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When Markets Fail: Electrification and Maritime Industrial Decline in the 1920s

FOR CANADIAN MANUFACTURING THE EARLY DECADES of the 20th century were years of unprecedented growth but significant geographical concentration of production. In real terms, after adjusting for price changes, the gross value of production almost quadrupled between 1900 and 1926, rising from $753 million to $2752 million. Employment in manufacturing rose from 423 thousand to 559 thousand, and fixed capital employed from $227 million to $1080 million. However, the share of manufacturing output originating in the Maritime provinces fell from 10 per cent in 1900, to 7 per cent in 1920, and to 4.5 per cent in 1930.[1] This paper argues that industrial retardation in the Maritime provinces in the early 20th century and especially the 1920s can be explained at least in part by the failure of Maritime power suppliers to make available centrally generated electrical power and of Maritime industrialists to move away from own-generated to purchased electricity as a power source in manufacturing. These failures had their roots in the poor public policy decisions of Maritime provincial governments, who relied on market forces to encourage central power development and the purchased power electrification of manufacturing. But market forces did not encourage these developments because power producers and manufacturers in the Maritimes did not have the same incentives as those in central Canada to extend and utilize purchased power and hence reap the productivity gains available to the regional economy. Public policy therefore failed in the sense that in the Maritimes political and legislative decisions maintained the status quo of existing relationships in electricity demand and supply, whereas in central Canada and especially in Ontario, political, legislative and institutional innovation opened up new avenues for electrification and industrial development. Market failures, uncorrected by government initiatives and policy, doomed the Maritime industrial sector to natural obsolescence and to relative decline in the 1920s.

By reworking the manufacturing census compilations, Canadian economic historians have developed reliable data on manufacturing growth in Canada from around 1870 through to the 1930s.[2] By 1900 manufacturing accounted for

1 The data quoted is from M.C. Urquhart, "New Estimates of Canadian Gross National Product, 1870-1926: Implications for Canadian Development", in R. Gallman and S. Engerman, eds., *Long Term Factors in American Growth* (New York, 1986) and S.A. Saunders, *The Economic History of the Maritime Provinces* (Fredericton, 1984), p. 85.

2 Most notable perhaps in G. Bertram, "Historical Statistics on Growth and Structure of Manufacturing in Canada, 1870-1957", in J. Henripin and A. Asimakopulos, eds., *Conference on*

21 per cent of gross national product and despite booming agricultural and resource sectors in the economy strengthened this contribution to 24 per cent by 1940. Early 20th century industrialisation lifted Canada to second place (behind the United States) in a worldwide ranking of industrial production per capita by the 1950s.[3] This industrialisation, or new industrialism, had a number of striking characteristics which distinguished it from its 19th century counterpart.[4] It was built with sophisticated science based technology (largely transferred to Canada via direct foreign investment) rather than on simple mechanical technology under local ownership. It most commonly used electricity purchased from central electric stations as its power base rather than direct own-generated water or steam power. It involved a large change in industrial structure, with growth concentrated in new, technologically sophisticated industries in the chemical, electrical, metallurgical, mineral, machinery and transportation equipment sectors rather than the food, vegetable and textile products sectors. And it was geographically and economically concentrated, having larger plants, fewer firms per industry and a tendency to locate in central Canada.[5]

The dimensions and consequences of the Maritime industrial lag in non forest-based sectors of manufacturing in the 1900-1940 period are well documented. In the late 19th century, both eastern and central Canada had shared in the industrialisation process of the old industrialism, based on local ownership, coal, steam, iron and textiles, even though Maritime growth rates of non-forest based manufacturing output were below those of central Canada. Between 1880 and 1910 the Maritimes recorded an average annual real growth rate in this sector of 2.3 per cent compared with 4.3 per cent in Canada as a whole. In the Maritimes, these years of healthy growth were followed by the sluggish growth rates of only 1.3 per cent per annum on average 1910-1939, and by a growth rate of only 0.3 per cent per annum on average in the 1920s. In contrast, manufacturing growth in central Canada accelerated through the 1900-1930 period, with the 1920s recording an average annual growth rate of 6.1 per cent.[6]

Statistics 1962 (Toronto, 1964). See also, J. Dales "Estimates of Canadian Manufacturing Output by Markets, 1870- 1915" in *ibid.* and D.M. McDougall, "Canadian Manufactured Commodity Output 1870-1915", *Canadian Journal of Economics*, 4 (1971), pp. 21-36. The latest reworking of these data, with intercensal year estimates, is M.C. Urquhart, *op. cit.*

3 A. Maizels, *Industrial Growth and World Trade* (London, 1963), p. 31.

4 The term "new industrialism" comes from W.T. Easterbrook and H. Aitken, *Canadian Economic History* (Toronto, 1958), ch. 21.

5 The pulp and paper industry was also a product of the new industrialism but it tended more towards own generation of power and dispersion through central and eastern Canada. The Maritimes, of course, did sustain growth in the forest based economy, especially in pulp and paper, and growth rates in this sector were not as low, but this paper focuses on the other industrial sectors and on why performance in those sectors was so weak.

6 The source of the data in this paragraph is D. Alexander, "Economic Growth in the Atlantic Region, 1880-1940", *Acadiensis*, VIII, 1 (Autumn 1978), pp. 47-76. Alexander cites as his

These data show aggregate trends but hide two particularly serious consequences of these trends. First, the relative slowdown in diversified, non-forest based industrial growth in the Maritime provinces was devastating to Maritime living standards relative to the rest of Canada. David Alexander has demonstrated that if manufacturing in the Maritimes had grown at the national rate in the 1880-1940 period, assuming no other sector would have grown slower, total gross regional output per head would have been 77 per cent of the national average in 1910 and 84 per cent in 1939, reflecting a convergence in regional living standards, rather than the diverging 67 and 55 per cent actually recorded.[7] Second, Maritime participation in the industries of the new industrialism, beyond pulp and paper, was particularly limited. Industries which survived in the Maritimes were largely traditional and resource based, such as fish products, butter and cheese, sawmills, flour and grist mills, and sugar refining.[8] Those which failed to develop were the new and technologically sophisticated industries upon which Canada came to rest much of her comparative advantage in manufacturing in the 20th century: electrochemicals, electrical products, transportation equipment and machinery. Indeed, fully two-thirds of all Canadian innovation in manufacturing as measured by the numbers of patents issued, a sign of competition strength, was in these four new sectors by the 1950s.[9]

The literature on the spatial and structural nature of Canadian industrialisation in the 1900-1940 period is, like the industrialisation itself, regionally specialised. At least three hypotheses have been proposed to explain Maritime industrial decline and another three to explain central Canadian industrial development. Unfortunately, few parallels have been drawn between these literatures.

Until recently the hypothesis explaining the slow growth of the Maritimes favoured by economists was the inevitability hypothesis, which argues that the Maritime provinces were doomed to industrial failure due to low productivity, low demand for industrial goods, and low urbanisation relative to central Canada.[10] This hypothesis has recently been questioned by Maritime historians.

primary source the statistics in *The Maritime Provinces in Relation to the National Economy of Canada* (Ottawa, 1948).

7 Alexander, "Economic Growth in the Atlantic Region", p. 73.

8 And in addition, in Saunders' words, "a large number of small plants producing speciality goods which can be transported long distances at a cost relatively low to the total value, and other manufacturing products for which proximity to the local market affords a natural protection". S.A. Saunders, "The Maritime Provinces" in H.A. Innis and A.F.W. Plumptre, eds., *The Canadian Economy and the Depression* (Toronto, 1934), p. 128.

9 O.J. Firestone, "Innovation and Economic Development: The Canadian Case", *Review of Income and Wealth*, 18 (1972), pp. 399-420.

10 This hypothesis is most closely associated with Saunders and Keirstead. See Saunders, *The Economic History of the Maritime Provinces* and B.S. Keirstead, ed., *The Theory of Economic Change* (Toronto, 1941).

In its place, they offer a view that the roots of Maritime industrial decline were in central Canadian corporate and public policy decisions (or lack of them).[11] Of political decisions, regional transportation policy has been singled out as of particular importance.[12] Of corporate decisions, case studies in the iron and steel, coal and banking sectors have appeared.[13] A third hypothesis tends to downplay the role of national transportation and other policies, and argues that the poor performance of Maritime industry can be blamed on local decision-makers, particularly entrepreneurs, who were deficient in education, initiative, innovation and management skills.[14]

There are difficulties in accepting any of these views as an adequate explanation for Maritime retardation. The economists' inevitability argument is circular. The inevitability thesis asks the question: why did the Maritimes fail to industrialise? Answer: because it had low productivity, low demand for industrial goods and low urbanisation. There is, however, a causality problem in this explanation — the question and answer could be reversed. Question: why did the Maritimes have low productivity, low demand for industrial goods and low urbanisation? Answer: because it failed to industrialise. The factors cited are symptoms rather than causes of weak industrialisation. As John Dales has argued, the size of the market or urban centres cannot be cited as a determinant of the location of an entire industrial structure in the same way as it can the location of any particular industrial plant.[15] The size of the market and the existence of urban centres are a creature of industry, through the existence of an industrial labour force and infrastructure. Moreover, the level of productivity is almost certainly a creature of the size of the market and urban centres, through economies of scale at the plant and industry level and general agglomeration economies.[16] What we need to know is why the agglomeration of an industrial

11 See, particularly, T.W. Acheson, "The National Policy and the Industrialisation of the Maritimes: 1880-1910", *Acadiensis*, I, 2 (Spring 1972), pp. 3-28 and "The Maritimes and Empire Canada" in D.J. Bercusen, ed., *Canada and the Burden of Unity* (Toronto, 1977), pp. 87-114; and D. Alexander, *Atlantic Canada and Confederation: Essays in Canadian Political Economy* (Toronto, 1983).

12 E. Forbes, *The Maritime Rights Movement 1919-27: A Study in Canadian Regionalism* (Montreal, 1979), and "Misguided Symmetry: the Destruction of Regional Transportation Policy for the Maritimes" in Bercusen, ed., *Canada and the Burden of Unity*, pp. 60-86.

13 D. Frank, "The Cape Breton Coal Industry and the Rise and Fall of the British American Steel Corporation", *Acadiensis*, VII, 1 (Autumn 1977), pp. 3-34 and J. D. Frost, "The 'Nationalization' of the Bank of Nova Scotia, 1880-1910", *ibid.*, XII, 1 (Autumn 1982), pp. 3-38.

14 R. George, *A Leader and a Laggard: Manufacturing Industry in Nova Scotia, Quebec and Ontario* (Toronto, 1970).

15 J. Dales, *Hydroelectricity and Industrial Development: Quebec 1898-1940* (Cambridge, 1957), ch. 8.

16 This point was recognised by George, *A Leader and a Laggard*, ch. 3. George found that Nova Scotia plants had lower labour productivity than Quebec or Ontario ones because average plant size was smaller. At the same size of plant, productivity was similar in the three provinces according to George's calculations. Therefore the existance of low labour productivity was not a

structure took place in central Canada and "deglomeration" of an industrial structure took place in the Maritimes. Hence, the inevitability thesis based on demand, productivity and labour availability and using the neoclassical economic model of the locational choice of a single plant is inadequate for the serious study of Maritime de-industrialisation.[17]

The poor public policy view explored by some Maritime historians has opened up a more promising research program, but also has some weaknesses. Transportation costs could not have been of fundamental importance since they are more important to single plant location than to the location of an entire industrial structure. Transport costs are an important barrier to industrialisation in a peripheral region, but the question is why did such a region become a peripheral region in the first place and another region the central region? The existence of a Maritime industrial economy, with its population and incomes, would have made the Maritimes more central and would have lessened the importance of transportation costs to other markets. The proximity and cost of transport to outside markets cannot explain British, New England, or central-Canadian industrialisation any more than it can explain Maritime de-industrialisation. Similarly, there have been some case studies demonstrating that corporate policy was an important factor in explaining the failure of particular firms and plants in the Maritimes, but a general conspiracy against the location of industry in the Maritimes is hard to fathom.

The poor local control hypothesis seems to provide an interesting approach but as formulated is vague and quite untestable. Most scholarly attention has been directed to the quality of Maritime entrepreneurship. But damning to the hypothesis is the fact that the same charges of inept entrepreneurship have been levelled at the Canadian manufacturing sector in this period, and thus the hypothesis cannot used to explain intra-Canadian manufacturing development — unless of course it is charged that Maritime industrialists were particularly inept, a difficult charge to accept.[18]

Three hypotheses dominate the literature on central Canadian industrialisation. The Faucher-Lamontagne hypothesis is a supply-side view which argues that Ontario developed into Canada's heavy industrial heartland because of its proximity to American coal and iron ore deposits, and Quebec into Canada's industrial sweatshop because of its abundant and therefore cheap and docile

factor hindering industrialists from opening plants in Nova Scotia. Indeed, lower wages at equal productivity gave Nova Scotia a distinct labour cost advantage.

17 The lack of commercialised agriculture is often cited as a reason for weak Maritime industrialisation, both because of low rural incomes and hence demand for industrial goods and because of an inadequate level of food supply to support urban populations. But this factor did not impede Quebec industrialisation, which found output demand and food supply elsewhere in Canada, as could, I suspect, the Maritime provinces.

18 See K. Levitt, *Silent Surrender: The Multinational Corporation in Canada* (Toronto, 1970) and R. T. Naylor, *The History of Canadian Business 1867-1914* (2 vols., Toronto, 1975).

labour.[19] Modern staple theorists have challenged this view and replaced it with a demand-side one: Ontario had a large market for manufactured goods due to heavily commercialised agriculture and developed industrially by this linkage. In Quebec, industries developed which could take advantage of low labour costs but could still locate a long distance from Ontario and western markets: light manufacturing industries producing goods with high value to weight ratios.[20] In a third hypothesis, Dales has argued that abundant hydroelectricity was a prerequisite and a powerful catalyst to the 20th century industrial revolution in central Canada.[21] Endorsing this view, Easterbrook and Aitken state: "In no means to be overlooked...is the support which cheap hydro power has given to general manufacturing development. The concentration of industry and population in the St. Lawrence lowlands, for example, would be inconceivable without hydroelectricity".[22]

Either the Faucher-Lamontagne thesis or the rival demand based hypothesis might be acceptable except for the fact that the Maritime provinces failed to industrialise even though they met the conditions of these hypotheses. Under the Faucher-Lamontagne thesis the Atlantic region should really have been Canada's industrial heartland since it had both abundant coal and iron ore and a distinct wage cost advantage. Of course, the Maritimes could have been held back by poor public policy such as transportation policy. But the fact that the hypothesis must escape refutation by noting extenuating circumstances undermines the credibility of the hypothesis. Under the demand based hypothesis, the Maritime provinces would also have been expected to develop a low wage enclave industrial sector exploiting imperial markets, especially under the Preferential Tariff, and markets in central and western Canada. Again, extenuating circumstances such as high transport costs have to be brought in to rescue the universality of the hypothesis. But transportation costs could not have been that significantly greater. At least, any higher transport costs faced by Maritime manufacturers vis-à-vis Quebec manufacturers might have been offset by lower costs for inputs such as coal and iron ore.

Dales' hydroelectricity hypothesis argues that it was the existence of hydroelectric power resources along with agricultural and industrial raw material bases which explains the growth of industry in central Canada. Quebec and Ontario's abundant hydroelectricity made up for their deficiency in coal and iron ore and gave them their industrial boost once long distance transmission of

19 A. Faucher and M. Lamontagne, "History of Industrial Development", in J-C. Falardeau, ed., *Essays on Contemporary Quebec* (Quebec, 1953).

20 J. Isbister, "Agriculture, Balanced Growth and Social Change in Central Canada since 1850: An Interpretation", *Economic Development and Cultural Change*, 25 (1977), pp. 673-97; J. McCallum, *Unequal Beginnings: Agriculture and Economic Development in Quebec and Ontario Until 1870* (Toronto, 1980).

21 J. Dales, "Fuel, Power and Industrial Development in Central Canada", *American Economic Review, Papers and Proceedings*, 43 (1953), pp. 181-93.

22 Easterbrook and Aitken, *Canadian Economic History*, p. 526.

hydroelectricity became technologically feasible in the early 20th century. This view is endorsed in the two major Canadian economic history textbooks of the last 30 years.[23] Dales argues that a region will industrialise if it has at least 50 per cent of the material base — food, raw materials and power — necessary to sustain an industrial structure. The logic is that if the region has less than 50 per cent, it must import the majority of its requirements, and will be facing a cost disadvantage to another region that has to import only a minority. Hence, the other region over time will become the industrial one. The development of hydroelectric power in the early 20th century quickly gave central Canada the material base to become industrial.

It was not Dales' intention to try to explain Maritime industrialisation or de-industrialisation. However, under his criteria for the existence of an industrial structure the Maritimes had the necessary material base in the 19th century and hence an advantage over central Canada. Deficiencies in agricultural resources were made up for by coal and iron ore, and the latter advantages explain the development of the Maritime industrial structure of the late 19th century. But in the 20th century the Maritimes did not lose its resource advantages in coal and iron ore and should still have recorded industrial growth, since industrial regions will be any regions that must import only a minority of their resource needs. Examples of other non-hydroelectric regions that remained industrial in the 20th century such as New England, Great Britian and the Rhur come to mind. Dales' hypothesis then is a convincing argument for explaining central Canadian industrialisation but cannot explain Maritime de-industrialisation. Extenuating circumstances again have to be brought in.

Dales' argument may, however, be reformulated. The electrification hypothesis proposed in this paper has two parts. First, it argues that electrification of manufacturing based on purchased power was a phenomenon important enough to explain relative regional industrial development. Second, it argues that there were Maritime lags in the development of central electrical power systems and in the conversion of industrial plants to utilize purchased electrical power. The structure of economic incentives and the political and legislative atmosphere present in central Canada were favourable to the early and widespread distribution of centrally generated electric power and to the industrial switchover from a reliance on own-generated power to a reliance on purchased power. These developments allowed Ontario and Quebec to develop high productivity industry exploiting the technologies of the new industrialism. On the other hand, the structure of economic incentives and the political and legislative atmosphere present in the Maritime provinces dictated limited development of centrally generated power and the continued reliance on own generated power in industry. Without the development, promotion and utilization of centrally generated power, Maritime industry was unable to

23 *Ibid.* and W. L. Marr and D. G. Paterson, *Canada: An Economic History* (Toronto, 1980), pp. 368, 392.

transform from the requirements of the old industrialism to the requirements of the new and the Maritimes lost ground in the 1920s.

Fundamentally, electrification based on purchased power allowed manufacturing productivity, the amount of output to be obtained from given inputs, to increase significantly. It is no coincidence that significant increases in North American manufacturing productivity occurred in the 1920s when the industrial power switch from direct drive based on own-generated power to unit drive based on purchased power was largely completed.[24] As Rosenberg has stated: "The sharp productivity rise in the American economy in the years after World War I owed a great deal, directly and indirectly, to the electrification of manufacturing".[25] Electrification was therefore probably crucial to regional industrial performance. Of course, other factors would have affected regional productivity growth and industrial performance. The creation of managerial hierarchies and their control over labour, the vertical integration of production and distribution, the integration of financial and industrial control, local resources and industrial mix, and local research and know how were obviously important. But electrification brought many of these factors into play.

It has been documented how electrification of manufacturing proceeded in the early 20th century.[26] Direct drive of all machinery from a central factory power plant, with its attendent belts and pulleys, was initially replaced by line shaft drive. Then, through World War I, line shaft drive was replaced by group drive, with strategically placed electric motors driven themselves by transmitted power from the central power plant. Unit electric drive with a motor placed on each machine and driven by purchased electricity available at the flick of a switch rather than from a factory powerplant slowly became the industrial norm by the end of the 1920s. Sixty-two per cent of power utilized in Canadian manufacturing was purchased by 1929, up from 45 per cent in 1923. In the Maritime provinces, these figures were 28 per cent in 1929 and 7 per cent in 1923.[27]

These progressive steps in the electrification of manufacturing had three significant productivity-boosting effects in transforming industry. Chandler has emphasised the role of electrification in fostering the development of "high speed, large batch, continuous process production methods, with new machines and an intensified use of energy enabling an integration and coordination of the

24 J. Kendrick, *Productivity Trends in the United States* (New York, 1961); A. Woolf, "Electricity, Productivity and Labor-Saving: American Manufacturing 1900-1929", *Explorations in Economic History*, 21 (1984), pp. 176-91.

25 N. Rosenberg, "Technological Interdependence in the American Economy", in N. Rosenberg, ed., *Inside the Black Box: Technology and Economics* (Cambridge, 1982), pp. 78-9.

26 See R. DuBoff, "The Introduction of Electric Power in American Manufacturing", *Economic History Review*, 20 (December 1967), pp. 509-18; W. Devine Jr., "From Shafts to Wires: Historical Perspectives on Electrification", *Journal of Economic History*, 43 (1983), pp. 347-72.

27 See the data sources listed in footnote 71.

faster flow of materials through the production process".[28] Electric drive, especially unit drive, enabled an increased flow of production (in Chandler's words, velocity of throughput and in the words of a Canadian engineer of the 1920s, "an increase in the units produced per unit of time"), an improved working environment, an ease of plant expansion and vastly improved organisational and engineering control.[29] The cost reducing effects reaped can be described as economies of speed — more inputs processed per unit of time with the same capital equipment. Rosenberg puts it in the following way:

> The reduced cost of power alone did not exhaust the productivity benefits of electricity. The social payoff to electricity would have to include not only lower energy and capital costs but also the benefits flowing from the new found freedom to redesign factories with a far more flexible power source than was previously available under the regime of the steam engine....Although the direct energy-saving and capital-saving effects (included, it should be noted, a vast saving of floor space) were great, the flexibility of the new power source made possible a wholesale reorganisation of work arrangement and, in this way, made a wide and pervasive contribution to productivity growth.[30]

The managers of Dominion Cotton Mills of Montreal, in describing their decision to switch to purchased electricity in 1908, noted that: "Considering the interest and depreciation on a steam plant, the cost of the rental of electric power was no more than steam would have cost" and that electric power would provide "all that could reasonably be expected in the way of flexibility, centralisation of control, reduction of attendence and minimisation of stoppages together with an ability to make up for delays by running any desired section overtime".[31]

As hinted at in the above remarks, the conversion of North American industry to run on purchased power also served to reduce long-run capital requirements in manufacturing as factory installed power generating equipment was scrapped.[32] Canadian observers in 1932 reported that: "The central supply utility renders large capital outlays for power by manufacturers unneccessary, and fills their requirements at lower annual cost".[33] More importantly, as Devine explains, "electric unit drive was an extremely flexible technique for driving machinery, and because of this flexiblity, manufacturers could turn their attention away from problems of power production and distribution and toward

28 A. Chandler Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, 1977), p. 285.

29 *Engineering Journal*, July 1930, p. 428.

30 Rosenberg, "Technological Interdependence in the American Economy", p. 77.

31 Quoted in Dales, *Hydroelectricity and Industrial Development*, p. 100.

32 See R. DuBoff, *Electric Power in American Manufacturing 1899-1958* (New York, 1979).

33 *Industrial Canada*, January 1932, p. 101.

improving the overall efficiency of their operations".[34] Hence, more output for less inputs, and more attention to the production process *per se*.

Finally, although electrification did not promote investment in power plant equipment in manufacturing (that was undertaken in the central electric stations), it did promote another type of investment in manufacturing — the investment in new plant and equipment to utilize purchased power. In this new plant and equipment was embodied new technology presenting new possibilities for productivity gain. Good examples were electric motors, electric furnaces, electric steam heat boilers, electric ovens, apparatus for electric arc welding, and electric lighting and materials handling systems.[35] All of these new techniques probably increased productivity. Twentieth century metallurgy and industrial chemistry increasingly relied on electricity as a material input in electrolytic methods, as a source of power to drive machinery, and as a source of heat to transform materials. Indeed, the electrification and mechanisation of industry was linked; just as Canadian manufacturing expansion and its electrification was peaking in 1929, so was new capital expenditure.[36] Much of the new technology of the second industrial revolution was designed to use electricity although there was not a wholesale shift away from other energy forms.

The importance of the availability of purchased electricity to Canadian manufacturing then went far beyond its use as a cheap energy input (its direct cost saving effect). It had a profound impact on the technology of production, altering the optimal mix of inputs and improving overall efficiency through organisational change on the factory floor. Electrification based on purchased power, because of its many indirect cost reducing effects, probably accounted for much of the manufacturing productivity improvement that was recorded in the Canadian economy of the early 20th century. By 1929, 83 per cent of all electric motors utilized in Canadian manufacturing, and 55 per cent of all motors utilized in Maritime manufacturing, ran on purchased rather than on own-generated electricity.[37] Given the importance of reliable electricity supply in operating the new continuous process production technologies, the primary considerations of the manufacturer with respect to purchased power were, ranked in order of importance, continuity of supply, adequacy of supply for the present and future, and only finally cost.[38] However, the structure of economic incentives and the geographical, political and legislative impetus for the development of central power systems and for the conversion of industrial plants to run on purchased power differed in the Maritimes and in central Canada.

34 Devine, "From Shafts to Wires", p. 368.

35 *Industrial Canada*, January 1929, p. 98.

36 T.R. Vout, "The Canadian Manufacturing Industry 1900-1957", in J. Beach and J. Weldon, eds., *Conference on Statistics 1960* (Toronto, 1962), pp. 295-314.

37 See footnote 71.

38 *Engineering Journal*, April 1924, p. 180.

Central power systems in western market economies must be seen as cultural artifacts, their development conditioned by local geography, economics, property ownership, politics and legislation. The technology of central power production was internationally known and available, but how it was applied in each region was governed by local conditions.[39] Bottlenecks to development were rarely technological but more often political, economic, geographic and legislative.

Economics and geography combined to present very different incentives in different regions to build and expand central power systems. In regions where coal was abundant, waterpower scarce and hence thermally generated electricity the norm, the supply of power could be adjusted easily to demand and hence thermal stations were built to operate at full capacity in the more heavily populated, typically urban areas. Since plants were built to meet local demand only, system expansion was not aggressively pursued. Local markets, especially if monopolised, were guaranteed. An owner of a thermal plant built to operate at full capacity had no particular incentive to promote his activities and expand his production, aside from incurring the fixed capital cost of building new plants. Increased production with existing plant meant operating at a less efficient higher output level, and hence meant increasing price to cover costs. Faced with competitors, he would not have wished to do this. More likely, if possessing a local monopoly, he would have restricted output and increased price to maximise profits.

In abundant waterpower regions, supply of power could not so easily be adjusted to demand. Supply was determined by the nature of the hydropower site and demand had to be adjusted to supply.[40] With large supplies of power available, hydropower companies aggressively sought markets to bring demand closer to capacity supply and to reap economies of scale, given the high ratio of fixed to variable cost.[41] An owner of a hydro plant operating with excess capacity had a large profit incentive to increase production and lower per unit costs. He was faced with the happy prospect of promoting his product, being able to lower his costs and hence prices, beating his competitors, and probably increasing his profits. On the other hand, the high initial cost of hydro plants, and the risk that the present and future demand for their power (in order that they could run close to capacity) might not materialise could have held back the private development of waterpower sites. This was less of a problem for thermal generation, given the much lower ratio of up front to operating cost. On economic grounds, private development of thermal capacity might be expected

39 T. Hughes, *Networks of Power: Electrification in Western Society 1880 - 1930* (Baltimore, 1983), esp. ch. 1.

40 Dales, *Hydroelectricity and Industrial Development*, pp. 10-11.

41 C. V. Christie, in "The Cost of Hydroelectric Power", *Engineering Journal*, April 1924, pp. 177-80 argues for an 80/20 ratio of fixed to operating costs for hydro plants and a 30/70 ratio for steam plants.

to have occurred quickly but expanded more tentatively. Private developers of hydro capacity would have been more tentative in making initial investment decisions, but would have marketed their power more aggressively once committed.

The local political and legislative milieu also played a role in central power development in the early 20th century. In regions where governments were suspicious of large organisations, consolidations and mergers, or of the need to supplant the market through public power provision, and extolled instead the virtues of competitive private enterprise, the development of large, regionally integrated power systems was held back. Prominent examples were the failure to interconnect power supply in Great Britain in the 1920s, the failure of the Giant Power movement in the United States, and the failure in the 1920s to develop power at Muscle Shoals in the Tennessee Valley. In the British case, interconnection was difficult due to the very atomistic and competitive structure of private power ownership. The United States Giant Power movement failed because of an ideological controversy over ownership and control. The first World War period had seen interconnection of private utility systems in the United States — as Hughes states "war accelerates negociations between interests which in peacetime might work for years with little or no physical co-ordination" — but peacetime power interconnection and public power management was too much like socialism to gain support in the 1920s.[42] The same ideological reservations kept Tennessee Valley power from being developed as a regional system by the state in the 1920s. Moreover, where private ownership of previously installed thermal generating plant existed, many governments were loath to allow new albeit more efficient private or publicly owned hydroelectric operations to take over existing markets.[43] Such governments did not wish to undermine existing property rights and profit expectations. As Hughes argues, "existing technologies give rise to binding nuclei for a host of dependent political and economic interests".[44]

In other regions where big government, big business and economic and political change were not quite so taboo and where existing property rights and profit expectations could be more easily undermined — for example in Ontario where state electricity provision was seen as a method of wresting control from United States interests — regionally integrated power systems grew more rapidly. The consolidation of operating and controlling organisations over large geographical areas either in the public or private sectors was often crucial to system building, interconnection and power supply.[45] "System builders", Hugues points out, "knew that the diversity of load that allowed load

42 Hughes, *Networks of Power*, p. 285.

43 Governments, of course, controlled private waterpower development through the granting or denial of water rights.

44 *Ibid.*, p. 325.

45 *Engineering Journal*, July 1930, p. 425.

management, a resulting improvement in load factor, and a lowering of unit capital cost was likely to be found in a large geographic area where the population engaged in a wide variety of energy-consuming activities".[46] Some examples were the hydroelectric power systems created by the Pacific Gas and Electric Co. in California and by the Bayernwerk-Walschenseewerk in Bavaria in the 1920s. The latter was a grid-style regional hydroelectrification project that was visionary in its coupling of large scale waterpower development with systematic, planned regional electrification.

In making the decision to convert plants to run on purchased rather than own generated power, early 20th century industrialists would have compared the expected discounted profit streams under the two technologies. A typical plant manager would have compared the operating cost of the old technology (own generation) with the operating and overhead cost of the new technology (purchased power) since the new involved the purchase of new machinery that the old did not. If the old was the most profitable technology, it would have persisted.[47] In regions where coal was abundant and purchased electricity scarce, profit incentives often led to the decision to stay with the old technology. The operating costs of own thermal generation were often lower than the costs of a switch to purchased electricity. The industrialist chose to stay with the old technology on which capital cost was either fully paid off or unavoidable. On the other hand, in regions where coal was scarce and hence the operating cost of thermal own-generated power was high and where purchased electricity, perhaps hydroelectricity, was abundant and hence low in cost, industrialists were led to introduce the new technology. More generally, in many older industrial regions, the old technology was retained because it was there already. In newer regions, the most cost-efficient, best practise technology was chosen. Hence, in any particular regional situation, the technology most privately profitable to use need not be the most efficient new one. Old technology can persist for long periods, and regions can get caught in the trap of natural obsolescence that is basic to the natural market process of technical change.[48] Moreover, the industrialist's decision to switch to purchased power often revolved around the perceived continuity and adequacy of supply of power, at present and in the future, and these perceptions differed from region to region.

If it is accepted that the availability and use of purchased power lay behind much of the manufacturing productivity change and relative industrial performance that occurred in Canada in the early 20th century, two findings would be necessary to allow relative regional electrification a role in explaining the

46 Hughes, *Networks of Power*, p. 463.

47 See W.G. Salter, *Productivity and Technical Change* (2nd ed., Cambridge, 1966), ch. 4. The overhead costs of the old technology is not relevant to the decision since these costs are already 'sunk'.

48 Even the United States was not immune to this fact. See A. Woolf, "Energy and Technology in American Manufacturing 1900-1929" (Ph.D. thesis, University of Wisconsin, 1980), p. 217.

Maritime industrial lag behind central Canada in the interwar years. One would be a finding of relatively slow development, interconnection and distribution of centrally generated electricity in the Maritime provinces compared to central Canada. The other would be a finding of a more continued reliance of Maritime manufacturers on the old technology of own-generated power rather than the new of purchased power.

There is evidence on the first point. Dales has examined the role of the central electric station in Quebec's industrial development in the early 20th century.[49] His case studies of Quebec's major power companies clearly demonstrate that local economic, political and legislative factors were the determinants of regional power system development. For example, the Shawinigan Water and Power Company controlled large hydro resources and was driven by a desire to expand its markets, reduce its overhead costs and preempt its regional competition. To increase markets, the enterprise actively promoted manufacturing development in its region, going so far as to set up an industrial development department of the company. It brought large aluminium, chemical and cotton textile companies into its region. Dales argues that the company succeeded the railway as the main development agency of central Quebec.

Dales found the same to be true of the Southern Canada Power Company, supplying the Eastern Townships. Again, the company set up its own industrial development department. Because the hydro resources of the company were relatively small, large power users were not sought but rather smaller labour intensive manufacturing operations. The company realised that by stimulating textile, metal, wood, rubber and leather-working industries, population and urban growth were encouraged. Nightime domestic demand for lighting dovetailed with the daytime industrial demand for power, and helped to raise the load and diversity factor of power supply and utilise existing limited capacity much more effectively and profitably.[50] In pursuing its own profit motives and by stimulating industry, the hydroelectric power company contributed to industrial development in the Eastern Townships in the 1920s. Industries were lured to the region by low labour costs and other attractions, but the reliability of power supply and the existence of an organised network of electric transmission lines was often the critical factor in locational choice.

The environment in which the other power companies operated in Quebec was not so favourable to industrialisation. Industrial development in the Ottawa valley region was held back by divided Quebec-Ontario ownership of the river and by the self-interest of the International Paper Company, which held the water rights on the river and sold only to large users such as pulp and paper and

49 Dales, *Hydroelectricity and Industrial Development*, chs. 3-7.

50 The load factor of a power system is the ratio of the average to peak power demanded. The diversity factor is the ratio of the sum of the peak power demands of the components of demand and the peak power demand on the system as a whole. The wider spread are the peak power demands through the day, the higher are the load and diversity factors.

aluminium companies and not to general manufacturing. In Montreal, the Montreal Light, Heat and Power Company was a vested interest that initiated several business actions which retarded the development of the huge water powers of the lower Ottawa and St. Lawrence and successfully protected the company from competition in the greater Montreal market from power generated on these rivers. These actions restrained industrial development in the rural fringes to the west and east of Montreal. The Gatineau and Montreal companies showed little interest in developing markets for power because they possessed large and guaranteed markets already; in the case of the Gatineau, large long term power contracts with pulp and paper and aluminium plants, and in the case of Montreal, a captive urban market. Dales concluded that where power enterprises had to find markets to provide for growth and diversity and to spread fixed costs, hydroelectric firms actively encouraged the development of manufacturing. But this was not the case where markets were already large and guaranteed.

A similar tale could be told of Ontario. The Hydroelectric Power Commission of Ontario created in 1906 installed its first bulk electrical power transmission lines to supply south-western Ontario in 1910, placing the province in the forefront of electrical transmission innovation. The Ontario commission went into operation under pressure from provincial manufacturers, who felt increasingly vulnerable to volatile coal prices and hence fluctuations in the cost of generation of steam power. They were also reluctant to see Niagara pass into the hands of the Toronto manufacturing interests or to United States interests who were thought to have had little interest in the electrification of Ontario's smaller municipalities. Ontario Hydro, as Nelles put it, "met a psychic and practical need for cheap and immediate electricity".[51] Ontario Hydro was a model in the active cultivation of markets for electricity and the development of manufacturing. By 1922 it was operating 22 hydroelectric developments, all interconnected, and was pioneering in high voltage transmission in order to increase the systems power factor.[52] The Commission engaged, in their own words, in the "widespread distribution of electricity at cost to many consumers rather than just the supply of large blocks of power to large users under long term contracts".[53] With low charges and with technical advice, Ontario manufacturers were induced by Adam Beck's commission to introduce technologies designed to run on purchased power. Consumer retail markets were actively cultivated by offering low retail rates, raising urban standards of living and helping to promote a diversified industrial structure around the production of the new consumer

51 V. Nelles, *The Politics of Development: Timber, Mines and Hydroelectricity in Ontario 1849-1940* (Toronto, 1974), p. 251.

52 The power factor of a system is the ratio of power current to total current, and is a measure of power loss.

53 *The Hydroelectric Power Commission of Ontario: Its Origin, Administration and Achievements* (Toronto, 1928), p. 1.

durables designed to run on electricity.[54] Productivity growth and marketing policy at Ontario Hydro promoted the use and distribution of electricity and accelerated the pace of development of a new industrialism in Ontario.

The story of central power provision and manufacturing development was very different in the Maritimes provinces where central electricity generating capacity was developed much more slowly than in central Canada.[55] Significantly, many of the central stations in the Maritimes, including New Brunswick's and Nova Scotia's largest, were thermal steam plants. These plants had higher ratios of operating to overhead costs than hydro plants and did not boast significant economies of scale. Maritime electricity suppliers had much less incentive to develop new markets for their power and to persuade local manufacturers to scrap their generating equipment and move to purchased power. The large thermal power suppliers had, by and large, guaranteed markets in urban centres such as Halifax and Saint John, and did not seek expansion. The development of cheaper hydroelectric power near these cities was held back because of the perceived risk of investing in high up-front cost hydroelectricity generation where local monopolies using thermal power were well established and the capacity to absorb additional energy problematic.[56]

Despite the formation of public power movements to develop central power generating capacity, especially hydroelectricity, the private utilities in the Maritimes were able to strengthen their monopoly positions. Public intervention managed to get some hydroelectricity projects financed, because they were often perceived as too great a capital investment and too great a risk for private capital, but the projects were not designed to benefit consumers but rather the urban distribution companies, especially those in Halifax and Saint John. The Nova Scotia and New Brunswick Power Commissions sold their power to these suppliers on often uneconomic terms, only for them to distribute it. The major customers of the public commissions were not final users but private distribution companies receiving supply in bulk. The public commissions did not move aggressively into the industrial, commercial and retail marketing of their power.

Despite public pronouncements by the provincial governments on the importance of hydroelectric development, the provinces were held back in the 1920s. The local coal industry was certainly opposed, and the legislatures of Nova Scotia and New Brunswick failed to cooperate on any joint public

54 This is one area where the Quebec companies are argued by Dales to have been less successful, possibly due to the fact that the Quebec companies were private monopolies interested in maximising profits rather than public monopolies designed to sell power at cost.

55 See the discussion in Canada, Dominion Bureau of Statistics, *The Maritime Provinces Since Confederation* (Ottawa, 1926). It is interesting to note, however, that the world's first long distance transmission of coal-fired electrical power occurred at Chignecto, New Brunswick in 1906.

56 C. Armstrong and V. Nelles, *Monopolies Moment: The Organisation and Regulation of Canadian Utilities 1830-1930* (Philadelphia, 1986), ch. 13.

ventures. The Grand Falls project, the public development of which was the main issue in the 1925 New Brunswick election, was not undertaken by the public commission. Rights to the development passed back to the International Paper Company. Having postponed development in the early 1920s, the company developed the site in 1927 but sold its power only in large blocks under long term contract.[57] In 1926, staffing at the New Brunswick Power Commission was cut, and many of the 25 private power companies existing in New Brunswick in 1918, which were "...small, and some of them inefficient", survived into the 1930s.[58] Progress for the New Brunswick commission was slow, and "up to 1931 the New Brunswick Power Commission was operating without sufficient generating capacity to fully develop the market served by them or to expand into new markets".[59]

By 1929 the talk was not of what had been done in the Maritimes with respect to central power provision but what could be done. Installation of central electricity generating capacity was much below that considered commercially viable.[60] In the early 1930s growth came, albeit somewhat belatedly. More attention turned to underdeveloped steam generation. The Grand Lake steam project of New Brunswick's Minto coal field began operation in 1931, and was soon "connected by high voltage transmission lines to Fredriction and Marysville and to the Musquash system at Moncton, thereby enabling the two plants of the [New Brunswick Electric Power] Commission to operate in parallel, one helping the other".[61] Another coal fired project, the Seaboard Plant at Glace Bay, serving Sydney, began operation in 1930. Indeed, the early 1930s saw a large growth in the activities of the Nova Scotia Power Commission. From operating three systems in 1928 — St. Margaret's Bay, Sheet Harbour and Mushamush — five more were added by 1933 — Tusket, Rosemary, Mersey, Markland and Antigonish. High voltage transmission lines grew from 94 miles in 1926 to 365 miles in 1933, and power delivered from 34.2 million kilowatt hours 1n 1926 to 148.8 million kilowatt hours in 1933.[62]

The Dominion Bureau of Statistics began providing data on central electric stations in Canada in 1917.[63] Power equipment installed in central stations in Canada rose from 3.8 million horsepower in 1926 to 4.9 million in 1929 and to 7.1 million in 1935. In the Maritimes, these respective figures were 80.4

57 A. T. Doyle, *Front Benches and Back Rooms* (Toronto, 1976); R. A. Young, "Planning for Power: The New Brunswick Electric Power Commission in the 1950s", *Acadiensis*, XII, 1 (Autumn 1982), pp. 73-99.

58 *Industrial Canada*, January 1932, p. 128.

59 *Financial Post*, 1 July 1933, p.20.

60 *Ibid.*, p. 20 observed that 400,000 horsepower of installed power was commercially viable in Nova Scotia in 1931 but only 116,000 had so far been installed.

61 *Ibid.*, p. 18.

62 *Ibid.*, p. 20.

63 Canada, Dominion Bureau of Statistics, *Central Electric Stations in Canada* (Ottawa, 1917-).

thousand, 180.1 thousand, and 378.9 thousand horsepower. Electricity generated by central stations rose in Canada from 12,093 million kilowatt hours in 1926 to 17,963 million in 1929 and to 23,283 million in 1935. In the Maritimes, electricity generated rose from 128 million kilowatt hours in 1926, to 253 million in 1929 and to 784 million in 1935. Hence in 1926, 2.1 per cent of all power equipment installed in central generating stations was in the Maritimes, but these stations generated only 1 per cent of centrally generated power in Canada. In 1929, these figures were 3.6 per cent and 1.4 per cent respectively, demonstrating that more stations had been built in the Maritimes but that comparatively little additional power was being generated and distributed. By 1935, however, the Maritimes had 3.9 per cent of installed horsepower and generated 3.4 per cent of central power, at a capacity utilisation rate that was much closer to the all-Canadian average (2,811 kilowatt hours generated per horsepower of generating equipment installed compared to 3,277 kilowatt hours for Canada). But in the critical years of the 1920s, Maritime power producers certainly lagged behind the rest of Canada in generating and distributing their power.

The Malay and Ruth Falls developments of the Nova Scotia Power Commission, supplying the towns of Pictou County through the Sheet Harbour system, demonstrated the importance of electricity supply to an industrial area in the 1920s. Beginning in operation in 1925, with 55 miles of high voltage transmission lines, deliveries to New Glasgow, Stellarton, Trenton, Pictou, and Westville grew from 6.2 million kilowatt hours in 1925, at 1.66 cents per kilowatt hour, to 9.3 million kilowatt hours in 1928, at 1.05 cents per kilowatt hour.[64] Pictou County factories were able to keep hold of their market share in Canadian metals fabricating in the late 1920s, after losing ground in the early years of the decade.[65] Indeed, the Pictou County metal firms were leaders in the Maritimes in the introduction of new technology based on the new industrialism and the J.W. Cummings Company was the first metals company in the Maritimes to invest in a steel foundry equipped with an electric furnace. It is interesting to note that the metal firms of Pictou County recaptured their lost markets in the late 1920s when cheap hydroelectricity and the opportunity to invest in new technology designed to run on reliable purchased power became available.

On the other hand, most Maritime manufacturers, unlike J.W.Cummings and many central Canadian manufacturers, were not successful in introducing the new technologies designed to run on purchased power in the 1920s, largely because purchased power was not available. At the end of the 1920s and in the early 1930s, however, the Maritime provinces began successful industrial

64 *Industrial Canada*, January 1929, p. 100.

65 L. McCann, "The Mercantile-Industrial Transition in the Metal Towns of Pictou County 1857-1931", *Acadiensis*, X, 2 (Spring 1981), pp. 29-64. This fact however attests against accepting without qualification McCann's view of unrelenting industrial decline in the region in the early 20th century.

development around purchased power electrification.[66] An industrial survey of the Annapolis Valley in 1929 demonstrated some of these new developments. Speaking of the brick and tile work of L.E. Shaw at Avonport, Nova Scotia, *Industrial Canada* reported that "the plant has been practically rebuilt in the last two years. Steam power has given away entirely to the electric motor....an adequate supply of water under pressure in all parts of the plant is now available by an electric pump".[67] The manufacturer reported that due to a new electric kiln and drier capacity, output was up 40 per cent. The Annapolis Hardwood Company reported that their sales doubled in 1927-29 once the plant was electrified with fireproof dry kilns, boiler house and heating system. The proprietors of Cosmos Imperial Mills Limited, the principal industry in Yarmouth, Nova Scotia, reported "another improvement in operating conditions for which preparations are now being made, is the opportunity to obtain hydroelectric power sufficient to operate the entire plant from the new hydroelectric development under construction by the Nova Scotia Power Commission on the Tusket River, 9 miles for Yarmouth. When this energy is available, it is anticipated considerable saving in power costs will be possible, as well as having a more flexible arrangement for the operation of machinery than at present, where a considerable portion of the equipment is on mechanical drive".[68]

To this anecdotal evidence on the lateness with which Maritime manufacturers transformed their operations to run on purchased power can be added manufacturing census evidence on the use by Maritime and central Canadian manufacturers of their own-generated and purchased power. The evidence presented deals with fuel and power costs and usage in total manufacturing and in the new industrialism sectors of iron and steel products, non-metallic mineral products, non-ferrous metal products and chemical products in the Maritimes and in Canada in the 1920 to 1940 period. These sectors were able to make the most dramatic use of the new processes of the second industrial revolution and the new energy source of purchased electricity.[69] The experience of these

66 Parallels could be drawn to Great Britain here. Leslie Hannah has argued that the coming of the National Grid, low cost interconnected electricity supply, and purchased power electrification of manufacturing in Britain in the late 1920s and early 1930s was the major reason for the success of the British industrial economy in the 1930s, just as the core of Britain's industrial problems in the 1920s lay in the failure to build up a national power system and to electrify industry. L. Hannah, *Electricity Before Nationalisation: A Study of the Development of the Electricity Supply Industry in Britain to 1948* (Baltimore, 1979) and "A Pioneer in Public Enterprise: The Central Electricity Board and the National Grid 1927-40", in B. Supple, ed., *Essays in British Business History* (Oxford, 1977).

67 *Industrial Canada*, June 1929, p. 67.

68 *Ibid.*, p. 70.

69 These are, in Chandler's terms, the industries of high speed, large batch continuous process production. As he states in *The Visible Hand*, p. 243, "in those industries where the processes of production required the application of heat and involved chemical rather than mechanical

industries in the interwar years demonstrates clearly the Maritime industrial problem. These four sectors made up a large and rapidly growing portion of Canadian manufacturing, accounting for 26.1 per cent in 1920, 33.7 per cent in 1930 and 41.7 per cent in 1940. In the Maritimes these industries had a 32.1 per cent share of Maritime manufacturing output in 1920. This share, however, fell to 28.5 per cent in 1930, to rebound to 34.6 per cent in 1940. Moreover, as the Maritime contribution to total Canadian manufacturing output fell from seven per cent in 1920 to 4.5 per cent in 1930 and 1940, the provinces' contribution in these four sectors also fell in the 1920s, rebounding somewhat later in the 1930s. For example, the Maritime share of total Canadian output in iron and steel products fell from 10.6 per cent in 1920 to 4.6 per cent in 1930, rising back to 5.1 per cent in 1940. In chemicals, the Maritimes had a 4.5 per cent Canadian output market share in 1920, but only 2.9 per cent in 1930. In non-metallic minerals, these percentages were 8.8 and 6.4 per cent respectively.[70]

The proportion of industrialists generating their own power instead of purchasing it from central stations was much higher in the Maritimes than it was in central Canada. Maritime industrialists therefore failed to reap some of the productivity improvements inherent in scrapping their power equipment and moving to purchased power electric drive. Some statistics that attest to this fact can be gleaned from the annual Canadian industrial census after 1923, which records, separately, the horsepower of electric motors run on own-generated electricity and the horsepower run on purchased electricity in Canadian industrial establishments.[71] Seventy-three per cent of electric motors utilised in Canadian manufacturing in 1923 were run on purchased power, but only 26 per cent in Maritime manufacturing. In 1926 these figures were 82 per cent and 33 per cent; in 1929, 83 per cent and 55 per cent; and in 1935, 85 per cent and 77 per cent. Purchased power electrification was certainly undertaken in the Maritimes but it occurred much later than in the rest of Canada.

This pattern was similar in the four subsectors of the new industrialism. In

methods, improved technology, a more intensified use of energy and improved organisation greatly expanded the speed of throughput and reduced the number of workers needed to produce a unit of output...in the metal working industries, the requirements of high volume output brought the most significant technical and organisational innovations".

70 Data in this paragraph are taken from Canada, Dominion Bureau of Statistics, *The Manufacturing Industries of Canada* (Ottawa, selected years 1919-1941).

71 In the annual Dominion Bureau of Statistics Census of Industry between 1917 and 1923, and in any decadal census before those dates, there was no separation of electric motors operated on purchased power and those operated on own-generated power. The following publications published between 1917 and 1940 were the souces for the manufacturing data discussed in this section: *The Manufacturing Industries of Canada, Manufacturing Industries of the Maritime Provinces, Use of Electrical Power in the Mining and Manufacturing Industries in Canada, Production and Use of Electrical Energy in Canada, Manufactures of Non-Metallic Minerals in Canada, Chemicals and Allied Products in Canada, Iron and Steel and their Products in Canada, Manufactures of Non-Ferrous Metals in Canada.* All Canada, Dominion Bureau of Statistics, (Ottawa).

iron and steel products, 81 per cent of electric motor horsepower utilised was run on purchased power in the Canadian industry, but only 25 per cent in the Maritime regional sub-sector. These figures were respectively 79 and 12, 89 and 56, and 79 and 7 per cent for the non-ferrous metals, chemicals and non-metallic minerals sectors respectively. In 1929, these sectors in the Maritimes still relied much more heavily on own-generated power to run electric motors than in Canada as a whole, although there were some significant moves to purchased power electrification in the Maritime chemicals and non-ferrous metals sectors.[72]

The census of industry also gives figures that allow for the calculation of purchased primary power utilised in Canadian manufacturing as a percentage of all primary power utilised. Primary power utilised is defined as the rated horsepower of factory installed primary power equipment (steam engines and turbines, gasoline, gas and oil engines, internal combustion engines, hydraulic turbines and waterwheels) plus rated horsepower of electric motors run on purchased power. In Canadian manufacturing in 1923, 45 per cent of primary power utilised was purchased, a figure that rose to 56 per cent in 1926, to 62 per cent in 1929, and to 66 per cent in 1935. In Maritimes manufacturing only 7.3 per cent of primary power utilised was purchased in 1923, only 14 per cent in 1925, 28 per cent in 1929 and 47 per cent in 1935. This pattern was similar in the new industrial sectors. In 1926, in iron and steel products, only 13 per cent of primary power utilised was purchased in the Maritimes industry, compared with 60 per cent in the industry in Canada as a whole. These figures were respectively 41 and 61, 21 and 64, and 9 and 91 per cent for the non-ferrous metals, chemicals and non-metallic minerals sectors respectively.

Maritime industrialists in the 1920s did not participate to the same extent as industrialists in central Canada in the transformation of the workplace to purchased electrical power, and probably incurred considerable costs in terms of additional capital equipment and lost opportunities for plant rationalisation by not doing so. The productivity implications of this retardation in purchased power electrification may have been significant enough to give purchased power availability and use an important role in explaining the Maritime industrial failures of the 1920s.

Although consideration must be given to relative electrification, one ought not attempt to replace a rich literature on Maritime de-industrialisation with a monocausal, deterministic explanation of the phenomenon. Almost certainly other factors were important. Indeed, the issues involved in regional electrification can possibly form additional elements in the three dominant theses on

72 In 1928, in non-ferrous metals products, 72 per cent of motors came to be run by purchased power, a figure to be compared to the 91 per cent figure for the Canadian sector as a whole. Chemical products records 100 per cent of electric motors run on purchased power in the Maritime sector by 1929. But both of these sectors were very small in the Maritimes and dominated by just a few establishments.

Maritime industrial failure: the inevitability, poor public policy and poor local control theses.

There is an element of inevitability in that private economic agents acting in a rational manner led central Canada into the new industrialism and the Maritimes into an industrial dead end by making privately profitable and correct business and technology decisions. The same economic instincts, designed to maximise profits, which led central Canadian power suppliers to promote and central Canadian industrialists to switch to purchased electrical power, also led Maritime power suppliers and industrialists to proceed more slowly with the development and introduction of the new form of power supply. What is privately and socially profitable can be the one and the same, as in central Canada, but unfortunately can be different, as in the Maritimes. Central Canada had hydroelectricity sites that, if run on a large scale, could produce electricity inexpensively and still leave healthy profits for private suppliers or cover costs for public suppliers. Assured continuity of supply of cheap hydroelectric power, vis-à-vis high and volatile coal prices, induced industrialists to switch readily to purchased power and in the process to reap the productivity improvements (in new machinery) that came to be embodied in making that choice. In the Maritimes, good hydroelectric sites were more scarce and the economics of thermal generation was such that large output was not rewarded by large profits — more likely, output was restricted and expansion held back by the local monopoly nature of markets captive to installed thermal generating capacity. Purchased power availability and cost to the entrepreneur was more uncertain, coal was cheaper, and staying with existing power arrangements and the older equipment that went along with them was the more privately profitable choice.

There is an element of poor public policy in that where private and social profitability diverge, and market solutions fail to be social benefit-maximising, there is a case for government intervention. Canadian governments did recognise the social benefits of purchased power electrification and especially the development of regional electricity systems built around hydroelectricity and thermal power. However, except in Ontario and Quebec, the extension of regional systems was slow. Most early 20th century governments in Canada, as in many other western industrial countries, were loath to intervene in markets for power. Ontario did so, helped by local factors such as strong personalities, a large visible power site and international rivalries over the development of Niagara power. In the Maritimes, the provincial governments were not as decisive in providing for power development. In part, the problem was that electricity supply was not a national government responsibility, and small provincial governments did not have the will or the financial resources to develop regional power systems. Since for the Maritime industrialist it was more profitable to stay with old equipment and own-generated power, provincial governments might have supplied power and offered subsidies for switching to purchased power and undertaking the redesign of production facilities, subsidies large enough to raise the profitability of the new above that of the old. But in the 1920s there was no great political mood for subsidising industrialists for the cost of their inputs or to speed up the introduction of new technology.[73]

The poor local control thesis on Maritime decline argues that "decline was not inevitable if appropriate actions had been taken by local interests when required".[74] If part of the problem was the delay in electrification, industrialists operating in the Maritimes, industrialist holders of rights to power developments, existing power suppliers, and provincial governments can take some of the blame. Ex post, decisions taken with regard to electrification appear to have been incorrect. But decisions that in hindsight would have been more correct cannot be expected to have been taken by early 20th century Maritime industrial interests. The Maritime industrial sector was therefore doomed to a natural obsolescence in the 1920s. As old equipment broke down and outlived its usefulness, there was some catching up in the 1930s, but valuable ground already had been lost.

73 Similar arguments are now being made in general terms about British industrial decline in the late 19th and early 20th centuries. Elbaum and Lazonick argue that British governments failed to put in place state policies and organisational innovations that could have allowed the economy to escape competitive decline, relying too much on the invisible hand of the self-regulating market and not enough on the visible hand of coordinated control. They argue that planning was required at the level of the enterprise, financial institutions and the state, and that the consequences of this failure of state policy first became evident in the interwar period. A similar argument might be made with regard to the Maritimes, especially since what Elbaum and Lazonick argue to have impeded state intervention in Britain was the fact that a very highly developed industrial economy based on market forces had already evolved in the 19th century. The same might have been the case for the Maritime provinces where the status quo in power production and industrial method proved difficult to dislodge. See I. Elbaum and W. Lazonick, "The Decline of the British Economy: An Institutional Perspective", *Journal of Economic History*, XLIV, 2 (June 1984), pp. 567-83.

74 J. B. Cannon, "Explaining Regional Development in Atlantic Canada: A Review Essay", *Journal of Canadian Studies*, 19, 3 (Fall 1984), p. 74.