

REGIONAL PRODUCTIVITY IN CANADIAN BREWERIES¹

Michael Denny
University of Toronto

J. Douglas May
Memorial University

Introduction

Regional disparities in real income have been a major Canadian political issue for over a century. The Economic Council of Canada [3] has recently identified regional disparities as a major economic issue. Underlying the Economic Council study was an extensive investigation of regional productivity by Auer [1], one of the conclusions of which was that large differences in regional productivity contributed to the income differentials.

In this paper, we have selected a single four digit industry, Breweries, and attempted to assess the changing patterns of regional productivity differentials over fifteen years. Four criteria that this industry satisfies provide the basis for its selection. First, the production technology in this industry is to a great extent standard across firms. Second, product differentiation is minimal in terms of production in contrast to marketing. Third, establishments exist in all areas of Canada because the product has a very high transportation cost relative to the value of the product. Fourth, it is possible to calculate regional output prices. These four characteristics of Breweries eliminate some of the major sources of errors in making regional comparisons. For many, perhaps most, industries several of these criteria will not be satisfied.

Our study is confined to the data collected by Statistics Canada supplemented by the annual reports of the major companies. This will permit us to explore the problems of calculating regional productivity differentials using data from the Census of Manufactures.

There are a number of major questions that we have attempted to answer. Have the patterns of regional productivity differentials changed over time? Are these changes in the pattern related to the levels or rates of change of output price, demand, and plant size?

¹Esther Chua provided excellent research assistance. Financial support was received from the Canada Council.

Has the time path of investment and of openings and closings of establishments affected productivity? Is there evidence that the productivity differentials within the larger provinces are similar to those across the provinces? If there is, then provincial productivity differentials may have little to do with provincial geographic boundaries.

The paper begins with a short description of the Breweries industry, followed by sections on the regional output price and the growth of output and plant size. Our measure of productivity is introduced next, and the results of the regional calculations are presented and interpreted. Finally some additional evidence on the importance of plant size and the evidence for subprovincial regions and for other productivity measures are discussed.

Breweries

There are a relatively small number of brewery establishments in Canada. From 1961 to 1975, the number of establishments dropped 20 percent, from 54 to 44, while total gallonage grew by 81 percent, from 24.4 to 44.3 million (Table 1); this indicates that the average gallons per establishment grew by 122 percent, from 4.5 to 10.0 million gallons. In all regions but the Atlantic, the number of establishments in 1975 was smaller than, or remained the same as, in 1961. The average gallons per establishment rose in every section of Canada.

The primary reason for selecting breweries as a case study was the relative homogeneity of their product. The technological processes in breweries do not substantially differ across companies and their products are fairly similar. This immediately eliminates the product line or mix as a major determinant of productivity differentials in the manufacturing of beer.² Beer is packaged in different sizes and types of containers and we have not been able to fully investigate the consequences for productivity of this differentiation. As far as we could determine, it did not seem to be a major factor in the measurement of regional productivity.³

Beer has a high weight to value ratio and consequently is not normally shipped very long distances. Breweries are located near the largest markets that they serve to minimize the transportation costs, particularly in regard to the back shipments of empty bottles.

²When substantial differences in product mix exist, it is difficult to compare productivity. Product specific differences in the technology tend to be misinterpreted as efficiency differences.

³Specific regions have different consumption patterns by type of container. The relative patterns did not change swiftly. There was no pattern between the levels and rates of growth of productivity and the consumption.

Table 1
REGIONAL OUTPUT AND NUMBER OF ESTABLISHMENTS
1961 and 1975

Region	Gallons Shipped (millions)		Number of Establishments	
	1961	1975	1961	1975
Atlantic	11.9	33.9	7	8
Quebec	72.7	140.4	5	3
Ontario	98.7	158.9	17	11
Manitoba	12.7	21.5	6	5
Saskatchewan	10.2	14.0	5	5
Alberta	17.1	31.6	6	6
British Columbia	21.0	42.7	8	6
CANADA	244.4	442.9	54	44

This eliminates certain locational issues that might have determined which regions actually possess any establishments in the industry. Breweries exist in all regions because it is not economically sound to locate only in Central Canada and ship to the outer regions. The only extensive interregional shipments originate in Montreal and are destined for the Atlantic regions. Until recently the major national beer companies did not have breweries in New Brunswick, Prince Edward Island, or Nova Scotia and serviced the Atlantic region from Montreal plants.

By selecting an industry without major regional product differentials, we have eliminated a problem that plagues most regional productivity studies. The locational principles of economic theory place severe constraints on the existence of product homogeneity across regions.⁴ In many Canadian industries, the regional product mix differential may be a major source of measured productivity differences.

The brewery industry in Canada is dominated by three large companies, Labatt's, Molson's and Carling-O'Keefe. These companies supply the majority of all major markets with the exception of the Atlantic region, excluding Newfoundland. Consequently, regional differences are not due to regional entrepreneurial skills except possibly in the Atlantic region.

Marketing, particularly advertising, is an important aspect of the brewing industry. Conventional beliefs suggest that it is in marketing that scale advantages exist. We are not concerned with the marketing function in this paper.

⁴Without a small efficient plant size relative to all provincial markets for all products, product mixes will vary by region.

Our data begin in 1961 and end in 1975.⁵ Seven regions have been employed: six provinces and the Atlantic region, which includes Prince Edward Island, Nova Scotia, New Brunswick, and Newfoundland. The Atlantic region aggregation has been employed since the data for these provinces is confidential. In 1975 Ontario and Quebec had less than one-third of the establishments but more than two-thirds of the shipments. Larger plants are located in central Canada and plant scale is determined by the size of the neighbouring market.

The Supply Price of Beer

One of the most interesting aspects of the data is the possibility of investigating regional differentials in the producers' supply price. Beer is marketed under a wide variety of arrangements in the different provinces. The methods of government control and taxation differ substantially across Canada. Statistics Canada collects information on the value of shipments, excluding all forms of taxation. By dividing the value of shipments by the number of gallons shipped, we can define an implicit price per gallon to the producer. The price per gallon will vary with the type of container, but these data are not available. For Canada and the provinces, Table 2 shows the supply price of beer in selected years.

These figures show considerable diversity in the supply price for different regions and in the movements of these prices through time. The supply price, in addition to expectations of growth in demand, will influence decision about innovation and investment. Although it is only one component, a relatively high regional supply price is an incentive to increase supply in that region.⁶ An interesting implication of the high shipping costs of beer is the quasi-separation of different regional markets. Substantial regional supply price differentials need not be eliminated by competition. Persistent low or falling relative prices in a particular region vis-à-vis other regions are an incentive for cost saving innovations but also for reducing one's commitment to that market.

To check our data, we compared the Canadian price index that is partially shown in Table 2 with the output price index used by

⁵All data are taken from a variety of Census of Manufacturers publications. Most of the information can be found in the *General Review of the Manufacturing Industries of Canada, Volume I* [9]. Additional information is contained in *Breweries* [8]. The annual reports of the three major companies for the fifteen years, 1961-75, were used to confirm the interpretations of changes in the Brewery industry during these years.

⁶Without evidence about demand elasticities and a specification of the price setting mechanism in these controlled markets, precise statements about productivity and supply prices are difficult to derive.

Statistics Canada [12] for computing real gross output; they are virtually identical. The prices for the individual regions, however, are not very similar to the Canadian price index.⁷ This has serious implications for the conventional productivity measures discussed below.

Table 2
SUPPLY PRICE OF BEER, SELECTED YEARS, 1961-1975
CANADA AND THE PROVINCES
(\$/Gallon)

Region	Price per gallon			
	1961	1965	1970	1975
Atlantic	1.44	1.36	1.48	1.87
Quebec	0.84	0.93	1.00	1.45
Ontario	1.13	1.11	1.28	1.74
Manitoba	1.19	1.13	1.09	1.29
Saskatchewan	1.07	1.04	1.21	1.55
Alberta	1.02	1.00	1.00	1.40
British Columbia	1.11	1.02	1.01	1.34
CANADA	1.05	1.06	1.15	1.57

In Table 3, the price of beer in each region relative to Ontario for 1961 is shown in column one. The Atlantic region had a high relative supply price while Quebec's was very low. Aside from Manitoba, the western provinces had relative prices less than one. In column two, we see that by 1975 the Atlantic region had lost much of its higher relative price and that Quebec's relative price had risen but remained substantially below Ontario's. In the West, Manitoba's relative price had dropped from 1.05 to 0.74, British Columbia's decline was similarly steep, and we can observe modest declines in Alberta and Saskatchewan. The West has become a region in which price incentives are weak relative to the remainder of Canada.

A more complete description can be offered by considering the movements in absolute regional prices. In column three, the price index (1961 = 1.00) for each region in 1970 is shown. The supply price of beer in Canada rose by only 9 percent in nine years; there were substantial declines, however, in Manitoba and British Columbia. Only in Quebec was the price up by almost twice the national average. The seventies were a period of rapid price increases as the average price in Canada rose by about 40 percent. This masks the major variability across the regions. Only Ontario and

⁷In New Brunswick, Nova Scotia and P.E.I., all retail containers are purchased outright by the consumer and there is no direct repurchase by the distributing stores. This increases the retail price in the Atlantic region relative to all other provinces.

Quebec managed to match the Canada price increase. Most of the relative price increase for Quebec occurred during these five years. All of the other regions had lower price increases.

Table 3

**ABSOLUTE AND RELATIVE SUPPLY PRICE INDEXES
CANADA AND REGIONS, SELECTED YEARS**

Region	Relative ^a		Absolute ^b	
	1961	1975	1970	1975
Atlantic	1.27	1.08	1.03	1.30
Quebec	0.75	0.84	1.17	1.71
Ontario	1.00	1.00	1.12	1.53
Manitoba	1.05	0.74	0.92	1.08
Saskatchewan	0.95	0.89	1.13	1.44
Alberta	0.90	0.81	0.99	1.38
British Columbia	0.98	0.77	0.91	1.20
CANADA	0.93	0.90	1.09	1.49

^a Ontario = 1.00 ^b 1961 = 1.00.

The extreme case is Manitoba, where prices in 1975 were only 8 percent higher than 1961 and 17 percent higher than 1970. In British Columbia, prices declined from 1961 to 1970 and then increased in the 1970s. The Western and Atlantic markets had many price declines in the 1960s and these, combined with slower rates of increase in the 1970s, resulted in the large relative price changes. The rapid changes in regional relative prices offers enormous incentive problems for firms.⁸

There is another important lesson for regional studies that is illustrated by this brewery data. The large shipping costs per gallon and the government taxation and control of beer marketing throughout Canada result in these odd supply prices. In a freely traded market for beer we might not observe these price patterns. In this sense, the observed variations over-emphasize the point that will be made directly below.

At this time, Statistics Canada has almost no regional industrial price data. The price samples that are collected are national. It is starkly revealing to observe the tremendous variations in the regional supply prices of beer. Regional studies, including all of the regional productivity studies, have been forced to use national price data. Regional information on the values of shipments, for example, is often deflated by a national price index. For beer,

⁸ Even the partial equilibrium consequences of these incentives are not simple to specify more fully in a spatial model with increasing returns to scale. At the same marginal cost level, the firm should seek to shift production to the region with the highest price. Recall that prices are not set freely by the producers, which obscures the appropriate model to be used.

this is obviously a serious source of error. Most regions have had price changes that are not well approximated by the national price index. As stated above, the extreme differential patterns for beer are probably not repeated for many industries. In other industries, other problems will exist that are not prevalent in Breweries. If the regional product mix is different and national weights are used to aggregate price indexes of product lines, than a very similar problem may appear. Unfortunately, the lack of resources devoted to regional statistics is going to confound many empirical investigations.

Demand and Plant Size

The size of plants in beer production varies widely both between provinces and within provinces. Table 4 shows the regional and national distribution of plants by employment size for 1975. The evidence suggests that competitive forces do not preclude the operation of plants of strikingly different sizes, both within and across regions.

Table 4

**REGIONAL DISTRIBUTION OF ESTABLISHMENTS BY
EMPLOYMENT SIZE GROUP, 1975**

Region	10-19	20-49	50-99	100-199	200-499	500-999	1000+	TOTAL
Atlantic	-	-	1	6	1	-	-	8
Quebec	-	-	-	-	-	-	3	3
Ontario	2	3	-	1	2	3	-	11
Manitoba	1	-	1	1	2	-	-	5
Saskatchewan	-	1	3	1	-	-	-	5
Alberta	1	-	2	3	-	-	-	6
British Columbia	-	1	1	2	2	-	-	6
CANADA	4	5	8	14	7	3	3	44

Quebec has three very large establishments which shipped 140 million gallons in 1975. Ontario shipped 159 million gallons from eleven plants. Ontario has over half of the ten smallest establishments in Canada as well as three large establishments. The Atlantic region has a very large number of establishments relative to the size of the market. Four of the eight Atlantic establishments are located in Newfoundland.

The market for beer has grown at a modest rate in Canada. The regional markets have, however, experienced quite different growth patterns. Gallons shipped increased by 81 percent in Canada from 1961 to 1975 (Table 5). In Saskatchewan the growth was only 37 percent while in the Atlantic region a spectacular 185

percent increase was recorded. The pattern in the rest of Canada (Table 5) is fairly easy to interpret. Rapid population growth in Alberta and British Columbia have raised the growth in consumption above the national average. Ontario and Manitoba have had a very modest growth in consumption. Quebec, like the Atlantic provinces, has had faster than average growth that is not based on population growth.

Table 5
INDEX OF GALLONS PRODUCED, CANADA AND REGIONS
SELECTED YEARS, 1961-1975
(1961 = 1.00)

Region	1965	1969	1972	1975
Atlantic	1.38	1.70	2.31	2.85
Quebec	1.08	1.41	1.68	1.93
Ontario	1.20	1.22	1.45	1.61
Manitoba	1.02	1.29	1.49	1.69
Saskatchewan	1.15	1.15	1.27	1.37
Alberta	1.11	1.41	1.60	1.84
British Columbia	1.15	1.62	2.01	2.03
CANADA	1.15	1.35	1.61	1.81

The growth in demand has several implications for productivity. Rapid growth provides the incentive and opportunity to invest in more productive equipment. This investment is not prohibited by slow growth, but the range of profitable investment opportunities is larger with rapid growth. Even without any change in the technology, rapid growth in demand may sharply affect productivity. If the plant size is important in determining productivity then a sharp increase in demand may permit a change in the scale of operation. For example, the growth in demand in Saskatchewan and the Atlantic region during this period has been sharply different. We would like to know the consequences for productivity.

In all regions the growth in demand has been translated into substantial increases in plant size. In Canada, while the beer market grew by 81 percent, the output per establishment increased by 122 percent (Table 6). The number of establishments declined, but not uniformly. In Quebec, Ontario, and British Columbia enough establishments closed to make their growth in output per establishment at least as great as that in the Atlantic region. Recall (Table 5) that this implies that the large growth in demand in the Atlantic region did not result in an exceptional relative increase in the scale of operation.

The relative scale of operation in the Atlantic region compared to Ontario (Table 7) has remained almost constant. The absolute scale of operation has increased in the Atlantic region but it re-

mains very small relative to Ontario. Quebec, which had the largest plants at the beginning of the period, has increased its position substantially relative to Ontario. Relatively small changes occurred in the rest of the provinces, except Saskatchewan. Since demand grew very little and no plants were closed, the scale of operation in Saskatchewan in 1975 is very small relative to the rest of Canada.

Table 6
OUTPUT PER ESTABLISHMENT
(1961 = 1.00)

Region	1965	1969	1972	1975
Atlantic	1.21	1.48	2.31	2.49
Quebec	1.36	2.35	2.80	3.22
Ontario	1.36	1.73	2.47	2.48
Manitoba	1.02	1.55	1.79	2.03
Saskatchewan	1.15	1.15	1.27	1.37
Alberta	0.96	1.41	1.60	1.84
British Columbia	1.32	2.16	2.68	2.71
CANADA	1.20	1.62	2.07	2.22

Table 7
INDEX OF GALLONS PRODUCED PER ESTABLISHMENT
SELECTED YEARS, 1961-1975
(Ontario = 1.00)

Region	1961	1965	1970	1975
Atlantic	0.29	0.26	0.27	0.29
Quebec	2.50	2.51	2.70	3.24
Ontario	1.00	1.00	1.00	1.00
Manitoba	0.36	0.28	0.33	0.30
Saskatchewan	0.35	0.30	0.19	0.19
Alberta	0.49	0.35	0.30	0.36
British Columbia	0.45	0.44	0.46	0.49
CANADA	0.78	0.69	0.63	0.70

Our evidence suggests the following rough pattern. The average establishment size has grown throughout Canada. At the beginning and the end of our period, there is a large diversity in the scale of operation across the regions. In fact, there is a substantial size range within provinces or regions.

Regional Productivity

In measuring regional productivity, our initial procedure is to measure the productivity of breweries as output per man-hour. The

output is measured in gallons and the man-hours are man-hours worked by production workers. This is a particularly simple measure that is dictated by the data. Before turning to the results, a brief interpretation of this measure is required.

Our preferred measure would be total factor productivity.⁹ This would indicate the contribution of improvements in efficiency to output growth after accounting for the growth of all inputs. To clarify the relationships, consider a production function,

$$Q = f(K, L_p, L_A, M)$$

where Q = gross output

K = capital services

L_p = production worker man-hours

L_A = administrative worker man-hours

M = materials

The proportional rate of growth of total factor productivity (\dot{P}) can be defined as

$$\dot{P} = \dot{Q} - s_p \dot{L}_p - s_A \dot{L}_A - s_K \dot{K} - s_M \dot{M},$$

where the shares (s) of each factor are weights used to aggregate the input growth rates. Labour productivity grows at a rate,

$$\dot{Q} - \dot{L}_p = \dot{P} + s_A (\dot{L}_A - \dot{L}_p) + s_K (\dot{K} - \dot{L}_p) + s_M (\dot{M} - \dot{L}_p).$$

Labour productivity will change not only because of growth in total factor productivity but because of the relative quantities of other inputs per man-hour of production labour changes. Data are not available to indicate the exact relative importance of each component in the growth of labour productivity. Some information on the different influences will be discussed, however, after the initial results are presented.

The estimates are presented in two forms. Table 8A shows an index of productivity (1961 = 1.00) for each region. Table 8B presents the productivity levels of each region relative to Ontario (Ontario = 1.00).

In all regions productivity grew at a substantial rate throughout the 1960s. With the exception of British Columbia, productivity grew at an average annual rate of 5 percent or more from 1961 to 1969. By 1972 the average annual rate had fallen to about 4 percent in all but Quebec and the Atlantic region. The

⁹A complete discussion of the conceptual issues in this section may be found in Denny, Fuss and Waverman [5].

unexplained decline in productivity after 1972 blurs the rankings for the earlier period. The overall growth leader is certainly the Atlantic region, with Quebec in second place. British Columbia has had the most erratic performance and probably ranks at the bottom.

Table 8A

INDEX OF PRODUCTIVITY, CANADA AND REGIONS
SELECTED YEARS, 1961-1975
(1961 = 1.00)

Region	1965	1969	1972	1975
Atlantic	1.27	1.71	2.20	1.84
Quebec	1.25	1.52	1.74	1.57
Ontario	1.21	1.45	1.53	1.35
Manitoba	1.21	1.50	1.57	1.50
Saskatchewan	1.37	1.40	1.51	1.46
Alberta	1.15	1.59	1.49	1.38
British Columbia	1.33	1.25	1.50	1.15
CANADA	1.23	1.47	1.62	1.43

Table 8B

INDEX OF RELATIVE PRODUCTIVITY LEVEL, REGIONS
(Ontario = 1.00)

Region	1961	1965	1970	1975
Atlantic	0.46	0.48	0.54	0.62
Quebec	0.91	0.93	0.99	1.05
Ontario	1.00	1.00	1.00	1.00
Manitoba	0.61	0.61	0.66	0.67
Saskatchewan	0.67	0.76	0.70	0.72
Alberta	0.86	0.82	0.89	0.88
British Columbia	0.99	1.09	0.86	0.84

In relative terms, Ontario and British Columbia had high productivity at the beginning of the period. Quebec and Alberta were less than 15 percent behind them. Saskatchewan and Manitoba had productivity levels that were only about two-thirds that of Ontario. In last place, with productivity that was less than half of Ontario's, was the Atlantic region.

By 1975, substantial relative gains had been made by Quebec and, most noticeably, the Atlantic region. The Prairie provinces had made modest relative improvements and British Columbia had regressed badly.

It has been noted that the Atlantic region had (i) a high relative supply price that declined during the period, and (ii) exceptionally

rapid increases in demand that were not translated into large relative increases in plant size. Large plant size increases were not required for a sharp shift in the relative productivity in the Atlantic regions. Productivity grew at almost 8 percent per annum from 1961 to 1972 in the Atlantic region, more than twice as fast as Ontario. Yet the gap remains large, and it will take long sustained increases in productivity at a faster rate than Ontario's before it is closed. Short-run policies are unlikely to eliminate the current gap. The Atlantic region's efficiency is now close to that of Manitoba and Saskatchewan. It is an open question whether further relative efficiency gains are possible without additional plant size increases. The latter will be possible if demand growth continues at a very high rate.¹⁰

Quebec and British Columbia were the only provinces whose productivity was close to that of Ontario in 1961. Both provide some interesting insights. During the early sixties, average productivity in British Columbia was equal to that in Ontario. This was true even though the average plant size in British Columbia was only half of that in Ontario and one-fifth of that in Quebec. There is obviously no evidence that size alone dominates productivity differentials. British Columbia plants were able to equal productivity in Ontario for several years. For unknown reasons, these plants have not been able to increase their productivity. Plants in British Columbia have had the slowest rate of productivity growth. The growth in demand and the scale of operation has been larger in British Columbia than in Ontario. Neither of these factors have led to a strong relative productivity performance. The one known negative factor is the supply price. This price fell in absolute terms in the first ten years of the period studied. Although prices rose by one-third during the 1970s, the relative price had fallen by almost 25 percent in 1975 compared to 1961. The performance of the British Columbia plants is the most difficult to interpret. The very high productivity in smaller B.C. plants during the 1960s is strong evidence that size is not the only important determinant of regional productivity. The very poor performance of these plants in the last half of the period studied cannot be adequately explained with the information that is available.

Productivity in Quebec plants was 10 percent below Ontario plants at the beginning of the period and 5 percent above by the end. Production in these plants grew faster than in Ontario. Quebec plants have a scale of operation much larger than Ontario plants. During the period the size advantage widened even further due to plant closings. Whatever size advantages did exist, they did not lead to sharp productivity differentials relative to Ontario at

¹⁰An important factor may be the reduction in the number of breweries due to the purchasing of regional companies by national companies.

the plant size currently in production in Quebec. The supply price in Quebec was more than 20 percent below the price in the rest of Canada. Although the relative price has risen, it is still 15 percent below Ontario's price. Productivity growth in the Quebec plants has permitted them to surpass the productivity levels in Ontario. The advantages of the very large Quebec plants are, however, small. Scale is more important at lower levels of plant output than at the higher levels experienced in Ontario.

The provinces of Saskatchewan and Manitoba provide interesting contrasts. In 1961, Saskatchewan's plants had a productivity level slightly more than two-thirds of those in Ontario. Their position relative to Ontario improved by roughly 10 percent from 1961 to 1975. Yet Saskatchewan had the lowest rates of growth of output and plant size. Output grew by only 37 percent. Since no plants closed, this was also the increase in the average plant size. These may be contrasted with an 81 percent growth in output and 122 percent growth in plant size for all of Canada. Saskatchewan's performance reinforces the conclusion that the levels and growth of plant size and demand are not strong determinants of productivity growth.

Manitoba's plants had roughly the same productivity growth, yet plant size and demand grew by 103 and 69 percent respectively from 1961 to 1975. These increases are much larger than the changes in Saskatchewan. By the end of the period Manitoba's plants were one-third larger than those in Saskatchewan without any improved relative productivity.

The supply price changes were working in opposite directions to scale changes. Manitoba had a high initial supply price that rose only 8 percent in fourteen years; consequently, relative to Ontario the supply price fell by almost 30 percent. In 1961 the relative price in Manitoba was 10 percent higher than in Saskatchewan; by 1975 the supply price was 20 percent lower. The relative price declines in Manitoba were the severest of all the regions.

The evidence that we possess suggests a number of conclusions about productivity in breweries.

1. If one presumes that technological innovations underlie productivity changes, the industry has found it possible to use these innovations in all regions despite divergent business conditions.
2. Productivity levels are closely related to plant size. Productivity increases with plant size although at a decreasing rate.
3. Higher rates of growth of demand have not led to consistently higher rates of productivity growth; however, the fastest rates of growth of productivity have occurred in Quebec and the Atlantic region where demand growth was very high.

4. Productivity growth has not been associated with the initial levels of productivity or plant size.

There are some optimistic implications which can be drawn from these results. Although small plant size holds down the productivity level in many regions, it has not prevented increases in the productivity of these plants. There is no evidence, however, that productivity differentials are widening; most regions have remained in roughly the same position relative to Ontario. On the negative side, if small size plants cannot be designed to be as efficient as the larger plants, there is very little that regional policies can do to eliminate all productivity differentials. Consolidation of plants may be possible in some regions, but not without the withdrawal of some firms from those regional markets.

Alternative Evidence on Productivity and Scale

If there are economies of scale in the production of beer, then these will be measured as part of the higher productivity in the larger plants. Productivity can be separated from scale, as Denny, Fuss and Waverman [5] have shown, but only through econometric estimation of the production technology. The sparse regional brewery data will not permit us to follow this approach.

For the years 1969-75, national data are available on the value of shipments per man-hour for establishments grouped by employment size. If prices were constant across Canada, this measure would be identical to our productivity variable except for a scalar constant. From the earlier sections, the prices received by the firms is known to vary regionally. Information is not available to correct exactly for the regional price variations. Using the regional price data in Table 2 and the regional distribution of plants by employment size in Table 4, we have made an approximate correction for the year 1975.¹¹ Our results are presented in Table 9.

Table 9
INDEX OF PRODUCTIVITY BY PLANT SIZE

No. of Employees	10-49	50-99	100-499	500-999	1000 +
Productivity index	50	67	79	98	100

The index for the largest plant size equals 100. Productivity increases with plant size in Canadian breweries, and the rate of increase in productivity with respect to size declines as size increases.

¹¹The price in each region entered into the new price with a weight equal to the number of breweries in that province in a particular size grouping.

While the values of the index may not be precise, it is unlikely that any errors would reverse either of these conclusions. Similar calculations for the other years for which data are available show the same pattern. Although a few exceptions have been noted earlier, plant size would seem to be a major determinant of productivity level.

Subregions of Provinces

Comparisons of regions have often been limited to provincial areas, yet the non-metropolitan areas of the larger provinces may have an economic structure with performance characteristics that are similar to the smaller provinces. The market forces that create the productivity differentials observed between provinces are likely to operate within provinces. The importance of this point is the emphasis that it casts on the possible weaknesses of provincial comparisons. Provinces are not uniform regional economic spaces, and the provincial geographic boundaries do not necessarily coincide with economic forces.

The evidence for breweries is limited because the total number of establishments is sufficiently small that the confidentiality clauses of the Statistics Act eliminates a large portion of the data.¹² For Quebec, the small number of establishments prevents any distinction within the province. There is some evidence for Ontario. In the mid-1960s, the establishments in York County (the Toronto area) were approximately two and a half times as large as those in the rest of the province. Productivity was 40 to 60 percent higher in York County. This is consistent with the relationship between productivity and the size of establishment observed across provinces. Some further evidence exists for British Columbia, Alberta, and Newfoundland. All the plants in these provinces are much smaller than the three largest Ontario plants. In British Columbia, the plants outside the Vancouver metropolitan area are on average 20 percent smaller than those in Vancouver. Productivity during the 1960s was 30 percent less outside Vancouver. In Alberta, during the 1960s, the plants in Edmonton were approximately one-third smaller than those in the rest of the province; however, the average size was quite small in both areas. Very little difference in productivity existed. While the average size of the Newfoundland plants in the 1960s was small, outside St. John's the plants were larger, and the productivity was higher in these plants. Strong conclusions may not be drawn without further observations. The available data do support the hypothesis that larger size plants have higher produc-

¹²Unless there are three breweries in a provincial subregion the data will be confidential.

tivity within provinces as well as between them.

We would like to test the hypothesis that plants of the same size have the same productivity independent of the province in which they are located, but the evidence is too limited.¹³ In a separate study on the Soft Drink industry, which has many establishments, we are pursuing this question.

Further Implications

An attempt was made to identify the consequences for productivity of the building of new plants and the closing of existing plants. There were relatively few new facilities compared to the substantial number of closures. While a few dramatic jumps in productivity can be identified in the data, openings and closures are not a major reason for differential productivity levels of growth. Annual reports indicate that investment has been widely dispersed among existing plants in all regions. These investments, combined with improved management and labour efficiency, would seem to account for the productivity growth.

An alternative labour productivity measure was constructed using total employees rather than production worker man-hours. This measure overestimates the use of labour, since man-hours per year have declined; however, it does reflect the use of non-production workers. The regional productivity differentials for this measure are different from the measure discussed above. Relative to Ontario and Quebec, the other regions use fewer non-production workers per unit of output. Consequently, their relative productivity is higher using this measure. Quebec has a very high proportion of non-production workers relative to Ontario, and Quebec's productivity is much lower than Ontario's. Although the Quebec situation is extreme, the concentration of administrative staff in Ontario and Quebec probably explains most of the difference between the two labour productivity measures.

Earlier we noted that the rate of growth of non-production workers relative to production workers is one of the factors that determines the rate of growth of labour productivity measures. For Breweries in all regions this has not been an important factor. The share of non-production workers is less than 10 percent in most regions and the incomplete evidence suggests only a moderate rate of growth of the ratio of non-production to production workers input.

¹³ The B.C. results for the middle sixties clearly contradict this hypothesis.

Summary

The pattern of regional productivity differentials has changed only modestly from 1961 to 1975. The only significant increase in the relative productivity level occurred in the Atlantic provinces. A sharp decline was experienced in British Columbia. The level and rates of growth of the output price and of demand were not consistently linked to productivity performance. Plant size was a major determinant of the level of productivity, but the rate of growth of productivity was largely independent of the initial plant size. The latter is highly significant, since it indicates that the "inefficiencies" of small markets have not grown through time.

References

1. Auer, L. , "Regional Disparities of Productivity and Growth in Canada", Working Paper, Economic Council of Canada, 1977.
2. Canada. Department of Industry, Trade and Commerce. "An Analysis of Regional Productivity Variation in Canadian Manufacturing Industries", Office of Policy Analysis, Ottawa, 1976.
3. Canada. Department of Industry, Trade and Commerce. "Productivity and Competitiveness in the Canadian Economy", Office of Policy Analysis, Ottawa, 1976.
4. Economic Council of Canada. *Living Together: A Study of Regional Disparities*, Ottawa: 1977.
5. Denny, M., M. Fuss and L. Waverman. "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries, with an Application to Canadian Telecommunications", Working Paper 7911. Toronto: Institute for Policy Analysis, University of Toronto, 1979.
6. May, J.D. and M. Denny, "Post-war Productivity in Canadian Manufacturing", *Canadian Journal of Economics*, XXI (1979) 29-41.
7. Rao, P.S. "An Econometric Analysis of Labour Productivity in Canadian Industries", Discussion Paper 125. Ottawa: Economic Council of Canada, 1978.
8. Statistics Canada. *Breweries*, (32-019, 32-205). Ottawa.
9. Statistics Canada. *General Review of the Manufacturing Industries of Canada, Vol. I: Industries by Province*, (31-203). Ottawa.
10. Statistics Canada. *Manufacturing Industries of Canada: Geographical Distributions*, (31-209). Ottawa.

11. Statistics Canada. *Productivity Trends in Industry, Report No. 1, Synthetic Textile Mills, Breweries, Pulp and Paper Mills, 1947-61*. Ottawa: 1966.
12. Statistics Canada. *Real Domestic Product By Industry, (61-516, 61-213)*. Ottawa.