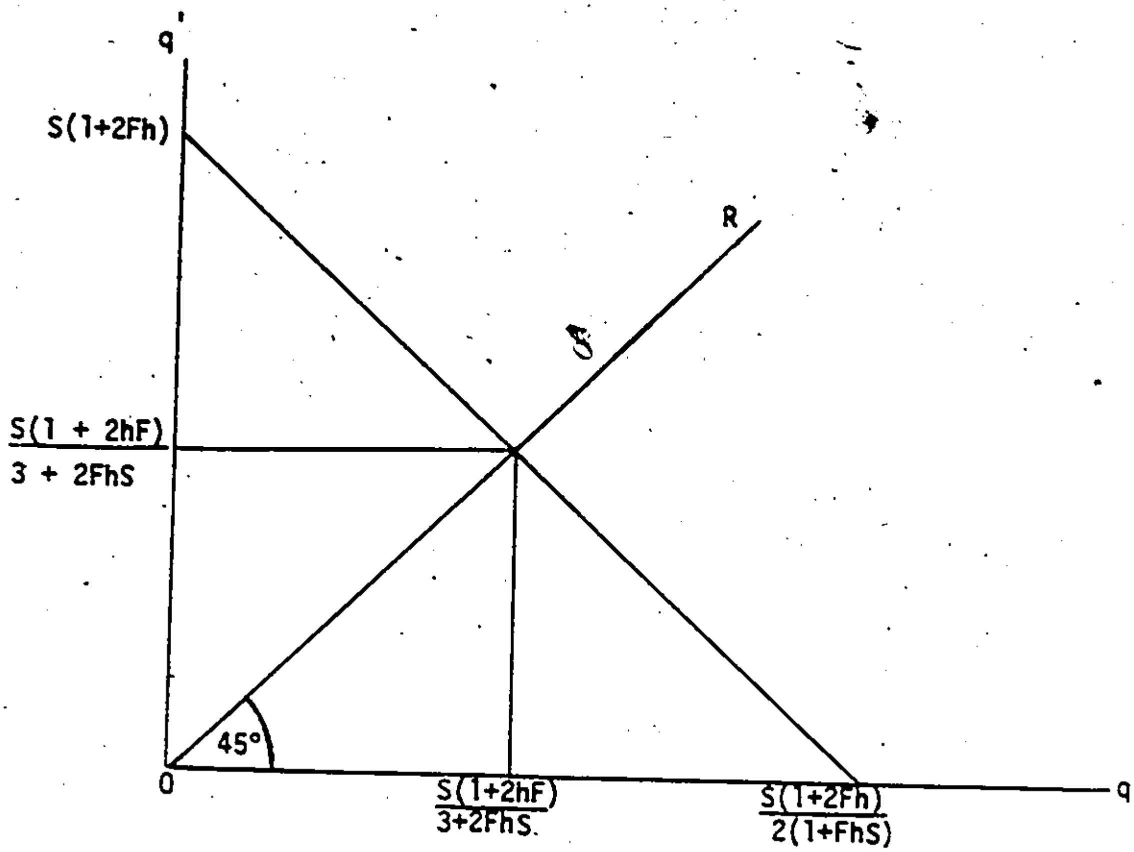


DIAGRAM 4.4: THE REACTION FUNCTION OF DOMESTIC OLIGOPOLISTS WHEN DOMESTIC PRICE IS BELOW THE TARIFF LIMIT PRICE.

Diagram 4.5 shows the reaction functions for Cases 1, 2 and 3. Again, for n = 2, line ZT is the reaction function (12) corresponding to Case 1 for all $Q < Q^*$. Line MX is the reaction function (15) corresponding to Case 3 for all $Q > Q^*$. Line FE (equation 14) corresponds to Case 2 for $Q = Q^*$ and divides the reaction function space into two areas. Inside triangle OFE we have $Q < Q^*$ and hence the firms' reaction function is given by ZT. Outside of the triangle OFE, $Q > Q^*$ and the reaction function MX applies.

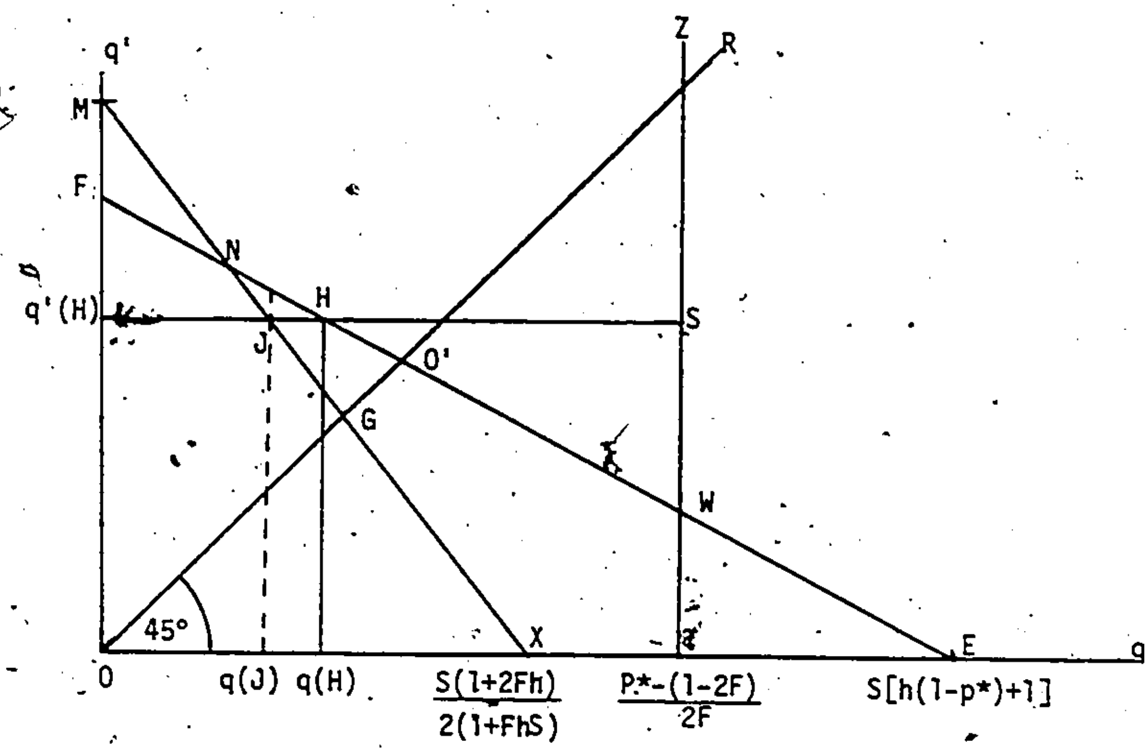


DIAGRAM 4.5: THE COMPOSITE REACTION FUNCTION FOR IMPORT COMPETITION, TARIFF LIMIT PRICING AND DOMESTIC OLIGOPOLISTS.

Q is greater than Q^* only outside of triangle OFE and hence only the segment MN of the reaction MX is relevant. Q is less than Q^* only inside OFE and hence WT is the only relevant segment of the reaction function ZT.

We now wish to show that the reaction function for the representative firm is given by the continuous, kinked line MNWT. It will be convenient to denote by q(N) and $q'(N)$ the coordinates of any point such as N.

Consider an arbitrary level of output, q', chosen by the other firms. If $q' > q'(N)$ then equation (15) is relevant, and we have a Case 3 equilibrium along MN. If $q' < q'(W)$, the equation (12) is satisfied and we have a Case 1 equilibrium along TW.

If $q'(W) < q' < q'(N)$ then neither equation (12) nor (15) can be satisfied. Suppose $q' = q'(H)$. Then line $q'(H)S$ is the locus of all possible outcomes. No point to the left of H can be the best response, since for all such points $q' + q < Q^*$, Case 1 prevails, and profits fall as output is reduced and the firm moves away from ZWT. No point to the right of H can be the best response, since for all such points $q' + q > Q^*$, Case 3 prevails, and profits fall as output increases and the firm moves away from NX. Therefore, point H is the best response to an output of $q'(H)$ units by the other firms.

Accordingly, for $q'(W) < q' < q_j(N)$, the best response function is given by line NW (equation 14). For all such points Case 2 (tariff limit pricing) prevails.

Diagram 4.5 also shows that in the absence of imports, symmetric domestic oligopolists produce at G on their best response function MNX. With the opening of trade, the line segment NW becomes the relevant best response function and oligopolists operate at O', where the tariff limit price prevails. Thus, diagram 4.4 shows that the immediate effect of the Canadian tariff has not only yielded a complicated reaction function MNWT, but also has induced additional domestic production relative to the autarky equilibrium at G.

4.1.3 LONG-RUN EQUILIBRIUM

In the previous section, we showed firms' Cournot equilibria for each of the three cases when the number of firms, n, is fixed. Now we will consider free entry and its impact on equilibrium in the long run for the various cases: import competition, tariff limit pricing and domestic oligopolists. In considering entry, we impose a zero profit condition such that in the long run each firm earns zero profit. We also simplify by allowing a fractional number of firms to avoid the computational problem which would be introduced by restricting our attention to an integral number of firms.

Case I: Import Competition and Free Entry

The easiest way to show the possible types of long-run equilibrium output is by considering a successively large number of firms as shown in diagram 4.6 by R_2, R_3, and R_5. Note that in

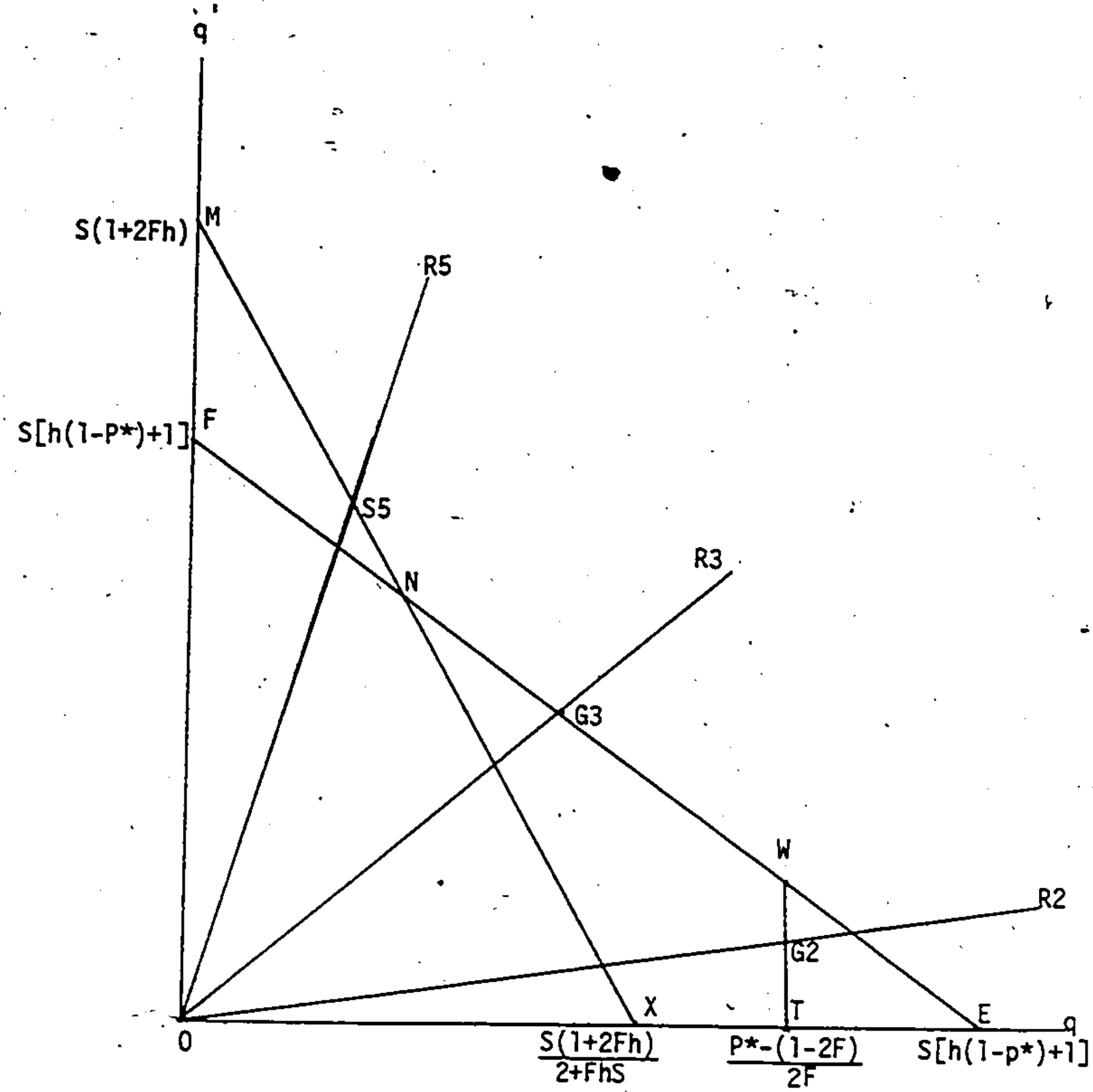


DIAGRAM 4.6: THE LONG-RUN EQUILIBRIUM OUTPUT FOR IMPORT COMPETITION, TARIFF LIMIT PRICING AND DOMESTIC OLIGOPOLISTS

this diagram, the scale of the horizontal axis is larger than that of the vertical.

The reaction function is again given by MNWT. We assume that the numeric values of the parameter are such that, for two firms, the short run equilibrium in (12) is at G_2 where the best response function WT intersects the symmetric equilibrium line OR_2. At G2, the price is equal to the tariff limit price, the combined output of domestic firm is less than market demand at the tariff limit price, and the remaining output is imported.

If profits are positive, entry will occur, and line OR rotates counter clockwise. For point G2 to be a long-run equilibrium, the zero profit condition would imply that total revenue equals total cost such that $P_q - F - (1 - 2F)q - Fq^2 = 0$. From the above zero profit equation we can solve for the representative firm's output to obtain

$$q = \frac{-[(1 - 2F)-P] \pm \sqrt{[(1 - 2F)-P]^2 - 4F^2}}{2F}$$

$$= \frac{(P + 2F-1) \pm \sqrt{1 + 4F(P - 1) + P(P-2)}}{2F}$$

(17) $\quad \therefore \quad q = P + 2F-1 \pm \Delta^{1/2}$

where $\Delta \equiv 1 + 4F(P - 1) + P(P - 2)$

Take the lesser root, we can substitute $P = P^*$ into (17) to yield the firm's long-run equilibrium. Thus, if long run equilibrium occurs along WT in diagram 4.6, each firm produces

(18) $$q = \frac{(P^* + 2F - 1) - \Delta^{1/2}}{2F}.$$

This long-run equilibrium occurs only if, by chance, the tariff limit price (P^*) equals both MC and AC, that is, if P^* equals minimum average cost. If, however, the tariff limit price deviates from this condition, long run equilibrium will not be restored in this range. For instance, if the tariff limit price becomes greater than the minimum average cost, profit becomes positive and entry of new firms will occur until profit is zero. As entry occurs, the line OR (in diagram 4.6) rotates counterclockwise until firms are operating in a different regime, that is, Case 2, with no import competition. Thus, long run equilibrium is not likely to occur under the condition of Case 1.

Case 2: Tariff Limit Pricing and Free Entry

If there are more than 2 firms the symmetric equilibrium line OR rotates counter-clockwise. Eventually it will intersect the reaction function on segment NW and we have a Case II equilibrium. In this case, the combined output equals market demand at the tariff limie price, price equals the tariff price, and there are no imports. If profit per firm is positive at G3, entry of new firms occurs. As the number of firms increase while holding market output at Q^*, we move along NW towards

N. If long run equilibrium occurs along NW (that is profits are driven to zero), equation (18) implies that output of each firm is

$$q = \frac{(P^* + 2F - 1) - \Delta^{1/2}}{2F}$$

Case 3: Domestic Oligopolists and Free Entry

If the number of firms increases still further, the line OR will intersect the reaction function along segment MN. This is the case of domestic oligopology. Diagrammatically, the domestic oligopolists' long run equilibrium output is shown at G5 in diagram 4.6. The price at G5 is less than the tariff limit price, output is greater than Q^*, and there are no imports. If profits are positive when P is less than the tariff, there would still be some suboptimal capacity.

To calculate the output of each firm in the event that long run equilibrium occurs along MN, we notice that the zero profit condition requires

$$P - F/q - (1 - 2F) - Fq = 0$$

Substitution of P from equation (5) into the zero profit equation yields the maximum number of firms for which profit is non-negative, that is:

$$(19) \qquad n = \frac{hS}{q}\,[1/h - F/q + 2F - Fq]$$

When the number of firms is fixed, the short-run equilibrium is derived from equation (16) as

(16a) $$q = \frac{S(1 + 2hF)}{n+1 + 2FhS}$$

Substitution of (19) into (16a), yields

(20) $$(FhS + 1)q^2 - hSF = 0$$

Hence the oligopolists' long-run equilibrium is

(21) $$q = \sqrt{\frac{FhS}{FhS+1}} = \sqrt{\frac{1}{1+\frac{1}{FhS}}}$$

Note that the denominator $(1 + \frac{1}{FhS})$ is greater than unity, which implies that q is less than 1. When market size becomes abnormally large relative to MES, q approaches unity, the size that is required to exhaust economies of scale.

4.2 COMPARATIVE STATICS

This section focusses on both the short-run and long-run equilibrium impacts of Canadian tariff, Canadian market size and the Eastman-Stykolt effect on relative plant scale in the cases where equilibrium is along MN, NW and WT in Diagram 4.5. As mentioned in Section 4.1, relative plant scale in our model is equivalent to output level (q) since the American plants are assumed to produce at efficient scale which is normalized at a value of unity. We will show that the Eastman-Stykolt model implies the interaction of small market size (the reciprocal of large market size, S) with tariff protection should lead to a negative coefficient in our regression. Comparative static techniques will be used to demonstrate for each of the three different cases, the following relationships: a) relative plant size and tariff protection ($\partial q/\partial P^*$); b) relative plant size and market size ($\partial q/\partial S$), and c) relative plant size and Eastman-Stykolt effect ($\partial^2 q/\partial S \partial P^*$).

4.2.1 Short-Run With No Entry

In Case I where the tariff limit price prevails and industry output lies below Q^*, the short-run equilibrium output for each firm is given by the best response function, namely $q = \frac{P^* - (1 - 2F)}{2F}$. Clearly $\partial q/\partial P^* = 1/2F > 0$. Thus, an increase in Canadian tariff (and hence an increase in P^*) will have a positive effect on relative plant scale if firms behave competitively by equating P^* to the marginal cost of production. Diagram 4.7 shows that relative plant scale will expand from q_0^* to q_1^* along the marginal cost curve in response to an increase in Canadian tariff protection from P_0^* to P_1^*.

Note that when the tariff has been increased, the total quantity demanded is reduced from Q_0^* to Q_1^*. The positive increase in relative plant size to an increase in P^* can also be shown in diagram 4.6 by an outward shift of the best response function (line WT) along the symmetric equilibrium line OR2[3].

Relative plant scale, however, will not be affected when Canadian market size becomes large. Analytically, it is clear that $\partial q/\partial S = 0$. Diagrammatically we see that with P^* remaining fixed at P_0^*,

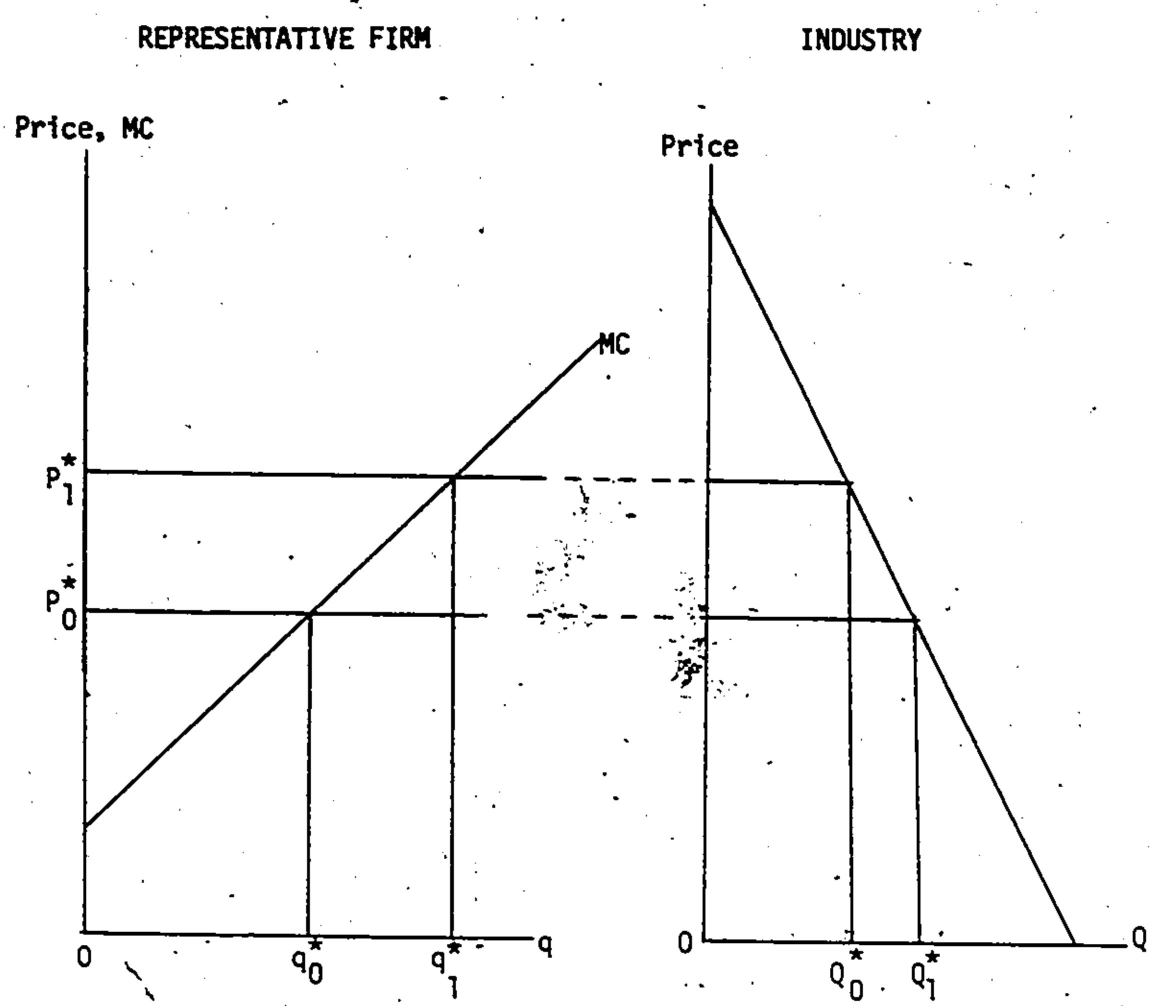


DIAGRAM 4.7: THE SHORT-RUN IMPACT OF CANADIAN TARIFF PROTECTION ON RELATIVE PLANT SCALE, CASE 1.

the increase in market size (as shown in an outward rotation of market demand curve in diagram 4.8) will not affect marginal cost and hence the profit maximization position of firms at q_0^*.

The increased demand is absorbed by increased imports abroad as given by the difference BC in diagram 4.8. If $\partial q/\partial P^* > 0$ and $\partial q/\partial S = 0$

it follows that there is no Eastman-Stykolt effect on relative plant scale, that is $\partial^2 q/\partial P^* \partial S = 0$.

Case 2: Tariff Limit Pricing and No Entry

In Case 2, the industry output Q^* is determined at the kink

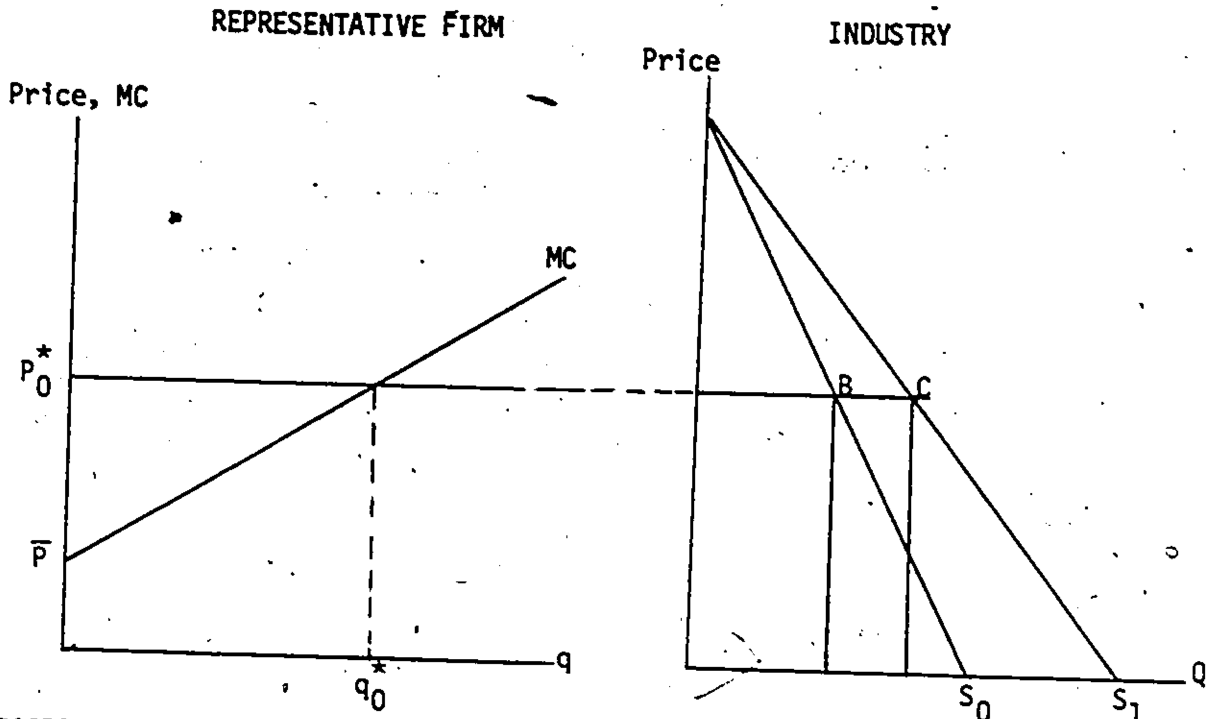


DIAGRAM 4.8: THE SHORT-RUN IMPACT OF MARKET SIZE ON RELATIVE PLANT SCALE, CASE 1.

of the market demand curve where $P = P^*$. Under these circumstances, the best response function is given from (14) as $q = S[h(1 - P^*) + 1] - q'$. Symmetric equilibrium, however, requires that $q' = (n - 1)q)$. Therefore, as shown in Section 4.1.3 above, in equilibrium the representative firms' output at the tariff limit price becomes

(22) $$q = \frac{S}{h}[h(1 - P^*) + 1]$$

The impact of Canadian tariff protection on relative plant scale is negative, as

$$\partial q/\partial P^* = \frac{-Sh}{n} < 0; \qquad S > 0,\ n > 0,\ h > 0$$

This inverse relationship between tariff protection and relative plant scale is shown in diagram 4.9. The line segment NW depicts the best response function in equation (14). Hence, an increase in P^* moves the NW segment to $N'W'$ along $00'$ line for a fixed number of firms. Intuitively, an increase in tc moves us up the market demand curve to the new kink. Total output is lower with the same number of firms. Market size, however, has a positive impact on relative plant scale. From equation (22) $\partial q/\partial S = 1/n[h(1 - P^*) + 1]$ which is positive provided that $1 + h(1 - P^*) > 0$ or alternatively, $1 + 1/h > P^*$. This condition is guaranteed because the expression $(1 + 1/h)$ is the intercept of the market demand function and, for the problem to be meaningful it exceeds P^* as shown in Diagram 4.3.

Diagrammatically, the positive influence of market size on relative plant scale is shown in Diagram 4.10 as an outward shift of line NW to $N'W'$ along line OR. The equilibrium output of the representative firm rises from $q(0')$ to $q(0'')$. In terms of the demand curve,

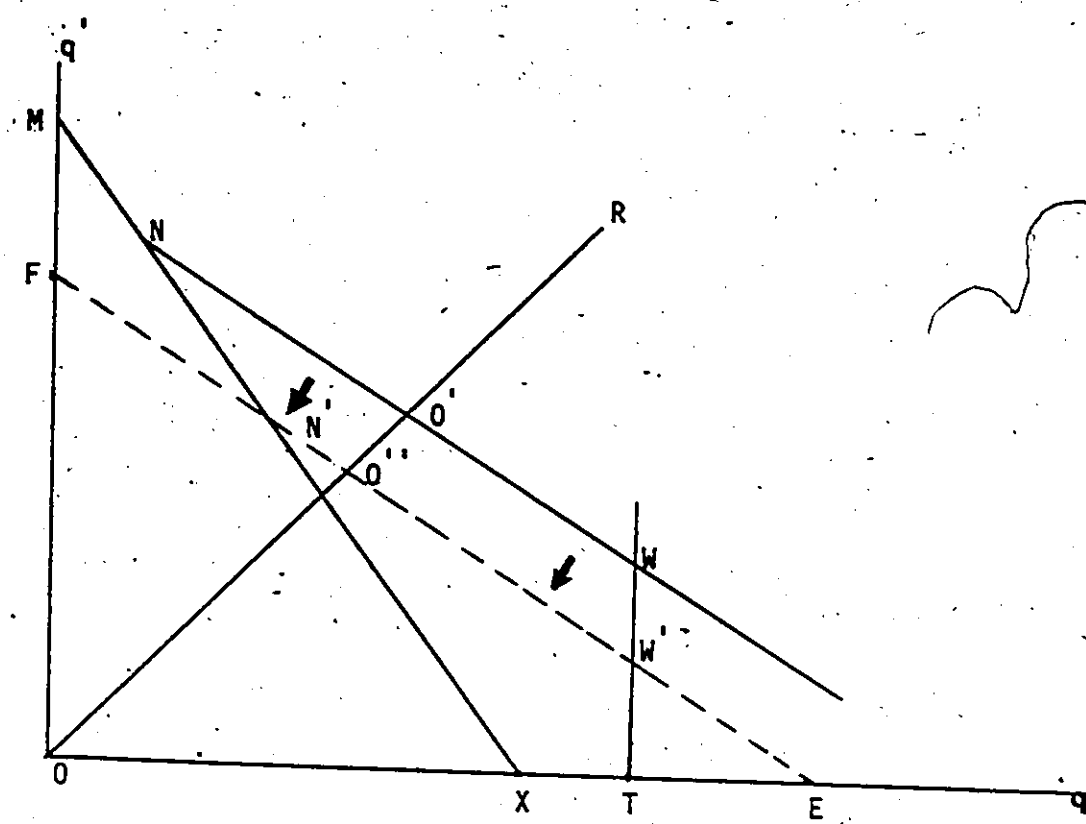


DIAGRAM 4.9: THE SHORT-RUN IMPACT OF CANADIAN TARIFF PROTECTION ON RELATIVE PLANT SCALE, CASE 2.

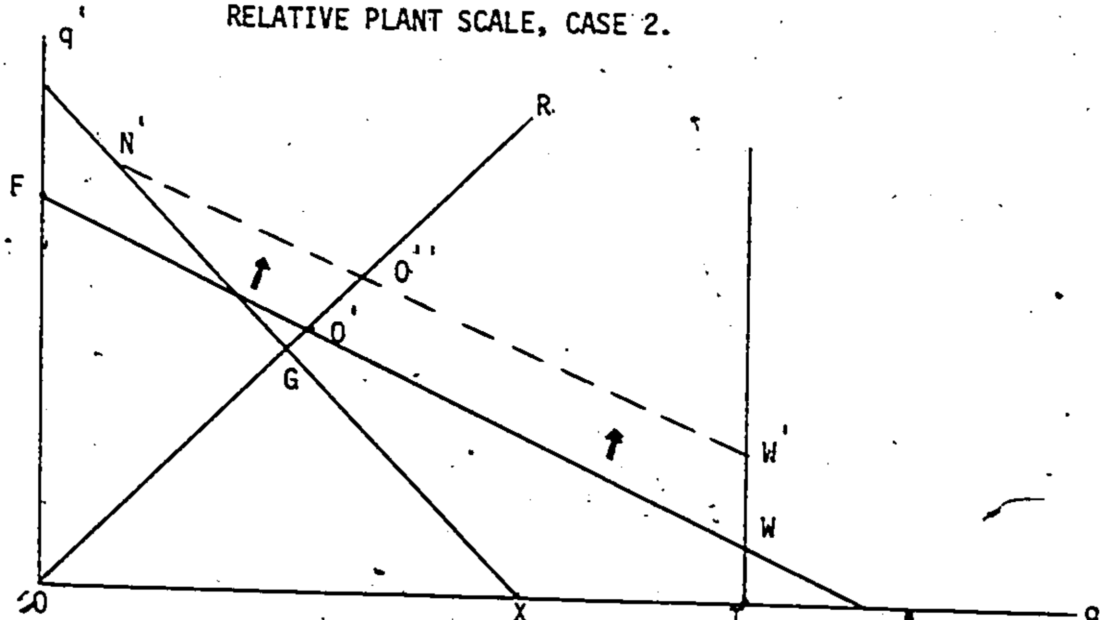


DIAGRAM 4.10: THE SHORT-RUN IMPACT OF MARKET SIZE ON RELATIVE PLANT SCALE, CASE 2.

the shift is like BC in diagram 4.8.

The cross-partial derivative of relative plant scale with respect to market size and tariff protection is negative. From equation (22) $\partial^2 q/\partial S \partial P^* = -h/n$ which is negative because the price elasticity of demand, h, has been defined to be positive and the number of firms (n) is clearly positive. This Eastman-Stykolt effect on industry equilibrium (and hence firm equilibrium) is shown in diagram 4.11 as a simultaneous increase in both tariff protection and market size variable.

Initially, industry output has increased from (a to b) in response to a rise in market size from S_0 to S_1 for each level of tariff protection, P_0^*. However, when tariff protection also increased, industry output is reduced from (b to c). Thus diagram 4.11 shows that the Eastman-Stykolt effect on industry output (and accordingly on relative plant scale with a fixed number of firms) is negative. Eastman and Stykolt (1967), however, argued that the scale reducing effects of the tariff would be more important in small markets, which would imply that $\partial^2 q/\partial P^* \partial S$ should be positive. Thus the negative cross partial derivative obtained in our model is the opposite of the usual Eastman-Stykolt effect.

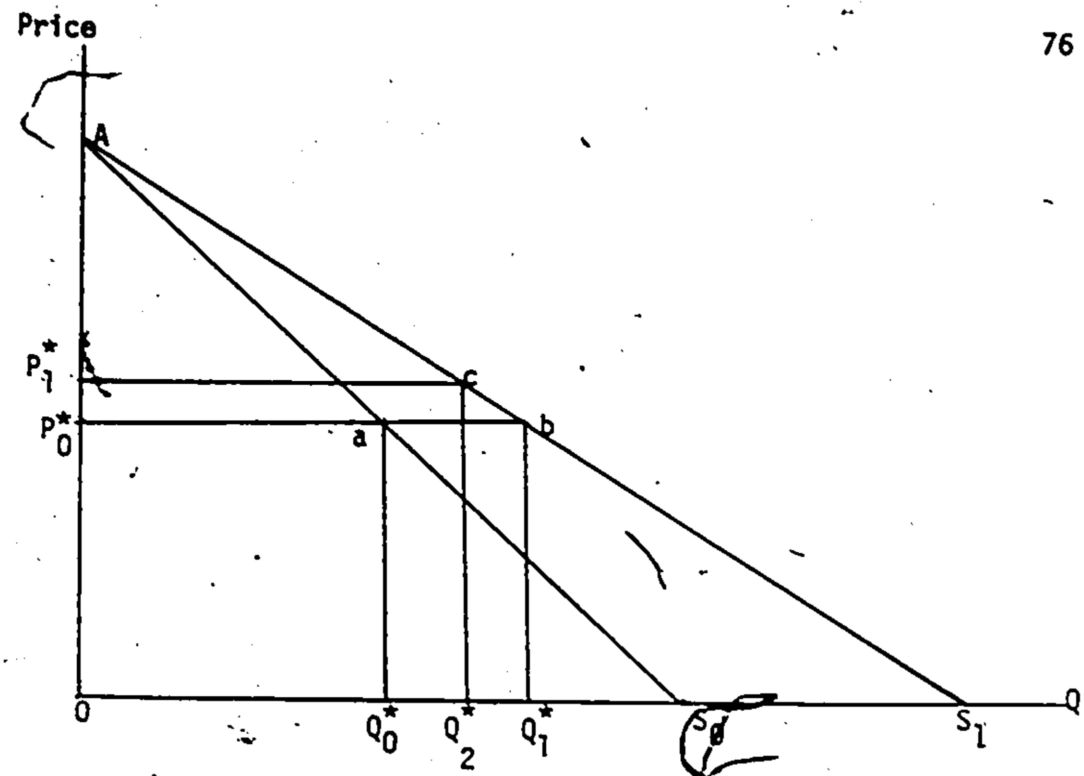


DIAGRAM 4.11: THE EASTMAN-STYKOLT EFFECT ON INDUSTRY OUTPUT IN THE SHORT-RUN, CASE 2.

Case 3: Domestic Oligopolists and No Entry

Domestic oligopolists, in Case 3, charge a price intermediate between the tariff limit and the world price. From the best response function in (15), the oligopolists' equilibrium is derived in (16) as $q = \frac{S(1 + 2\,hF)}{n+1 + 2FhS}$. Hence, $\frac{\partial q}{\partial S} = \frac{(n + 1)(1 + 2hF)}{(n + 1 + 2FhS)^2}$ which is positive. This positive influence of market size on relative plant scale is also shown in diagram 4.12. The line segment MN reflects the best response function in (15). For a given number of firms, oligopolist output equilibrium G5 is determined at the intersection of line OR5 and the best response function given by line MN. Now an increase in the Canadian market size is seen to shift the best response function outward from MN to M'N' along line OR5. This outward shift of the best response function for a given number of firms results in a positive increase in relative plant size from G5 to a higher equilibrium G6.

The fact that domestic oligopolists ignore the tariff limit price would imply that an increase in tariff protection is not expected to influence their scale of operation. Thus $\partial q/\partial P^*$ is zero because the line segment MN in diagram 4.12 is unchanged in response to changes in the tariff limit price. Analytically, it is clear from (16a) that $\partial^2 q/\partial S \partial P^* = 0$ as well.

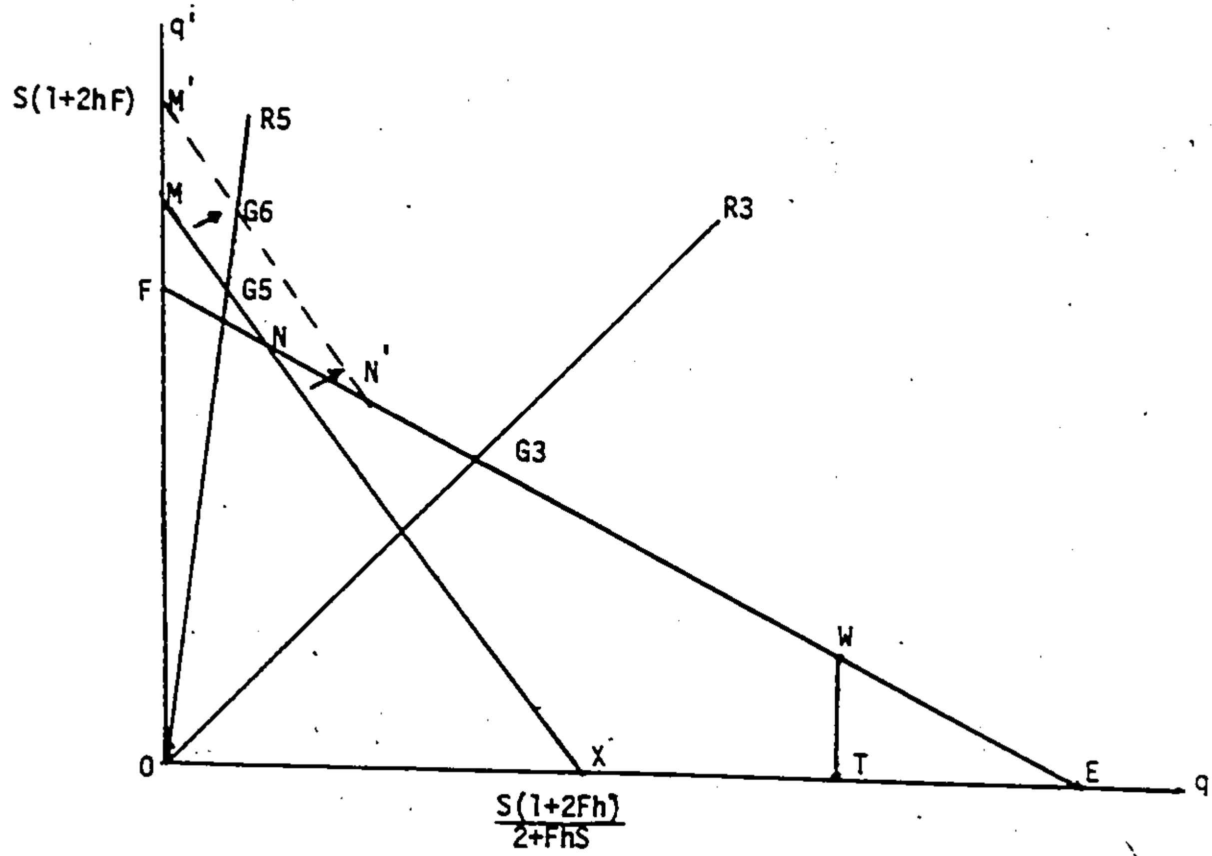


DIAGRAM 4.12: SHOWING THE POSITIVE INFLUENCE OF MARKET SIZE ON RELATIVE PLANT SCALE IN THE SHORT-RUN, CASE 3.

4.2.2 Long-Run Equilibrium With Free Entry

This section presents the long run impacts of tariffs, market size and their joint effect (the Eastman-Stykolt effect) on relative plant scale, taking into account entry of new firms.

Case 1: Import Competition With Entry

As discussed earlier in Section 4.1.3, the import competing firms' long run equilibrium is not determined in this range. Consequently, the influence of Canadian tariff protection, market size and the Eastman-Stykolt effect on relative plant scale becomes undefined.

Case 2: Tariff Limit Pricing With Free Entry

The easiest way to show the impact of tariff on relative plant scale is through a diagram such as 4.13. Suppose the initial relative plant scale is q_0^* and price (P_0^*) is equal to the unit cost of production such that firms are in a zero profit position. An increase in the tariff limit price from P_0^* to P_1^* will result in positive profits for existing firms at initial q_0^*. This pure profit, measured as the distance DA in diagram 4.13 encourages potential entrants, even at a scale below minimum efficient plant size.

Entry will continue until profit is zero at B on the long run average cost curve or until the system starts to move down the demand curve. Hence, each existing firm in the long run is expected to operate a smaller relative plant scale (q_1^*) and incur a higher unit

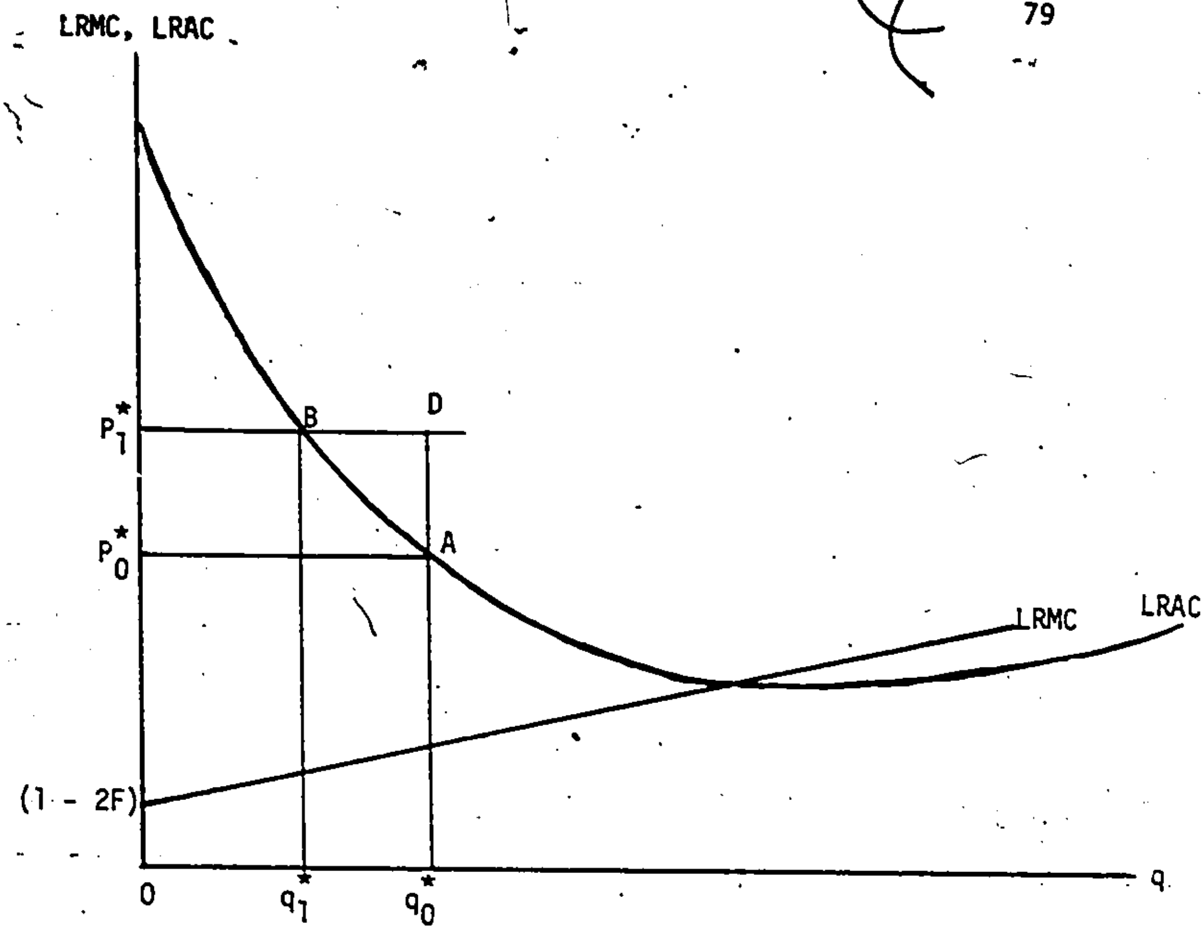


DIAGRAM 4.13: THE NEGATIVE INFLUENCE OF TARIFF PROTECTION ON CANADIAN RELATIVE PLANT SCALE IN THE LONG RUN, CASE II.

cost at B on the long run average cost curve. Analytically, this negative influence of tariff protection on relative plant scale can be seen from the firm's output in equation (18) as

$$q = \frac{(P^* + 2F-1) - [1 + 4F(P - 1) + P(P - 2)}{2F}$$

From the above equation (18), $\partial q/\partial P^* = \frac{1}{2F}[3 - 2(2F + P^*)]$. The second term $2(2F + P^*) > 3$ since average fixed cost is positive and the tariff limit price is assumed to exceed unity. An increase in Canadian tariff protection will result in excessive entry with each firm operating plants below the minimum efficient scale than the market could accommodate.

Also, the impact of both the market size and the Eastman-Stykolt effect on relative plant scale is zero. Analytically, this is obvious from equation (18) since $\partial q/\partial S = 0$ and $\partial^2 q/\partial SP^* = 0$.

Case 3: Domestic Oligopolists with Free Entry

In case 3, domestic oligopolists maximize profits at the same equilibrium regardless of the changes in Canadian tariff protection[4]. Thus, increased tariff protection is not expected to influence oligopolists' scale of manufacturing plants in Canada. From the long run equilibrium in equation (21), it is clear that $\partial q/\partial P^*$ is zero.

Market size, however, is seen to exert a positive influence on relative plant scale. The easiest way to show the positive impact of market size on relative plant scale is through equation (20). Specifically from equation (20) $\partial q/\partial S = \dfrac{hF(1 - q^2)}{2q(1 + FhS)}$, which is positive because, in equilibrium, q is less than unity as demonstrated in equation (21).

Since $\partial q/\partial P^*$ is independent of P^* the cross partial $(\partial^2 q/\partial P^* S)$ is also zero. Hence, the Eastman-Stykolt effect does not operate when oligopolists charge a price intermediate between the tariff limit and the world price.

Summary of the Expected Signs: Cases 1, 2 and 3 With and Without Free Entry

Table 4.1 presents a summary of the comparative static results of tariff, market size and the Eastman-Stykolt effect on relative plant scale. For each case, we report the predicted sign under conditions of no entry and free entry equilibrium. Under Case 1 for example, with no entry, the expected impact of an increase in Canadian tariff on relative plant scale ($\partial q/\partial P^*$) is positive (+). Similarly, for Case 2, with no entry, the expected influence of tariff on plant scale becomes negative (-). However, for Case 3, the influence of tariff on plant scale is zero. Table 4.1 also shows that the Eastman-Stykolt effect ($\partial^2 q/\partial S \partial P^*$) only exists with no entry under Case 2. With free entry, the tariff level continues to exert a negative impact on relative plant scale but the Eastman-Stykolt effect disappears.

Eastman and Stykolt (1967, 102-103), predicted that the Canadian tariff exerted a more deleterious effect on relative plant scale when the size of the Canadian market is small relative to minimum efficient plant scale. This implies that the cross-partial derivative $\partial^2 q/\partial P^* \partial S$ should be positive. Our model, however, shows that $\partial^2 q/\partial P^* \partial S$ is negative and is not in the direction predicted by Eastman and Stykolt. Specifically $\partial^2 q/\partial P^* \partial S$ is non-zero only in Case 2 with no entry but its

TABLE 4.1

Summary of Expected Signs of Tariff, Market Size and the Eastman-Stykolt Effect on Relative PLant Scale For Import Competition (Case I) at the Kink (Case II), and Domestic Oligopoly (Case III), No Entry and Free Entry

Variable Names	NO ENTRY			FREE ENTRY		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
Partial Derivative of Relative Plant Scale with respect to Canadian Tariff $\frac{dq}{dP^*}$	+	-	0	NF	-	0
Partial Derivative of Relative Plant Scale with respect to Market size $\frac{dq}{dS}$	0	+	+	NF	0	+
Eastman-Stykolt Effect-Cross Partial Derivative of Market Size and Tariff on Relative Plant Scale $\frac{d^2q}{dP^* ds}$	0	-	0	NF	0	0

NF denotes not defined

influence on relative plant scale is the opposite of what Eastman and Stykolt had predicted.

In our model, the apparently perverse impact of the Eastman-Stykolt effect on relative plant scale can be resolved by examining the interaction of two cases: a) domestic oligopoly, and b) tariff limit pricing. In these cases we assumed that the behaviour of the Canadian economy can be approximated by Cournot oligopolists who either price at the tariff limit price or operate plant size too small to exhaust all production economies of scale. For instance, under free entry equilibrium we would expect a) the Canadian tariff exerts a negative influence on relative plant scale, and b) Canadian market size is irrelevant in explaining plant scale. With no entry, however, the tariff continues to exert a negative impact on plant scale but now the market size becomes important.

Hence, when market size is small relative to minimum efficient plant scale, the tariff is important and is negatively related to plant scale. When market size is large relative to minimum efficient plant, the tariff influence on plant scale becomes negligible. This expected relationship between the tariff impact on relative plant scale for different sizes of the Canadian market is depicted in Diagram 4.14.

Suppose the Canadian market size is small relative to minimum efficient plant scale and is given at S_1 in diagram 4.14. In this small market size, Case 2 is relevant and we would expect the tariff to have a negative effect on plant scale such as $(\partial q/\partial P^*)_1$. In a large market such as S_2, Case 3 is relevant and the impact of the tariff on

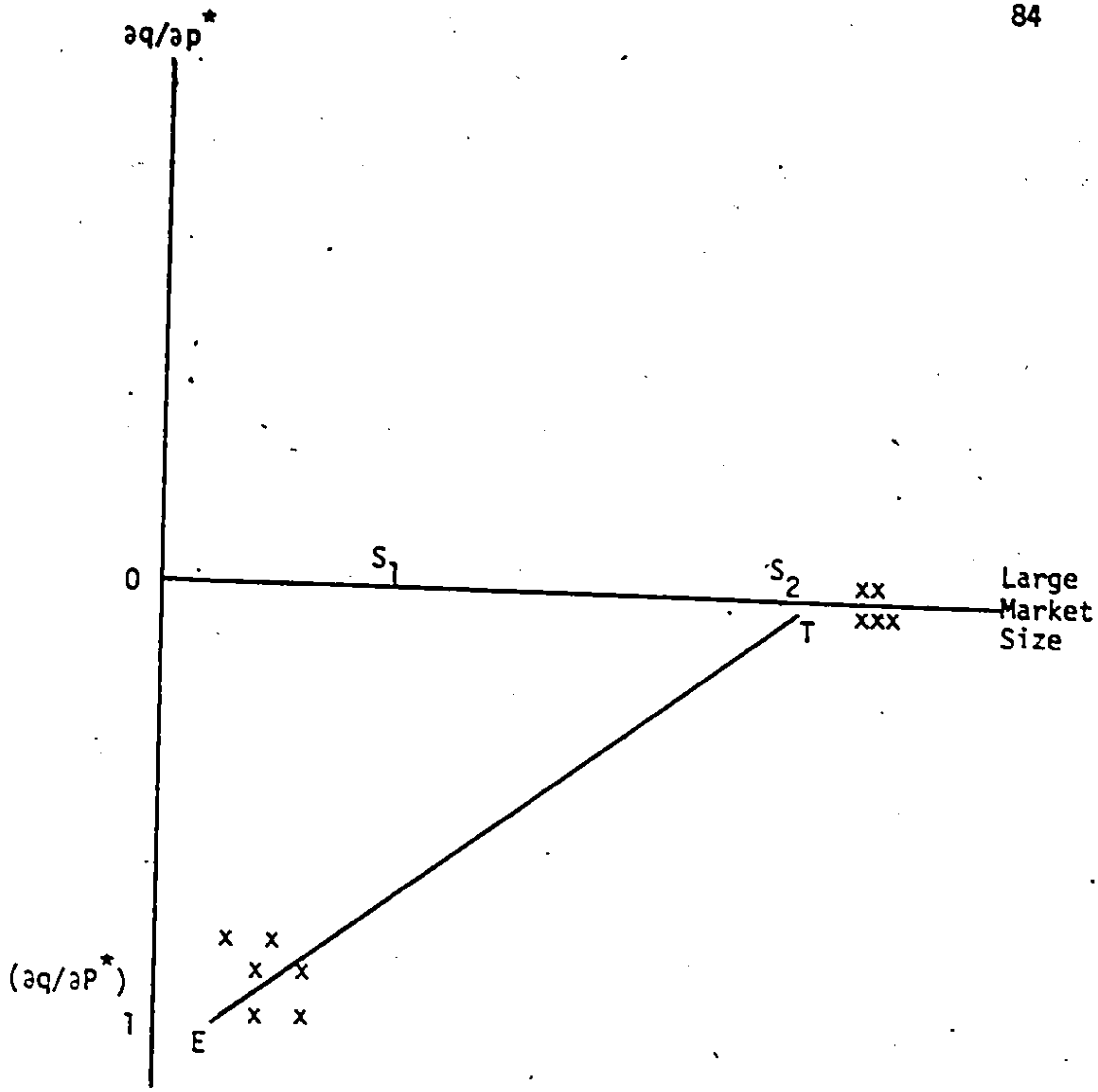


DIAGRAM 4.14: THE INFLUENCE OF CANADIAN TARIFF PROTECTION ON RELATIVE PLANT SCALE WHEN THE MARKET SIZE IS EITHER SMALL OR LARGE RELATIVE TO MINIMUM EFFICIENT PLANT SCALE.

plant scale becomes negligible. Thus, when we estimate the Eastman-Stykolt effect on relative plant scale we will observe a positive association between plant scale and the Eastman-Stykolt variable as shown by line ET in Diagram 4.14.

4.3 IMPLICATIONS FOR TESTING THE EASTMAN AND STYKOLT HYPOTHESIS

The preceding model of the determinants of relative plant scale appears to be the first explicit treatment of the effect of tariffs on relative plant scale. The model implies that relative plant size should be negatively related to small market size, negatively related to tariffs and negatively related to the interaction of the two.

Eastman and Stykolt (1967) conjectured that in industries where MES is large relative to the size of the market, we would expect a greater impact of trade protection on scale inefficiency. Furthermore, scale inefficiency would be more pronounced in those industries where sellers recognize their oligopolistic interdependence. These propositions by Eastman and Stykolt are captured in this model by the interaction of small market size and trade protection though without a model with collusion. Hence, the assumption of collusive oligopolistic behaviour is unnecessary. Thus, the use of a four-firm seller concentration as a surrogate measure to capture firm collusion also seems unnecessary. In fact, q and n are simultaneously determined in this model and concentration is closely related to n (it equals $4 * Q/n$). Consequently, we would introduce simultaneous equation bias if we were to include concentration in a regression explaining plant scale.

4.4.1 EXPECTED SIGNS OF ADDITIONAL VARIABLES

The Cournot model could be extended to allow for the influence of foreign tariffs and non-tariff barriers but that seems quite complicated. Accordingly, we hypothesize without proof the signs we expect for the additional variables included in our regression analysis.

Canadian NTBs

Canadian NTBs serve to insulate the domestic market from the larger foreign market and lead to higher domestic prices via the physical limitation on imports. The greater the degree of protection from efficient foreign competition, the more likely firms will compete among themselves in a small domestic market and produce output levels below the level at which unit production cost attains its minimum level. Thus, a negative association is expected between Canadian NTBs and relative plant scale.

The Interaction of Canadian NTBs and Market Size

The interaction of Canadian NTBs with market size works in an analogous manner to other composite variables in promoting scale efficiency. For instance, when the market size is large relative to MES, the impact of Canadian NTBs on relative plant scale disappears. This means we would expect the cross partial derivative of market size and NTBs on relative plant scale to be positive.

US Tariff Protection

US tariff protection promotes scale inefficiency by separating the Canadian market from the larger US market. By restricting Canadian producers to serve the Canadian market, firms are encouraged to construct scale inefficient plants. If the US tariffs were reduced, Canadian producers would have greater access to the large US market and accordingly able to realize economies of scale (Wonnacott and Wonnacott, 1982, 413-414). Thus, a negative relationship is predicted between US tariff protection and relative plant size. Further discussion of the role of US tariffs in preventing scale efficiency is provided in Section 3.1.3.1.

The Interaction of US Tariff Protection and Canadian Market Size

Clearly, the presence of US tariff protection reduces Canadian export market opportunities and induces scale inefficiency. If, however, the Canadian market becomes large relative to the output of a minimum efficient plant, the influence of US tariff on relative plant scale should diminish. Conversely, when Canadian market is small, US tariff protection is expected to exert a negative impact on q. Therefore, the cross partial effect of US tariff and Canadian market size on relative plant scale is expected to be positive.

US Non-Tariff Barriers (NTBs)

Like US tariff, US NTBs reduce Canadian export potentials and accordingly promote scale inefficient operation. Thus a negative relationship is expected between relative plant scale and US NTBs.

The Interaction of US NTBs and Canadian Market Size

When the Canadian market is large relative to MES level, the impact of US NTBs on relative plant scale disappears. In instances where Canadian market is small relative to MES, US NTBs is expected to exert a negative impact on relative plant scale. Therefore, the cross partial derivative of market size and US NTBs on relative plant scale is predicted to be positive.

4.4.2 Other Variables

In addition to US tariff, US NTBs and Canadian NTBs, there are other variables including subsidy, transportation cost, product differentiation and Research and Development used to explain relative plant scale. These control variables have been employed by many authors including Baldwin and Gorecki (1983c) to explain relative plant scale. For convenience, we have discussed and incorporated these variables in our regression analysis.

Canadian Subsidy

Canadian subsidy is expected to prevent scale efficiency by raising the domestic price received by the producer above the world price by the full amount of the subsidy (Moroz, 1984, 11). By raising domestic price above the world price of imports, the subsidy separates the Canadian market from the rest of the world and encourages firms to build scale inefficient plants. Thus, a negative relationship is expected between subsidy and relative plant scale.

Transportation Cost and Its Interaction With Canadian Market Size

The influence of transportation costs on relative plant scale depends crucially on unit production cost (UPC) relative to outbound unit transportation cost (UTC). Firms would expand average plant size to the point where the incremental saving accruing from declining average production cost equals the incremental cost of transporting the increased output to distant customers. Scherer (1973, 38) argues that firms would build that particular plant size by minimizing average total cost (ATC) which is the sum of UPC and UTC.

Diagram 4.15 describes the relationship between unit transportation cost, unit production cost and the minimum point on the average total cost curve. The continuous decline of UPC means that unit production cost falls as output is expanded towards the MES plant, X. As increased output is shipped to more distant markets, unit transportation cost increases and is reflected in the upward slope of UTC curve.

Average total cost is minimized at a smaller output level OX and a higher than minimum unit production cost, namely CX of UTC and BX of UPC. The scale of production might be smaller or larger than OX depending on the size of the relevant market. If the national market becomes large (North American rather than across Canada), UTC would be lesser relative to UPC and average plant size would be larger than OX. Such trade would provide increased opprotunities for Canadian industrial plants to expand their scale of production towards the MES level and accordingly the Eastman-Stykolt effect on relative plant is expected to be positive.

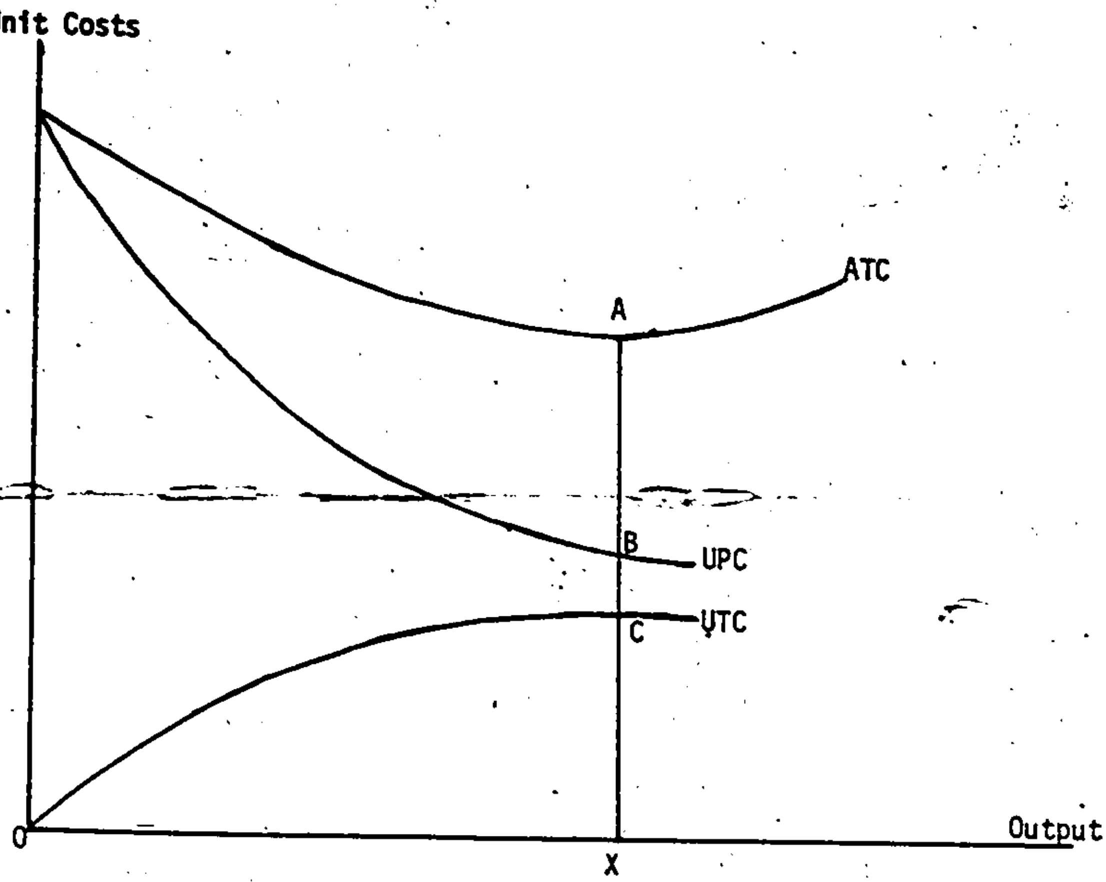


DIAGRAM 4.15: RELATIONSHIP BETWEEN UNIT TRANSPORTATION COST, UNIT PRODUCTION COST AND THE MINIMUM POINT ON THE AVERAGE TOTAL COST CURVE

ATC denotes Average Total Cost

UPC denotes Unit Production Cost

UTC denotes Unit Transportation Cost

X is the Minimum Efficient Scale Plant

Source: Scherer (1973, 38)

Product Differentiation

Product differentiation, created by locational advantages, customers' brand loyalty and physical product attribute might influence the extent of suboptimal capacity. Product differentiation results in decreasing the price elasticity of demand and allows firms to exert a control over the demand for their products. The more effective is the market demand control, the greater is the firms' market power and hence its ability to raise price above minimum average cost of production. Baldwin and Gorecki (1983C, 42), describe product differentiation as a "rent yielding asset" which permits a firm to command a "price premium" to offset the higher cost incurred in operating a suboptimal plant relative to the cost associated of a MES plant. This leads to a positive association between product differentiation and suboptimal capacity.

Research and Development (R & D)

In developing and processing new productive techniques, heavy initial expenditures are required on R & D. These expenditures which are necessary to implement new efficient productive equipments may create a barrier for existing plants to expand towards the MES level or the entry of plants at MES level. Baldwin and Gorecki (1983C, 42) argued that R & D works in an analogous manner as advertising in promoting scale efficient plants.

Variance in Margins

The theoretical relationship between variance in margins and relative plant scale has been developed by Baldwin and Gorecki (1983C, 46). They argued that the large variation in earnings ratio within an industry, the more likely will small and large firms co-exist side by side.

Specifically, they suggested that the variance in margin or the "coefficient of variation is another proxy for market segmentation" which induces firms to systematically construct plants below MES level. A negative relationship is hypothesized between relative plant scale and variance in margins.

Cost Disadvantage Ratio

The cost disadvantage ratio, defined as the cost incurred in operating a suboptimal scale plant relative to the cost associated with an MES plant, might influence the extent of suboptimal capacity. Usually the cost disadvantage ratio is reflected by the slope of the long-run average cost curve below MES plant. Scherer et. al. (1975, 80) estimates the cost penalty by a plant size equal to 1/3 of MES; whereas, Pratten (1971), Weiss (1976, 131), Gupta and Fuss (1979, 17-24) provided estimates of the cost penalty at 1/2 of an MES plant. Unlike these studies, Baldwin and Gorecki (1983c, 36) used a proxy measure of the cost disadvantage ratio as "the ratio of value added per man-hour of the smallest plants accounting for 50 per cent of industry employments, divided by the value added per man-hour of the largest plants accounting for 50 per cent of industry employment" In our study we have employed two measures of the cost disadvantage ratio: a) the Gupta and Fuss cost penalty at 1/2 of MES plant, and b) the Baldwin and Gorecki proxy measure.

If the long-run average cost curve rises sharply below the MES plant level, we would expect increased pressure on firms to build efficient plant scale. Conversely, if the cost curve falls less steeply below MES, the cost disadvantage ratio becomes insignificant, suggesting that firms might build suboptimal sized plants. Thus, a negative association between suboptimal capacity and the cost disadvantage ratio is hypothesized.

FOOTNOTES

Chapter 4

1. Let units of output be chosen so that the output of a MES plant equals 1. Let units of price be chosen so that minimum average cost equals 1. Then the relative size of the market, S, is defined by the condition

   $1 = H(S)$

   and the elasticity of demand at the competitive output level, h, is defined by

   $$h = -\frac{P}{S}\frac{dQ}{dP} = -\frac{1}{S}\left[\frac{dH(S)}{dQ}\right]^{-1}$$

   Substituting equation (1) for H(Q) in the expression yields

   $$S = \frac{A-1}{g} \text{ and } h = \frac{1}{A-1}.$$

2. Solving $S = (A - 1)/g$ and $h = 1/(A - 1)$ for A and g yields

   $A = 1 + 1/h$

   $g = 1/hS$

   Substituting into equation (1) yields

   $P = 1 + 1/h - Q/hS$

3. We assume here that imports from the rest of the world are large enough to begin with so that the market is not driven to the kink, and hence, Case 2.

4. This condition holds as long as tariffs do not fall substantially enough to move us back into Case 3.

CHAPTER 5

NON-TARIFF BARRIERS

As mentioned in chapter 3, previous studies have found tariff protection variable to be statistically insignificant in a regression equation explaining scale inefficiency. Such insignificant tariff estimates might be due to the problem of misspecification; for example, failure to incorporate US tariff and US-Canadian non-tariff barriers to international trade in manufactured goods. In recent years, many writers have emphasized the importance of non-tariff barriers, particularly following the Kennedy Round (1964-67) and more recently the Tokyo Round (1973-79) of tariff reductions on a wide range of manufactured goods[1]. For instance, in their study on the determinants of protection in the US economy, Ray and Marvel (1983, 453) found that "in many cases tariffs have been replaced or supplemented by the proliferation on non-tariff impediments to trade". Also, the MacDonald Commission (1984, 312) have repeatedly raised great concern about non-tariff barriers which have been growing in importance relative to tariffs. The Commissioners cited "measures of contingent protection" and "laws or regulations as the main forms of US barriers affecting Canadian exports".

Hence, this chapter is concerned with the identification and measurements of non-tariff barriers relying mainly on existing literature. Section 5.2 describes the identification and the number of ways in which non-tariff barriers can be measured, and the advantages of each method. Next, Section 5.2 reports and describes a relatively unexploited source of data on non-tariff barriers released by the U.S. International Trade Commission in 1975 that will be incorporated into our empirical model.

5.1 Identifying Non-Tariff Barriers

A wide range of non-tariff barriers exist such as import quotas, government procurement policies and production subsidies. Not only are there many dissimilar non-tariff barriers but they are often difficult to identify especially in the case of custom clearance procedures and consular formalities. In particular the presence of multiple non-tariff barriers make the task of identifying the individual impact of non-tariff impediments on output and price extremely difficult. This wide application of non-tariff barriers led Balassa (1973, 422) to define non-tariff protection afforded to domestic industry as 'new protectionism' with that of tariff protection as 'old protectionism'. A useful classification of non-tariff barriers is provided by Inglo Walters (1972, 336-338).

<u>Type I</u>. Policies and practices designed specifically to expand exports or impede imports

<u>Type II</u>. Measures intended to deal primarily with problems not related to trade, but which are from time to time

purposely used for trade restrictive reasons.

Type III. Measures intended to deal only with non-trade related problems but whose effects unavoidably spill over into the trade sector.

5.1.1 Measurement of Non-Tariff Barriers

There are at least two different approaches to measuring non-tariff barriers: a) "Counting or the inventory approach method", and b) tariff equivalence. The counting approach was extensively employed by Walters (1972) to approximate import-directed Type I or Type II non-tariff barriers by applying the following formula:

$$A_j = \frac{N_R}{\sum N_j} \times 100$$

where N_R represents the number of commodities subject to non-tariff barriers within a 2-digit Standard Industrial Trade Classification; and $\sum N_j$ is the total number of individual commodities included in that class.

The counting method allows easy computation of the percentage of commodities subjected to quantitative restriction, especially where several types and non-transparent non-tariff barriers exist. Adopting the above index of non-tariff barrier incidence, Walters computed the percentage of commodities subjected to quantitative restriction for many western economies, including the US and Canada in 1967. Table 5.1

TABLE 5.1

Coverage of Non-Tariff Import Barriers (Per cent of Commodities Covered by NTBs with Each Commodity Group)

Commodity Group	U.S.	Canada
Live Animals	17	17
Meat	25	8
Dairy	50	50
Fish	25	--
Cereals	14	26
Fruit	--	--
Sugar	33	--
Coffee, tea, cocoa, spices	--	--
Feeds	--	--
Miscellaneous Food Preparation	--	33
Beverages	20	20
Tobacco	33	--
Hides and Skins	12	--
Oil, seeds and nuts	11	--
Crude rubber	--	--
Wood and cork	--	27
Pulp and waste paper	--	--
Textile Fibers	8	--
Crude Minerals and Fertilizers	--	--
Metal Ores and Scrap	--	--
Miscellaneous Crude Animals/Vegetables Materials	--	--
Coal, Coke and Briquettes	--	20
Petroleum	25	--
Gas	--	--

-- denotes not available.

SOURCE: Ingo Walters, (1972, 341)

shows that non-tariff barriers are applied more on the agricultural sectors such as diary and cereals; and less regularly on industrial products.

Table 5.1 also shows that US non-tariff barriers are imposed on a comparatively wider range of commodities than on the Canadian counterpart products. This product coverage of non-tariff barriers incidence, however, should be interpreted with caution. In other words, the non-tariff barrier incidence "merely catalogues the nature and frequency with which certain non-tariff barriers are applied to product groups, but fails to provide any indication as to the actual magnitude of the restriction" (Ronnigen and Yeats, 1976, 613).

The above criticism levelled against the inventory approach method to measuring non-tariff barriers has given rise to the calculation of non-tariff protection over and above the protection afforded by tariff. This concept of tariff equivalence is defined by Bhagwati (1965, 53) in "the sense that a tariff rate would produce an import level which, if alternatively set as a quota would produce an identical discrepancy between foreign and domestic price". The tariff equivalent method has been adopted by Moroz (1984, 13) to estimate the tariff equivalence of all non-tariff barriers across all Canadian industries.

Basically, there are two approaches to measuring the tariff equivalent of non-tariff barriers: comparative price analysis and the elasticity approach.

Comparative Price Analysis

Comparative price analysis of the measurement of non-tariff barriers assumes that the protection afforded to domestic producers is approximated 'by the extent to which the price paid to the producers exceeds the world price for imports (Glismann and Neu, 1971, 246; Moroz, 1984, 9-10). In other words, the degree of protection (TE) provided by non-tariff barriers is obtained from the following formula:

$$TE = \frac{\rho^d}{\rho_f} - 1$$

where ρ^d and ρ_f represent domestic and foreign price in one of the currencies.

The application of the comparative price analysis largely depends on the type of the product under consideration. Glismann and Neu (1971, 246), for example, have argued that when the product is homogeneous, data on domestic prices can be obtained through the Business International Statistics while the world price is approximated by the lowest observed price of imports[2].

Adopting comparative price analysis to estimate non-tariff barriers, Ronnigen and Yeats (1976, 623) developed estimates for 15 developed countries and showed that the estimates range from "about 25% in the US to approximately 60% in Japan". This wide variability in the comparative price estimates of non-tariff barriers could arise from the problems of a) acquiring observations on identical product at identical trade levels, and b) the presence of market imperfections (Moroz, 1984, 15).

Hence, the comparative price estimates are unreliable in measuring the non-tariff protection afforded to domestic producers.

Elasticity Approach

The elasticity approach is important in measuring the effect of non-tariff barriers on the value of imports in cases where "neither homogeneous products nor comparable commodity-groups are available (Glismann and Neu, 1971, 251). To estimate the extent of the tariff rate (TQ) required to induce a given change in the quantity of imports (Moroz, 1984, 16) provides the following formula:

$$TQ = \frac{\Delta Q_m}{Q_m} \quad \frac{(1 + t)}{\eta_m}$$

where ΔQ_m is the change in imports induced by non-tariff barriers; Q_m is the pre-non-tariff barriers level of imports; t is the tariff rate and η_m is the import price elasticity of demand.

Information on the level of imports and import price elasticity required to calculate the tariff rate (TQ) is obtained from the appropriate import demand function. For instance, Glismann and Neu (1971, 251) specified the import demand function in logarithmic form as:

(1) $$\log Q_m = \delta_0 + \delta_1 \log \frac{\rho^m}{\rho^d} + \delta_2 \log C$$

where ρ^m and ρ^d denote import and domestic prices; C is the level of comestic consumption; δ_1 and δ_2 denote import price and income elasticity, respectively.

Import price, however, is determined partly by non-tariff barriers, namely import quotas. Thus, a separate equation is required to estimate ρ^m. In logarithmic form, the import price equation is:

(2) $$\log \rho^m = \delta_3 + \delta_4 \log Q + \delta_5 \log \rho^d$$

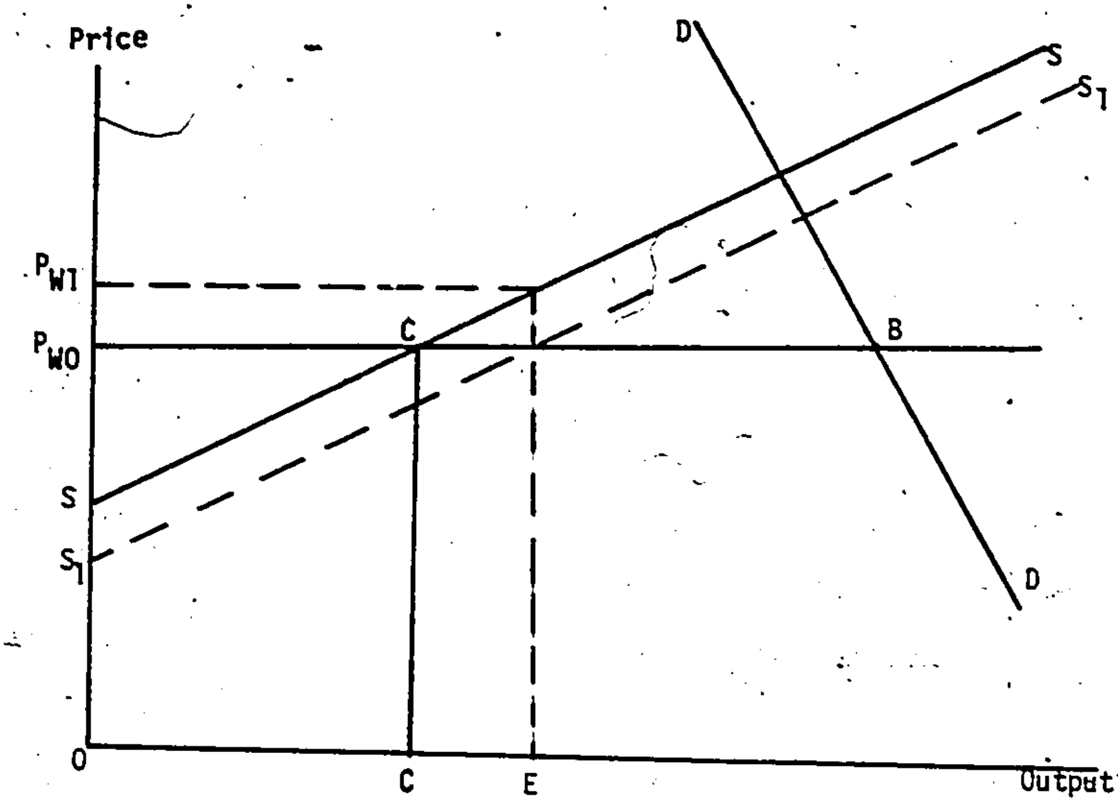
where Q is the level of quota; δ_4 and δ_5 are the appropriate elasticities (Glismann and Neu, 1971, 251; Moroz, 1984, 16-81).

Finally, the appropriate information needed to calculate TQ are obtained from equations (1) and (2). Besides import quotas, there is a production subsidy which influences the price received by the producer but not the price paid by the consumer. The theoretical relationship between the subsidy and domestic production has also been investigated by Moroz (1984, 22-23). Specifically, Moroz argued that in a small open economy domestic producers receive a price above the landed price of imports by the full amount of the subsidy while consumers continue to face the world price. This relationship between production subsidy and producer price is depicted in diagram 5.1.

In the absence of a subsidy, the world price P_{W0} determines the volume of imports (CB) and the level of domestic production (OC). With the imposition of the subsidy and for non-tariff barriers, however, the supply curve SS is lowered to SS_1 and the level of imports are displaced by CE increase of domestic production. Hence, the price received by producers increases from P_{W0} to P_{W1}. Consumers, however, are not affected by the new world price P_{W1}. They continue to face the original price P_{W0}.

DIAGRAM 5.1

The Relationship Between Production Subsidy, Producer Price and the Level of Imports



DD denotes Demand Curve

SS denotes Supply Curve

P_{WO} denotes world price

P_{W1} denotes world price (including subsidy)

SOURCE: Moroz, (1984. Figures 3, 11).

5.1.2 CONCLUSION

Many studies have repeatedly documented the relative importance of non-tariff barriers over tariff protection in protecting inefficient manufacturing industries. However, none of the studies provides a reliable method to estimate the impact of non-tariff barriers on the extent of suboptimal capacity in Canada. For instance, each of the two different ways of measuring NTBs (the inventory and tariff equivalence) has certain advantages and disadvantages. Moroz (1984), however, has provided a more useful method of estimating NTBs, by measuring the protection over and above the protection afforded by tariff.

5.2 US Tariff Commission Data on Non-Tariff Barriers and US Tariff

This section describes in detail the sources involved in assembling the data set on non-tariff barriers and US tariff protection to be used in explaining relative plant scale across Canadian manufacturing industries.. This study makes use of Ingo Walter's inventory approach, the method to estimate import and subsidy non-tariff barriers. Moroz is currently involved in estimating the tariff equivalents of various non-tariff barriers and thus his data are not made available to use. The data on Canadian-US non-tariff barriers and US tariff protection were obtained from the US International Trade Commission(USTC, 1975). We obtained two measures of US tariff protection: a) US nominal rate of protection, and b) Post Kennedy Round Rates.

For each country, the USTC created a matrix for 15 types of quantitative restrictions over 1318 items of the five digit Brussels Tariff Nomenclature. The types of quantitative restrictions were:

1. Bilateral quota
2. Global quota
3. Quota (unspecified)
4. Prohibited imports (embargoes)
5. State trading
6. Automatic licensing
7. Liberal licensing
8. Discretionary licensing

9. Licensing (unsuspended)
10. Minimum price system
11. Seasonal restriction
12. Restriction (unspecified)
13. Export restraint
14. Suspended import restrictions
15. Mixing regulations

The index of non-tariff barriers, published by US Trade Commission is the actual number of non-tariff barriers as a percentage of the total possible within the Standard Industrial Classification (SIC) category. Hence, it is considered as "a relative measure of the frequency of existence of known non-tariff barriers within various SIC categories". As a dummy variable, moreover, it varies from 0 to 1, according to whether a particular SIC category has some non-tariff barriers applied to it.

Using the concordance provided by Baldwin and Gorecki (1983C, 107-120), we obtained 155 matching Canadian industries from the USTC data set. In chapter 2 we mentioned two data bases: a) the Gupta and Fuss data for 79 Canadian industries in 1968, and b) the Baldwin and Gorecki data for 120 industries in 1970 and 1979. These data sets are supplemented with USTC data to explain suboptimal capacity (1968) and relative plant scale (1970 and 1979). However, only a subset of the USTC data is used for this purpose. When the dependent variable is suboptimal capacity, 12 industries are excluded to obtain a set of industries corresponding to the Gupta and Fuss data set; and in the case of relative plant scale 35 industries were omitted to match the Baldwin and Gorecki data set.

Finally, for a given Canadian SIC code, each US industry is weighted by the sales weight and then summed across to yield the total external protection facing Canadian producers. The sales weight are directly available from the concordance table. Table 5.2 describes the US-Canadian trade barriers across 120 Canadian manufacturing industries in 1970.

Table 5.2 shows that Canadian non-tariff barriers are mainly concentrated in affording protection to Food and Beverages, and to the Tobacco Produce Industries. For instance, under the Food and Beverage SIC codes 1020 (Fish Product Industries); 1040 (Dairy Products); 1050 (Flour and Breakfast), and 1094 (Wineries), the degree of protection ranges from 3 to 5 per cent. In the Tobacco Product Industries, SIC codes 1510 (Leaf Tobacco) and 1550 (Tobacco Products) it is as high as 7 per cent.

In the case of US protection facing Canadian producers, US non-tariff barriers are applied to a wider range of industries than those of Canada. For instance, the percentage of actual non-tariff barriers facing Canadian producers ranges from 3 to 8 per cent.

TABLE 5.2

US International Trade Commission Data on Canadian NTBs and US Trade Barriers Across 120 Four-Digit SIC Canadian Manufacturing Industries in 1970

1970 SIC	Industry Name	Canadian NTBs	US NTBs	US Tariff	Post Kennedy Round Rates
1011	Slaughtering & Meat Processors	.0045	.01986	.04806	.04580
1012	Poultry Processors	.01013	.00891	.11547	.11117
1020	Fish Products	.03025	.00973	.03237	.02482
1031	Fruits & Vegetable Canners and Preservatives	.00560	.00173	.09549	.08570
1032	Frozen Fruits and Vegetable Processor	.02400	.00500	.11400	.11400
1040	Dairy Products	.04411	.07579	.08037	.08679
1050	Flour and Breakfast Cereal Product	.04344	.02885	.03734	.02696
1060	Feed Industry	.01878	.00782	.02034	.01565
1071	Biscuit Manufacturers	.01878	.00782	.02034	.01565
1072	Bakeries	.00000	.02200	.04200	.02800
1081	Confectionery	.01024	.05513	.07642	.05850
1082	Cane and Beet Sugar	.00900	.06700	.06700	.07800
1083	Vegetable Oil Mills	.06623	.00000	.30118	.19731
1091	Soft Drinks	.00000	.00000	.01200	.01100
1092	Distillers	.03300	.03300	.12600	.09100
1093	Breweries	.01700	.00800	.05800	.04100
1094	Wineries	.04700	.03300	.09100	.08300
1510	Leaf Tobacco Processors	.06700	.00000	.16500	.17200
1530	Tobacco Products	.06700	.00000	.37992	.42431
1720	Leather Tanneries	.00000	.00000	.07200	.05500
1740	Shoe Factories	.00000	.00000	.02920	.02250
1750	Leather Gloves Factories	.00000	.00000	.19400	.22700
1792	Boot and Shoe Findings	.00000	.00000	.06300	.04500
1810	Cotton and Spun Yarn Throwsers and Cloth	.00036	.00361	.21719	.05410
1820	Wool Yarn and Cotton Mills	.00429	.00593	.09594	.07480
1831	Fibre	.00460	.00718	.15000	.11622
1840	Cordage and Twine	.00000	.03300	.05400	.05100
1851	Fibre Processing Mills	.00000	.01949	.14057	.11267

...continued

1970 SIC	Industry Name	Canadian NTBs	US NTBs	US. Tariff	Post Kennedy Round Rates
1852	Processed and Punched Felt Mills	.00000	.03300	.20000	.17200
1860	Carpets, Mat and Rug	.00000	.02200	.13500	.10200
1871	Cotton and Jute Bags	.00000	.03300	.05400	.03900
1872	Canvas Products	.00000	.00000	.00000	.00000
1891	Thread Mills	.00000	.00900	.17800	.17600
1892	Narrow Fabrics Mills	.00100	.01100	.17400	.14300
1893	Embroidery, Pleating and Hemstitching	.00322	.01715	.11643	.08566
2310	Hosiery Mills	.00265	.03565	.31316	.30246
2391	Knitted Fabric Manufacturers	.03300	.03300	.27200	.27200
2450	Children's Clothing	.00500	.03000	.25400	.25500
2460	Fur Goods	.00500	.03000	.25400	.25500
2480	Foundation Garments	.00500	.03000	.25400	.25500
2491	Fabric Globes Manufacturers	.00500	.03000	.25400	.25500
2492	Hat and Cap Industry	.00500	.03000	.25400	.25500
2520	Veneer and Plywood Mills	.00000	.00000	.12600	.12500
2543	Pre-Fabricated Buildings (WD Frames)	.00000	.00000	.09500	.06600
2560	Wooden Box Factories	.00000	.00000	.01708	.01584
2580	Cofin and Casket	.00000	.00000	.00000	.00000
2640	Office Furniture	.00800	.00800	.11626	.08351
2680	Electric Lamp and Shade	.00000	.00000	.00000	.00000
2710	Pulp and Paper Mills	.00000	.00000	.01459	.00826
2720	Asphalt Roofing	.00000	.00000	.01900	.00000
2731	Folding Cartoon and Set-Up Box	.00000	.00000	.08800	.06500
2733	Paper and Plastic Bags	.00000	.00000	.09900	.07100
2860	Commercial Printing	.00125	.00292	.03121	.02493
2870	Platemaking, Tyeset,Trade, TRD. Bind.	.00692	.00859	.01245	.01551
2910	Iron and Steel Mills	.00000	.00179	.06116	.05967
2920	Steel Pipe and Tube Mills	.00000	.00000	.05100	.05100
2940	Iron Foundries	.00000	.00000	.04500	.03600
2960	Aluminium Rolling, Casting and Extrud.	.00000	.00000	.03393	.02674
2970	Copper and Alloy Rolling, Casting, Extrud.	.00000	.00000	.03775	.03066
3010	Boiler and Plate Works	.00000	.01500	.08700	.06400

...continued

1970 SIC	Industry Name	Canadian NTBs	US NTBs	US Tariff	Post Kennedy Round Rates
3020	Fabricated Structural Metal	.00000	.00000	.06400	.05600
3031	Metal Door and Window	.00000	.00000	.10200	.07500
3041	Metal Coating	.00000	.00000	.08000	.08000
3042	Metal Stamping and Pressing	.00000	.00000	.05845	.04501
3050	Wire and Wire Products	.00000	.00000	.04440	.03435
3060	Hardware, Tool and Cutlery	.00000	.00000	.09186	.06978
3070	Heating and Equipment	.00000	.00000	.08100	.05800
3110	Agricultural Implements	.00000	.00000	.00000	.00000
3160	Commercial Refrig. and Air Conditioning	.00000	.00000	.05100	.03700
3180	Office and Store Machinery	.00000	.00000	.02780	.01987
3210	Aircraft and Aircraft Parts	.00966	.00966	.05459	.04953
3230	Motor Vehicles	.00000	.00000	.02000	.01400
3242	Non-Commercial Trailer Manufacture	.00000	.00000	.00000	.00000
3243	Commercial Trailer Manufacturers	.00000	.00000	.07800	.08000
3250	Motor Vehicle Parts and Accessories	.00409	.00000	.01613	.01143
3260	Railway Rolling Stock	.00000	.00000	.12800	.11500
3270	Shipbuilding and Repair	.00000	.03300	.05800	.04300
3280	Boat Building and Repair	.00400	.03300	.05700	.04280
3310	Small Electrical Appliances	.00000	.00000	.09200	.06455
3320	Major Appliances (Electric and Non Electric)	.00000	.00000	.08206	.05968
3330	Lighting Fixtures	.00000	.00000	.13500	.12500
3340	Household Radio and TV Receivers	.00000	.00000	.08300	.06600
3350	Communication Equipment	.00867	.00000	.06719	.04009
3360	Electrical Industrial Equipment	.00000	.00000	.08985	.06884
3380	Electric Wire and Cable	.00000	.00000	.10400	.07900
3391	Battery Manufacturers	.00000	.00000	.08952	.07538
3511	Clay Prod. (Domestic)	.00000	.00162	.07131	.06241
3512	Clay Product Manuf. (Imported Clay)	.00033	.00000	.18349	.14724
3520	Cement Manufacturers	.00000	.00000	.01200	.00000
3530	Stone Products	.00000	.00000	.08700	.06300
3540	Manufacture of Structural Con. Prod.	.00000	.00000	.09200	.06900
3561	Glass Manufacturers	.00000	.00000	.05830	.04165

....continued

1970 SIC	Industry Name	Canadian NTBs	US NTBs	US Tariff	Post Kennedy Round Rates
3562	Glass Products	.00200	.00000	.14200	.10800
3570	Abrasives	.00000	.00000	.01100	.00800
3580	Lime Manufacturers	.0000	.00000	.03800	.02200
3591	Refractories	.00000	.00000	.05701	.04152
3651	Petroleum Refining	.00100	.01300	.02300	.04000
3652	Lubricating Oils and Greases	.00100	.01300	.02300	.04000
3720	Mixed Fertilizers	.00000	.00000	.00000	.00000
3730	Plastics and Synthetic Resins	.00000	.00300	.14100	.10200
3740	Pharmaceuticals and Medicines	.00100	.00200	.08900	.06900
3750	Paints and Varnish	.00000	.00000	.05700	.04100
3760	Soap and Cleaning Compounds	.00067	.00135	.05772	.04915
3770	Toilet Preparations	.00000	.00000	.10500	.97700
3781	Manufacture of Pigment and Dry Goods	.00200	.00100	.08100	.06800
3791	Manufacture of Printing Inks	.00000	.00000	.01900	.01400
3911	Instruments and Related Product	.00126	.00160	.07880	.06082
3912	Clock and Watch	.00000	.00000	.25800	.19800
3913	Ophtopaedic and Surgical Appliances	.00000	.01500	.08400	.06100
3914	Ophtalmic Goods	.00000	.00000	.14700	.13700
3915	Dental Laboratories	.00000	.00000	.09800	.07200
3920	Jewellery and Silverware	.00000	.00000	.18487	.13968
3931	Sporting Goods	.00000	.00400	.12100	.09500
3932	Toys and Games	.00669	.00669	.30591	.22958
3970	Signs and Displays	.00000	.00000	.10600	.07800
3991	Brooms, Brushes and Mops	.00000	.00000	.13800	.10200
3992	Button, Buckle and Fastener	.00000	.00000	.17228	.13594
3993	Floor Tile, Linoleum and Coat Fabrics	.00000	.00000	.09992	.08408
3994	Sound Recording and Musical Instruments	.00000	.00000	.10164	.07530
3996	Pencils and Pens	.00000	.00234	.16497	.11851

Source: US Tariffs and US-Canadian NTBs were obtained from US International Trade Commission (1975, Publication #737, various pages). US-Canadian Corresponding industries and the sales weight used to calculate US-Canadian Trade Protections were obtained from Baldwin and Gorecki (1983C, various pages).

FOOTNOTES

Chapter 5

1. See, for example, Ingo Walters (1972, 335); Ingo Walters and Jae W. Chung (1972, 122); Peter Morici and L. Megna (1983, 1-5).

2. Glismann and Neu (1971, 246); A Moroz (1984, 14).

CHAPTER 6

PROCEDURE AND DATA

Previous chapters have provided an improved model of the effect of Canadian tariffs on suboptimal capacity and have identified additional data on non-tariff barriers and trade protection. Now we wish to examine whether both the improved modelling and data on NTBs add to the explanation of suboptimal capacity. To do so we adopt as a starting point the studies of Gupta-Fuss and Baldwin-Gorecki (described in chapter 3). First, we plan to modify their data in light of our theoretical discussion and to add our data on NTBs and foreign tariffs. Second, we will systematically test the effect of opportunities for foreign trade on scale efficiency in Canadian manufacturing using three data sets: the modified Fuss-Gupta data set (Data Set I); and the modified Baldwin-Gorecki data sets (Data Sets II and III).

6.1 HYPOTHESES TO BE TESTED

The hypotheses to be tested are those ones labelled the trade liberalization hypothesis, the Canadian market size hypothesis and Eastman-Stykolt hypothesis. These hypotheses were defined earlier in chapter 4, where a model of the determinant of relative plant scale was constructed.

6.1.1 Main Hypothesis

The trade liberalization hypothesis states that scale efficiency is a function of market size, trade barriers and certain other variables. Thus:

$$E = f(S, B, Z)$$

where E denotes a measure of scale efficiency; S denotes a measure of market size, for example, the ratio of domestic consumption to minimum efficient scale; B denotes a vector of trade barriers, and Z denotes a vector of other variables such as transportation costs.

The general trade liberalization hypothesis holds that efficiency depends negatively on trade barriers, that is

$$\frac{\partial E}{\partial B_i} < 0 \text{ for any component } B_i \text{ of } B.$$

Second, there is the hypothesis that scale efficiency depends positively on market size, that is.

$$\frac{\partial E}{\partial S} > 0$$

This positive impact of S (a direct measure of market size) on scale efficiency is referred to as the market size hypothesis.

Finally, the Eastman-Stykolt hypothesis maintains that trade barriers have a greater deleterious and negative effect on scale efficiency when the Canadian market size is small relative to minimum efficient scale. Conversely, when the Canadian market size is large relative to minimum efficient plant scale, the Eastman-Stykolt effect on relative plant scale disappears. This can be expressed formally as the prediction that

$$\frac{\partial E}{\partial B_i \partial S} > 0$$

A detailed theoretical discussion of the Eastman-Stykolt effect was provided in chapter 4.

6.1.2 Functional Form

The functional form of the regression model chosen is linear with interaction terms. Previous work (Muller, 1982) has shown that an inverse measure of market size, the percentage effect barrier is more successful than large market size in explaining scale efficiency. Let the reciprocal of market size be represented as $P = 1/S$. Note that the expected signs on the derivatives with respect to P will be opposite to those expected with respect to S.

Thus the final functional form is

$$E = b_0 + b_1 P + b_2 B + b_3 (P \times B) + b_4 Z + u$$

where B_i denotes the coefficient and u is a disturbance term representing omitted variables such as government procurement policies. We expect that

$$\frac{\partial E}{\partial P} = b_1 + b_3 B < 0$$

$$\frac{\partial E}{\partial B} = b_2 + b_3 P < 0$$

and

$$\frac{\partial E}{\partial (P \times B)} = b_3 < 0$$

The expressions $(b_1 + b_3 B)$ and $(b_2 + b_3 P)$ are the total effect on scale efficiency of small market size (P) and trade barriers (B). The coefficient 'b_3' measures the impact of the market size interaction term on scale efficiency. The methods used to compute the total effect and standard errors of interaction terms are fully disoussed in Appendix 6A.

6.2 THE DATA: 1968, 1970 AND 1979

This section describes in detail the variables and data sources used in explaining opportunities for foreign trade and the extent of scale efficiency in Canadian manufacturing industries. The mnemonic, names, definition and sources of variables used in 1968, 1970, and 1979 regression equations are reported in Appendix 6B. Specifically we have obtained two measures of scale efficiency: sub-optimal capacity and relative plant scale. The former is available for the year 1968 while the latter is for 1970 and 1979. Thus we have three data sets corresponding to three dependent variables. Data Set I, Data Set II, and Data Set III, respectively, refer to years 1968, 1970 and 1979.

6.2.1 Data Set I, 1968

Data Set I draws from two main sources: (a) Gupta-Fuss and (b) US International Trade Commission (1975). The data set includes 79 Canadian manufacturing industries from an universe of 91 three- and four-digit 1960 SIC codes. Twelve industries were omitted due to the 1970 SIC revisions which are more aggregated than the 1960 SIC. The 1970 SIC 105, for example, includes flour mills (124) and breakfast cereals (125) which were previously classified as separate industries. Table 2.1 in chapter 2 provides a listing of the Gupta-Fuss data while Table 5.1 (chapter 5) describes the US Trade Commission data.

6.2.1.1 Dependent Variable

The dependent variable used in the 1968 regression analysis is suboptimal capacity (SI68), which is the fraction of industry output originating from plants of less than minimum efficient scale. This variable was obtained from Gupta-Fuss (1979) and was fully discussed in Section 2.3.1.4.

6.2.1.2 Independent Variables

The number of independent variables used in 1968 regression analysis of suboptimal capacity draws mainly from Gupta-Fuss and is supplemented with additional variables on NTBs and tariffs.

6.2.1.3 Included Gupta and Fuss Variables

In Gupta-Fuss 1979 study on returns to scale and suboptimal capacity, two independent variables were obtained: the percentage effect barrier (small market size) and the cost disadvantage ratio. Each of these variables is scaled in ratio form and is shown on Table 2.3 in chapter 2.

6.2.1.4 Additional Variables

Additional variables to the Gupta-Fuss data set are the interaction of cost disadvantage ratio with small market size; US-Canadian tariffs, US-Canadian NTBs and their respective interaction with small market size variables; and, finally the level of transportation cost and its interaction with small market size.

Note that data on trade barriers for 1968 were not available. Instead, data on 1970 trade barriers were employed to explain suboptimal capacity in 1968 on the assumption that the missing values for 1968 are highly correlated with the actual values used.

The mnemonics, names and expected signs of variables on suboptimal capacity in Data Set I, 1968 are shown on Table 6.1. These expected signs were based on both the model of relative plant scale and the theoretical discussions provided in chapter 4.

TABLE 6.1

Mnemonic, Variable Names and Expected Signs of Variables in Regression Analysis Across 79 Canadian Manufacturing Industries, 1968

Mnemonic	Variable Names	Expected Sign
CDR	Cost Disadvantage Ratio, 1968	-
CDRSM68	CDR Interacting with PEB68	+
CNTB68	Canadian Non-Tariff Barriers, 1968	+
CNTBSM68	CNTB68 Interacting with PEB68	+
NRP68	Canadian Nominal Rate of Protection, 1968	+
NRPSM68	NRP68 Interacting with PEB68	+
PEB68	Canadian Small Market Size, 1968	+
PKR	Post Kennedy Round Rates	+
PKRSM	PKR Interacting with PEB68	+
SI68	Suboptimal Capacity, 1968	*
SUB68	Canadian Unit Subsidy, 1968	+
SUBSM68	SUB68 Interacting with PEB68	+
USNTB68	US Non-Tariff Barriers, 1968	+
USNTBSM8	USNTB68 Interacting with PEB68	+
USNRP68	US Nominal Rate of Protection, 1968	+
USNRPSM8	USNRP68 Interacting with PEB68	+
UTC68	Canadian Unit Transportation Cost, 1968	+
UTCSM68	UTC68 Interacting with PEB68	+

* Dependent Variable

6.3 DATA SET II

The 1970 data base includes 120 Canadian manufacturing industries and draws primarily from Baldwin-Gorecki and the US Trade Commission. The Baldwin-Gorecki data on 120 Canadian industries were initially derived from 167 four-digit manufacturing industries. Of the 47 industries that were excluded, 26 were classified as miscellaneous, 16 were neglected due to differences in the US and Canadian SIC systems; and a further five industries were omitted because trade variables for comparative advantage and intra-industry trade were undefined[2]. Most of the excluded industries are clothing, textile and wood. Table 6.2 describes the 1970 SIC and the names of excluded industries.

6.3.1 Dependent Variable

Relative plant scale (EFF1T70) is the dependent variable for 1970 regression equations. Earlier in Section 2.3.1.5, a full description of EFF1T70 was provided. It is the ratio of the average size of Canadian largest plants to the average size of US largest plants. The average size is measured in terms of shipments of the smallest number of the largest plants accounting for 50 per cent of industry employment for 1970 in Canada and comparable US industries (Baldwin-Gorecki, 1981c, 12).

TABLE 6.2

1970 SIC Code and Names of Industries Excluded from Data Set II, 1970

(1089)	Miscellaneous Food Processors, N.E.S.
(1620)	Rubber Products Industries
(1650)	Plastics Fabricating Industry, N.E.S.
(1799)	Miscellaneous Leather Products Manufacturers
(1832)	Throwsters, Spun Yarn and Cloth Mills
(1880)	Automobile Fabric Accessories Industry
(1894)	Textile Dyeing and Finishing Plants
(1899)	Miscellaneous Textile Industries, N.E.S.
(2392)	Other Knitted Mills
(2499)	Miscellaneous Clothing Industries, N.E.S.
(2431)	Men's Clothing Industries
(2432)	Men's Clothing Contractors
(2441)	Women's Clothing Factories
(2442)	Women's Clothing Contractors
(2511)	Shingle Mills
(2513)	Sawmills and Planning Mills
(2541)	Sash, Door, and other Millwork Plants, N.E.S.
(2591)	Wood Preservation Industry
(2592)	Wood Handles and Turning Industry
(2593)	Manufacturers of Particle Board
(2599)	Miscellaneous Wood Industries, N.E.S.
(2611)	Furniture re-Upholstery and Repair Shops
(2619)	Household Furniture Manufacturers, N.E.S.
(2660)	Miscellaneous Furniture and Fixture Manufacturers
(2733)	Corrugated Box Manufacturers
(2740)	Miscellaneous Paper Converters
(2880)	Publishing Only
(2890)	Publishing and Printing
(2950)	Smelting and Refining
(2980)	Metal Rolling, Casting and Extruding, N.E.S.
(3039)	Ornamental and Architectural Metal Industry, N.E.S.
(3090)	Miscellaneous Metal Fabricating Industries
(3080)	Machine Shops
(3150)	Miscellaneous Machinery and Equipment Manufacturers
(3290)	Miscellaneous Vehicles Manufacturers
(3399)	Manufacturers of Miscellaneous Electrical Products, N.E.S.
(3541)	Concrete Pipe Manufacturers
(3549)	Concrete Products Manufacturers, N.E.S.
(3550)	Ready-Mix Concrete Manufacturers
(3599)	Miscellaneous non-Metallic Mineral Products Industry, N.E.S.
(3690)	Miscellaneous Petroleum and Coal Products Industries
(3241)	Truck Body Manufacturers
(3782)	Manufacturers of Industrial Chemicals (inorganic), N.E.S.
(3799)	Miscellaneous Chemicals Industries, N.E.S.
(3998)	Fur Dressing and Dyeing
(3999)	Other Miscellaneous Manufacturing Industries
(3783)	Manufacturers of Industrial Chemicals (organic), N.E.S.

6.3.2 Independent Variables

The set of independent variables employed to explain relative plant scale in 1970 originates partly from Baldwin-Gorecki and the US International Trade Commission. The Baldwin-Gorecki data set, created by Statistics Canada, was confidential according to the Statistics Canada Act. Because of the confidentiality problems inherent in using the Statistics Canada data base, the following methods have been adopted so as to ensure that the appropriate regression on EFFIT70 is performed. First, equations 3 and 7 of Baldwin and Gorecki (1983c, 55-57) have been replicated as reported by the Economic Council of Canada. Second, their extensive data base has been modified and supplemented with USTC data on trade barriers (tariff and non-tariff barriers). The mnemonic, names and explanations of variables which have been either omitted or redefined from Baldwin-Gorecki regression equations are shown in Table 6.3. Finally, relative plant scale is regressed on the combined Baldwin-Gorecki and USTC data set.

6.3.2.1 Included Baldwin-Gorecki Variables

The Baldwin and Gorecki data set includes a relatively large number of explanatory variables of relative plant scale but our analysis has shown that only some of them are appropriate. The included variables are the Canadian nominal rate of protection (NRP), market size (MESMSD), Research and Development (R&D) expenditure, extent of product differentiation (ADVDM) and the earnings sales/ratio (MARCVA).

TABLE 6.3

Mnemonic, Names and Explanation of Variables, Omitted/Redefined from Baldwin-Gorecki Regression Equations 3 and 7.

Mnamonic	Names	Explanations
CA	Comparative Advantage	Endogenous
CON	Concentration Ratio	Endogenous
EASTN EASTFN HNTRHCR HNTRHCRF EASTV EASTFV HVTRHCR HVTRHCRF	Eastman-Stykolt Interaction Terms involving concentration ratio, nominal, effective tariff and foreign ownership	These terms are replaced with other various interaction terms involving small market and high trade barriers
FOR	Foreign Ownership	Not Necessary
REG	Regional Dummy Variables	Replaced with UTC
CDRI, CDR2	Cost Disadvantage Ratio	Replaced with CDRMS
MESMSD	Market Size	Replaced with PEB
MARCVA	Earnings sales/ratio	Remained
ADVDM	Product Differentiation	Served as an entry barrier
NRP	Nominal Rate of Protection	Served as a focal-point-pricing
EFFIT	Relative Plant Size	Remained as dependent variable

SOURCE: The mnemonic and names of variable are obtained from Baldwin and Gorecki (1983c, 98-100).

R&D, the extent of product differentiation and the earnings sales ratio serve as barriers to entry and are included in the vector of variables under Z. We have employed these Baldwin-Gorecki variables mainly because data on these variables were supplied by Statistics Canada and because they are appropriate in explaining relative plant scale.

6.3.2.2 Excluded Baldwin-Gorecki Variables

Variables excluded from Baldwin-Gorecki extensive data set are: the concentration ratio (CON); the extent of foreign ownership (FOR); measure of comparative advantage (CA); the Canadian effective rate of protection (ERP); and, all Eastman-Stykolt interaction terms involving either concentration ratio, nominal tariff, effective tariff or foreign ownership variable (Table 6.3).

In this thesis we have argued that the concentration ratio variable is partly determined by the dependent variable and is therefore endogeneous to the model. Also foreign ownership is irrelevant to the model of the determinants of relative plant scale developed in chapter 4. Other variables such as imports, comparative advantage and intra-industry trade variables are excluded because they are assumed to be partly determined by the dependent variable.

6.3.2.3 Modified Baldwin-Gorecki Variables

In our earlier discussion on the functional form of the regression equation, small market size was considered as an important explanation of scale efficiency. Consequently to adequately capture the effect of the small size of the Canadian market, the Baldwin and Gorecki market size variable has been redefined as its reciprocal. Furthermore, the various Eastman-Stykolt interaction terms have been redefined to reflect the interaction of small market size and trade barriers. These modified interaction terms (without the concentration ratio variable) are in sharp contrast to the Baldwin and Gorecki interaction terms which they represent as the Eastman and Stykolt effect. Lastly, the regional dummy variable is replaced by a measure of unit transportation costs and is included in the vector of variables under Z.

6.3.2.4 Additional Variables to the Baldwin-Gorecki Set of Variables

In addition to the Baldwin-Gorecki modified set of variables are Canadian subsidy, US tariff protection, US NTBs and Canadian NTB variables. In Baldwin and Gorecki's work, however, subsidy was incorporated in the measurement of the Canadian effective tariff protection variable. Hence, if the effective tariff protection and the subsidy were included in the regression, we would introduce high collinearity between these variables. Under these circumstances, effective tariff protection is excluded as a separate explanatory variable of relative plant scale.

The mnemonics, names and expected signs of variables on relative plant scale in Data Set II, 1970 are shown on Table 6.4. These expected signs were based on the model and theoretical discussions provided in chapter 4.

TABLE 6.4

Nmenomic, Variable Names and Expected Signs of Variables Used in the 1970 Regression Analysis Across 120 Canadian Manufacturing Industries, 1970

Mnemonic	Variable Names	Expected Sign
ADVDM70	Advertising Sales Ratio, 1970	-
CDRMS70	V9S70 Interacting with PEB70	-
CNTBI	Canadian Non-Tariff Barriers, 1970	-
CNTBIMS	CNTBI Interacting with PEB70	-
EMPRAT75	R & D Expenditure, 1970	-
EFFIT70	Relative Plant Scale, 1970	-
MMARCVA	Margin/Sales Ratio	*
NRP70	Canadian Nominal Rate of Protection, 1970	-
NRP70MS	NRP70 Interacting with PEB70	-
PEB70	Canadian Small Market Size, 1970	-
SB70	Canadian Unit Subsidy, 1970	-
SB70MS	SB70 Interacting with PEB70	-
USNRP70	US Nominal Rate of Protection, 1970	-
UNP70MS	USNRP70 Interacting with PEB70	-
UTC70	Canadian Unit Transportation Cost, 1970	-
UTC70MS	UTC70 Interacting with PEB70	-
USNTBI	US Non-Tariff Barriers, 1970	-
USNTBMS	USNTBI Interacting with PEB70	-
V9S70	Cost Disadvantage Ratio, 1970	+

*Dependent variable

6.4 DATA SET III

Like Data Set II, Data Set III includes 120 Canadian manufacturing industries and draws mainly from the Baldwin-Gorecki extensive data base.

6.4.1 DEPENDENT VARIABLE

The 1979 dependent variable is identical to that of 1970 except that it is defined for the later year.

6.4.2 INDEPENDENT VARIABLES

Also, the independent variables in the 1979 regression equations are the same as 1970 except that (a) they are defined for different years, and (b) US NTBs, US Tariffs and Canadian NTBs are not available. Instead of US tariff protection in 1979, we employed Post Kennedy Round rates because they were negotiated in the 1970s and are assumed to be highly correlated with US tariff in 1979.

The mnemonics, names and expected signs of variables in 1979 regression are shown in Table 6.5.

6.5 PROCEDURE

This section describes the research strategy adopted in testing for small market size, trade liberalization and Eastman-Stykolt hypotheses on data available for years 1968, 1970 and 1979.

TABLE 6.5

Nmenomic, Variable Names and Expected Signs of Variables in 1979 Regression Analysis Across 120 Canadian Manufacturing Industries, 1979

Mnemonic	Variable Names Relative Plant Scale, 1979	Expected Sign
ADVDM79	Advertising Sales Ratio, 1979	-
CDRMS79	V9S79 Interacting with PEB79	-
EFF1T79	Relative Plant Scale, 1979	*
EMPRAT79	R & D Expenditure, 1979	-
MMARCVA	Margin/Sales Ratio	-
NRP79	Canadian Nominal Rate of Protection, 1978	-
NRP78MS	NRP78 Interacting with PEB79	-
PEB79	Canadian Small Market Size, 1979	-
PKR	Post Kennedy Round Rates	-
PKRMS	PKR Interacting with PEB79	-
SB79	Canadian Unit Subsidy, 1979	-
SB79MS	SB79 Interacting with PEB79	-
UTC79	Canadian Unit Transportation Cost, 1979	-
UTC79MS	UTC79 Interacting with PEB79	-
V9S79	Cost Disadvantage Ratio, 1979	+

* Dependent variable.

First, a check on the simple correlation matrix is performed to identify variables that appear to be measuring the same effect. Second, to test whether a group of variables add significantly to the explanation of the dependent variable, F-tests on relevant subset of variables are performed. Finally, because many variables enter the regression at the same time, we have reported two kinds of regression equations: (a) the grand equations in which all theoretically relevant variables are included, and (b) the descriptive or best equations in the sense of maximizing adjusted R-squared.

6.5.1 COLLINEARITY CHECK

In our regression analysis, highly collinear variables refer to variables with simple correlations of above .800 between any pair of variables. The presence of collinearity in a regression equation makes the interpretation of coefficients quite difficult. To reduce the collinearity problem, we have adopted the following multicollinearity checks. First, all relevant variables derived from the underlying model of the determinants of relevant plant scale developed in chapter 4 are included in the regression equation. Second, highly collinear variables which measure the same effect on relative plant scale are successively excluded from the same regression run. Under these circumstances, we have reported several regression equations. In interpreting the results these regressions should be accorded less weight because they omit some variables which our theoretical reasoning has shown to be important.

The partial regression coefficient, for example, is interpreted as the change in the dependent variable with respect to the change in the explanatory variable in question, other things remain constant. But the other collinear variable does not remain unchanged when collinearity is present. Hence, the effects of the two variable on the dependent variable cannot be separated.

6.5.2 HYPOTHESIS TESTING USING F TESTS ON GROUPS OF VARIABLES

To examine whether US, Canadian, and US-Canadian trade barriers as a group influence scale efficiency in Canadian manufacturing industries, we have provided a series of F-tests on subsets of variables for Data Sets I, II, and III[2]. The F-tests indicate whether a group of variables add significantly to the explanation of variation already accounted for by the included variables in the regression equation. Nie and Hull (1975, 339) provided the following formula to compute the F-test[3]:

$$F = \frac{\left(\text{incremental sum of squares due to the subset of variables}\right)/DFS}{\left(\text{sum of squares residuals from the unrestricted regression}\right)/DFR}$$

where DFS and DFR respectively, refer to the degrees of freedom associated with subset of variables and sum of squared residuals.

6.5.3 REGRESSION EQUATIONS: GRAND AND DESCRIPTIVE

We have reported two kinds of regression equations: (a) the grand or simply the regression equation, and (b) descriptive or best fitting equations. The grand equation refers to that equation which includes all initial relevant variables based on the underlying theory developed in chapter 4. Adopting the backward regression method as described by Hull and Nie (1981, 99), scale efficiency is regressed on a large number of explanatory variables.

The best fit equation in the sense of maximum adjusted R-squared include only those variables that add significantly to the variation of the dependent variable. These best fit equations are presented only as descriptive because the estimated regression coefficients are exaggerated (Lovell, 1983, 1-2).

FOOTNOTES

Chapter 6

1. Baldwin and Gorecki (1983c, 14-15).

2. See, for example, Hull and Nie (1981, 101-102).

3. The degrees of freedom employed to calculate the significance level are obrained from the formula N-K; where N is the number of observations and K represents the number of estimated coefficients. In the 1968 regression analysis, for example, N is 79 and K is 13. Thus, the t-values of 2.301 with DF equals 66 has a 2.5 per cent significance level.

APPENDIX 6A

THE CALCULATION OF THE TOTAL EFFECT OF A VARIABLE IN REGRESSION ANALYSIS

We define the total effect of a variable as partial derivative with respect to that variable.

Suppose we specify a linear equation with interactions in which subsidy non-tariff barriers positively affect suboptimal plant scale as follows:

(1) $$SUBC = a + b(PS) + c(PEB) + d(PS.PEB) + u$$

where SUBC is suboptimal plant capacity, a, b, c and d are parameters with signs assumed positive; PS is the amount of production subsidy afforded to Canadian producers; PEB is the small Canadian market size; u is a disturbance term that represents other relevant variables such as import quotas and US tariff.

Assuming the disturbance term is statistically independent of suboptimal capacity and market size, we obtain the effect of production subsidy on SUBC by partially differentiating SUBC with respect to PS to yield

(2) $$\frac{\partial SUBC}{\partial PS} = \hat{b} + \hat{d}(PEB)$$

The estimated parameters $\hat{b}$ and $\hat{d}$ can be obtained from the underlying estimated regression equation. To obtain the total effect of production subsidy evaluated at the mean value of small market size (PEB), simply substitute for the mean value of $\overline{PEB}$ in equation 2 to otbain

(3) $\hat{b} + \hat{d}(\overline{PEB})$

Similarly by making the appropriate substitution for PEB at one standard deviation above its mean value ($\overline{PEB}$ A) or at one standard deviation below its mean value ($\overline{PEB}$ B), the total effects of production subsidy are:

(4) $\hat{b} + \hat{d}(\overline{PEB}\ A)$ --- The total effect of production subsidy evaluated above the mean value of market size.

(5) $\hat{b} + \hat{d}(\overline{PEB}\ B)$ --- The total effect of production subsidy evaluated below the mean value of market size

The means and standard deviations required to calculate the total effect of a variable are reported for each data set in chapter 7.

The standard error of the total effect of production subsidy at the mean value of small market size is calculated from the following formula:

$$\sqrt{\text{variance }(\hat{b}) + \overline{PEB}^2\text{ variance }(\hat{d}) + 2(PEB)\text{ covariance }(\hat{b},\hat{d})}$$

Similarly, the standard errors of production subsidy at one standard deviation above or below the mean market size are:

$$\sqrt{\text{variance }(\hat{b}) + \overline{\text{PEBA}}^2 \text{ variance } \hat{d} + 2(\overline{\text{PEB A}}) \text{ covariance } (\hat{b}, \hat{d})}$$

$$\sqrt{\text{variance }(\hat{b}) + \overline{\text{PEB B}}^2 \text{ variance } \hat{d} + 2(\overline{\text{PEBB}}) \text{ covariance } (\hat{b}, \hat{d})}$$

Finally, the t-scores appropriate for testing the null hypothesis of a zero total effect are obtained by dividing the estimated total effect of production subsidy by the appropriate standard error of the total effect.

APPENDIX 6B

MNEMONIC, NAMES, DEFINITION AND SOURCE OF VARIABLES USED IN 1968, 1970 AND 1979 REGRESSION EQUATIONS

Mnemonic	Name, Definition and Source
ADVDM	is product differentiation and is defined as advertising/sales ratio for consumer non-durable goods industry, 0 otherwise. The data are provided by Baldwin and Gorecki for 1970 and 1979.
CDR	is the cost disadvantage ratio. Two measures of CDR are obtained: Gupta-Fuss and Baldwin-Gorecki data. The former defined CDR as "the percentage by which the estimated average cost at half of MES exceeds the estimated average cost of MES (Gupta and Fuss, 1979, 11). In this thesis, we expressed Gupta-Fuss measure of CDR as a ratio and this is reported in Table 2.1 in chapter 2. The latter defined CDR as "the ratio of value-added per man-hour of the smallest plants accounting for 50 per cent of industry employment divided by value added per man-hour for the largest plants accounting for 50 per cent of industry employment" These data are available for 1970 and 1979.
CDRSM	is high cost disadvantage ratio interacting with Canadian small market size (PEB) and is defined as (CDR) × (PEB).
CNTB	is Canadian non-tariff barriers (NTBs). It is a ratio of the actual number of NTBs relative to the total number possible within a SIC category. The data are obtained from US International Trade Commission (1975) for the year 1970.
CNTBSM	is the interaction of Canadian small market size and Canadian NTBs and is defined as (PEB) × (CNTB).
EFF1T	is relative plant scale. It is the ratio of the average size of larger Canadian plants to the average size of larger US plants. The data are supplied by R.E. Caves (Harvard University) and P. Gorecki (Economic Council of Canada) for 120 Canadian Manufacturing industries in 1970 and 197 .

EMPRAT is R&D defined as the ratio of Research and Development personnel to all wage and salary earners. Data were supplied by Gorecki and Baldwin for 1970 and 1979.

NRP is Canadian nominal rate of protection which is defined as the actual duties collected relative to the value of total imports less duties. The data for 1968 were obtained from US International Trade Commission (1975); for 1970 and 1979 from Gorecki and Baldwin.

NRPSM is the interaction of small market size and Canadian nominal tariff protection. It is defined as (PEB) × (NRP).

PEB is Canadian small market size. It is defined as the ratio of MES plants to market size. The data on PEB were obtained from Gupta-Fuss (1979) and Baldwin-Gorecki (Economic Council of Canada). Given the estimates of MES plants (which were discussed in chapter 2), Gupta-Fuss defined the relevant market size to include domestic production while Baldwin-Gorecki employed domestic disappearance for years 1970 and 1979, i.e., domestic production plus imports less exports.

PKR is Post Kennedy Round rates which are negotiated after the Kennedy Round tariff reduction (1964-67). The data were obtained from the US International Trade Commission (1975).

PKRSM is Post Kennedy Round rates interacting with Canadian small market size and it is defined as (PKR) × (PEB).

SUB is the Canadian unit subsidy which is defined as the level of subsidy divided by industry sales or domestic disappearance. The data on subsidy are provided by Statistics Canada, Input-Output Division for 1970 and 1979. Also, Industry Sales are are derived from Statistics Canada, Manufacturing Industries of Canada: Type of Organization and Size of Establishment, 1970 and 1979 (Catalogue No. 31-210). Finally, data on domestic disappearance (i.e., domestic production plus imports less exports) are provided by Baldwin-Gorecki.

SI is suboptimal capacity. It is the fraction of industry output originating from plants below MES plant. The data are obtained from Gupta and Fuss (1979) for 79 Canadian manufacturing industries in 1970.

SUBSM is the interaction of small market size and Canadian unit subsidy. It is defined as (PEB) × (SUB).

USNRP is US nominal rate of tariff protection. It is defined as actual duties collected divided by total imports less duties. The data are obtained from the US International Trade Commission (1975) and are available only for the year 1970.

USNRSM is the interaction of US nominal tariff and Canadian small market size. It is defined as (USNRP) × (PEB).

USNTB is US non-tariff barriers facing Canadian exports. It is defined as an actual number of non-tariff barriers to the total possible within a S.I.C. category. The data are obtained from the US International Trade Commission (1975) for the year 1970.

USNTBSM is the interaction of US non-tariff barriers and Canadian small market size. It is defined as (USNTBs) × (PEB).

UTC is Canadian unit transportation cost which is defined as "transportation margin" divided by Industry Shipments in 1968 or by domestic disappearance in 1970 and 1979. Statistics Canada (Input-Output Division) provides data on transportation margins for four-digit S.I.C. industries. These margins reflect the amount of outbound transportation cost in ('000) of dollars from producers to buyers (Kishori, 1982, 420).

UTCSM is the interaction of unit transportation and Canadian small market size. It is defined as (UTC) × (PEB).

MARCVA is defined as the difference between (value-added) and (Wages and Salaries) divided by the value of shipments (Baldwin and Gorecki, 1983c, 104). The data are provided by Baldwin and Gorecki for the years 1970 and 1979.

CHAPTER 7

REGRESSION RESULTS AND DISCUSSION

This chapter presents and discusses the empirical tests of the Canadian small market size, trade liberalization and the Eastman-Stykolt hypotheses developed in the previous chapters. The data for years 1970 and 1979 were made available to us by Statistics Canada. Also, the various regressions and F-tests were performed at Statistics Canada with the assistance of Statistics Canada Staff. This chapter is organized into four sections. Sections 7.1 through 7.3 discuss and describe the regression results for the three Data Sets. The final section gives a summary and main conclusions of the empirical results in 1968, 1970 and 1979. Note that the dependent variable for Data Set I is a measure of scale inefficiency while, for Data Sets II and III it is a measure of relative plant scale. Thus the expected sign on each coefficient with Data Set I is presumed to be the opposite of those of Data Set II and III.

7.1 REGRESSION RESULTS: DATA SET I, 1968

The dependent variable for the regression equation across 79 Canadian manufacturing industries in 1968 is suboptimal capacity (SI), the fraction of industry output originating from plants below MES level.

TABLE 7.1

Mnemonic, Variable Names, Expected Signs, Mean and Standard Deviation of Variables in Regression Analysis Across 79 Canadian Manufacturing Industries, 1968

Mnemonic	Variable Names	Expected Sign	Mean	Standard Deviation
CDR	Cost Disadvantage Ratio, 1968	-	0.031	0.057
CDRSM68	CDR Interacting with PEB68	+	0.001	0.002
CNTB68	Canadian Non-Tariff Barriers, 1968	+	0.006	0.004
CNTBSM68	CNTB68 Interacting with PEB68	+	0.000	0.001
NRP68	Canadian Nominal Rate of Protection, 1968	+	0.110	0.064
NRPSM68	NRP68 Interacting with PEB68	+	0.003	0.004
PEB68	Canadian Small Market Size, 1968	+	0.030	0.032
PKR	Post Kennedy Round Rates	+	0.076	0.079
PKRSM	PKR Interacting with PEB68	+	0.003	0.007
SI68	Suboptimal Capacity, 1968	*	0.308	0.207
SUB68	Canadian Unit Subsidy, 1968	+	0.004	0.031
SUBSM68	SUB68 Interacting with PEB68	+	0.000	0.001
USNTB68	US Non-Tariff Barriers, 1968	+	0.006	0.013
USNTBSM8	USNTB68 Interacting with PEB68	+	0.000	0.001
USNRP68	US Nominal Rate of Protection, 1968	+	0.090	0.080
USNRPSM8	USNRP68 Interacting with PEB68	+	0.003	0.007
UTC68	Canadian Unit Transportation Cost, 1968	+	0.046	0.104
UTCSM68	UTC68 Interacting with PEB68	+	0.002	0.005

* Dependent Variable

TABLE 7.2

Names and Correlation Matrix of All Variables Across 79 Canadian Manufacturing Industries, 1968. Data Set I

Name	Variable
Suboptimal Capacity	SI68
Canadian Small Market Size, 1968	PEB68
Canadian Nominal Rate of Protection, 1968	NRP68
Canadian Non-Tariff Barriers, 1968	CNTB68
Canadian Unit Subsidy, 1968	SUB68
Post Kennedy Round Rates	PKR
US Non-Tariff Barriers, 1968	USNTB68
NRP68 Interacting with PEB68	NRPSM68
CNTB68 Interacting with PEB68	CNTBSM68
CDR Interacting with PEB68	CDRSM68
PKR Interacting with PEB68	PKRSM
USNTB68 Interacting with PEB68	USNTBSM8
UTC68 Interacting with PEB68	UTCSM68
Cost Disadvantage Ratio, 1968	CDR
Canadian Unit Transportation Cost, 1968	UTC68
SUB68 Interacting with PEB68	SUBSM68
US Nominal Rate of Protection, 1968	USNRP68
USNRP68 Interacting with PEB68	USNRPSM8

	SI68	PEB68	NRP68	CNTB68	SUB68	PKR	USNTB68	NRPSM68	CNTBSM68
SI68	1.000	.350	.006	.015	-.137	.214	.087	.356	.224
PEB68	.350	1.000	-.082	.195	-.006	.240	.006	.799	.511
NRP68	.006	-.082	1.000	.040	-.077	.562	.154	.335	-.074
CNTB68	.015	.195	.040	1.000	-.017	.387	.441	.094	.699
SUB68	-.137	-.006	-.077	-.017	1.000	-.012	-.009	-.037	-.033
PKR	.214	.240	.562	.387	-.012	1.000	.294	.366	.464
USNTB68	.087	.006	.154	.441	-.009	.294	1.000	.087	.127
NRPSM68	.356	.799	.335	.094	-.037	.366	.087	1.000	.299
CNTBSM68	.224	.511	-.074	.699	-.033	.464	.127	.299	1.000
CDRSM68	.089	.521	-.162	.109	-.024	-.015	.028	.426	.279
PKRSM	.298	.633	.074	.459	-.017	.675	.054	.553	.823
USNTBSM8	.273	.404	.084	.313	-.048	.197	.546	.452	.366
UTCSM68	.138	.251	-.143	-.076	.085	-.065	-.008	.123	-.020
CDR	.047	.084	-.291	-.073	-.024	-.164	-.077	-.003	.024
UTC68	.082	.072	-.159	-.073	-.121	-.108	-.016	-.033	-.066
SUBSM68	-.112	.017	-.069	-.053	.993	-.006	-.059	-.021	-.028
USNRP68	.190	.210	.619	.269	-.025	.937	.172	.375	.385
USNRPSM8	.329	.692	.099	.425	-.017	.659	.055	.646	.785

	CDR	UTC68	SUBSM68	USNRP68	USNRPSM8	CDRSM68	PKRSM	USNTBSM8	UTCSM68
SI68	.047	.082	-.112	.190	.329	.089	.298	.273	.138
PEB68	.084	.072	.017	.210	.692	.521	.633	.404	.251
NRP68	-.291	-.159	-.069	.619	.099	-.162	.074	.084	-.143
CNTB68	-.073	-.073	-.053	.269	.425	.109	.459	.313	-.076
SUB68	-.024	.121	.993	-.025	-.017	-.024	-.017	-.048	.085
PKR	-.164	-.108	-.006	.937	.659	-.015	.675	.197	-.065
USNTB68	-.077	-.016	-.059	.172	.055	.028	.054	.546	-.008
NRPSM68	-.003	-.033	-.021	.375	.646	.426	.553	.452	.123
CNTBSM68	.024	-.066	-.028	.385	.785	.279	.823	.366	-.020
CDRSM68	.697	.005	-.012	-.015	.297	1.000	.244	.345	.092
PKRSM	-.024	-.049	-.008	.599	.987	.244	1.000	.221	.041
USNTBSM8	.054	.015	-.041	.180	.257	.345	.221	1.000	.119
UTCSM68	.002	.954	.110	-.095	.038	.092	.041	.119	1.000
CDR	1.000	.011	-.013	-.162	-.014	.697	-.024	.054	.002
UTC68	.011	1.000	.139	-.131	-.060	.005	-.049	.015	.954
SUBSM68	-.013	.139	1.000	-.008	-.007	-.012	-.008	-.041	.110
USNRP68	-.162	-.131	-.008	1.000	.608	-.015	.599	.180	-.095
USNRPSM8	-.014	-.060	-.007	.608	1.000	.297	.987	.257	.038

The variable names along with their expected signs, means and standard deviation of suboptimal capacity are reported in Table 7.1.

Table 7.2 describes the correlation matrix for suboptimal capacity and all independent variables across 79 Canadian manufacturing industries. A close examination of the correlation matrix on Table 7.2 reveals a high degree of collinearity especially between the following pairs of variables: Canadian subsidy (SUB68) and its interaction with small market (SUBSM68); Canadian NTBs and their interaction with small market size (CNTBSM68); and, finally, Post Kennedy Round rates (PKR) and its interaction with small market size (PKRSM). By high collinearity we mean a simple correlation above .800 between any pair of variables. The problems of collinearity are due mainly to the definition of the various interaction terms. Table 7.1 shows that each interaction term includes Canadian small market size (PEB68). The interaction term PKRSM, for example, includes PKR and PEB68, whereas CNTBSM68 includes Canadian NTBs (CNTB68) and PEB68. Thus we would expect a high degree of correlation (.823) between PKRSM and (CNTBSM68). The collinearity problem, however, can be reduced by running several regressions. Highly collinear variables which measure the same effect on the dependent variable are excluded in the same regression run.

Table 7.3 reports the regression results for this data set. Specifically, Table 7.3A includes all the relevant variables underlying the theory developed in chapter 4. Table 7.3B excludes unit subsidy (SUB68), unit transportation cost (UTC68), US nominal tariff (USNRP68),

TABLE 7.3A

Regression Results Across 79 Canadian Manufacturing Industries Showing the Effect of Small Market Size, Trade Liberalization and the Eastman-Stykolt Effect of Suboptimal Capacity, 1968. (Equation I.) Data Set I.

Variable	Estimated Coefficient	Marginal Significance Level
Small Market Size Hypothesis		
PEB68 (Canadian Small Market Size, 1968)	.132	.474
Trade Liberalization Hypothesis		
NRP68 (Canadian Nominal Rate of Protection, 1968)	-1.026	.080
CNTB68 (Canadian Non-Tariff Barriers, 1968)	-4.702	.056
SUB68 (Canadian Unit Subsidy, 1968)	-.969	.093
PKR (Post Kennedy Round Rates)	.980	.078
USNTB68 (US Non-Tariff Barriers, 1968)	1.368	.306
Eastman-Stykolt Hypothesis		
NRPSM68 (PEB68 interacting with NRP68)	31.734	.044
CNTBSM68 (PEB68 interacting with CNTB68)	97.940	.088
SUBSM68 (PEB68 interacting with SUB68)	-27.243	.110
CDRSM68 (PEB68 interacting with PKR)	-39.990	.023
PKRMS (PEB68 interacting with USNTB68)	-13.878	.142
USNTBSM (PEB68 interacting with USNTB68)	12.352	.435
UTCSM68 (PEB68 interacting with UTC68)	-.703	.486
Others		
CDR (Cost Disadvantage Ratio, 1968)	.946	.074
UTC68 (Unit Transportation Cost, 1968)	.226	.405
(Constant)	.2829	.001
Adjusted R-squared	.1351	

* t-tests are one-tailed

TABLE 7.3B

Regression Results Across 79 Canadian Manufacturing Industries Showing the Effect of Small Market Size, Trade Liberalization and the Eastman-Stykolt Effect of Suboptimal Capacity, 1968 (Equation 2). Data Set I.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB68 (Canadian Small Market Size, 1968)	0.868	.307
Trade Liberalization Hypothesis		
NRP68 (Canadian Nominal Rate of Protection, 1968)	-0.679	.159
CNTB68 (Canadian Non-Tariff Barriers, 1968)	-1.953	.190
PKR (Post Kennedy Round Rates)	0.596	.179
USNTB68 (US Non-Tariff Barriers, 1968)	-0.059	.491
Eastman-Stykolt Hypothesis		
NRPSM68 (PEB68 Interacting with NRP68)	16.155	.130
CNTBSM68 (PEB68 interacting with CNTB68)	--	--
SUBSM68 (PEB68 interacting with subsidy)	26.058	.118
CDRSM68 (PEB68 interacting with CDR)	-37.327	.030
PKRSM (PEB68 interacting with PKR)	0.666	.960
USNTBSM8 (PEB68 interacting with USNTB68)	75.876	.097
UTCSM68 (PEB68 interacting with CDR)	2.670	.280
Others		
CDR (Cost Disadvantage Ratio, 1968)	0.955	.072
UTC68 (Unit Transportation Cost, 1968)	--	--
(Constant)	0.272	.000
Adjusted R-Squared	0.1397	

* t-tests are one-tailed

-- variables are omitted.

TABLE 7.3C

Regression Results Across 79 Canadian Manufacturing Industries Showing the Effect of Small Market Size, Trade Liberalization and the Eastman-Stykoly Hypotheses on Suboptimal Capacity, 1968 (Equation 3); Data Set I.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB68 (Canadian Small Market Size, 1968)	0.376	.416
Trade Liberalization Hypothesis		
NRP68 (Canadian Nominal Rate of Protection, 1968)	-0.577	.167
CNTB68 (Canadian Non-Tariff Barriers, 1968)	-3.658	.092
PKR (Post Kennedy Round Rates)	0.422	.183
USNTB68 (US Non-Tariff Barriers, 1968)	1.026	.350
Eastman-Stykolt Hypothesis		
NRPSM68 (PEB68 interacting with NRP68)	19.119	.084
CNTBSM68 (PEB68 interacting with CNTB68)	39.193	.169
SUBSM68 (PEB68 interacting with subsidy)	-25.281	.123
PKRSM (PEB68 interacting with PKR)	--	--
USNTBSM68 (PEB68 interacting with USNTB68)	54.331	.189
UTCSM68 (PEB68 interacting with UTC68)	3.372	.232
CDRSM68 (PEB68 interacting with CDR)	-38.236	.030
Others		
CDR (Cost Disadvantage Ratio, 1968)	--	--
UTC68 (Unit Transportation Cost, 1968)	--	--
(Constant)	0.272	.000
Adjusted R-Squared	0.1397	

* t-tests are one-tailed

-- denotes that variables are omitted from the equation the interaction of US nominal tariff with Canadian small market size (USNRPSM8) and finally, the interaction of Post Kennedy Round Rates with Canadian small market size (PKRSM). Table 7.3C continues to exclude the above set variables except that PKRSM is replaced with the interaction term of Canadian NTBs and small market size (CNTBSM68).

The expected sign for each variable is discussed in chapter 4. The marginal significance levels reported in each table are based on a one-tailed test. They are the probability of rejecting a true null hypothesis of zero.

For each regression equation, three hypotheses are tested: (i) the small market hypothesis which states that suboptimal capacity depends positively on Canadian small market size; (ii) the trade liberalization hypothesis which holds that suboptimal capacity depends positively on US-Canadian trade protection, and finally (iii) the Eastman-Stykolt hypothesis which asserts that US-Canadian trade barriers have a greater deleterious effect when the Canadian market is small relative to minimum efficient plant scale. The impact of other variables on suboptimal capacity is described under the heading 'others'.

In interpreting the results, it will be useful to consider the effect of individual variables on the degree of suboptimal capacity. Because many variables enter the regression both independently (as levels) and in interaction with other variables, the effect of a variable cannot be directly read from the coefficient on its level. In such cases, we refer to the total effect of the variable by which we mean the direct effect of a unit change in the variable plus any indirect effect through a second term in the expression when the value of the second term is at its mean.

The indirect effect of a variable will depend on its level. In the accompanying tables, the indirect effect of each variable in question at the mean values and at values one standard deviation above and below the mean are shown. In particular, variables measured at one standard deviation above and below their mean values are reported in the accompanying tables as <u>small market</u> and <u>large market</u>, respectively. Since the small market size has been defined as the reciprocal of the ratio of domestic consumption to the output of a minimum efficient scale plant, it means that the small market size (measured at one standard deviation above its mean value) would become abnormally small. Conversely, the small market size (measured at one standard deviation below its mean value) is referred to as being evaluated in large markets. This concept of small and large markets seems useful in interpreting the impact of both the Eastman-Stykolt effect and trade protection on scale efficiency in Canada. Details of the calculation are provided in Appendix 6A.

Tables 7.4A, 7.4B and 7.4C show (a) the total effect of small market size measured at the different mean values of Canadian-US trade barriers, (b) the total effect of Canadian-US trade barriers measured from the various mean values of Canadian small market size, and (c) the total effect of other variables such as unit transportation cost measured at various values of small market size.

TABLE 7.4A

Total Effect on Suboptimal Capacity of Canadian Small Market Size, Canadian-US Trade Barriers and other Variables Measured from the Mean, One Standard Deviation Above and Below their Respective Values Across Regression Equation 1, 1968*
Data Set I.

Variable	Mean	Above Mean (Small Market)	Below Mean (Large Market)
Total Effect of Canadian Small Market Size			
PEB68 (Canadian Small Market Size, 1968)	2.830 (5.840)	5.755 (1.425)	-6.937 (4.35)
Total Effect of Canadian-US Trade Barriers			
NRP68 (Canadian Nominal Rate of Protection, 1968)	-.2740 (-.142)	.942 (1.150)	.963 (-1.357)
CNTB68 (Canadian NTBs, 1968)	-1.764 (-.530)	1.370 (.179)	-4.639 (-1.600)
UTC (Unit Transportation Cost, 1968)	-.205 (-.187)	.182 (.119)	.224 (.231)
PKR (Post Kennedy Round Rates)	.564 (.621)	.120 (.151)	.952 (1.384)
USNTB68 (US NTBs, 1968)	1.739 (.478)	2.134 (.383)	1.393 (.523)

* t-values are enclosed in parentheses.

TABLE 7.4B

Total Effect on Suboptimal Capacity of Canadian Small Market Size, Canadian/US Trade Barriers and Other Variables Measured From the Mean, One Standard Deviation Above and Below their Respective values Across Regression Equation 2, 1986*. Data Set I.

Variable	Mean	Above Mean (Sm.Mkt.)	Below Mean (Lg.Mkt.)
Total Effect of Canadian Small Market Size			
PEB68 (Canadian Small Market Size, 1968)	1.994	5.122	1.179
	(.982)	(2.301)	(1.604)
Total Effect of Canadian-US Trade Barriers			
NRP68 (Canadian Nominal Rate of Protection	-.194	.323	-.647
	(.999)	(.473)	(.984)
CNTB68 (Canadian Non-Tariff Barriers)	--	--	--
PKR (Post Kennedy Round Rates)	.616	.637	.597
	(1.004)	(1.556)	(.966)
USNTB68 Non-Tariff Barriers)	2.217	4.645	.092
	(.968)	(1.421)	(.037)
Total Effect of Other Variables			
CDR (Cost Disadvantage Ratio)	-.165	-1.359	.880
	(-.395)	(-1.653)	(1.430)

* t-values are enclosed in parentheses

-- indicates the variable is omitted from the regression

TABLE 7.4C

Total Effect on Suboptimal Capacity of Canadian Small Market Size, Canadian-US Trade Barriers and Other Variables Measured From the Mean, one Standard Deviation Above and Below Their Respective Values Across Regression Equation 3, 1968: Data Set I.

Variable	Mean	Above Mean (Sm.Mkt.)	Below Mean (Lg.Mkt.)
Total Effect of Canadian Small Market Size			
PEB68 (Canadian Small Market Size)	3.416 (3.300)	5.895 (4.130)	2.112 (1.620)
Total Effect of Canadian-US Trade Barriers			
NRP68 (Canadian Nominal Rate of Protection)	-.004 (-.007)	.608 (.823)	-.195 (-.385)
CNTB68 (Canadian Non-Tariff Barriers)	-2.480 (-1.180)	-1.228 (-.581)	-2.874 (-1.273)
PKR (Post Kennedy Round Rates)	--	--	--
USNTB68 (US-Non-Tariff Barriers)	2.656 (1.251)	4.394 (1.445)	2.113 (.985)
Total Effect of Other Variables			
CDR (Cost Disadvantage Ratio)	-.171 (-.414)	-1.395 (1.710)	.211 (.505)

* the t-values are enclosed in parentheses.

-- indicates that the variable is omitted from the regression.

Enclosed in parentheses below the estimated total effect of each variable as reported in Tables 7.4A, 7.4B and 7.4C are the t-values, the ratio of the estimated coefficient to the standard error of prediction[1]. For example, the estimated total effect of small market size measured from the mean value of Canadian nominal rate of protection is 2.830 (Table 7.4A). This means an increase of 1% in the small market size variable will increase the percentage of output produced in plants of suboptimal capacity by a 2.8 percentage point and that the estimate is highly significant.

Finally, to examine whether US, Canadian and US-Canadian trade barriers as a group influence suboptimal capacity in Canadian manufacturing, we have provided a series of F-tests on subset of variables for each Data Set I, II and III.

Tables 7.5A, 7.5B and 7.5C report values of the F-test for subsets of variables for 1968 regression equations 1 and 2. The degrees of freedom are listed under the column DF. The F-test (F) of 1.170 with a significance F-level (SIGF) of .332 means that US trade protection does not explain a significant portion of the variation in the dependent variable at the 33 per cent level (line 1, Table 7.6A). Specifically, the impact of US trade protection variables as a group on suboptimal capacity is statistically insignificant at the 33 per cent level.

TABLE 7.5A

Hypothesis Testing the Significance of the Apparent Positive Effect of Subsets of Trade Variable on Suboptimal Capacity, Regression Equation 1, 1968. Data Set I.

No.	DF	F	SIGF	SUBSETS OF VARIABLES*
1	4	1.170	.332	(USNTB68 USNTBSM8 PKR PKRSM)
2	2	.254	.776	(USNTB68 USNTBSM8)
3	2	1.148	.324	(PKR PKRSM)
4	4	2.480	.053	(CNTB68 CNTBSM68 NRP68 NRPSM68 SUBSM68)
5	2	3.479	.037	(NRP68 NRPSM68)
6	2	1.612	.207	(CNTB68 CNTBSM68)
7	9	2.416	.020	(USNTB68 USNTBSM68 PKR PKRSM CNTB68 CNTBSM68 CNTBSM68 NRPSM68 NRP68 SUBSM68)
8	4	2.423	.057	(PKR PKRSM NRP68 NRPSM68)
9	5	1.314	.269	(USNTB68 USNTBSM8 CNTB68 CNTBSM68 SUBSM)
10	5	3.157	.013	(USNTBSM8 PKRSM NRPSM SUBSM68 CNTBSM68)
11	2	.435	.649	(UTC68 UTCSM68)
12	3	2.727	.051	(NRPSM68 SUBSM68 CNTBSM68)
13	2	1.096	.340	(USNTBSM8 PKRSM)
14	2	2.174	.122	(CDR CDRSM68)
15	2	1.411	.251	(USNTB68 PKR)
16	2	2.756	.071	(CNTB68 NRP68)
17	4	1.392	.247	(USNTB68 PKR CNTB68 NRP68)
18	4	3.594	.010	(USNTBSM8 PKRSM CNTBSM68 NRPSM68)
	13	2.018	.033	Regression
	65			Residual
	.1450			Adjusted R-squared

* Mnemonics are defined in Table 7.6.

No. denotes line sequance of F-tests.

DF denotes the value of the F statistics.

SIGF denotes the significant F-level.

TABLE 7.5B

Hypotheses Testing the Significance of the Apparent Positive Effect Of Subsets of Trade Variables On Suboptimal Capacity, Regression Equation 2, 1968. Data Set I.

No.	DF	F	SIGF	Subsets of Variables*
1	4	1.328	.269	(USNTB68 USNTBSM8 PKR PKRSM)
2	2	1.077	.346	(USNTB68 USNTBSM8)
3	2	1.652	.199	(PKR PKRSM)
4	4	2.072	.094	(CNTB68 NRP68 NRPSM68 SUBSM68)
5	2	2.189	.120	(NRP68 NRPSM68)
6	--	--	--	(CNTB68 CNTBSM68)
7	8	2.641	.0140	(USNTB68 USNTBSM8 PKR PKRSM CNTB68 NRPSM68 SUBSM68)
8	4	3.396	.014	(PKR PKRSM NRP68 NRPSM68)
9	4	.983	.423	(USNTB68 USNTBSM8 CNTB68 SUBSM68)
10	4	3.568	.011	(USNTBSM8 PKRSM NRPSM68 SUBSM68)
11	2	2.787	.069	(NRPSM68 SUBSM68)
12	4	.762	.554	(USNTB68 PKR CNTB68 NRP68)
13	2	.895	.413	(USNTBSM8 PKRSM)
14	2	1.713	.188	(CDR CDRSM68)
15	2	.537	.587	(USNTB68 PKR)
16	2	1.488	.233	(CNTB68 NRP68)
17	4	.762	.554	(USNTB68 PKR CNTB68 NRP68)
18	3	4.179	.009	(USNTBSM8 PKRSM NRPSM68)
19	4	3.568	.011	(USNTBSM8 PKRSM NRPSM68 SUBSM68)
	11			Regression
	67			Residual
		Adjusted R-Squared .1600		

* Mnemonics are defined in Table 7.1
No. denotes line sequance of F-tests
DF denotes the value of the F statistics
SIGF denotes the significant F-level
-- indicates that CNTB68 is omitted from equation 1.

TABLE 7.5C

Hypotheses Testing the Significance of the Apparent Positive Effect of Subsets of Trade Variables on Suboptimal Capacity, Regression Equation 3, 1968. Data Set I.

No.	DF	F	SIGF	Subsets of Variables*
1	3	1.085	.362	(USNTB68 USNTBSM8 PKR)
2	2	1.061	.352	(USNTB68 USNTBSM8)
3	--	--	--	(PKR PKRSM)
4	5	2.480	.040	(CNTB68 CNTBSM68 NRP68 NRPSM68 SUBSM68)
5	2	3.533	.035	(NRP68 NRPSM68)
6	2	.964	.386	(CNTB68 CNTBSM68)
7	8	2.832	.009	(USNTB68 USNTBSM8 PKR CNTBSM68 CNTB68 NRP68 NRPSM68 SUBSM68)
8	5	3.052	.395	(USNTB68 USNTBSM8 CNTB68 CNTBSM68 SUBSM68)
9	3	2.917	.041	(PKR NRP68 NRPSM68)
10	4	3.919	.006	(USNTBSM8 CNTBSM68 NRPSM68 SUBSM68)
11	9	1.068	.380	(USNTB68 PKR CNTB68 NRP68)
12	2	1.993	.149	(CDR CDRSM68)
13	2	.733	.484	(USNTB68 PKR)
14	4	1.068	.380	(USNTB68 PKR CNTB68 NRP68)
16	3	4.637	.005	(USNTBSM CNTBSM NRP68)
17	4	3.919	.006	(USNTBSM CNTBSM NRPSM SUBSM68
18	2	4.057	.022	(NRPSM68 SUBSM68)
19	3	3.312	.025	(CNTBSM68 NRPSM68 SUBSM68)
	11			Regression
	67			Residual

Adjusted R-Squared, 1760

* Mnemonics are defined in Table 7.1

No. denotes line sequence of F-tests

DF denotes the value of the F statistic

SIGF denotes the significant F-level

-- indicates that PKR is omitted from equation 2.

7.1 DISCUSSION OF REGRESSION RESULTS: DATA SET I, 1968

In presenting the results, we will consider the three hypotheses in turn. First, does small market promote scale ineffICENCY? Table 7.3A through 7.3C show that the coefficient of small market size (PEB68) has the expected impact on suboptimal capacity (SI68) but is insignificant. However, the total effect of small market size on suboptimal capacity is positive, as expected, and is statistically significant. Specifically, Table 7.4A shows that the total effect of small market is highly significant when it is evaluated at the various values of US-Canadian trade barriers. Hence, Data Set I supports the hypothesis that small market size induces the proliferation of small scale manufacturing plants in Canada.

The next question is whether the general trade liberalization hypothesis is valid. The F-test on this subset of variables, reported on line 7 of Tables 7.5A, 7.5B and 7.5C show that trade variables as a group are highly significant. Line 7 of these tables test whether Canadian and US trade protection together isolate the small Canadian market from larger US markets. The difference between the F-test given in Table 7.5B and 7.5C reflects the high collinearity between small market size interacting with US tariff (PKRS) and Canadian NTBs (CNTBSM68). These significant F-tests at the 1 per cent level support the trade liberalization proposition that the combined effect of Canadian and US protection explains a considerable amount of suboptimal capacity in

Canada. However, it is somewhat difficult to separate the roles of the individual barriers. The F-tests indicate that Canadian protection variables as a group are statistically significant (Tables 7.5A, 7.5B and 7.5C, line 4), but that US protection variables are not (line 1). The tariff variables taken as a group (Tables 7.5A and 7.5B, line 8 and Table 7.5B line 9) are highly significant while the nontariff barriers taken as a group are not (Tables 7.5A and 7.5B, line 9 and Table 7.5B, line 8).

Finally, Table 7.4A shows that the total effect of Canadian nontariff barriers (CNTB68) is insignificant but US nontariff barriers (USNTB68) are consistently significant with the expected sign. The effect of Canadian tariff barriers on suboptimal capacity is insignificant while US tariffs consistently have the right sign and are significant in small Canadian market.

The third question is whether the data support the Eastman-Stykolt proposition. First, note from Table 7.3C that with the exception of subsidy interacting with small market size (SUBSM68), all interaction terms have the expected positive sign, thus supporting the Eastman-Stykolt hypothesis. Most coefficients, however, were not statistically significant. The joint significance of all interaction terms is reported in Tables 7.5A, 7.5B and 7.5C. As a group, all Canadian and US protection variables (line 10) are statistically significant. The separate effects of Canadian and US trade protection, and of tariff and nontariff protection, however, are less clear. On one hand, all interactions involving US protection (line 13, Tables 7.5A and 7.5B) are insignificant, whereas those involving Canadian protection are always statistically significant (line 12, Table 7.5A and line 19, Table 7.5C).

In summary, Data Set I provides support for all three hypotheses rather well.

OTHERS

Other determinants of suboptimal capacity are cost disadvantage ratio and unit transportation cost. Unit transportation cost has the expected impact on suboptimal capacity but is never significant. In both regression equations (Tables 7.3B and 7.3C), the level of unit transportation cost is omitted because of its high correlation with small market size composite variable (UTCSM68).

Data Set I supports the cost disadvantage ratio better than unit transportation cost. It has the expected sign and is consistently significant.

7.2 REGRESSION RESULTS: DATA SET II, 1970

The dependent variable for regression equation across 120 Canadian manufacturing industries in 1970 is relative plant scale, the ratio of Canadian larger plant size to US larger plant size. Because of the large size and competitiveness of US markets, US larger plant size serves as a proxy for Canadian minimum efficient plant scale (Baldwin and Gorecki, 1981c, 10-11).

TABLE 7.6

Mnemonic, Variable Names, Expected Signs, Mean and Standard Deviation of Variables Used in the 1970 Regression Analysis Across 120 Canadian Manufacturing Industries, 1970. Data Set II.

Mnemonic	Variable Names	Expected Sign	Mean	Standard Deviation
ADVDM70	Advertising Sales Ratio, 1970	-	0.008	0.022
CDRMS70	V9S70 Interacting with PEB70	-	0.198	0.280
CNTBI	Canadian Non-Tariff Barriers, 1970	-	0.005	0.013
CNTBIMS	CNTBI Interacting with PEB70	-	0.002	0.008
EMPRAT75	R & D Expenditure, 1970	-	0.008	0.015
EFFIT70	Relative Plant Scale, 1970	*	0.671	0.576
MMARCVA	Margin/Sales Ratio	-	0.858	0.357
NRP70	Canadian National Nominal Rate of Protection, 1970	-	0.122	0.163
NRP70MS	NRP70 Interacting with PEB70	-	0.030	0.069
PEB70	Canadian Small Market Size, 1970	-	0.227	0.411
SB70	Canadian Unit Subsidy, 1970	-	0.003	0.018
SB70MS	SB70 Interacting with PEB70	-	0.002	0.013
USNRP70	US Nominal Rate of Protection, 1970	-	0.098	0.077
UNP70MS	USNRP70 Interacting with PEB70	-	0.030	0.087
UTC70	Canadian Unit Transportation Cost, 1970	-	0.047	0.074
UTC70MS	UTC70 Interacting with PEB70	-	0.011	0.038
USNTBI	US Non-Tariff Barriers, 1970	-	0.008	0.014
USNTBMS	USNTBI Interacting with PEB70	-	0.003	0.013
V9S70	Cost Disadvantage Ratio, 1970	+	0.917	0.229

* Dependent variable

TABLE 7.7

Names and Correlation Matrix of All Variables Across 120 Canadian Manufacturing Industries, 1970

Relative Plant Scale, 1970	EFFIT70
Canadian Nominal Rate of Protection, 1970	NRP70
Advertising Sales Ratio, 1970	ADVSN70
R&D Expenditure, 1970	EMPRAT75
Margin/Sales Ratio	MMARCVA
Canadian Small Market Size, 1970	PE870
Canadian Unit Transportation Cost, 1970	UTC70
UTC70 Interacting with PE870	UTC70MS
Canadian Unit Subsidy, 1970	SB70
SB70 Interacting with PE870	SB70MS
Canadian Non-Tariff Barriers, 1970	CNTBI
CNTBI Interacting with PE870	CNTBIMS
US Nominal Rate of Protection, 1970	USNRP70
USNRP70 Interacting with PE870	UNP70MS
US Non-Tariff Barriers, 1970	USNTBI
USNTBI Interacting with PE870	USNTBMS
Cost Disadvantage Ratio, 1970	YY570
YY570 Interacting with PE870	CDMMS70
NRP70 Interacting with PE870	NRP70MS

	EFFIT70	NRP70	ADVSN70	EMPRAT75	MMARCVA	PE870	UTC70	UTC70MS	SB70	SB70MS	CNTBI	CNTBIMS	USNRP70
EFFIT70	1.000	-0.020	-0.065	0.066	0.008	-0.240	-0.020	-0.160	-0.063	-0.062	-0.160	-0.131	-0.221
NRP70	-0.020	1.000	0.224	-0.116	-0.158	0.020	-0.066	-0.019	-0.040	-0.032	0.314	0.270	0.295
ADVSN70	-0.045	0.224	1.000	0.042	-0.173	0.036	-0.126	-0.069	-0.037	-0.040	0.272	0.250	0.012
EMPRAT75	0.066	-0.116	0.042	1.000	0.106	0.011	-0.073	-0.047	0.016	-0.037	-0.016	0.000	-0.100
MMARCVA	0.008	-0.158	-0.173	0.106	1.000	-0.048	0.031	-0.072	-0.009	-0.000	0.107	0.191	-0.059
PE870	-0.260	0.020	0.036	0.011	-0.048	1.000	0.029	0.040	0.129	0.040	0.106	0.214	0.235
UTC70	-0.020	-0.066	-0.126	-0.073	0.011	0.029	1.000	0.397	0.076	0.071	-0.055	-0.050	0.177
UTC70MS	-0.160	-0.019	-0.049	-0.047	-0.072	0.040	0.397	1.000	0.162	0.049	-0.024	0.002	0.237
SB70	-0.063	-0.040	-0.017	0.016	-0.009	0.129	0.076	0.162	1.000	0.403	-0.005	-0.029	0.000
SB70MS	-0.042	-0.032	-0.040	-0.037	-0.000	0.040	0.071	0.049	0.403	1.000	-0.045	-0.025	0.122
CNTBI	-0.160	0.314	0.272	-0.016	0.107	0.106	-0.055	-0.024	-0.005	-0.045	1.000	0.797	0.326
CNTBIMS	-0.131	0.270	0.250	0.000	0.191	0.214	-0.050	0.002	-0.029	-0.025	0.797	1.000	0.376
USNRP70	-0.222	0.295	0.012	-0.100	-0.059	0.235	0.177	0.237	0.000	0.122	0.326	0.376	1.000
UNP70MS	-0.205	0.096	0.071	-0.042	-0.090	0.935	0.066	0.030	0.124	0.027	0.215	0.360	0.417
USNTBI	-0.066	0.106	0.069	-0.125	-0.190	0.112	0.048	0.170	0.022	0.143	0.209	-0.005	0.205
USNTBMS	-0.118	0.019	-0.016	-0.060	-0.090	0.040	0.073	0.067	0.143	0.930	0.006	-0.011	0.143
YY570	-0.092	-0.054	-0.249	0.002	0.300	-0.106	-0.031	-0.179	-0.010	-0.136	0.030	0.127	0.039
CDMMS70	-0.323	0.030	0.020	0.049	0.057	0.934	-0.013	0.697	0.100	0.664	0.220	0.304	0.259
NRP70MS	-0.178	0.670	0.260	-0.045	-0.129	0.549	-0.013	0.390	0.035	0.345	0.442	0.657	0.369

	UNP70MS	USNTBI	USNTBMS	YY570	CDMMS70	NRP70MS
EFFIT70	-0.205	-0.066	-0.118	-0.092	-0.323	-0.178
NRP70	0.096	0.106	0.019	-0.054	0.030	0.670
ADVSN70	0.071	0.069	-0.016	-0.249	0.020	0.260
EMPRAT75	-0.042	-0.125	-0.060	0.002	0.049	-0.045
MMARCVA	-0.090	-0.100	-0.090	0.300	0.057	-0.129
PE870	0.935	0.112	0.040	-0.106	0.934	0.549
UTC70	0.066	0.045	0.073	-0.031	-0.013	-0.013
UTC70MS	0.030	0.170	0.067	-0.179	0.697	0.390
SB70	0.124	0.022	0.143	-0.010	0.100	0.035
SB70MS	0.027	0.143	0.930	-0.136	0.664	0.345
CNTBI	0.215	0.209	0.006	0.030	0.220	0.442
CNTBIMS	0.360	-0.005	-0.011	0.127	0.304	0.657
USNRP70	0.417	0.205	0.143	0.039	0.259	0.369
UNP70MS	1.000	0.114	0.040	-0.110	0.054	0.676
USNTBI	0.114	1.000	0.316	-0.100	0.051	0.105
USNTBMS	0.040	0.316	1.000	-0.167	0.700	0.495
YY570	-0.110	-0.100	-0.167	1.000	0.119	-0.076
CDMMS70	0.054	0.051	0.700	0.119	1.000	0.417
NRP70MS	0.676	0.105	0.495	-0.076	0.417	1.000

Table 7.6 describes the variable names, expected sign, mean and standard deviation of all variables in the 1970 regression equations. The correlation matrix described in Table 7.7 shows that Canadian small market size (PEB70) is correlated with Canadian-US trade protection. Highly collinear variables are small market size and its interaction separately with unit transportation cost, US nontariff barriers, Canadian subsidy, US nominal tariff, and cost disadvantage ratio. Other collinear variables are the level of US tariff and the interaction of small market size with US nontariff barriers (UNP70, USNTBMS) the level of unit transportation cost and the interaction of US tariff with small market size (UTC70, UNP70MS).

Table 7.8A includes all relevant variables while Tables 7.8B through 7.8E exclude highly collinear variables in the same regression run. The estimated coefficients are reported separately in Tables 7.8A through 7.8E.

For example, Table 7.8B excludes the interaction term with market size and subsidy (SB70MS), market size and transportation cost (UTC70MS), market size and US nontariff barriers (USNTBMS), market size and cost disadvantage ratio (CDRMS70).

Table 7.8C includes the interaction of small market size with US nontariff barriers, US tariff, Canadian subsidy and unit transportation cost. Table 7.8D includes the interaction of small market size with US tariff but excludes the level of small market size, its interaction with transportation cost and cost disadvantage ratio; and finally, Table 7.8E includes small market size (PEB70), its interaction

TABLE 7.8A

Coefficients Relating to Small Market Size, Trade Liberalization and the Eastman-Stykolt Hypotheses Obtained when Relative Plant Size is the Dependent Variable: Regression Results Across 120 Canadian Manufacturing Industries, Equation 1, 1970. Data Set II.

Variable	Estimated Coefficients	Marginal Significance Level
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	-1.258	.010
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	.894	.189
CNTBI (Canadian Non-Tariff Barriers, 1970)	-13.205	.063
USNRP70 (US Nominal Rate of Protection, 1970)	-1.900	.049
USNTBI (US Non-Tariff Barriers, 1970)	1.972	.367
SB70 (Canadian Unit Subsidy, 1970)	-7.329	.103
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	-2.432	.271
CNTBIMS (PEB70 interacting with CNTBI)	25.675	.121
UNP70MS (PEB70 interacting with UNP70)	3.873	.157
USNTBMS (PEB70 interacting with USNTBI)	-2.730	.455
SB70MS (PEB70 interacting with SB70)	31.672	.113
UTC70MS (PEB70 interacting with UTC70)	-4.466	.187
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	-.412	.048
UTC70 (Canadian Unit Transportation Cost, 1970)	.662	.277
EMPRAT75 (R & D Expenditure, 1970)	3.395	.151
MMARCVA (Margin/Sales Ratio)	.105	.268
ADVDM70 (Advertising Sales Ratio, 1970)	-2.689	.147
(Constant)	1.276	.000
Adjusted R-squared .1406		

* t-tests are one-tailed

SOURCE: Statistics Canada

TABLE 7.8B

Coefficients Relating to Small Market Size, Trade Liberalization and the Eastman-Stykolt Hypotheses Obtained when Relative Plant Size is the Dependent Variable: Regression Results Across 120 Canadian Manufacturing Industries, Equation 2, 1970*. Data Set II.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	-0.265	.181
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	0.560	.254
CNTBI (Canadian Non-Tariff Barriers, 1970)	-12.293	.083
USNRP70 (US National Rate of Protection, 1970)	-1.242	.063
USNTBI (US Non-Tariff Barriers, 1970)	1.666	.351
SB70 (Canadian Unit Subsidy, 1970)	-0.742	.402
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	-1.048	.376
CNTBIMS (PEB70 interacting with CNTBI)	19.097	.198
UNP70MS (PEB70 interacting with USNRP70)	--	--
USNTBMS (PEB70 interacting with USNTBI)	--	--
SB70MS (PEB70 interacting with SB70)	--	--
CDRMS70 (PEB70 interacting with V9S70)	--	--
UTC70MS (PEB70 interacting with UTC70)	--	--
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	-0.448	.038
UTC70 (Canadian Unit Transportation Cost, 1970)	-0.037	.480
EMPRAT75 (R & D Expenditure)	1.872	.297
MMARCVA (Margin/Sales Ratio)	0.141	.209
ADVDM70 (Advertising Sales Ratio, 1970)	-2.693	.158
(Constant)	1.131	.000
Adjusted R-squared	.0479	

* t-tests are one-tailed

-- indicates omitted variables

Source: Statistics Canada

TABLE 7.8C

Coefficients Relating to Small Market Size, Trade Liberalization and the Eastman-Stykolt Hypotheses Obtained when Relative Plant Size is the Dependent Variable: Regression Results Across 120 Canadian Manufacturing Industries, Equation 3, 1970.
Data Set II.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	--	.275
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	0.442	.275
CNTBI (Canadian Non-Tariff Barriers, 1970)	-12.959	.060
USNRP70 (US Nominal Rate of Protection, 1970)	-1.085	.080
USNTBI (US Non-Tariff Barriers, 1970)	-2.387	.295
SB70 (Canadian Unit Subsidy, 1970)	-1.190	.339
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	-0.80	.389
CNTBIMS (PEB70 interacting with CNTBI)	31.988	.058
UNP70MS (PEB70 interacting with USNRP70)	--	--
USNTBMS (PEB70 interacting with USNTBI)	19.637	.006
SB70MS (PEB70 interacting with SB70)	--	--
CDRMS70 (PEB70 interacting with V9S70)	-1.317	.001
UTC70MS (PEB70 interacting with UTC70)	--	--
OTHERS		
V9S70 (Cost Disadvantage Ratio, 1970)	-0.105	.346
UTC70 (Canadian Unit Transportation Cost, 1970)	-0.205	.384
EMPRAT75 (R & D Expenditure)	3.376	.161
MMARCVA (Margin/Sales Ratio)	0.141	.202
ADVDM70 (Advertising Sales Ratio, 1970)	-2.459	.170
(Constant)	0.968	.000
Adjusted R-Squared	.1258	

* t-tests are one-tailed
-- indicates omitted variables

Source: Statistics Canada

TABLE 7.8D

Coefficients Relating to Small Market Size, Trade Liberalization and the Eastman-Stykolt Hypotheses Obtained when Relative Plant Size is the Dependent Variable: Regression Results Across 120 Canadian Manufacturing Industries, Equation 4, 1970. Data Set II.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	--	--
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	2.187	.006
CNTBI (Canadian Non-Tariff Barriers, 1970	-19.546	.013
USNRP70 (US Nominal Rate of Protection, 1970)	-2.043	.013
USNTBI (US Non-Tariff Barriers, 1970)	1.975	
SB70 (Canadian Unit Subsidy, 1970)	-1.104	.355
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	-7.859	.010
CNTBIMS (PEB70 interacting with CNTBI)	49.698	.010
UNP70MS (PEB70 interacting with USNRP70)	2.142	.081
USNTBMS (PEB70 interacting with USNTBI)	--	--
SB70MS (PEB70 interacting with SB70)	--	--
CDRMS70 (PEB70 interacting with V9S70)	--	--
UTC70MS (PEB70 interacting with UTC70)	--	--
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	-0.448	.037
UTC70 (Canadian Unit Transportation Cost, 1970)	0.010	.494
EMPRAT75 (R & D Expenditure)	2.171	.268
MMARCVA (Margin/Sales Ratio)	0.049	.388
ADJDM70 (Advertising Sales Ratio, 1970)	-1.856	.243
(Constant)	1.138	.000
Adjusted R-squared	.0580	.000

* t-tests are one tailed
-- indicates omitted variables

Source: Statistics Canada

TABLE 7.8E

Coefficients Relating to Small Market Size, Trade Liberalization and the Eastman-Stykolt Hypotheses Obtained when Relative Plant Size is the Dependent Variable: Regression Results Across 120 Canadian Manufacturing Industries, Equation 5, 1970. Data Set II.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	--	--
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	0.670	.187
CNTBI (Canadian Non-Tariff Barriers, 1970)	-14.558	.040
USNRP70 (US Nominal Rate of Protection, 1970)	-1.259	.051
USNTBI (US Non-Tariff Barriers, 1970)	0.846	.419
SB70 (Canadian Unit Subsidy, 1970)	-5.371	.187
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	-1.670	.282
CNTBIMS (PEB70 interacting with CNTBI)	37.530	.034
UNP70MS (PEB70 interacting with USNRP70)	--	--
USNTBMS (PEB70 interacting with USNTBI)	--	--
SB70MS (PEB70 interacting with SB70)	21.351	.002
CDRMS70 (PEB70 interacting with V9S70)	-1.204	.001
UTC70MS (PEB70 interacting with UTC70)	--	--
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	-0.143	.290
UTC70 (Canadian unit Transportation Cost, 1970)	-0.145	.417
EMPRAT75 (R & D Expenditure)	3.404	.157
MMARCVA (Margin/Sales Ratio)	0.110	.257
ADVDM70 (Advertising Sales Ratio, 1970)	-2.426	.171
(Constant)		.000
Adjusted R-squared	.1404	

* t-tests are one tailed
-- indicates omitted variables

Source: Statistics Canada

with unit transportation cost, US nontariff barriers and US nominal tariff.

7.2.1 DISCUSSION OF REGRESSION RESULTS: DATA SET II, 1970

As for Data Set I, we will organize our discussion of Data Set II to deal systematically with the effect of market size, trade barriers and finally, the Eastman-Stykolt effect. In these regressions the dependent variable is relative plant scale (EFFIT70).

Small Market Size

Table 7.8B shows that Canadian small market size has the expected negative impact on relative plant scale but the significance level is low. However, when all theoretically relevant variables are included in the regression equation (Table 7.8A), it becomes statistically significant with the expected sign. The total effect of small market size, as reported in Tables 7.9A through 7.9E, also has the predicted negative effect on Canadian relative plant scale. In particular, when small market size is measured at the various values of Canadian-US trade protection, it becomes statistically significant (Table 7.9A).

Again the Canadian small market size continues to have the expected sign and is significant when it is evaluated at one standard deviation above the mean value of US-Canadian trade barriers (Table 7.9C and 7.9D). Thus, there is evidence that small market size explains Canadian relative plant scale.

TABLE 7.9A

Total Effect on Relative Plant Scale of Canadian Small Market Size, Canadian-US Trade Barriers Measured from the Mean, One-Standard Deviation Above and Below their Respective Values Across Regression Equation 1, 1970. Data Set II.

Variables	Mean	Above Mean (Small Market)	Below Mean (Large Market)
Total Effect of Canadian Small Market Size			
PEB70 (Canadian Small Market Size, 1970)	-1.170 (-2.195)	-.719 (-1.70)	-1.060 (-1.23)
Total Effect of Canadian-US Trade Barriers	.3420	-.658	.447
NRP70 (Canadian Nominal Rate of Protection, 1970)	.3420 (.282)	-.658 (-.260)	.447 (.398)
CNTBI (Canadian Non-Tariff Barriers, 1970)	-7.377 (-.741)	-12.743 (-1.489)	-8.48 (.979)
USNRP70 (US 70 Nominal Rate of Protection, 1970)	-1.021 (.756)	.371 (.222)	1.187 (.937)
USNTBI (US Non-Tariff Barriers, 1970)	-.758 (.098)	-1.742 (.014)	1.469 (.206)
SB70 (Canadian Unit Subsidy, 1970)	-.139 (-.017)	12.877 (1.565)	-2.895 (.479)
UTC79 (Canadian Unit Transportation Cost, 1970)	-.352 (-.243)	-2.187 (-.683)	-.160 (-.121)

* t-values are enclosed in parentheses

TABLE 7.9B

Total Effect on Relative Plant Scale of Canadian Small Market Size, Canadian-US Trade Barriers and Other Variables Measured From the Mean, One-Standard Deviation Above and Below their Respective Values Across Regression Equation 2, 1970*. Data Set II.

Variable	Mean	Above Mean (Sm. Mkt.)	Below Mean (Lg. Mkt.
Total Effect of Canadian Small Market Size			
PEB70 (Canadian Small Market Size)	-.297 (-2.049)	-.220 (-.518)	-.135 (-.509)
Total Effect of Canadian-US Trade Barriers			
NRP70 (Canadian Nominal Rate of Protection)	.322 (.911)	-.109 (-.078)	.367 (.949)
CNTBI (Canadian Non-Tariff Barriers)	-7.958 (-1.438)	-.109 (-.012)	-8.779 (-1.473)
SB70 (Canadian Unit Subsidy)	--	--	--
USNRP70 (US Nominal Rate of Protection)	--	--	--
USNTBI (US Non-Tariff Barriers	-	--	--
Total Effect of Other Variables			
V9S70 (Cost Disadvantage Rate)	--	--	--
UTC70 (Canadian Unit Transportation Cost)	--	--	--

* t-values are enclosed in parentheses.

-- indicates omitted variables from regression equation 2.

TABLE 7.9C

Total Effect on Relative Plant Scale of Canadian Small Market Size, Canadian-US Trade Barriers and Other Variables Measured From the Mean, One-Standard Deviation Above and Below their Respective Values Across Regression Equation 3, 1970*
Data Set II.

Variable	Mean	Above Mean (Sm. Mkt.)	Below Mean (Lg. Mkt.)
Total Effect of Canadian Small Market Size			
PEB70 (Canadian Small Market Size)	-.988 (-3.908)	-.730 (-2.077)	-.405 (-1.230)
Total Effect of Canadian-US Trade Barriers			
NRP70 (Canadian Nominal Rate of Protection	.260 (.768)	-.068 (-.057)	.295 (.801)
CNTBI (Canadian Non-Tariff Barriers)	-5.700 (-1.065)	7.449 (.936)	-7.073 (1.23)
SB70 (Canadian Unit Subsidy)	--	--	--
USNRP70 (US Nominal Rate of Protection	--	--	--
USNTBI (US Non-Tariff Barriers)	2.071 (.497)	10.141 (1.889)	1.226 (.295)
Total Effect of Other Variables			
V9S70 (Cost Disadvantage Ratio)	-.403 (-1.278)	-.945 (-3.29)	-.347 (-1.440)
UTC70 (Canadian Unit Transportation Cost)	--	--	--

* t-values are enclosed in parentheses.

-- indicates omitted variables from regression equation 2.

TABLE 7.9D

Total Effect on Relative Plant Scale of Canadian Small Market Size, Canadian-US Trade Barriers and Other Variables Measured from the Mean, One-Standard Deviation Above and Below Their Respective Values Across Regression Equation 4, 1970*.
Data Set II.

Variable	Mean	Above Mean (Sm.Mkt.)	Below Mean (Lg. Mkt.)
Total Effect of Canadian Small Market Size			
PEB70 (Canadian Small Market Size)	-.5004 (-2.411)	-.970 (-2.036)	.369 (1.291)
Total Effect of Canadian-US Trade Barriers			
NRP70 (Canadian Nominal Rate of Protection)	.403 (1.142)	-2.827 (-3.400)	.741 (1.896)
CNTBI (Canadian Non-Tariff Barriers)	-8.265 (-1.501)	12.161 (1.512)	22.250 (4.619
SB70 (Canadian Non-Tariff Barriers)	--	--	--
USNRP70(US Nominal Rate of Protection)	-1.557 (-2.085)	-.676 (-1.148)	-1.649 (-2.056)
USNTBI (US Non-Tariff Barriers)	--	--	--
Total Effect of Other Variables			
V9S70 (Cost Disadvantage Ratio)	--	--	--
UTC70 (Canadian Unit Transportation Cost)	--	--	--

* t-values are enclosed in parentheses.

-- indicates omitted variables from regression equation 4.

TABLE 7.9E

Total Effect on Relative Plant Scale of Canadian Small Market Size, Canadian-US Trade Barriers and Other Variables Measured From the Mean, One-Standard Deviation Above and Below Their Respective Values Across Regression Equation 3, 1970*
Data Set II.

Variable	Mean	Above Mean (Sm.Mkt.)	Below Mean (Lg.Mkt.)
Total Effect of Canadian Small Market Size			
PEB70 (Canadian Small Market Size)	-.771 (-3.049)	-.065 (-.183)	.007 (.018)
Total Effect of US-Canadian Trade Barriers			
NRP70 (Canadian Nominal Rate of Protection)	.291 (.865)	-.471 (-.386)	.363 (.998)
CNTBI (Canadian Non-Tariff Barriers)	8.67 (1.667)	24.090 (3.004)	7.052 (5.678)
SB70 (Canadian Unit Subsidy)	-5.240 (-.225)	8.251 (1.971)	-1.442 (-.451)
USNRP70 (US Nominal Rate of Protection)	--	--	--
USNTBI (US Non-Tariff Barriers)	--	--	--
Total Effect of Other Variables			
V9S70 (Cost Disadvantage Rate)	--	--	--
UTC70 (Canadian Unit Transportation Cost)	--	--	--

* t-values are enclosed in parentheses

-- indicates omitted variables from regression equation 5.

Trade Liberalization

The total effect of Canadian-US trade variables (representing the trade liberalization hypothesis) on relative plant size changes sign across the regression equations. On one hand, the Canadian nominal rate of protection consistently has the expected sign in small market size and is highly significant (Table 7.9D). In the remaining equations, it changes sign across the various values of market size and is often statistically insignificant with the large market size. The coefficient of Canadian nontariff barriers has the expected sign and is significant when measured at the mean value and one standard deviation above the mean values of Canadian small market size (Table 7.9A). In other equations such as that on Table 7.9B, it is significant with the correct sign in small and large markets.

US nominal rate of protection also changes sign and is significant in only Table 7.9D. In this table, it has a negative impact on relative plant scale and is significant at the mean and in large market but not in small market size. The total effect of US non-tariff barriers has the expected sign but with low significance level (Table 7.9A).

Except for Canadian nominal rate of protection and US NTBs, Tables 7.8A and 7.8B show that Canadian US trade protection variables have the expected signs and some significant. Also the F-test shown in Tables 7.10A and 7.10B (on line 9) indicates that all forms of US-Canadian trade protection as a group are statistically significant but it is difficult to separate the individual impact of US-Canadian

TABLE 7.10A

Hypotheses Testing the Significance of the Apparent Negative Effect of Subsets of Trade Variables on Relative Plant Scale, Regression Equation 1, 1970. Data Set II

No.	DF	F	SIGF	SUBSETS OF VARIABLES*
1	2	1.2565	.2887	(USNTBI USNRP70)
2	2	1.3655	.2596	(USNTBI USNTBMS)
3	2	2.9005	.0593	(USNRP70 UNP70MS)
4	4	1.9607	.1056	(USNTBI USNTBMS USNRP70 UNP70MS)
5	6	2.0303	.0676	(NRP70 NRP70MS CNTBI CNTBIMS SB70 SB70MS)
6	2	1.2202	.2992	(NRP70 NRP70MS)
8	2	2.2818	.1070	(SB70 SB70MS)
9	10	2.1577	.0258	(USNTBI USNTBMS USNRP70 UNP70MS NRP70 NRP70MS CNTBI CNTBIMS SB70 SB70MS)
10	6	1.8707	.0923	(USNTBI USNTBMS CNTBI CNTBIMS SB70 SB70MS)
11	2	2.7250	.0700	(NRP70MS CNTBIMS)
12	2	.3570	.2299	(UNP70MS USNTBMS)
13	2	2.5304	.0330	(USNTBI USNRP70 NRP70 CNTBI SB70)
14	4	3.1746	.0165	(USNRP70 UNP70MS NRP70 NRP70MS)
15	5	2.5223	.0335	(NRP70MS CNTBIMS SB70MS UNP70MS USNTBMS)
	10	2.1577	.0258	Regression
	109			Residual

Adjusted R-squared .0887

* Mnemonics are defined in Table 7.6

No. denotes line sequence of F-tests.

DF denotes the degrees of freedom.

F denotes the value of the F statistic.

SIGF denotes significance F level.

SOURCE: Statistics Canada.

TABLE 7.10B

Hypotheses Testing the Significance of the Apparent Negative Effect of Subsets of Trade Variables on Relative Plant Scale, Regression Equation 2, 1970. Data Set II.

No.	DF	F	SIGF	Subsets of Variables*
1				
2	2	1.76467	0.1761	(USNTBI USNRP70)
3	--	--	--	(USNTBI USNTBMS)
4	--	--	--	(USNRP70 UNP70MS)
5	--	--	--	(USNTBI USNTBMS USNRP70 UNP70MS)
6	5	1.87810	.1039	(NRP70 NRP70MS CNTBI CNTBIMS SB70)
7	2	2.39461	0.0959	(CNTBI CNTBIMS)
8	2	3.81112	0.0251	(NRP70 NRP70MS)
9	--	--	--	(SB70 SB70MS)
10	7	2.24128	0.0361	(USNTBI USNRP70 NRP70 NRP70MS CNTBI CNTBIMS SB70)
11	4	1.43562	0.2270	(USNTBI CNTBI CNTBIMS SB70)
12	2	3.64222	0.0294	(NRP70MS CNTBIMS)
13	--	--	--	(UNP70MS USNTBMS)
14	5	2.26565	0.0528	(USNTBI USNRP70 NRP70 CNTBI SB70)
15	--	--	--	(UTC70 UTC70MS)
16	--	--	--	(V9S70 CDRMS70)
17	3	3.80521	.0122	(USNRP70 NRP70 NRP70MS)
18	9	1.86876	0.0640	Regression
19	110			Residual
	Adjusted R-Squared		.0600	

* Mnemonics are defined in Table 7.6.

No. denotes line sequence of F-tests.

DF denotes the degrees of freedom.

F denotes the value of the F statistic.

SIGF denotes significance F level.

-- indicates omitted variables.

Source: Statistic Canada

TABLE 7.10C

Hypotheses Testing the Significance of the Apparent Negative Effect of Subsets of Trade Variables on Relative Plant Scale, Regression Equation 3, 1970

No.	DF	F	SIGF	Subsets of Variables*
1	3	3.42028	0.0199	(USNTBI USNRP70 USNTBMS)
2	2	3.72130	0.0273	(USNTBI USNTBMS)
3		--	--	(USNRP70 UNP70MS)
4		--	--	(USNTBI USNTBMS USNRP70 UNP70MS)
5	5	1.26073	0.2862	(NRP70 NRP70MS CNTBI CNTBIMS SB70)
6	2	2.27826	0.1073	(CNTBI CNTBIMS)
7	2	0.41340	0.6624	(NRP70 NRP70MS)
8		--	--	(SB70 SB70MS)
9	8	1.72866	0.0997	(USNTBI USNTBMS USNRP70 NRP70 NRP70MS USNTBI CNTBIMS SB70)
10	5	2.07125	0.0745	(USNTBI USNTBMS CNTBI CNTBIMS SB70)
11	2	.41340	.662	(NRP70MS CNTBIMS)
12		--	--	UNP70MS USNTBMS)
13		--	--	(NRP70MS CNTBIMS UNP70MS USNTBMS)
14	3	3.28799	0.0235	(NRP70MS CNTBIMS USNTBMS)
15	5	1.98982	0.0858	(USNTBI USNRP70 NRP70 CNTBI SB70)
16		--	--	(UTC70 UTC70MS)
17	2	5.61143	0.0048	(V9S70 CDRMS70)
18	3	1.15907	.3288	(USNRP70 NRP70 NRP70MS)
	10	2.86239	.0033	Regression
	109			Residual
		Adjusted R-squared		.1300

* Mnemonics are defined in Table 7.6.
No. denotes line sequence of F-tests.
DF denotes the degree of freedom.
F denotes the value fothe F statistic.
SIGF denotes significance F-level.
-- indicates omitted variables.

Source: Statistics Canada

TABLE 7.10D

Hypotheses Testing the Significance of the Apparent Negative Effect of Subsets of Trade Variables on Relative Plant Scale, Regression Equation 4, 1970

No.	DF	F	SIGF	Subsets of Variables*
1	3	2.06443	0.1090	(USNTBI USNRP70 UNP70MS)
2		--	--	(USNTBI USNTBMS)
3	2	3.09-59	0.0491	(USNRP70 UNP70MS)
4		--	--	(USNTBI USNTBMS USNRP70 UNP70MS)
5	5	1.68484	0.1441	(NRP70 NRP70MS CNTBI CNTBIMS SB70)
6	2	2.89051	0.0597	(CNTBI CNTBIMS)
7	2	3.28961	0.0409	(NRP70 NRP70MS)
8		--	--	(SB70 SB70MS)
9	8	2.09974	0.0416	(USNTBI SUMRP70 NRP70 NRP70MS CNTBI CNTBI CNTBIMS SB70 UNP70MS)
10	4	1.66596	0.1630	(USNTBI CNTBI CNTBIMS SB70)
11	4	3.11394	0.0180	(USNRP70 UNP70MS NRP70 NRP70MS)
12	2	3.32108	0.0397	(NRP70MS CNTBIMS)
13		--	--	(UNP70MS USNTBMS)
14		--	--	(NRP70MS CNTBIMS UNP70MS USNTBMS)
15	3	2.67376	0.0508	(NRP70MS CNTBIMS USNTBMS)
16	5	2.17989	0.0614	(USNTBI UNP70 NRP70 CNTBI SB70)
17		--	--	(UTC70 UTC70MS)
18		--	--	(V9S70 CDRMS70)
	8			Regression
	111			Residual
	Adjusted R-squared			.06884

* Mnemonics are defined in Table 7.6

No. denotes line sequence of F tests.

DF denotes the degrees of Freedom.

F denotes the value of the F statistic.

SIGF denotes significance F-level.

-- indicates omitted variables.

Source: Statistics Canada

TABLE 7.10E

Hypotheses Testing the Significance of the Apparent Negative Effect of Subsets of Trade Variables on Relative Plant Scale, Regression Equation 5, 1970.
Data Set II.

No.	DF	F	SIGF	Subsets of Variables*
1	2	1.91032	0.1530	(USNTBI UNSRP70)
2		--	--	(USNTBI USNTBMS)
3		--	--	(USNRP70 UNP70MS)
4		--	--	(USNTBI USNTBMS USNRP70 UNP70MS)
5	6	2.19388	0.0489	(NRP70 NRP70MS CNTBI CNTBIMS SB70 SB70MS)
6	2	2.79571	0.0655	(CNTBI CNTBIMS)
7	2	.70618	.4958	(NRP70 NRP70MS)
8	2	4.87235	.0094	(SB70 SB70MS)
9	3	1.5399	.2083	(USNRP70 NRP70 NRP70MS)
10	8	2.03684	0.0485	(USNTBI USNRP70 NRP70 NRP70MS CNTBI CNTBIMS SB70 SB70MS)
11	5	2.55040	0.0319	(USNTBI CNTBI CNTBIMS SB70 SB70MS)
12	3	4.08328	0.0086	(NRP70MS CNTBIMS SB70MS)
13		--	--	(UNP70MS USNTBMS)
14		--	--	(NRP70MS CNTBIMS UNP70MS USNTBIMS)
15	4	2.23286	0.0701	(USNTBI USNRP70 NRP70 CNTBI SB70)
16		--	--	(UTC70 UTC70MS)
17	2	5.69595	0.0044	9V9S70 CDRMS70)
	10			Regression.
	109			Residual
	Adjusted R-squared			.15234

* Mnemonics are defined in Table 7.6.
No. denotes line sequence of F-tests.
DF denotes the degrees of Freedom.
F denotes the value of F statistic.
SIGF denotes significance F-level.
-- indicates omitted variables.

Source: Statistics Canada

trade protection on relative plant scale. In some F-tests, especially in Table 7.10A (line 5) and Table 7.10B (line 6) show that all forms of Canadian trade protection are significant whereas in others (Tables 7.10C and 7.10D, line) they are not. Similarly, the various forms of US trade protection facing Canadian producers are significant in some equations (Table 7.10C, line 1) while in others (Table 7.10A, line 4) it has low significance level. Thus, Data Set II shows some support of the trade liberalization hypothesis that US-Canadian protection as a group influence relative plant scale in Canadian manufacturing industries.

Eastman-Stykolt Effect

The interaction of Canadian nominal rate of protection with small market size (NRP70MS) always exert a negative impact on relative plant scale and is highly significant in some equations (Table 7.8D). The coefficient of other interaction terms such as CNTBIMS, UNP70MS and USNTBMS which represent the Eastman-Stykolt effect on relative plant scale have the wrong sign but are significant in many equations (Table 7.8C).

The F-tests on all interaction terms described in Table 7.10A (line 15), Table 7.10C (line 14), Table 7.10D (line 15) and Table 7.10E (line 12) are always statistically significant. In addition, the various measures of trade protection provided in line 11 of Table 7.10A and on line 12 of Table 7.10B are statistically significant. An F-test on US interaction term is not statistically significant (Table 7.10A, line 12). Thus Data Set II gives some support of the Eastman-Stykolt hypothesis that small market size combining with domestic tariff and nontariff protection exacerbate the difficulties which Canadian plants face realizing economies of scale. However, the results do not support the preposition that US nontariff barriers and US tariffs (interacting with Canadian market size) have a similar effect on relative plant scale.

Other Variables

Data Set II includes a larger set of other explanatory variables compared to Data Set I. Besides the cost disadvantage ratio and unit transportation cost, there are other control variables of relative plant scale including R & D expenditure(EMPRAT75), margin/sales ratio (MMARCVA) and product differentiation (ADVDM). However, many of these variables have the wrong sign and are statistically insignificant[3]. Only the coefficient of product differentiation variable has the expected impact on relative plant scale but is never significant. The coefficient of unit transportation cost changes across the regression equations and is also never significant.

7.3 REGRESSION RESULTS: DATA SET III, 1979

As in Data Set II, the dependent variable for the third set of regressions is relative plant scale except that it is defined for year 1979. Unlike 1970 regression analysis, US nominal rate of tariff protection and US-Canadian nontariff barriers are unavailable. Instead we employed Post Kennedy Round rates because, a) they were negotiated during the 1970s and b) they are assumed to highly correlate with the missing values of US nominal protection in 1979.

The names of variables, expected signs, means and standard deviations are described in Table 7.11. The estimated regression coefficients are reported in two separate equations because of the presence of high collinearity between small market size (PEB79) and its interaction with Canadian tariff protection (NRP78MS).

The simple correlation matrix is reported in Table 7.12. Other highly collinear variables are market size and cost disadvantage ratio interacting with market size (PEB79, CDRMS79), subsidy and the interaction of subsidy with market size (SB79, SB79MS), US and Canadian tariff interacting with market size (PKRMS and NRP78MS).

TABLE 7.11

Mnemonic, Variable Names, Expected Signs, Mean and Standard Deviation of Variables in 1979 Regression Data Set II

Mnemonic	Variable Names	Expected Sign	Mean	Standard Deviation
ADVDM79	Advertising Sales Ratio, 1979	-	0.006	0.017
CDRMS79	V9S79 Interacting with PEB79	-	0.164	0.278
EFFIT79	Relative Plant Scale, 1979	*	0.722	0.628
EMPRAT79	R & D Expenditure, 1979	-	0.008	0.018
MMARCVA	Margin/Sales Ratio	-	0.858	0.354
NRP79	Canadian Nominal Rate of Protection, 1978	-	0.102	0.090
NRP78MS	NRP78 Interacting with PEB79	-	0.019	0.043
PEB79	Canadian Small Market Size, 1979	-	0.167	0.221
PKR	Post Kennedy Round Rates	-	0.082	0.074
PKRMS	PKR Interacting with PEB79	-	0.018	0.052
SB79	Canadian Unit Subsidy, 1979	-	0.058	0.570
SB79MS	SB79 Interacting with PEB79	-	0.005	0.041
UTC79	Canadian Unit Transportation Cost, 1979	-	0.042	0.072
UTC79MS	UTC79 Interacting with PEB79	-	0.007	0.018
V9S79	Cost Disadvantage Ratio, 1979	+	0.903	0.293

* Dependent variable.

TABLE 7.12

Names and Correlation Matrix of All Variables Across 120 Canadian Manufacturing Industries, 1979. Data Set III

Relative Plant Scale, 1979
Canadian Nominal Rate of Protection, 1978
Advertising Sales Ratio, 1979
R&D Expenditure, 1979
Canadian Small Market Size, 1979
Margin/Sales Ratio
Canadian Unit Transportation Cost, 1979
UTC79 Interacting with PEB79
Canadian Unit Subsidy, 1979
SB79 Interacting with PEB79
NRP78 Interacting with PEB79
Post Kennedy Round Rates
PKR Interacting with PEB79
Cost Disadvantage Ratio, 1979
V9S79 Interacting with PEB79

	EFFIT79	NRP78	ADVDM79	EMPRAT79	PEB79	MMARCYA	UTC79	UTC79MS	SB79	SB79MS	NRP78MS	PKR	PKRMS
EFFIT79	1.000	-0.075	-0.126	-0.091	-0.347	0.176	0.146	-0.156	0.111	0.099	-0.228	-0.107	-0.193
NRP78	-0.075	1.000	0.171	-0.180	0.115	-0.197	0.065	0.029	-0.073	-0.078	0.525	0.379	0.230
ADVDM79	-0.126	0.171	1.000	0.060	0.097	-0.171	-0.123	-0.070	-0.034	-0.038	0.239	0.036	0.195
EMPRAT79	-0.091	-0.180	0.060	1.000	0.069	-0.119	-0.037	0.038	0.231	-0.235	-0.031	-0.140	0.018
PEB79	-0.347	0.115	0.097	0.069	1.000	-0.133	-0.040	0.470	-0.040	-0.018	0.806	0.277	0.781
MMARCYA	0.176	-0.197	-0.171	0.119	-0.133	1.000	0.065	-0.097	0.105	0.097	-0.199	-0.006	-0.140
UTC79	0.146	0.055	-0.123	-0.037	-0.040	0.065	1.000	0.509	0.156	0.167	-0.037	0.228	-0.001
UTC79MS	-0.156	0.029	-0.070	0.038	0.470	-0.097	0.509	1.000	0.030	0.059	0.297	0.179	0.292
SB79	0.111	-0.073	-0.034	0.231	-0.040	0.106	0.156	0.030	1.000	0.999	-0.038	-0.048	-0.027
SB79MS	0.099	-0.078	-0.038	0.236	-0.018	0.097	0.167	0.059	0.999	1.000	-0.031	-0.043	-0.017
NRP78MS	-0.228	0.525	0.239	-0.031	0.806	-0.199	-0.037	-0.297	-0.038	-0.031	1.000	0.428	0.886
PKR	-0.107	0.379	0.036	-0.140	0.277	-0.006	0.228	0.179	-0.048	-0.043	0.428	1.000	0.572
PKRMS	-0.193	0.230	0.196	0.018	0.781	-0.140	-0.001	0.292	-0.027	-0.017	0.886	0.572	1.000
V9S79	-0.037	0.008	-0.062	-0.019	0.208	-0.108	-0.101	0.079	-0.041	-0.039	0.191	0.096	0.182
CONMS79	-0.284	0.123	0.073	0.044	0.961	-0.140	-0.037	0.459	-0.036	-0.020	0.832	0.279	0.798

	V9S79	CONMS79
EFFIT79	-0.037	-0.284
NRP68	0.008	0.123
ADVDM79	-0.062	0.073
EMPRAT79	-0.319	0.044
PEB79	0.208	0.961
MMARCYA	-0.108	-0.140
UTC79	-0.101	-0.037
UTC79MS	0.079	0.459
SB79	-0.041	-0.036
SB79MS	-0.039	-0.020
NRP78MS	0.191	0.832
PKR	0.096	0.279
PKRMS	0.182	0.798
V9S79	1.000	0.373
CONMS79	0.373	1.000

7.3.1 DISCUSSION OF REGRESSION RESULTS: DATA SET III, 1979

Small Market Size

Data Set III provides support for the hypothesis that a small market promotes lower relative plant scale (EFFIT79) in Canada. Tables 7.13A and 7.13B show that small market size (PEB79) consistently has the expected negative impact on relative plant scale and is statistically significant. Also the total effect of small market on relative plant scale, as reported in Tables 7.14A and 7.14B has the correct sign and is significant in both cases.

Trade Liberalization

The combined US-Canadian trade protection illustrated in Tables 7.15A and 7.15B (line 4) is not significant. Neither US (line 1) nor Canada's (line 2) trade protection is statistically significant. But note that Table 7.13A shows that US tariff protection (PKR) has the expected negative impact on relative plant scale and is significant. Canadian tariff protection has the wrong sign and is not significant when entered without an interaction term, but is statistically significant with the correct sign in equation 2 (Table 7.13B). Thus, there is evidence that trade barriers help to promote Canadian small relative plant scale in 1979.

TABLE 7.13A

Coefficients Relating to Small Market Size, Trade Liberalization and the Eastman-Stykolt Hypotheses Obtained when Relative Plant Size is the Dependent Variable: Regression Results Across 120 Canadian Manufacturing Industries, Equation 1, 1979
Data Set III

Variable	Significant Coefficient	Marginal Significance Level
Small Market Size Hypothesis		
PEB79 (Canadian Small Market Size, 1979)	-1.452	.002
Trade Liberalization Hypothesis		
NRP78 (Canadian Nominal Rate of Protection, 1978)	0.007	.496
PKR (Post Kennedy Round Rates	-2.084	.024
Eastman-Stykolt Hypothesis		
NRP78MS (PEB79 interacting with NRP78)	--	--
SB79MS (PEB79 interacting with subsidy, 1979)	1.037	.225
PKRMS (PEB79 interacting with PKR)	4.981	.011
UTC79MS (PEB79 interacting with UTC79)	-4.270	.190
Others		
V9S79 (Cost Disadvantage Ratio, 1979)	0.126	.253
UTC79 (Canadian Unit Transportation Cost, (1979)	1.964	.039
EMPRAT79 (R & D Expenditure)	-3.890	.116
MMARCVA (Margin/Sales Ratio)	0.238	.071
ADVDM79 (Advertising Sales Ratio, 1979)	-3.403	.154
(Constant)	.7176	.007
Adjusted R-squared	.1467	

* t-test are one tailed.

-- indicates omitted variables from equation 1.

Source: Statistics Canada

TABLE 7.13B

Coefficients Relating to Small Market Size, Trade Liberalization and the Eastman-Stykolt Hypotheses Obtained when Relative Plant Size is the Dependent Variable: Regression Results Across 120 Canadian Manufacturing Industries, Equation 2, 1979, Data Set III*

Variable	Estimated Coefficient	Marginal Significance Level
Small Market Size Hypothesis		
PEB79 (Canadian Small Market Size, 1979)	-1.677	.003
Trade Liberalization Hypothesis		
NRP78 (Canadian Nominal Rate of Protection, 1978)	-1.375	.068
PKR (Post Kennedy Round Rates)	-0.980	.130
Eastman-Stykolt Hypothesis		
NRP78MS (PEB79 interacting with NRP78)	7.097	.018
SB79MS (PEB79 interacting with Subsidy, 1979)	0.963	.243
PKRMS (PEB79 interacting with PKR)	--	--
UTC79MS (PEB79 interacting with UTC79)	-4.342	.187
Others		
V9S79 (Cost Disadvantage Ratio, 1979)	0.097	.305
UTC79 (Canadian Unit Transportation Cost, 1979)	1.935	.042
EMPRAT79 (R & D Expenditure, 1979)	-3.432	.146
MMARCVA (margin/Sales Ratio)	0.214	.093
ADVDM79 (Advertising Sales Ratio, 1979)	-3.509	.149
(Constant)	0.804	.004
Adjusted R-squared	0.2199	

* t-tests are one-tailed

-- indicates omitted variables from equation 2.

Source: Statistics Canada

TABLE 7.14A

Total Effect on Relative Plant Scale of Canadian Small Market Size, Canadian-US Trade Barriers Measured from the Mean, One-Standard Deviation Above and Below Their Respective Values Across Regression Equation 1, 1979*. Data Set III.

Variable	Mean	Above Mean (Sm. Mkt.)	Below Mean (Lg. Mkt.)
Total Effect of Canadian Small Market Size			
PEB79 (Canadian Small Market Size)	-1.227 (-4.070)	-1.166 (-2.638)	-1.536 (-3.668)
Total Effect of Canadian-US Trade Barriers			
NRP78 (Canadian Nominal Rate of Protection)	--	--	--
PKR (Post Kennedy Round Rates)	-1.252 (-1.414)	-.131 (-.171)	-1.815 (-1.852)

TABLE 7.14B

Total Effect on Relative Plant Scale of Canadian Small Market Size, Canadian-US Trade Barriers Measured From the Mean, One-Standard Deviation Above and Below Their Respective Values Across Regression Equation 2, 1979*. Data Set III.

Variable	Mean	Small Market (Sm.Mkt.)	Large Market (Lg. Mkt.)
Total Effect of Canadian Small Market Size			
PEB79 (Canadian Small Market Size)	-1.140 (3.939)	-.814 (-1.628)	-1.715 (3.349)
Total Effect of Canadian-US Trade Barriers			
NRP78 (Canadian Nominal Rate of Protection)	-.190 (-.282)	1.379 (1.449)	-.992 (-1.236)
PKR (Post Kennedy Round Rates)	--	--	--

* t-values are enclosed in parentheses.

-- indicates that variables are omitted from the equation.

TABLE 7.15A

Hypotheses Testing the Significance of the Apparent Negative Effect of Subsets of Trade Variables on Relative Plant Scale, Regression Equation 1, 1979, Data Set III

No.	DF	F	SIGF	Subsets of Variables*
1a	3	0.72651	0.5382	(PRK PKRMS NRP78)
1	2	0.68676	0.5053	(PKR PKRMS)
2	2	0.25513	0.7753	(NRP78 SB79MS)
3	--	--	--	(NRP78 NRP78MS)
4	4	0.66706	0.6162	(PKR PKRMS NRP78 SB79MS)
5	--	--	--	(SB79 SB79MS)
6	2	5.59037	0.0053	(UTC79 UTC79MS)
7				(V9S79 CDRMS79)
8	3	3.83302	0.0117	(PKRMS SB79MS UTC79MS)
9	2	.1759	.8389	(PKRMS SB79MS)
	6	2.8541	0.0126	Regression
	113			Residual
	Adjusted R-squared			0.08549

* Mnemonics are defined in Table 7.11.

No. denotes line sequence of F-tests.

DF denotes the value of the F-statistic.

SIGF Denotes the significance F-level.

-- indicates omitted variables.

Source: Statistics Canada.

TABLE 7.15B

Hypotheses Testing the Significance of the Apparent Negative Effect of Subsets of Trade Variables on Relative Plant Scale, Regression Equation 2, 1979, Data Set III

No.	DF	F	SIGF	Subsets of Variables*
1	--	--	--	(PKR PKRMS)
(1a)	3	0.83918	0.4751	(PKR NRP78 NRP78MS)
2	3	0.29176	0.8313	(NRP78 SB79MS NRP78MS)
3	2	0.26783	0.7655	(NRP78 NRP78MS)
4	4	0.75191	0.5588	(PKR NRP78 SB79MS NRP78MS)
5	--	--	--	(SB79 SB79MS)
6	2	4.53272	0.0128	(UTC79 UTC79MS)
7	3	3.95480	0.0101	(NRP78MS SB79MS UTC79MS)
8	2	.3422	0.7109	(NRP78MS SB79MS)
9	6	2.91769	0.110	Regression
	113			Residual
		Adjusted R-squared		0.08817

* Mnemonics are defined on Table 7.11.

No. denotes line sequence of F-tests.

DF denotes the value of the F-statistic.

SIGF denotes the significant F-level.

-- indicates omitted variables.

Source: Statistics Canada.

Eastman-Stykolt Effect

Canadian-US tariff protection variables (interacting with Canadian small market size) have the wrong and sign and are significantly different from zero on a two-tailed test. (Tables 7.13A and 7.13B.) Also the interaction of subsidy with small market size has the wrong sign and is statistically insignificant. Unit transportation cost interacting with small market size, however, exerts a negative influence on relative plant scale, as expected, but has a low significance level. Even the F-test on all US-Canadian interaction terms is statistically insignificant as reported in Table 7.15A (line 9) and Table 7.15B (line 8). Thus, Data Set III does not support the hypothesis that a small market combined with trade protection aggravates the problem of small scale manufacturing plants in Canada.

Other Variables

Table 7.13 shows that both R&D expenditure and product differentiation variables have the expected signs but are statistically insignificant. Also unit transportation cost and margin/sales ratio are not statistically significant. Unit transportation costs, however, become significant when entered jointly with market size composite variable (UTC70MS) as evidenced by the F-test shown in Table 7.15B.

7.4 EQUATIONS OF BEST FIT, SUMMARY AND MAIN CONCLUSIONS OF THE EMPIRICAL RESULTS: 1968, 1970 AND 1979

The previous sections examined the empirical tests of the small market size, trade liberalization and Eastman-Stykolt hypotheses, using data for years 1968, 1970 and 1979. The three hypotheses were tested on two measures of scale efficiency: a) suboptimal capacity, the fraction of industry output originating from plants below minimum efficient plant scale for 79 Canadian manufacturing industries in 1968, and b) relative plant scale, the ratio of the average size of Canadian largest plants to the average size of US largest plants for 120 manufacturing industries in 1970 and 197 . This section will present the best-fit regression equations, summary and main conclusions of the empirical results for Data Set I, II and III.

7.4.1 BEST-FIT REGRESSION EQUATIONS

The equations of best fit in the sense of maximum adjusted R-squared include only variables that add significantly to the variation of the dependent variable. Lovell (1983, 1-2) argued that the marginal significance levels of such regressions are exaggerated and should be interpreted with caution. Specifically, Lovell (1983, 2) recommended that the apparent marginal significance level should be deflated by a 'Rough Rule of Thumb' to arrive at the true significance[2]. Hence, on the basis of Lovell's criticism, the best fit equations are presented only as descriptive regressions, since the probability of making a Type I error when the null hypothesis of zero is rejected is much greater than what is suggested by the t-scores. The estimated coefficients and marginal significance levels for the Data Sets are presented separately on Tables 7.16A, 7.16B; Tables 7.17A through 7.17D and Tables 7.17A and 7.18B.

TABLE 7.16A

Best ** Regression Results Explaining Suboptimal Capacity in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypothesis, 1968, Equation 1 of Data Set I

Variables	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB68 (Canadian Small Market Size, 1968)	--	--
Trade Liberalization Hypothesis		
NRP68 (Canadian Nominal Rate of Protection, 1968)	-1.237	.016
CNTB68 (Canadian Non-Tariff Barriers, 1968)	-4.064	.049
SUB68 (Canadian Unit Subsidy, 1968)	-.915	.096
PKR (Post Kennedy Round Rates)	1.199	.023
USNTB68 (US Non-Tariff Barriers, 1968)	--	--
Eastman-Stykolt Hypothesis		
NRPSM68 (PEB68 interacting with NRP68)	35.543	.000
CNTBSM68 (PEB68 interacting with CNTB68)	101.908	.025
SUBSM68 (PEB68 interacting with SUB68)	--	--
CDRSM68 (PEB68 interacting with CDR)	-39.081	.019
PKRMS (PEB68 interacting with PKR)	-17.202	.043
USNTBSM (PEB68 interacting with USNTB68)	--	--
UTCSM68 (PEB68 interacting with UTC68)	--	--
Others		
CDR (Cost Disadvantage Ratio, 1968)	.896	.072
UTC68 (Unit Transportation Cost, 1968)	--	--
Constant	.3070	.000
Adjusted R-squared	.1794	

** Best as measured by the maximum adjusted R-squared
* t-tests are one-tailed
-- indicates omitted variables from Equation 1, 1968.

TABLE 7.16B

Best** Regression Results Explaining Suboptimal Capacity in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypotheses, 1968, Equation 2. Data Set I.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB68 (Canadian Small Market Size, 1968)	--	--
Trade Liberalization Hypothesis		
NRP68 (Canadian Nominal Rate of Protection, 1968)	-0.960	.016
CNTB68 (Canadian Non-Tariff Barriers, 1968)	-1.940	.151
PKR (Post Kennedy Round Rates)	0.701	.034
USNTB68 (US Non-Tariff Barriers, 1968)	--	--
Eastman-Stykolt Hypothesis		
NRPSM68 (PEB68 interacting with NRP68)	22.939	.003
CNTBSM68 (PEB68 interacting with CNTB68)	--	--
SUBSM68 (PEB68 interacting with subsidy, 1968)	-24.758	.129
CDRSM68 (PEB68 interacting with CDR, 1968)	-33.678	.030
PKRSM (PEB68 interacting with PKR)	--	--
USNTBSM (PEB68 interacting with USNTB68)	74.064	.060
UTCSM68 (PEB68 interacting with transportation cost, 1968)	--	--
Others		
CDR (Cost Disadvantage Ratio, 1968)	.833	.082
(Constant)	.299	.000
Adjusted R-Squared	.166	

* t-tests are one tailed.

-- indicates omitted variables from Equation 2, 1968.

** Best as measured by the maximum adjusted R-squared.

TABLE 7.17A

Best ** Regression Results Explaining Relative Plant Scale in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypothesis, Equation 1, 1970, Data Set II

Variable	Estimated Coefficient	Marginal Significance Level
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	-1.315	.000
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	.266	.206
CNTBI (Canadian Non-Tariff Barriers, 1970)	-12.011	.026
USNRP70 (US Nominal Rate of Protection, 1970)	-1.124	.059
USNTBI (US Non-Tariff Barriers, 1970)	--	--
SB70(Canadian Unit Subsidy, 1970)	-8.666	.006
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	--	--
CNTBIMS (PEB70 interacting with CNTBI)	27.328	.007
UNP70MS (PEB70 interacting with USNRP70)	--	--
USNTBMS (PEB70 interacting with USNTBI)	--	--
SB70MS (PEB70 interacting with SB70)	37.176	.000
UTC70MS (PEB70 interacting with UTC70)	--	--
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	-.348	.062
UTC70 (Canadian Unit Transportation Cost, 1970)	--	--
EMPRAT75 (R & D Expenditure, 1970)	3.572	.137
MMARCVA (Margin/Sales Ratio)	--	--
ADVDM70 (Advertising Sales Ratio, 1970)	-2.800	.125
(Constant)	1.339	.000
Adjusted R-squared	.0842	

TABLE 7.17B

Best** Regression Results Explaining Relative Plant Scale in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypotheses, Equation 2, 1970. Data Set II.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	-0.318	.007
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	--	--
CNTBI (Canadian Non-Tariff Barriers, 1970)	-4.862	.115
USNRP70 (US Nominal Rate of Protection, 1970)	-.878	.110
USNTBI (US Non-Tariff Barriers, 1970)	--	--
SB70 (Canadian Unit Subsidy, 1970)	--	--
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	--	--
CNTBIMS (PEB70 interacting with CNTBI)	--	--
UNP70MS (PEB70 interacting with USNRP70)	--	--
USNTBMS (PEB70 interacting with USNTBI)	--	--
CDRMS70 (PEB70 interacting with U9S70)	--	--
UTC70MS (PEB70 interacting with UTC70)	--	--
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	-.362	.062
UTC70 (Canadian Unit Transportation Cost, 1970)	--	--
EMPRAT75 (R & D Expenditure)	--	--
MMARCVA (Margin/Sale Ratio)	0.198	.097
ADVDM70 (Advertising Sales Ratio, 1970)	--	--
(Constant)	1.017	.000
Adjusted R-squared	.0895	

** Best as measured by the maximum adjusted R-squared.

* the t-tests are one tailed.

-- indicates omitted variables.

Source: Statistics Canada.

TABLE 7.17C

Best** Regression Results Explaining Relative Plant Scale in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypotheses, Equation 3, 1970. Data Set II.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB79 (Canadian Small Market Size, 1970)	--	--
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	--	--
CNTBI (Canadian Non-Tariff Barriers, 1970)	-13.614	.015
USNRP70 (US Nominal Rate of Protection, 1970)	-1.127	.052
USNTBI (US Non-Tariff Barriers, 1970)	--	--
SB70 (Canadian Unit Subsidy, 1970)	--	--
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	--	--
CNTBIMS (PEB70 interacting with CNTBI)	29.136	.008
UNP70MS (PEB70 interacting with USNRP70)	--	--
USNTBMS (PEB70 interacting with USNTBI)	17.295	.003
CDRMS70 (PEB70 interacting with U9S70)	-1.335	.000
UTC70MS (PEB70 interacting with UTC70)	--	--
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	--	--
UTC70 (Canadian Unit Transportation Cost, 1970)	--	--
EMPRAT75 (R & D Expenditure)	--	--
MMARCVA (margin/Sales Ratio)	0.171	.114
ADVDM70 (Advertising Sales Ratio, 1970)	--	--
(Constant)	0.876	
Adjusted R-Squared	.1656	

** Best are measured by the maximum adjusted R-squared.
* t-tests are one-tailed
-- indicates omitted variables.

Source: Statistics Canada

Table 7.17D

Best** Regression Results Explaining Relative Plant Scale in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypotheses: Equation 4, 1970. Data Set II.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	--	--
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	2.235	.004
CNTBI (Canadian Non-Tariff Barriers, 1970)	-18.955	.005
USNRP70 (US Nominal Rate of Protection, 1970)	-2.055	.008
USNTBI (US Non-Tariff Barriers, 1970	--	--
SB70 (Canadian Unit Subsidy, 1970)	--	--
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	-8.289	.004
CNTBIMS (PEB70 interacting with CNTBI)	49.461	.003
UNP70MS (PEB70 interacting with USNRP70)	2.317	.055
USNTBMS (PEB70 interacting with USNTBI)	--	--
CDRMS70 (PEB70 interacting with V9S70)	--	--
UTC70MS (PEB70 interacting with UTC70)	--	--
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	-0.392	.046
UTC70 (Canadian Unit Transportation Cost, 1970)		
EMPRAT75 (R & D Expenditure)	--	--
MMARCVA (Margin/Sales Ratio)	--	--
ADVDM70 (Adversiting Sales Ratio, 1970)	--	--
(Constant)	1.1471	.000
R-Squared	.1505	
Adjusted R-squared	.0975	

** Best as measured by the maximum adjusted R-squared.
* t-tests are one tailed.
-- indicates omitted variables.

Source: Statistics Canada.

TABLE 7.17E

Best** Regression Results Explaining Relative Plant Scale in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypotheses: Equation 5, 1970. Data Set II.

Variable	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB70 (Canadian Small Market Size, 1970)	--	--
Trade Liberalization Hypothesis		
NRP70 (Canadian Nominal Rate of Protection, 1970)	--	--
CNTBI (Canadian Non-Tariff Barriers, 1970)	-11.128	.036
USNRP70 (US Nominal Rate of Protection, 1970)	-1.172	.047
USNTBI (US Non-Tariff Barriers, 1970)	--	--
SB70 (Canadian Unit Subsidy, 1970)	-5.647	.036
Eastman-Stykolt Hypothesis		
NRP70MS (PEB70 interacting with NRP70)	--	--
CNTBIMS (PEB70 interacting with CNTBI)	29.918	.005
UNP70MS (PEB70 interacting with USNRP70)	--	--
USNTBMS (PEB70 interacting with USNTBI)	--	--
CDRMS70 (PEB70 interacting with V9S70)	-1.383	.000
UTC70MS (PEB70 interacting with UTC70)	--	--
Others		
V9S70 (Cost Disadvantage Ratio, 1970)	--	--
UTC70 (Canadian Unit Transportation Cost, 1970)	--	--
EMPRAT75 (R & D Expenditure)	--	--
MMARCVA, (Margin, Sales Ratio)	--	--
ADVDM70 (Advertising Sales Ratio, 1970)	-2.501	.140
(Constant)	1.040	.000
R-Squared	.2282	
Adjusted R-squared	.1726	

** Best as measured by the maximum adjusted R-squared.
* t-tests are one-tailed.
-- indicates omitted variables.

Source: Statistics Canada

TABLE 7.18A

Best** Regression Results Explaining Relative Plant Scale in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypotheses, Equation 1, 1979. Data Set III.

Variables	Estimated Coefficient	Marginal Significance Level*
Small Market Size Hypothesis		
PEB79 (Canadian Small Market Size, 1979)	-1.668	.000
Trade Liberalization Hypothesis		
NRP78 (Canadian Nominal Rate of Protection, 1978)	--	--
PKR (Post Kennedy Round Rates)	-2.085	.018
Eastman-Stykolt Hypothesis		
NRP78MS (PEB79 interacting with NRP78)	--	--
PKRMS (PEB79 interacting with PKR)	5.411	.001
Others		
UTC79 (Canadian Unit Transportation Cost, 1979)	1.349	.041
ADVDM79 (Advertising Sales Ratio, 1979)	-3.581	.135
EMPRAT79 (R & D Expenditure)	-3.495	.130
MMARCVA (Margin/Sales Ratio)	0.259	.051
(Constant)	.847	.000
R-Squared	.2126	
Adjusted R-squared	.1634	

** Best as measured by the maximum adjusted R-squared.

* t-tests are one tailed.

-- indicates omitted variables from the regression.

Source: Statistics Canada.

TABLE 7.18B

Best** Regression Results Explaining Relative Plant Scale in Terms of Small Market Size, Trade Liberalization and Eastman-Stykolt Hypotheses, Equation 2, 1979, Data Set III.

Variable	Estimated Coefficient	Marginal Significance Level*
Smal Market Size Hypothesis		
PEB79 (Canadian Small Market Size, 1979)	-1.982	.000
Trade Liberalization Hypothesis		
NRP78 (Canadian Nominal Rate of Protection, 1978)	-1.579	.039
Eastman-Stykolt Hypothesis		
NRP78MS (PEB79 interacting with NRP78)	7.417	.011
PKRMS (PEB79 interacting with PKR)	--	--
Others		
UTC79 (Canadian Unit Transportation Cost, 1979)	1.128	.067
ADVDM79 (Advertising Sales Ratio, 1979)	-3.850	.122
EMPRAT79 (R & D Expenditure)	--	--
MMARCVA (Margin/Sales Ratio)	.199	.101
(Constant)	.874	.000
R-squared	.1953	
Adjusted R-squared	.1526	

** Best as measured by the maximum adjusted R-squared.

* the t-tests are one-tailed.

-- indicates omitted variables from the regression.

Source: Statistics Canada.

7.5 SUMMARY AND CONCLUSIONS

Data Sets I through III provide empirical support for the hypothesis that small market size promotes suboptimal capacity and low relative plant scale in Canada. Our results on small market size agree with previous work surveyed in chapter 3 and indicates that Canadian producers would build and operate plants at output levels below the size necessary to realize economies of scale. The small market size hypothesis seems to explain suboptimal capacity in 1968 and relative plant scale in 1970 and 1979.

Our study shows that the coefficient of Canadian nominal rate of protection changes sign across Data Sets and has low significance levels, except for Data Set III, where it has the correct sign and is statistically significant.

The total effect of Canadian nominal rate of protection also changes sign but becomes important in small markets (when the small market size is evaluated at one standard deviation above its mean value in 1968 and 1970). This result agrees with our trade model's prediction that tariff protection exerts a negative influence on relative plant scale.

Previous studies were unable to find the statistical significance of the level of tariff protection on a measure of scale efficiency. Dickson, however, found tariff to be statistically significant when the dependent variable is the ratio of average cost of scale efficient plant to the industry average. Also, Caves et. al. (1975) found the significance of tariff but only when it interacts with small market size. Hence our results differ from previous empirical works which failed to find the statistical significance of tariff protection.

Canadian nontariff barriers also change sign across Data Sets but seem to better explain relative plant scale in 1970 than suboptimal capacity in 1968. This discrepancy in the importance of Canadian nontariff barriers across data sets could possibly arise from the use of different dependent variables. Possibly the increased importance of the trade liberalization hypothesis on scale efficiency could reflect the more protectionist nature of the Canadian economy in the late 1970s.

The total effect of US nontariff barriers seems to better explain Data Set I than Data Set II. In the 1968 regressions, it consistently has the expected sign and is statistically significant when it is evaluated at the mean and with Canadian small market. In the 1970 regressions it is significant with the correct sign. The statistical insignificance of the US nontariff barriers could arise from the different use of the dependent variable or possibly reflect the less protectionist nature of the US economy.

The total effect of US tariff protection has the expected sign and is always statistically significant (when evaluated with Canadian small market size across data sets). Thus, there is evidence that US tariffs restrict Canadian producers to operate manufacturing plants designed to serve our small domestic market.

The importance of various interaction terms which represent the Eastman-Stykolt effect on scale efficiency remains inconclusive. In the 1968 data some Canadian-US interaction terms have the correct sign and are significant. In the 1970 regressions, the Canadian tariff interacting with Canadian small market size has the expected negative impact on relative scale but has low significance level. Other remaining Canadian interaction terms such as market size combining separately with unit transportation cost, unit subsidy and cost disadvantage ratio are statistically insignificant.

In addition to the total effect of a variable, we have performed a series of F-tests on subset of US-Canadian trade variable in explaining scale efficiency. The F-tests examine whether a group of variables add significantly to the explanation in the dependent variable other than the variation already accounted for by the included variables in the regression equation.

A summary of these F-tests on the trade liberalization and Eastman-Stykolt hypotheses for Data Sets I, II and III are described on Table 7.19. In some cases a variable has been omitted from the corresponding regression equation. The interaction of US tariff with Canadian small market size (PKRSM), for example, was omitted from equation 3 of Data Set 1. In these circumstances, the corresponding entry for US tariff barriers was obtained from the t-statistic on the coefficient of Post Kennedy rates (PKR).

The Canadian tariff variables reported in Table 7.19 include the level of Canadian nominal tariff and its interaction with small market size. Also, Canadian nontariff barriers include the level of nontariff barriers and their interaction with small market size. Similarly, US tariff includes both the level and its

Table 7.19

Summary of Tests on the Trade Liberalization and Eastman-Stykolt Hypothesis

Subset of Trade Variables*	I Eqn.1	I Eqn.2	I Eqn.3	II Eqn.1	II Eqn.2	II Eqn.3	II Eqn.4	II Eqn.5	III Eqn.1	III Eqn.2
Canadian Tariff	.04	.12	.04	.30	.03	.66	.04	.50	.50	.77X
Canadian NTBs	.21	.19	.39X	.06	.10	.11	.06	.07	.23	.24
Both Canadian Tariffs and NTBs	.05	.09	.04	.07	.10	.29	.14	.01	.77	.83
US Tariffs	.32	.20	.36	.06	.12	.16	.05	.05	.51	.26
US NTBs	.78	.35	.35	.26	.70	.03X	.64	.42	--	--
Both US Tariffs and NTBs	.33	.27	.36	.11	.18	.02	.11	.15	--	--
Both Canadian and US Tariffs	.06	.01	.04	.02	.01	.33	.02	.21	.54	.48
Both Canadian and US NTBs	.27	.42	.40	.09	.23	.07	.16	.03	--	--
All Protection Variables	.02	.01	.01	.03	.04	.10	.04	.05	.62	.56
All Interaction Terms	.01	.01	.01	.02	.03	.02	.05	.01	.83	.71

Eqn. denotes regression equation

* reported values are the F-significance levels which are two-tailed

X denotes that the total effect of the variable measured at one standard deviation above the mean value of Canadian Small Market size has the wrong sign.

-- US and Canadian NTBs are not available for 1979 data.

interaction with Canadian small market size. All protection variables refer to the joint test of US-Canadian tariff and nontariff barriers. Finally, all interaction terms describe only the interaction of US-Canadian trade barriers with Canadian small market size.

In many equations, as reported in Table 7.19, the F-test on the separate effect of Canadian nontariff barriers is statistically significant. In some equations in Data Set II, the total effect of Canadian nontariff barriers has the expected sign on relative plant scale and is statistically significant (when evaluated at the mean value of Canadian small market size). Thus Canadian nontariff barriers seem to be associated more closely with relative plant scale rather than suboptimal capacity.

Both US nominal tariff protection and nontariff barriers seem to better explain relative plant scale in 1970 than suboptimal capacity in 1968. Specifically, the F-test on US nontariff barriers is significant only in one equation of Data Set II while its total effect is statistically significant with the wrong sign. Hence, we conclude that US nominal tariff protection provides evidence of restricting Canadian producers to operate manufacturing plants designed to serve our small domestic market size.

All interaction terms are often statistically significant at the less than 5 per cent level for Data Set I and II, indicating strong evidence of the Eastman-Stykolt on scale efficiency in Canada. Also all protection variables are always significant at the 10 per cent level. The Eastman-Stykolt effect is statistically insignificant in explaining relative plant scale in 1979. Note that data on the US and Canadian nontariff barriers are not available for 1979 Data Set.

FOOTNOTES

Chapter 7

1. See, for example, Berenson and Levine (1979, 520-523). They discussed the methodology used to calculate the standard errors of regression coefficients.

2. In this study we have not employed Lovell's "rule of thumb" mainly because we are interested in the "grand equation" which includes all initial variables (and not the best-fit equations). Lovell's rule of thumb is to calculate the true probability of committing a Type I error for a subset of variables of size k in the best regression equation, i.e., $\alpha = 1 - (1 - \hat{\alpha})^{c/k}$ where c is the number of variables in data set that are candidates for inclusion in the grand equations; k is the number of variables in the best fit equation; $\hat{\alpha}$ is the reported marginal significance level when the test is conducted with all initial variables of size c. (Lovell, 1983, 3).

3. Data on R & D expenditure, margin/sales ratio and product differentiation were not available for 1968 regression equations.

CHAPTER 8

SUMMARY AND CONCLUSIONS

This final chapter is devoted to a summary and conclusion of the main results obtained in this study (sections 8.1 and 8.2). Section 8.3 reviews some possible extensions of this study.

8.1 SUMMARY OF THE STUDY

This dissertation has studied the opportunities for foreign trade and the extent to which Canadian manufacturing plants exhaust economies of scale. The failure of Canadian plants to realize scale economies has been an important factor explaining Canada's lagging productivity level relative to the United States.Canada's productivity level, measured as a ratio of output to man-hours, has been persistently low and continues to be approximately 25 per cent of the US level. In recent years, however, the productivity gap has been declined.

Many studies have measured scale economies and investigated its determinants. A remarkable feature of these published studies is the failure to find statistical significance of tariff protection in explaining scale efficiency, despite the generally accepted proposition that trade barriers have promoted suboptimal capacity in Canadian manufacturing.

Canadian tariff protection is alleged to promote suboptimal capacity by separating the small Canadian market from larger foreign markets. Also, there has been growing concern about the increasing use of nontariff barriers to protect scale inefficient plants following the Kennedy and Tokyo Rounds of tariff cuts on a wide range of manufactured goods.

Thus the basic empirical question addressed in this thesis is whether small markets and trade protection interact to promote scale inefficiency in Canada, and if so, how? To address this question a model of the determinants of scale efficiency was constructed. It incorporated scale economies, market imperfection and Canadian tariff protection. It was then generalized in intuitive fashion to allow for Canadian nontariff barriers, US tariffs and US nontariff barriers.

The solution concept used in the model is Cournot-Nash equilibrium. It distinguishes between short-run (no entry) and long-run (free entry) equilibrium. In the presence of tariff protection, representative firms either charge a price greater than the world price by the full amount of the tariff or a price intermediate between domestic and world price. The domestic price plus the full amount of the tariff is referred to as the tariff limit price. In these circumstances, three possible cases were identified: 1) Import Competition; 2) Tariff Limit Pricing, and 3) Domestic Oligopolists. Firms charge the tariff limit price in cases 1) and 2), but not in case 3). Assuming that the behaviour of Canadian firms can be approximated by Cournot Oligopolists, we ignored case 1) of import competition. In the remaining two cases, the model predicts that Canadian tariff protection induces firms to operate plants below minimum efficient plant scale but that small changes in the tariff will have an effect only in the case of tariff limit pricing.

In industries where the output of the minimum efficient plant is large relative to the industry size, the model predicts that firms will operate plants of suboptimal scale. Finally, the model predicts that the Eastman-Stykolt (i.e., the interaction of small market size with tariff protection) on relative plant scale is negative.

These theoretical results led us to test three hypotheses in our empirical work. These were termed a) the small market size hypothesis; b) the trade liberalization hypothesis, and c) the Eastman-Stykolt hypothesis. The first hypothesis is that small market size prevents scale efficiency in Canada. The trade liberalization hypothesis predicts that US-Canadian trade barriers promote scale inefficiency by separating Canadian market from larger US markets. Finally, the Eastman-Stykolt hypothesis predicts that the interaction of small Canadian market size and high trade barriers should lead to more scale inefficiency.

We drew on variety of data sources including a set of measures of nontariff barriers which have never before been used for this purpose.

This thesis makes use of two measures of scale efficiency: suboptimal capacity and relative plant scale. The former measure refers to the fraction of industry output originating from plants below minimum efficient scale. The latter measure is a ratio of the average size of Canadian larger plants for 50 per cent of industry employment to the average size of US matching larger accounting for 50 per cent of industry employment. The dependent variable for regression analysis across 79 Canadian manufacturing industries in 1968 is suboptimal capacity. For the 1970 and 1979 regression equations, the dependent variable is relative plant scale across 120 Canadian manufacturing industries.

The model was tested using SPSS (Statistical Package for the Social Sciences). It has the advantage of allowing the researcher to select the best-fit equation in the sense of maximum adjusted R-squared. These equations of best fit are presented only as descriptives since the apparent marginal significance level is much greater than what can be reasonably claimed.

The functional form of the regression model is linear with interaction terms. In many regression equations this led to severe problems of multicollinearity. This problem was reduced by running several regressions with each excluding highly collinear variables.

Because many variables enter the regression both independently (as levels) and in interaction with other variables the effect of a variable cannot be directly read from the coefficient on its level. In such cases, we refer to the total effect of the variable by which we mean the direct effect of the variable and its indirect effect through a second term in the expression when the value of the second term is at its mean. The indirect effect of each variable has been evaluated at the mean value of the variable in question and at values one standard deviation above and below the mean.

Our empirical results show that US-Canadian nominal tariff protection and US-Canadian nontariff barriers together are important explanation of suboptimal capacity and relative plant scale in Canadian manufacturing industries in 1968 and 1970, respectively. The separate effect of US-Canadian nominal tariff protection and Canadian NTBs on scale efficiency is more pronounced relative to that of US nontariff barriers. This result supports the trade liberalization hypothesis that US-Canadian trade protection is often statistically significant and is negatively related to scale efficiency.

Previous empirical studies did not find tariff to be statistically significant except when used as part of a composite variable. Thus in previous studies the tariff becomes important only when it interacts with either small market size (Caves et. al., 1975) or with large market size and four firm concentration ratio (Baldwin and Gorecki, 1981C). We argued that concentration ratio variable is partly determined by the dependent variable and would introduce simultaneous bias if it were included in the regression equation explaining scale efficiency. Hence in our study, we omitted the concentration ratio variable. By interacting the tariff level with the market size, Caves et. al. confused what we have termed the Eastman-Stykolt effect with the more general trade liberalization hypothesis. In this study we have tried to distinguish between these two hypotheses.

8.2 MAIN CONCLUSIONS OF THE STUDY

The main conclusions can be stated as follows:

a) The 1979 regressions support the small market hypothesis and the total effect of US tariff (when evaluated with Canadian small markets). Otherwise, nothing works in 1979. In the 1970 regressions, highest priority should be paid to equations 1 and 2 than to the remaining equations, because only in these equations is the level of the small market size variable included. Specifically, equation 1 includes both the market size and other theoretically relevant variables.

In the 1968 and 1970 regressions, we have the following results:

b) The Eastman-Stykolt hypothesis is strongly supported by the joint significance of all interaction terms in all regressions. Moreover, our results are consistent with earlier studies in strongly supporting the small market hypothesis.

c) The Trade Liberalization hypothesis is strongly supported by the joint significance of all the trade variables. However,

d) US NTBs are generally not significant.

e) Canadian NTBs are significant, especially in the 1970s.

f) Canadian tariffs are jointly significant when proper account is taken of the interaction between market size and tariff protection variable.

g) Considered alone, Canadian protection (tariffs and NTBs) is more significant (statistically than US protection).

h) Considered alone, US tariffs are significant.

Generally, these results seem to imply that it is US-Canadian tariffs and Canadian NTBs rather than US-NTBs which are most closely associated with suboptimal capacity.

These empirical results have important policy implications. Canada's manufacturing industries, for example, need to increase their productivity levels relative to the US. A reduction in both Canadian tariff and nontariff protection is one important way to accomplish this end. Also US tariffs should be eliminated. Under these circumstances the procompetitive effect of import competition and the unrestricted access to US large market would encourage Canadian firms to build larger plant scale and accordingly realize economies of scale. Our study is the first to document these effects because it is the first to use nontariff barriers and US tariff data for this purpose.

However, the empirical results on US-Canadian nontariff barriers should be interpreted with caution. For example, the statistical insignificance of US nontariff barriers and the often "wrong" sign of Canadian nontariff barriers in 1968 might possibly arise either from the inaccurate measurement or underestimation of the extent of NTBs protection. According to Ray and Marvel (1984, 453), the NTBs data are poorly documented by the US Tariff Commission. They criticized the US Tariff Commission for not adopting certain "standard" when the NTBs data were derived from GATT compilations.

The key contributions of this thesis are: a) progress in formally modelling the effect of trade barriers on scale, and b) an improved test of the Eastman-Stykolt hypothesis (improved because the regression model is better specified as the result of formal modelling and because of the use of additional data).

8.3 AREAS FOR FURTHER RESEARCH

A possible extension of this study relates to the paucity of data in 1979, especially in US-Canadian NTBs. Use of such variables in a model explaining scale efficiency should be of importance in formulating commercial policy when tariffs are continuously declining on a wide range of manufactured goods.

Another possible avenue for extension relates to the empirical specification of the Eastman-Stykolt effect in a regression explaining scale inefficiency. For example, in markets where minimum efficient plant scale is a large fraction of the industry size, the model predicts that the Eastman-Stykolt effect on relative plant scale is important. In cases where the minimum efficient plant scale constitutes a small fraction of the industry size, the Eastman-Stykolt effect on relative plant scale is zero. Hence, an appropriate test of the Eastman-Stykolt hypothesis would require a dummy variable that discriminates between small and large markets relative to minimum efficient plant scale. Such a dummy variable was not available at Statistics Canada when we performed our regressions on relative plant scale.

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