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WAS CANADIAN MANUFACTURING INEFFICIENT BEFORE WWI? THE CASE OF THE COTTON TEXTILE INDUSTRY, 1870-1910

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Was Canadian manufacturing inefficient before WWI? The case of the cotton textile industry, 1870-1910

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Abstract: Is it possible that generations of Canadian economists and historians have got it wrong and Canadian manufacturing before WWI was fairly efficient? Yes, because they do not pay enough attention to the measurement of efficiency. New cliometric evidence supporting the revisionist side of this question is presented on total factor productivity and five other measures of efficiency for the Canadian cotton textile industry, 1870-1910, an industry long thought to be grossly inefficient, which shows the industry performed strongly relative to the U.S. cotton textile industry and other cotton textile industries elsewhere in the world.

Key words: Manufacturing, Nineteenth Century. Canada. Cotton Textiles, Efficiency, Total Factor Productivity
JEL classification: D24, L67, N60, N61, 014

Introduction

Canadian manufacturing in the nineteenth century has traditionally been viewed as inefficient (Dales 1966; Macdonald 1975; Williams 1979; Bradford and Williams 1989). Because manufacturing was inefficient, historians say, it could not compete without substantial tariff protection with imports from the United States, Britain, Germany and other large industrial countries. But for most of the century, the story goes, little growth took place in manufacturing largely because tariff policy was dictated by Britain's desire, both as a mercantilist and a free trader, to keep domestic tariffs low in what is now Canada and the need for successive Canadian governments, before and after Confederation, to rely primarily on the tariff for

revenue. In the late 1870s, however, a favourable "conjuncture of interests" (Forester 1979; 1986) made possible the advent of the National Policy tariff of 1879 which gave manufacturing substantial protection. And, as a result, eventually, manufacturing grew rapidly; but manufacturing never outgrew its need for protection. On the contrary, the infant industry argument for protection notwithstanding, protection appears to have made the problem worse.

"[T]ariffs …," write Professors Norrie, Owram and Emery (2008, p. 227), "created not just a secondary manufacturing sector in Canada but a high cost, inefficient one as well." "[T]he tariff," writes Bliss (1987a, p14) "was the mother of a fragmented, inefficient manufacturing sector, slow to modernize and non-competitive outside the Canadian market."

Of course, other explanations have been offered in addition to the tariff to explain the weakness of Canadian manufacturing: a colonial mentality, the strengths and weaknesses of the natural resource base, the small size of the domestic market, entrepreneurial failure, and the closeness of the much larger American economy, to name but a few. A large literature has grown up debating their relative importance as causal factors. Recently, however, a small number of revisionist economists and economic historians writing in the cliometric tradition (Wylie 1989; Keay 2000; Keay and Inwood 2005; and Baldwin and Green 2008) have argued that historians may have been wrestling with an illusion. Canadian manufacturing, they claim, may have been far more efficient than historians have traditionally believed.

The idea that manufacturing was weak, they observe, rests on remarkably little hard evidence. Most of the hard evidence comes from studies of the efficiency of Canadian manufacturing after WWII. Two of the most influential of these studies are Dales's (1966) finding that on average labour productivity in Canadian manufacturing between 1926 and 1955 was 20 percent less than American, and Fullerton and Hampson's (1957) finding that labour productivity in Canadian manufacturing, in the single year, 1953, was 40 percent less than American. As far as I am aware only one study has presented quantitative evidence for the nineteenth century. Broadberry's (1997, p. 53) wide-ranging study of the productivity performance of British manufacturing does confirm the traditional view, finding that labour productivity in Canadian manufacturing was on average 12 to 20 percent less than British and 60 percent less than American in the four census years 1870, 1880, 1890, and 1900. But this evidence is not as hard as it might first appear.

Labour productivity, the revisionists observe, and economists now generally agree, can be a misleading measure of efficiency, because it does not allow one to distinguish between differences in efficiency and differences in the capital, land, or materials intensity of production. A better measure of productivity, they say, and economists now generally agree, is total factor productivity (TFP)because it measures efficiency in the use of all inputs not just labour input.

And, indeed, the initial findings of these newer studies based on measures of TFP suggest the traditional view may be mistaken. For example, Inwood and Keay (2005, p. 1328-32) measured the TFP performance of thousands of individual Canadian and American manufacturing establishments in the census year 1870 for Canada with that of the census year 1869 for the United States and found "only a small T.F.P. advantage [was] enjoyed by the average U.S. manufacturer." Keay (2000, p. 1049-1051) found for a much smaller selected sample of 39 Canadian and 39 American manufacturing firms covering 9 industries over most of the 20th century, 1907 to 1990, that: "there is virtually no evidence of consistent and substantial relative technical inefficiency on behalf of the Canadian manufacturers." And, Baldwin and Green (2008) found for a much more comprehensive matched sample of 51 Canadian and American manufacturing industries in the single year 1929 no substantial difference in relative productivity, the median relative TFP of the Canadian industries compared to the American being between 0.89 and 0.96.

But for economic historians interested in the growth of the Canadian economy in the critical years 1870 to 1913 when Canada made the transition to modern economic growth these newer findings intriguing though they are still leave many questions unanswered: How well do these findings apply to the period after 1870 and before 1913? What can we say more directly about productivity in these critical years when the problem is said to have begun?

This paper presents new quantitative evidence bearing on these questions, through a case study of the efficiency of the Canadian cotton textile industry in the

nineteenth century. It is a matter of arithmetic that the efficiency of one industry cannot tell us much about the efficiency of manufacturing as a whole (Domar 1961). But cotton textiles is a special case. If any industry one might think is likely to have performed poorly surely it was the cotton industry. After all, the cotton textile industry in Canada has traditionally been viewed as a classic case of an inefficient Canadian manufacture that grew up behind the National Policy tariff wall (Acheson 1972, Bliss 1970, 1987, Clement 1977, Levitt 1970, McCullough 1991, McDiarmid 1946, Naylor 1975, 1987, Kealey 1980, Scheinberg 1973 and Williams 1979). And its relative TFP performance in the 20th century was found by Keay, unlike the other 8 industries included in his sample study, to be "poor." Nevertheless, it will be shown that this industry performed well relative to other national cotton textile industries, particularly the American cotton textile industry, which was a world leader in inventiveness and efficiency. In so doing the case of the cotton textile industry provides strong support for the new revisionist position.

The Case of the Cotton Textile Industry

Historians do not always have the luxury of judging the efficiency of an industry by measures of its productivity. It is customary when data is scarce to use other less trustworthy indicators of its strength or weakness, such as the opinion of contemporaries, the industry's early or late appearance, whether it grew fast or slow, its large or small size, or whether it used the most up-to-date machinery. Before looking at TFP in the Canadian cotton industry let us see what can be learned by looking at these other indicators.

Contemporary Opinion

Today historians seem convinced the pre-WWI Canadian cotton industry was inefficient. "At all times the cotton manufacturers," writes Michael Bliss (1987, p. 305), kept a close eye on the tariff, for any significant reduction in the National Policy rates could doom the Canadian industry. There was little hope that the twenty-odd cotton mills scattered from Yarmouth to Hamilton, many more than the Dominion needed, many equipped with obsolete machinery and second-rate managers, could ever mature into a truly competitive industry." Some contemporaries, however, thought highly of the efficiency of the late nineteenth century Canadian cotton textile industry. "It is gratifying to find Canadian grey cottons successfully competing with English made goods," said H. Beaumont Small (1868) in the late 1860s. "I believe," said George Parkin (1895) in the 1890s, "that coarse cottons can be produced in Eastern Canada to-day and placed on the [domestic] market as cheaply as those from Manchester." "The Canadian mills," said James D. Edgar (Debates 1893, p. 811), again in the 1890s, "can successfully compete in the outside world with England and the United states without any protection." But opinion is a poor substitute for evidence, even if they are free from bias, which is far from certain - Edgar, for example was an anti-protectionist politician. As interesting as they are, however, in the end opinion is only opinion. When evidence is available, and evidence is available, that is where we should turn for guidance.

Early or Late Appearance

It is not surprising that a cotton textile industry grew up in Canada in the nineteenth century. As Clark (2007, p. 337) points out:

> Cotton textiles seemed the path to industrialization … before World War I. There was a ready local market for textile products everywhere and also a huge, open international market. Textile mills were not capital intensive. And the optimal mill size was small compared even to market sizes in the smallest countries. … The technology was readily available internationally, at moderate prices, through exports of machinery by British engineering firms. Unskilled labor accounted for the majority of production costs in countries such as England.

And W. Arthur Lewis (1978, p. 7-8) says much the same thing. What is surprising is that given these characteristics cotton mills appeared so late. Elsewhere cotton mills appeared soon after invention of factory-based cotton textile production. Selecting Arkwright's 1771 water-powered cotton spinning mill at Cromford, England, as the world's first modern mill, Clark (2008, p. 304) presents data on the speed of the diffusion of the cotton mill in 12 other countries around the world. Supplementing his data with the dates for the appearance of the first mills in Canada and 6 other countries missing from his table, the following pattern emerges. Canada's first mill appeared in 1844 (a lag of 73 years) which was well-behind 16 countries - among them the United States (20 years), France (7 years), Germany (13 years), and Italy

(37 years) - and ahead of only 3 countries, Brazil (75 years), Denmark (119-128 years) and possibly Portugal.

The relatively late appearance of Canadian cotton mills, however, probably better reflects the openness of British North America markets to British exports of cotton yarn and cloth in the first half of the nineteenth century and the greater ability with which the British were able to prevent the export of new cotton machinery for spinning and weaving and emigration of skilled workers before the 1840s under the old colonial system to their own colonies than it does the backwardness of the Canadian industry.

Fast or Slow Growth?

Once planted, the cotton textile industry grew rapidly in Canada. Measuring the growth of the industry by the growth of imports of raw cotton, a widely used measure of the real value or quantity of production, Canadian cotton textiles grew at an annualized rate of 15.5 percent a year 1870-1890, and 4.2 percent a year 1890-1910. (Unless otherwise indicated all rates of growth reported in this paper are annualized rates.) Over roughly similar periods American cotton textiles at a rate of 5.3 percent a year (1869-1889) and 3.7 percent (1889-1909). And over the same time periods real Canadian GNP, (Green and Urquhart 1987) grew at 2.9 percent (1870-1890) and 4.8 percent (1890-1910), which would suggest that Canadian cotton textiles turned in a highly creditable performance.

But the speed of the Canadian industry's growth in output, and indeed any industry's growth, can give a misleading impression of success because both demand and cost conditions are at work. If an industry grows largely because demand is growing its growth has little to tell us about its efficiency. Demand conditions are thought by the industry's historians to be particularly strong influence in the industry's growth. According to the literature (see McCullough 1992 for an extensive survey) the 1879 tariff is the single most important causal factor in the industry's history, explaining the lion's share of the cotton industry's nineteenth-century growth.

Moreover the way in which the industry is said to have grown is troubling. The tariff protection introduced in 1879, it is said, stimulated such rapid "hothouse" growth - a "cotton orgy" the *Monetary Times* called it - the industry was plunged into depression (Bliss 1987b, pp. 304-05 and Naylor 1987, pp. 443-45). And, it is also said, the over-production crisis stimulated a cartel and then a merger movement which resulted in a sharp decline in competition. If the industry's historians are correct, it would seem, one can infer very little about changes in efficiency from the rapidity of the industry's growth.

Large or Small Size?

By 1910 cotton textiles was a large Canadian manufacturing industry. The census of that year reported that manufacturing's gross value of product was $1,166 million, breaking down the sector into 15 large industry groups. Textiles ranked third largest of these groups with a gross value of output of $135.9 million (11.7

percent of the total). Only two groups, food products and timber and lumber were larger. Cotton textiles, or cottons as it was called, was the largest industry in the textiles group accounting for $24.6 million in output, representing a 18.1 percent share of textiles. Cotton textiles also was one of Canada's larger manufacturing industries if we look at it in comparison to all of the 211 smaller kinds of industries the census broke manufacturing into below the large 15 industry level. Cotton textiles, for example, was larger than many other industries historians are used to thinking of as important domestic industries, such as agricultural implements, railroad cars and car works, paper, and tobacco and cigarettes. Above it, but not that far above it, in the $30 to $40 million dollar range, are such important players as: lumber products, butter and cheese, iron and steel products, smelting, boots and shoes, and railroad car repairs.

Accepting that the cotton industry was large relative to other Canadian manufacturing industries, what does this tell us about its efficiency? The answer is very little. As is the case with the rate of growth, the industry's large size relative to other Canadian industries may simply reflect the good fortune of greater demand rather than it does superior entrepreneurship and wiser management and or investment discipline.

More importantly, though, the Canadian cotton industry is better described as a small industry in a large world market. Spindles installed are a widely-used measure of both capacity output and fixed capital in the cotton textile industry. In 1913 Robson estimates (1957, pp. 333, and 354-55) the total number of spinning

spindles installed in the world's 35 national cotton industries was 143.5 million. In this year, the Canadian industry had about 0.9 million spindles installed, that is about 0.6 percent of world capacity.

Is this small? One way to see is to ask what affect an industry of this size could have had on the world price of cotton yarn or cloth. Now, say Canada doubled its output, increasing its output by 100 percent, by how much would the world price fall? The answer depends on the elasticity of demand facing the Canadian industry on the world market (Ec) . As is well known this elasticity can be written as

$$Ec = 1/s \cdot Ew - (1/s - 1) \cdot Es$$

where Ew is the elasticity of world demand, s is the Canadian industries share of the world market, and Es is the elasticity of supply by the world's other cotton industries. Assuming not unreasonably that Ew is equal to -1 and Es to 1, and setting s equal to 0.006, then Ec is equal to -332. With this elasticity a 100 percent increase in Canadian output would reduce the world price by less than one half of one percent. The Canadian industry, therefore, was so small as to be insignificant. This, however, tells us nothing about its efficiency.

New or Old Machinery?

The extent to which an industry uses the most modern machinery is often used as an index of an industry's efficiency. Canada had no cotton textile machine building

industry (W. A. Graham Clark 1912). However, the industry could easily purchase modern machinery at reasonable prices from British and American machinery makers. And it would appear that the Canadian industry was using fairly up to date modern equipment. One of the new technologies that spread rapidly in the second half of the nineteenth century in the cotton textile industry was ring spinning. If we look around the world in 1910 (see table 1), the Canadian industry, although behind the American industry, was on the leading edge in terms of mechanization and the shift to rings.

[Insert Table 1 about here]

Canada looks good but as the large literature on Britain's lag behind the United States suggests the faster adoption of ring spinning in Canada than Britain may say more about differences in Canadian relative prices for labour and capital than it does about efficiency. Measures such as these, of course, are no substitute for direct measures of efficiency.

TFP Measures of Efficiency

Total factor productivity is the best measure of efficiency. To make this a stiff test of the Canadian industry's efficiency I have measured the TFP for Canadian cotton textiles between 1870 and 1910 relative to the cotton textile industry in the United States, which together with the British industry dominated

the world market for cotton textiles and led the world in inventiveness and efficiency (Clark 1987, p. 167).

I make the usual assumptions that cotton industry output (Q) in both countries can be represented by a standard textbook production function with three factors of production, capital (K), labour (L), and raw materials (C) - that is $Q = F(K, L, C; A)$ where A is the total factor productivity index. Assuming a Cobb-Douglas technology in both countries - constant returns to scale, unitary elasticity of substitution , and factor-neutral technical change - and that competition takes place in all markets, the percentage rate of growth in TFP ($A^* = \Delta A/A \times 100$) can be written as:

$$A^* = (Q^* - L^*) - sk\,(K^* - L^*) - sc\,(C^* - L^*)$$

where sk and sc are the output elasticities of capital and raw materials, which are equal, here, to the shares of capital and raw materials in total output. $Q^* - L^*$ is the percentage rate of growth in labour productivity. $K^* - L^*$ is the percentage rate of growth in capital per worker. And $C^* - L^*$ is the percentage rate of growth in raw materials per worker. Note that these starred variables can be interpreted either as percentage changes over time for either the Canadian or U.S, industries or as percentage differences between the Canadian and U.S. cotton industries at a single point in time.

Estimates for A^* are constructed for the Canadian cotton industry in the Canadian census years 1870, 1890, and 1910 and for the United States cotton industry in the American census years 1869, 1889, and 1909. The Canadian and

US. Industries are compared in terms of their productivity performances at three points in time (Canada in 1870, 1890, and 1910 with the U.S. in 1869, 1889 and 1909) and between censuses (Canada 1870-1890 and 1890-1910 with the U.S. 1869-1889 and 1889-1909.)

In constructing the estimates, inevitably, a large number of decisions needed to be made. As far as possible, physical measures of the required variables were used rather than value or money-based measures. To begin, it was decided to measure output by estimates of pounds of raw cotton imported (Canada) or consumed by mills (U.S.). The weight of output, pounds of cloth or yarn, is generally considered a good measure of output. Assuming the weight lost in spinning and weaving is constant the pounds of raw cotton consumed will serve as a good index of output. David (1970 p 547) found this was so for Massachusetts mills 1825-1860. Raw cotton data, available annually, are taken for Canada from the Canadian Tables of Trade and Navigation and for the U.S. from the U.S. censuses. Labour is measured simply by the number of workers as it is reported in the Canadian and U.S. censuses. Capital input is measured by the number of spindles installed, a commonly used physical measure of capital in the industry. Spindlage data matched as closely as possible to census years is drawn from textile directories and the business press for Canada and for the U.S. from the U.S. censuses. The cost shares for capital and raw materials used are taken from the censuses of the two countries.

Table 2 shows estimate of the rate of change of productivity over time for the Canadian and U.S. industries 1869/1870-1889/90 and 1889/90-1909/10. Table 3 shows the relative difference in the productivity of the Canadian and U.S industries for each year 1869/70, 1889/90, and 1909/1910. The cost shares used in each set of calculations are shown in the tables.

[Insert Table 2 about here]

[Insert Table 3 about here]

Surprisingly, perhaps, these measures suggest that the Canadian industry outperformed the American industry in 1869/70 and again in 1909/10. In 1869/70 I find that the Canadian cotton industry was 5.1 percent more efficient than the American and in 1909/10 it was 2.5 percent greater. Only in 1889/90 at the end of an extremely turbulent decade in the industry's history was the Canadian industry outperformed by the American. Note also that the Canadian industry's lower labour productivity is in line with Dales finding of a 20 percent gap in Canadian –American labour productivity, and when corrected for the effects of greater American capital and materials intensity is in line with the newer total factor productivity findings for the twentieth century. Overall the performance of the Canadian industry appears to be much stronger in the later period, 1889/90 to

1909/10, than it was in the earlier period, 1869/70 to 1889/90. The Canadian industry's stronger performance after 1890 may be in part be a result of the mergers of 1890, 1905, and 1910 which created much larger firms and a more concentrated market structure in the Canadian industry.

Conclusion

The Canadian cotton industry is traditionally seen as a classic example of what was wrong with Canadian manufacturing – weak, high cost and non-inventive. The new quantitative evidence presented here, however, says otherwise. The strong TFP performance of the Canadian cotton industry relative to the much-celebrated U.S. cotton industry in 1870 and 1910 suggests that the traditional wisdom on the weakness of Canadian manufacturing before WWI is in need of revision. Industries such as cotton textiles far from being a drag on Canada's per capita growth may have been one of the reasons why Canada was able to make the leap to modern economic growth and become a rich country.

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Table 1: Machinery in the World's Cotton Industries in 1910

Country or Region	Machines per Worker (Index)	Ring Spindles per Worker (number)
New England	1.55	902
Southern U.S.	1.44	770
Canada	1.41	750
Britain	1.00	625
France	0.81	500
Russia	0.77	450
Mexico	0.77	540
Italy	0.76	436
Spain	0.73	450
Switzerland	0.70	450
Austro-Hungary	0.65	403
Germany	0.63	327
Japan	0.52	190

Source:

Clark (1987) p. 152

Table 2: Productivity Growth in the Canadian and U.S. Cotton Industries before WWI

	1869/70-1889/90		*1889/90-1909/1910*	
	U.S.	Canada	U.S.	Canada
Q*-L*	0.0280	0.0193	0.0374	0.0196
K* - L*	0.0101	0.0295	0.0102	0.0001
C* - L*	0.0280	0.0193	0.0374	0.0196
Sk	0.1631	0.2485	0.1869	0.2442
Sc	0.6038	0.5444	0.5843	0.5333
A*	0.0094	0.0015	0.0136	0.0269

Source: See text

Table 3: Relative Productivity in the Canadian and U.S. Cotton Industries

	1869/70	*1889/90*	*1909/10*
(Canada-U.S)/U.S.			
Q*-L*	-0.0576	-0.2042	-0.0256
K* - L*	-0.3741	-0.0824	-0.1637
C* - L*	-0.0576	-0.2042	-0.0256
Sk	0.1971	0.2145	0.2166
Sc	0.6102	0.5380	0.5795
A*	0.0508	-0.0766	0.0247

Source: See text