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INFANT INDUSTRY PROTECTION AND THE GROWTH OF CANADA'S COTTON MILLS: A TEST OF THE CHANG HYPOTHESIS

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INFANT INDUSTRY PROTECTION AND THE GROWTH OF CANADA'S COTTON MILLS: A TEST OF THE CHANG HYPOTHESIS

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Abstract: I argue that the 19th century Canadian cotton textile industry was an extremely successful infant industry. Judging the industry's performance by seven widely-employed measures of success – growth in output, contemporary opinion, size, the use of the most modern machinery, exports, and relative total factor productivity – it is shown that the growth of Canada's cotton mills provides strong support for Chang's provocative hypothesis that infant industry protection was the way the rich countries of today grew rich in the nineteenth century.

Key words: Infant Industry Protection, Total Factor Productivity, Cotton Textiles.
JEL classification: D24, L67, N60, N61, 014

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[I]nfant industry protection … has been the key to the development of most nations … Preventing the developing countries from adopting these policies constitutes a serious constraint on their capacity to generate economic development. - Ha-Joon Chang, *Kicking Away the Ladder: Development Strategy in Historical Perspective*. 2002.

Chang's book is provocative and interesting, but falls short of persuading. Perhaps the biggest disappointment is Chang's extremely superficial treatment of the historical experience of the now developed countries. – Douglas Irwin. *Review of Kicking Away the Ladder*. EH.NET (April) 2004)

CANADIAN COTTON TEXTILES AND THE CHANG HYPOTHESIS

At first glance, the growth of Canada's cotton mills in the nineteenth century would appear to provide little if any support for Ha-Joon Chang's (2002) "provocative" hypothesis as Douglas Irwin (2004) has called it that infant industry protection is the way the West grew rich. After all, the traditional view (Report on Textiles 1938, Bliss 1987, McCullough 1991, and Pomfret 1992) is that Canada's cotton mills grew largely because of the National Policy Tariff of 1879, and the cotton mills never outgrew their need for protection, remaining instead high-cost and

inefficient. Little hard evidence, however, has been presented to back up this claim, inefficiency being largely inferred from the fact that the cotton mills were protected. The presence or absence of tariffs tells us very little about the efficiency of an industry except in the classic case of a small open economy competitive industry and Canada's cotton mills were most likely monopolistic firms supplying the lion's share of the domestic market by the early 1880s and exporting as well. (Hinton 1985, 1990, 1994b, and 1994c, and Hinton and Barbiero 2012)

In this essay I present new quantitative and qualitative evidence that suggests that far from being an unsuccessful infant industry the Canadian cotton mills are actually a classic case of successful infant industry protection and Chang's hypothesis is supported.

Seven measures of cotton textile's success are examined: (1) the testimony of contemporary opinion, (2) the timing of its first appearance, (3) the speed of its growth, (4) its size, (5) the modernness of its machinery, (6) exports, and (7) the total factor productivity of its mills. But first let us take a closer look at the reasons why historians have been so ready to accept the notion that Canadian cotton textiles was inefficient.

THE ASSUMPTION OF INEFFICIENCY

Canadian manufacturing in the nineteenth century traditionally has 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 protection appears to have made the problem worse.

"[T]ariffs ...," write Professors Norrie, Owram and Emery (2008, p. 227) in Canada's leading economic history text, "created not just a secondary manufacturing sector in Canada but a high cost, inefficient one as well." "[T]he tariff," writes Professor Bliss (1987a, p14) in Canada's leading business history "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. Over the last ten-odd years, however, a brave band of revisionist economists and economic historians writing in the cliometric tradition (Wylie 1989; Keay 2000; Keay and Inwood 2005; Baldwin and Green 2008, Hinton and Barbiero 2012) have argued that historians 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 in the 1950s and 1960s. Two of the most influential of these studies are John 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 labour-productivity performance of British manufacturing confirming the traditional view that Canadian manufacturing was on average 12 to 20 percent less productive than British and 60 percent less than American in the four census years 1870, 1880, 1890, and 1900. But this evidence is not as damning 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.

Indeed, the initial findings of these newer studies based on measures of TFP suggest the traditional view is mistaken. For example, Inwood and Keay (2005, p. 1328-32) measuring 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 find "only a small T.F.P. advantage enjoyed by the average U.S. manufacturer." Keay (2000, p. 1049-1051) finds 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 : "there is virtually no evidence of consistent and substantial relative technical inefficiency

on behalf of the Canadian manufacturers." And, Baldwin and Green (2008) find 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 these newer findings intriguing though they are still leave many questions unanswered: How did the old-school economists and economic historians get Canadian manufacturing so wrong? How well do these findings apply to the critical years after 1870 and before 1913, the years in which the problem allegedly began? What can we say more directly about productivity in particular industries within the manufacturing sector?

LESSONS FROM THE COTTON MILLS

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 mills let us see what can be learned by looking at these other indicators.

WHAT CONTEMPORARIES SAY

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). "I believe," said George Parkin (1895), "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), "can successfully compete in the outside world with England and the United states without any protection."

Finally, consider this story which dates to the turn of the twentieth century. Like most jokes from another age this one is not likely to be a knee-slapper for the modern reader, but we can learn quite a bit about contemporaries' assumptions about and attitudes towards the Canadian cotton mills and their managers as they were over a century ago. The anecdote is to be found in T.M. Young's *The American Cotton Industry* written in 1902, about "which," he says, "although true as stories go, has in this connection some of the significance of a parable."

> The story is this: A Canadian manager, visiting an American mill, was taken by the superintendent to see a certain machine at work, and inquired what weekly production was obtained from it. The American, with a fine air of candour, named a quantity which, although it seemed sufficiently precise to be accurate, the Canadian knew from his own experience to be an exaggeration. But he did not betray the slightest surprise. 'Ah,' said he, 'I thought it would be that, or perhaps a shade more.' We have the same machine at our place, and we get off' – here he named a figure slightly in excess of the American's. There the matter dropped. But in the evening the departmental manager of the mill came to meet the Canadian at his hotel, and said.
>
> 'Look here, what have you been telling our boss about that new machine? He has been complaining to me that we are not getting nearly enough work out of it.'

> 'I think,' said the Canadian, 'that you had better ask your boss what he has been telling me.'
>
> Visitors to America are seldom heard to complain, like the Queen of Sheba, that the half has not been told them. Some Americans, as a friend of mine put it, have a way of telling rather more than the half. (Young 1902, p. 110-111)

At least three features of this story are worth underlining. First it is the American who is the butt of the joke, which is not surprising given Young was a British journalist who had travelled to America to investigate the economic basis for the American "invasion" of British markets. Second, the Canadian is the trickster, which to modern readers may be somewhat surprising and for the joke to work also somewhat surprising for contemporaries. Third, and this is the pay off for economic and business historians, the story suggests all cotton industries in the developed world probably had about the same level of capital or machinery productivity. Which is not what Canadian historians such as Bliss and Naylor tell us, but when you think about it makes more sense. A machine is what it is in Montreal, Fall River, or Manchester. The idea that Canadians used outdated machinery and were poor managers is hard to swallow particularly since Canadians had easy access to British and American machinery export markets and many the managers of Canadian mills were brought in from Britain and the United States.

Opinion however expert and however interesting is a poor substitute for evidence, even if it is free from bias, which is far from certain. (Edgar, for example, was an anti-protectionist politician and as such was willing to believe the cotton industry could do without tariff protection. And sometimes a story is just a story.) Let us turn now to examine the evidence on the industry's operation directly, unmediated by expert opinion or our own speculations.

THE APPEARANCE OF THE FIRST MILLS

It is not surprising that cotton mills came to 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.

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, Table 1 presents data on the speed of the diffusion of the cotton mill in 20 countries around the world. Canada's first mill appeared in 1844, a lag of 73 years behind the first cotton mill of the First Industrial Revolution, and well-behind the appearance of cotton mills in 14 other countries - among them the United States, 1791, France , 1779, Germany , 1784, and Italy, 1808, but well ahead of Japan

Table 1

The diffusion of cotton mills around the world before 1900

Country	Year first modern spinning mill opens	Total spindles in 1913 [millions]
1. United Kingdom	1771	55.7
2. France	1779	7.4
3. Germany	1784	11.2
4. Spain	1791	2.0
5. United States of America	1791	31.5
6. Russia	1793	9.2
7. Switzerland	1794	1,4
8. India	1818	6.1
9. Austro-Hungary	1796	4,9
10. Belgium	1801	1.5
11. Holland	1801	0.5
12. Italy	1808	4,6
13. Mexico	1823	0.7
14. Sweden	1834	0.5
15. Canada	**1844**	**0.9**
16. Brazil	1845*	0.7
17. Norway	1847	0.1
18. Japan	1866	2.3
19. China	1890	0.8
20. Denmark	1895*	0.8

* Approximately

Source:

Clark (2007) p. 304; *Robson (1957) p. 354-55, a*nd author's survey of secondary literature.

The relatively late appearance of cotton mills in Canada, 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 to the failure of Canadian entrepreneurs to exploit opportunities to make profit by investing in cotton mills.

RAPID GROWTH

Once planted, the cotton textiles grew rapidly in Canada. Measuring growth by imports of raw cotton, a widely used measure of the real value or quantity of production, Canadian cotton textiles grew at an astounding rate of 15.0 percent a year 1870-1890, see Table 2, below, the output of the industry doubling every 5 years. Looking around the world at cotton mills in the 16 other main countries in which modern factory-based cotton mills were to be found, only the Japanese mills smoking at 19 percent grew faster. The Italian mills growing at 10 percent a year came a distant third. The cotton mills of Britain and the United States, the oldest and the largest centers of modern cotton textile production, not surprisingly, trailed far behind at 2 and 5 percent.

Studying the growth of industries in 5 major industrial countries, Kuznets (1930, p.324-325) found that "the simple logistic and the simple Gompertz curves ..., chiefly the logistic, yielded suitable descriptions of the long-time movements in production," and over periods of 30 to 40 years "the tendency of industries to exhibit a declining rate of growth." According to Rostow, (1975, p. 160) the British cotton mills in the Industrial Revolution, grew "explosively" at 9.2 percent a year between 1775 and 1800, less than half of the rate achieved by the Canadian and Japanese industries a century later, "[t]his," he says, " is what a case of increasing returns ... looks like in real life."

In the last quarter of the nineteenth century, 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.

Yet Canadian business and economic historians have had little good to say about the nineteenth-century Canadian cotton mills. Partly, and undeservedly, because Canadian mills, as did almost every other national cotton industry, depended on British and American machinery makers for its machinery. Partly, and perhaps more deservedly, because of their reputation as harsh, monopolistic, and exploitive employers of labour. And partly, and probably most importantly as far as historians are concerned, because it is believed that the industry grew largely, some say wholly, because of the National Policy tariff of 1879, or as Victorian Canadians called it the NP; the deep-rooted idea that the NP was indispensable to the rapid growth of the cotton mills. (See Hinton and Barbiero 2012)

Table 2

Growth of Raw Cotton Imports or Consumption of the World's Cotton Mills (% per year)

Country	1870-1890	1890-1910	1870-1910
United Kingdom	2.2	1.0	1.0
United States of America	5.2	4.6	3.9
Germany	3.8	3.6	3.7
Russia	6.0	3.6	4.8
France	1.2	3.9	2.6
India	10.0*	3.5*	6.4*
Austro-Hungary	4.3	3.3	3.8
Italy	10.1	3.4	6.7
Japan	19.2*	12.8	14.5
Spain	4.6	1.6	3.0
Belgium	3.5	4.0	3.7
Switzerland	-1.8	-0.4	-1.1
Canada	**15.0**	**4.2**	**9.5**
Portugal	8.2	3.8	5.8
Netherlands	4.5	4.3	4.4
Finland	5.5	2.9	4.1

* Spindle growth

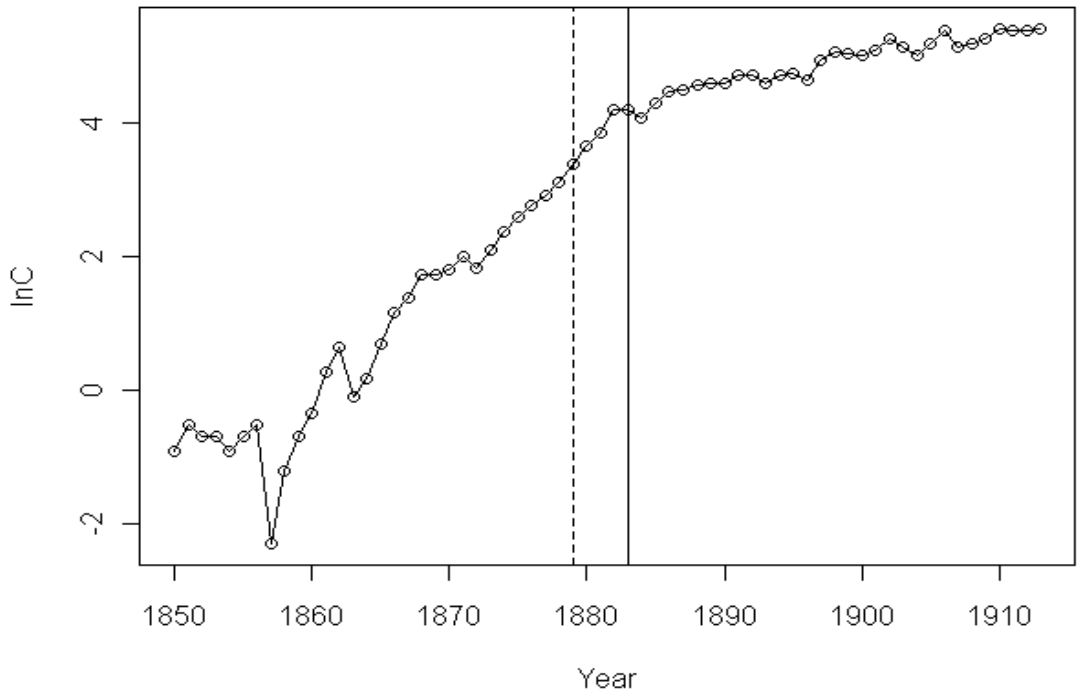
Source: U.S. Bureau of the Census (1976), series P228; European data, Mitchell (1975) Tables E14 and E15; India, Mitchell (1982) Table E 19; Japan Koh (1966) Appendix Table 1.

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. As far as I am aware only one other student of the industry besides myself, Kieran Furlong (1997) disputes the importance of the tariff. Furlong argues that the business cycle is the dominant force driving the industry's growth. His work however is a curious mix of institutionalism and political economy. The fundamental flaw in his argument is that he does not test the importance of the business relative to other causal factors as for example Hinton and Barbiero (2012) and fails to see that the industry's growth did not accelerate after 1879, as one would expect given the literature's position, rather it grew extremely rapidly 1850-1883 and then decelerated sharply and grew at a much more moderate rate 1883-1913. This is a pattern that it is difficult to see how the business cycle would determine.

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.

But it seems likely that the industry's historians are not correct. Consider Figure 1 showing the rate of growth of the industry between 1850 and 1913. In this figure the slope of the line indicates the industry's annual rate of growth. The dotted line marks the year 1879, which the literature claims to be a decisive turning point in the growth of the cotton mills. In Conan Doyle's Sherlock Holmes story "Silver Blaze" the curious event of the dog in the night is that it did not bark; and the curious movement of the curve of growth in 1879 is that it does not move, proceeding along at well established and rapid rate of 15 to 19 per cent a year (Hinton and Barbiero 2011). When did the curve of growth first move upward decisively? The figure suggests it was sometime in the late 1850s, some thirty years before the coming of the National Policy tariff. And also at about the same time as the introduction of the "incidentally" protective Galt Tariff of 1859 in what is now Ontario and Quebec, which increased protection to the cotton mills on the conversion of raw cotton into cotton cloth from 20 to 25 per cent to between 40 and 68 per cent. The solid line marks the year 1883 and here as we would expect given the onset of a major recession (1883-1889) in cotton textiles in Canada the United States and Britain the curve bends downward, indicating negative growth. While the results are preliminary, a working paper will soon appear in the Rimini Centre for Economic Analysis 2011 working paper series, "Montreal, the Cotton Mills, Trade, Tariffs, and Total Factor Productivity, 1850-1883," that finds productivity growth explains most of the extremely rapid rate of growth of output in the industry. But this finding tells us only that the cotton mills made great strides forward it tells us nothing about how efficient it actually was. For that we need to measure its productivity relative to some other national industry. This I do in the section below: Measuring Productivity.

Figure 1
The Growth of Canada's Cotton Mills, 1850-1913
(Log of Imports of Raw Cotton into what is now Canada)



LARGE 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, which is 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). This elasticity can be written as:

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

where E_w is the elasticity of world demand, s is the Canadian industries share of the world market, and E_s is the elasticity of supply by the world's other cotton industries. Assuming not unreasonably that E_w is equal to -1 and E_s to 1, and setting s equal to 0.006, then E_c 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.

MODERN MACHINERY

The extent to which an industry uses the most modern machinery is often used as an index of an industry's efficiency. As was the case with most other national cotton industries 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 3), the Canadian industry, although behind the American industry, was on the leading edge in terms of mechanization and the shift to rings.

Canada performs creditably in this race, 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.

Table 3

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

EXPORTS

The fact that an industry exports is often looked on by economists as a sign that the industry is efficient, but this is not always the case. As Hinton and Barbiero (2012) explain, exports present an interesting puzzle.[1] Canada was routinely exporting small amounts of cotton goods, typically to the United States, from the 1850s onwards, but there is little doubt this was largely a convenience trade in excess cotton waste, produced as a byproduct of the production of yarn by domestic cotton mills. And, as such, represents neither evidence that Canadian cotton mills had a comparative advantage in cotton textiles or that they were monopolists, routinely dumping product abroad to keep prices up in the domestic market. Looking at the long-term trend cotton exports rose on average from less than $5,000 a year in the 1850s and 1860s to under $10,000 a year in the 1870s and then for the first time over $20,000 in 1884/85 and then pushing dramatically up to over $100,000 a year in 1887/88. Most of these exports were now cloth and yarn, only $30,000 of which were cotton waste. At its height in 1905/1906 the export trade in

Canadian cottons reached to over $1,300,000. Was this trade simply the "sporadic" dumping of excess production, as Bliss claims, or was there something more systematic going on? At this point we cannot say. But this seems to be a more complex problem than anyone has been willing to admit. In the late 1880s in keeping with Bliss's claims 87 percent of the cotton mills exports went to the United States. But by the early 1900s when the trade was reaching its peak, less than 15 percent of exports were sent to the United States. Just over 20 per cent went to Latin America and Northern Europe, but the majority, 55 per cent, went to China, Australia, New Zealand and elsewhere in Asia. This may have been dumping but it is also likely to be evidence that Canadian mills were far more productive than the current literature assumes. The export trade in cottons did fall off sharply after 1905/06. By 1912/13 it had fallen to $124,551, which was down substantially from its peak of $1,331,712 in 1905/06, and under the exports of 1889/90 when $155,777 was exported. According to the literature this sharp decline in exports was due to the negative shock of the Boxer Rebellion. It is more likely however that exports fell off for a less dramatic reason: with the rapid growth in Canadian GNP of the Wheat Boom years of 6 per cent a year Canadian demand grew rapidly absorbing most of the output of the Canadian mills.

HOW PRODUCTIVE?

In the absence of better measures economic historians typically measure productivity by labour-productivity, total output divided by total labour input, but total factor productivity (TFP), the rate cotton mills can transform all inputs - raw cotton, labour, and capital - into cotton goods such as yarn and cloth 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. Together with the

British industry the Unites States 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 United States' 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 American 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. I 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. Spindleage 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 4 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 5 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 tables. 4 and 5.

Table 4

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 5

Relative Productivity in the Canadian and U.S. Cotton Industries

	1869/70	*1889/90*	*1909/10*
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

Remarkably, given the literature's harping on the cotton mills failings, 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 (Acheson 1972, Bliss 1974) 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 (Hinton 1986, 1990) 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 failed infant industry, a classic example of what was wrong with Canadian manufacturing – weak, high cost and non-inventive. The evidence presented here, however, says otherwise. In particular the modernity of the cotton mills machinery, the large size and the speed of the cotton mills growth being driven by productivity change, combined with the strong relative productivity performance of the Canadian cotton mills in comparison with the American cotton mills in 1870 and 1910 suggests that the traditional wisdom on the weakness of Canadian manufacturing before WWI is in need of revision. It is unusual for a mainstream neoclassical economist such as myself to admit, but it must be said, Chang may be right. Industries such as cotton textiles granted infant industry protection in the 1850s 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 in the nineteenth century.

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[1] This section is drawn largely from Hinton and Barbiero (2012).