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# 1871 Productivity Differentials and the Decline of the Maritime Manufacturing Sector: A Tale of Two Cities.

**Abstract**

How can we explain contemporary regional differentials in Canadian manufacturing output? To what extent is the poor performance of the Maritimes linked to the initial level of productivity in the region? Previous research has established that Maritime manufacturers were at best equally productive relative to Ontario manufacturing establishments in 1871. This paper delves deeper into this issue by contrasting the differences in productivity between urban and rural areas in the Maritime provinces. When the lens of perspective is shifted from the provincial to the city level, I find that the productivity performance of the Maritime cities exceeds that of its Central Canadian counterparts. To reconcile this finding with the earlier research, I illustrate that the overall depiction of productivity in the Maritime provinces is significantly lowered by the high percentage of technically inefficient rural establishments in the region. The paper concludes that the low levels of productivity in the rural areas of the Maritimes may have been an important contributing factor to the decline of manufacturing output in the region's two urban centres.

The years following Confederation mark the beginning of the industrial era in the Canadian economy. At the onset of this period the Maritime provinces represented an important manufacturing region in Canada. Norrie et al. (2002) note that manufacturing output per capita in New Brunswick rivalled that of Ontario and Québec in 1871. Between 1896 and the beginning of World War I, Canadian Real GNP grew at an impressive rate of 6.48% annually. The Canadian manufacturing sector expanded in step with national output by maintaining its share of roughly 22% of Canadian GDP over this boom period.[1] However growth in Maritime manufacturing output failed to keep pace with the rest of Canada, and the Maritime manufacturing sector fell into a period of decline that persisted throughout the twentieth century. In 1880 the Maritimes accounted for 14% of the goods produced in the Canadian economy; this fell to 9% by 1911, and 5% by 1939.[2] At precisely the point in history when the Canadian economy made the leap to modern economic growth, the Maritime manufacturing sector faltered.

According to endogenous growth theory, initial conditions matter. The structure of an economy, both from industrial and regional perspectives, cannot be fully understood independent of its beginnings. Per capita income in the Maritime region has consistently trailed the rest of Canada throughout the twentieth century and into the present. Undoubtedly the failure to sustain a vibrant manufacturing sector has factored in the region's poor economic performance in the modern era.

This paper examines the total factor productivity (TFP) performance of the Canadian manufacturing sector in 1871, and sheds light on the initial factors that led to the decline of the Maritime manufacturing sector. The paper places special emphasis on the differences in productivity between rural areas and urban centres in the Maritimes, and how these differences may have affected manufacturing growth in the region. In the first part of the paper I calculate estimates of the productivity performance of the manufacturing sector in New Brunswick, Nova Scotia and Québec, relative to Ontario. The next section of the paper uses regression analysis to isolate the initial conditions that

[1] Norrie et al. (2002)
[2] Savoie (2001)

had the greatest effect on productivity performance during this era. The third part of the paper links these initial conditions to data from the 1891 census with the objective of determining the factors that led to the decline of the Maritime manufacturing sector. Four sources of data are used: the Census manuscripts from the 1871 enumeration of Canadian manufacturing establishments; the 1871 Census of Canada; the 1891 Census of Canada, and the 1969 Canada Land Inventory Level I Latitude/Longitude Digital Data.

My paper builds on the literature that has been written on regional productivity and the origins of inequality in Canadian manufacturing output during this era.[3]. This literature has established that the Maritime provinces were at best equally productive, and in several sub-sectors less productive than Ontario in manufacturing. However when the lens of perspective is shifted from the provincial to the city level, my results suggest a different conclusion. In comparing St. John and Halifax with comparable urban centres in Québec and Ontario, I find that the productivity performance of the Maritime cities exceeds that of its Central Canadian counterparts. The Maritime region is found to have a highly disproportionate number of manufacturing establishments located in rural regions as compared with Ontario and Québec. Inwood and Keay (2012) have established that rural firms were less productive than urban firms in the Canadian manufacturing sector in 1871. Building on their findings, I present evidence that illustrates that the overall productivity performance of the Maritime provinces is significantly lowered by the high percentage of technically inefficient rural establishments in the region. Focusing on St. John and Halifax, the evidence reveals that growth manufacturing between 1871 and 1891 was correlated with each cities' initial productivity level, *as well as* the overall productivity level in each of the respective provinces. This suggests that lower productivity in rural areas may have contributed to the slower pace of manufacturing growth in St. John and Halifax during the late nineteenth century. I conclude that the lack of depth in the industrial hinterland of the Maritime region may have been an important factor contributing to the decline of manufacturing output in the region's city centres, as well as the overall collapse of the Maritime manufacturing sector.

Inwood (1991) is one of the earliest empirical studies inter-Provincial differences in the productivity performance of the late nineteenth century Canadian manufacturing sector. Inwood's (1991) motivation is to examine early empirical evidence in order to assess the proposed arguments explaining why the Maritime region failed to keep pace with the process of industrialization that occurred in Central Canada during the late nineteenth and early twentieth century. Inwood (1991) uses the 1871 Census data and a Diewert (1976) superlative index number approach to calculate TFP ratios for Québec, New Brunswick, and Nova Scotia relative to Ontario. His results indicate that in 1870, on average, Ontario based manufacturers were more productive than each of their provincial counterparts. New Brunswick based manufacturers were 12% less productive than Ontario based manufacturers, while Québec manufacturers were 14% less productive. Nova Scotia manufacturers were the least productive with a TFP level 22% below that of Ontario.

The manuscripts from the 1871 enumeration of Canadian manufacturing establishments were rendered into machine readable form by Inwood (1995). Using this data Gerriets and Inwood (1996) re-examine the 1871 inter-provincial productivity differentials between Ontario, Québec, New Brunswick, and Nova Scotia. In order facilitate meaningful comparisons, the authors construct provincial measures of productivity that are specific to firms of comparable size and industrial structure. Capital productivity is found to be lower in Québec and Nova Scotia and higher in New Brunswick, relative to Ontario. Labour productivity is found to be roughly equivalent in Québec and Nova Scotia and lower in New Brunswick, relative to Ontario. Gerriets and Inwood (1996, p.50)

[3]Recent empirical studies of the inter-provincial productivity performance of the manufacturing sector in the late nineteenth century include Inwood (1991), Gerriets and Inwood (1996) and Inwood and Keay (2012).

conclude that "productivity everywhere was roughly comparable to that of Ontario, providing the comparisons are drawn between the same size of enterprise in the same industries".

Inwood and Keay (2012) note that Canadian manufacturing establishments tended to be proto-industrial in that they were smaller and used less inanimate power and capital as compared with US manufacturing firms of the era. Interestingly, the authors find the Canadian firms technological choices were well suited to their environment in that the manufacturing sector was technically efficient despite its the seemingly 'backward' characteristics. While the proto-industrial nature of firms apparently did not constrain growth in Canadian manufacturing, an important factor affecting the productivity of Canadian manufacturing firms was whether they were located in an urban or rural area. In 17 of Canada's 20 largest manufacturing industries productivity was higher in urban sub-districts, with the average urban establishments being 17% more productive than rural firms.

Inwood and Keay's paper uses manuscript data from the 1871 enumeration of Canadian manufacturing establishments. The authors have provided me with access to the cleaned[4] manuscript data. The sample that I use is censored to include only the 20 Canadian manufacturing industries having the greatest number of establishments in 1871. In total, the sample that I begin with includes observations on 27,111 establishments. Henceforth in the paper I will refer to this sample of 27,111 observations as the 'complete sample'. Inwood (1995) notes that after the reconstitution of multi-process establishments, the total number of establishments listed in the 1871 manuscripts is 40,761. Thus the 27,111 establishments in the complete sample represents approximately two thirds of the total number of manufacturing establishments in Inwood's (1995) reconstituted version of the 1871 manuscripts.

Inwood (1995) notes that the 1871 enumerators were instructed to enumerate a broad spectrum of establishments ranging from small farm-based operations to large factories. Clearly there are fundamental differences between these two extremes that requires, for the purposes of my study, a narrowing of the definition of what it meant to be a Canadian manufacturing establishment in 1871. In this paper my objective is to identify the initial conditions that led to the emergence of regional differentials in the Canadian manufacturing sector. To achieve this objective, my aim is to isolate the sample of establishments that had the greatest potential for growth in the late nineteenth century. As previously noted, Inwood and Keay's (2012) paper finds a large productivity differential between urban and rural Canadian manufacturers during this era. More generally, the research of Robert Allen has established links between the process of urbanization and early industrialization.[5] It is therefore logical to focus my analysis on the sub-set of urban manufacturing establishments in 1871. Specifically I use a population density threshold to eliminate from my sample all those establishments residing in sub-districts having a population density less than or equal to 1000 persons per square mile. This threshold greatly reduces my sample size to 3,849 establishments. A further reduction of my sample occurs as a result of dropping missing observations for required variables, leaving a total of 3557 manufacturing establishments available for use in my analysis. The differences between urban, rural, and provincial productivity is a central theme in this paper. While the central focus of my analysis concerns manufacturing productivity and growth in the urban centres, I also explore these issues in a rural context and at the provincial level. To do, I periodically re-visit the complete sample to calculate estimates that contrast the difference between urban, rural and provincial productivity.

Geographically, the 3,557 establishments in my sample reside in 72 different Census districts, 147 different sub-districts, and 82 different municipalities. Regional maps of the 82 municipalities are provided in Figures 1-3. The maps use graduated dots to distinguish municipalities that have many

[4]For a details describing the data exclusions and preparation procedures for the sample see Inwood and Keay (2008, pp.89-91).

[5]See for example Allen (2003).

manufacturing establishments from those municipalities with few. Those municipalities having greater than 70 manufacturing establishments are labeled by name. The sub-district population density threshold results in a sample of 52 Ontario municipalities, 28 Québec municipalities, and only 2 Maritime municipalities (Saint John and Halifax). The median sub-district population density for the sample is 3359 people per square mile, and 91.73% of the establishments resided in sub-districts having a population greater than 1000 inhabitants. Thus my sample can be accurately characterized to feature predominantly urban-based manufacturing establishments.

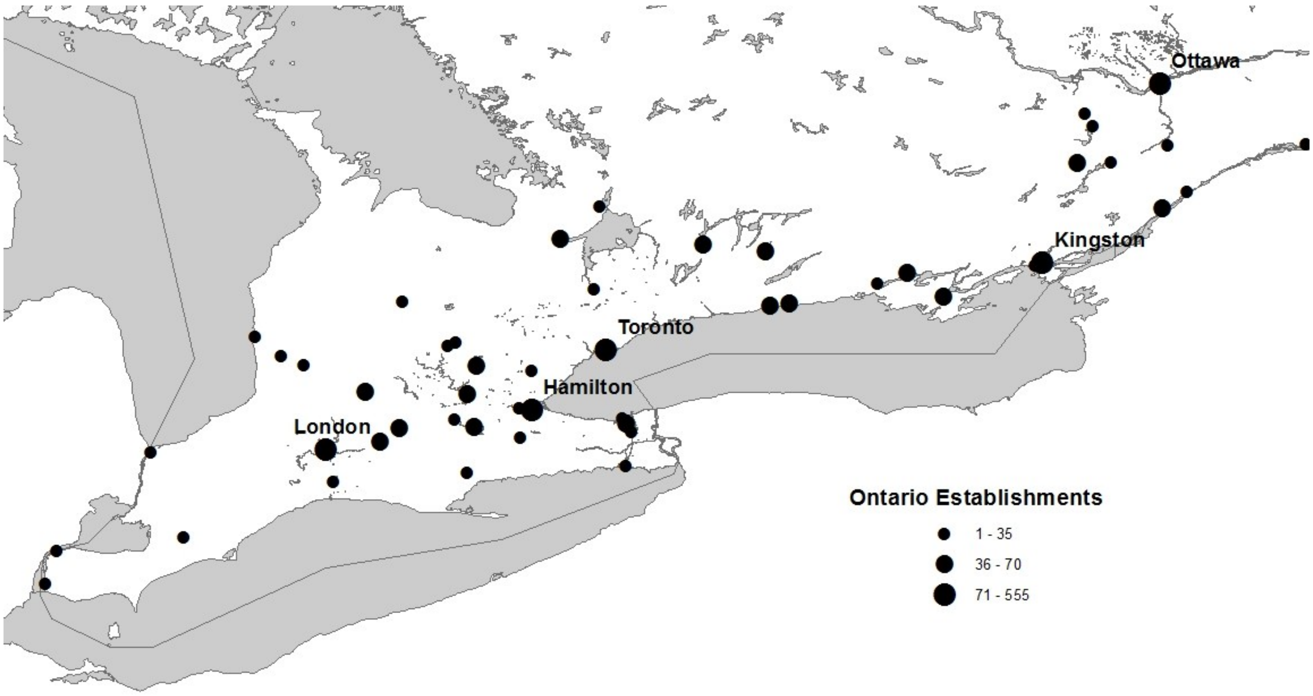


Figure 1: Manufacturing Establishments by Municipality - Ontario

Inwood (1991) has commented on the fact that the percentage of the population living in rural areas was much larger for the Maritimes as compared with Ontario and Québec. He notes that in 1851 only 8% of the population of the Maritimes lived in census districts with a population density exceeding 25 people per square mile, as compared with 53% in Québec and 75% in Ontario. This trend was prevalent throughout the nineteenth century with only 20% of Martimers living in urban areas in 1891, against 29% in Québec and 35% in Ontario. The proportion of manufacturing establishments residing in rural areas was also *much* higher in the Maritimes as compared with Ontario and Québec. *In 1871, the percentage of industrial establishment residing in sub-districts with population densities less than 25 persons per square mile was 6% in Ontario, 19% in Québec, 62% in New Brunswick and 48% in Nova Scotia.*[6]

For my measure of productivity, I use the Tornqvist approach to calculate establishment specific TFP. TFP is defined as the portion of output that is unexplained by the quantity of inputs used in production.[7] A common, albeit narrow, interpretation is to associate TFP with the level of physical technology that is employed by a firm. Inwood and Keay (2008) note that a more complete

[6]Calculated from the complete sample.
[7]Comin (2008)

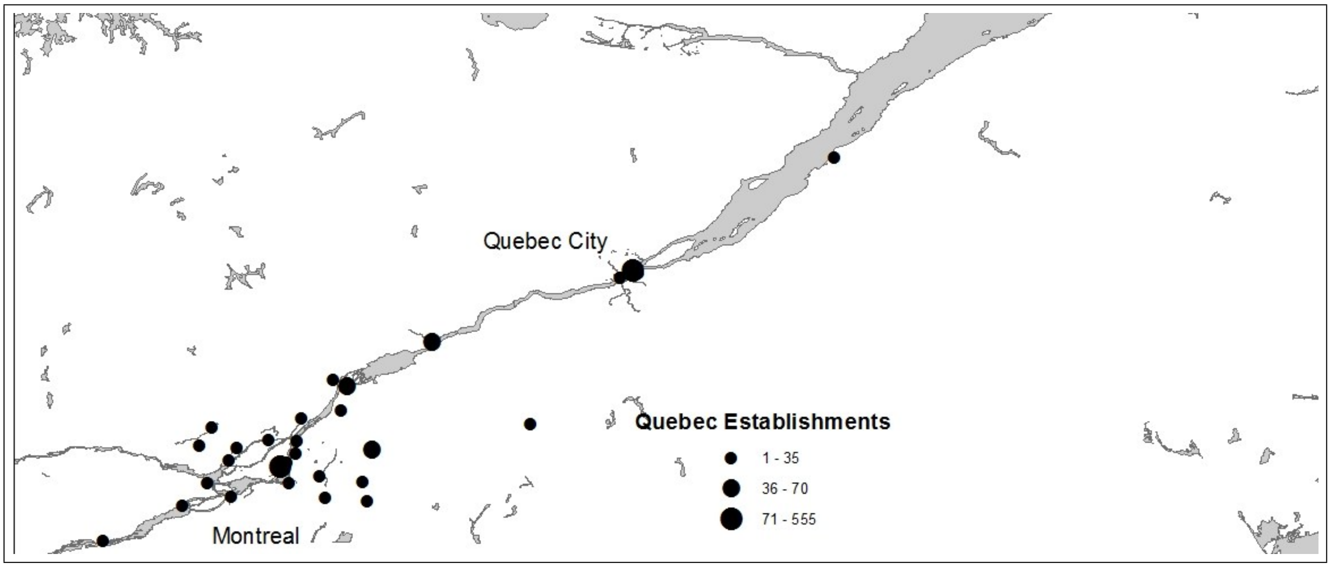

Figure 2: Manufacturing Establishments by Municipality - Québec

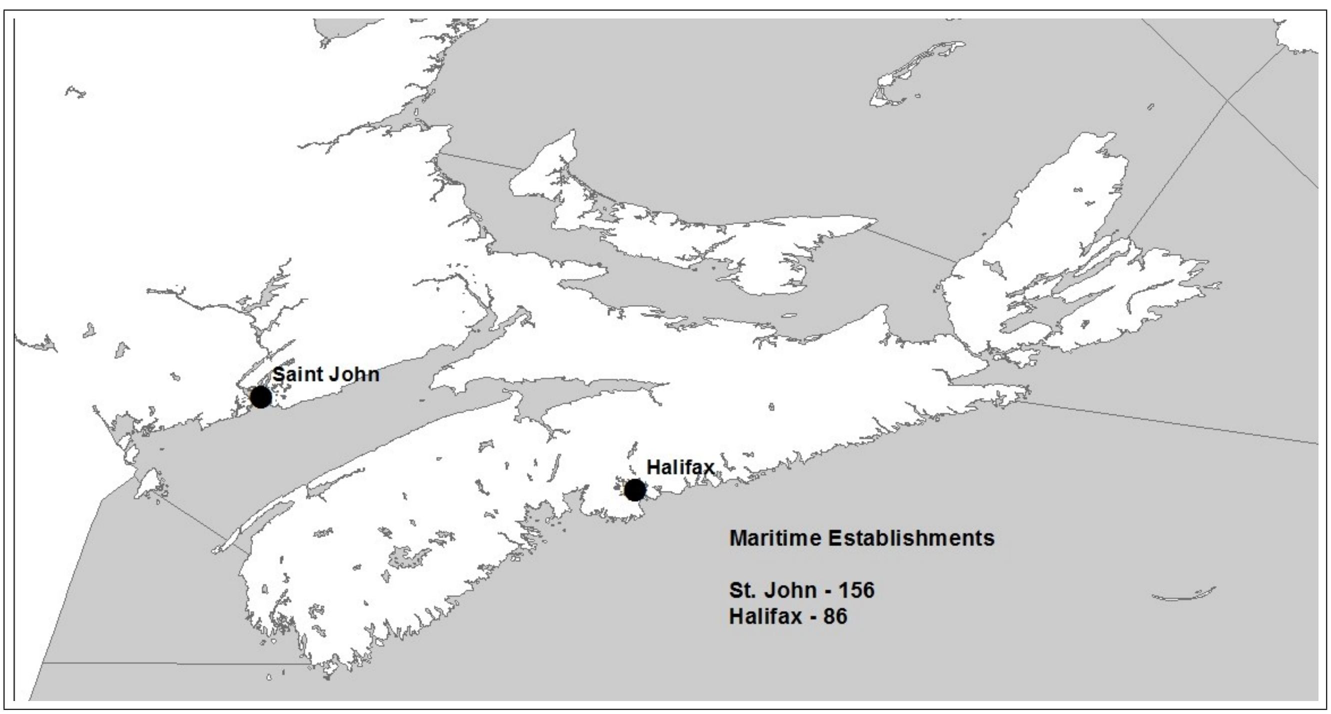

Figure 3: Manufacturing Establishments by Municipality - Maritimes

interpretation of TFP includes the contribution of factors such as internal and external scale effects, input quality, and firm and market structure. TFP is commonly used as a proxy for international competitiveness, technical efficiency and profitability, since it measures proficiency in converting inputs into outputs. [8].

There exists a wide range of methodological techniques for calculating TFP growth rates and levels. I use a Tornqvist index number approach to calculate establishment specific TFP relative to a sector specific national average TFP level. There are two reasons that I have chosen to use the Tornqvist approach over other TFP measurement techniques. From a theoretical perspective the Tornqvist approach requires that the sector specific production functions are of the translog form. An attribute of the translog production function is its flexibility. Commonly referenced production functions such as constant elasticity of substitution (CES) and Cobb-Douglas are simply special cases of the translog production function. [9]. A second advantage of the Tornqvist approach is that all of the data required to perform the TFP calculation is available in the 1871 Census manuscripts.

Table 1: Number of Observations by Sector and Province

| | **New Brunswick** | **Nova Scotia** | **Quebec** | **Ontario** | **Total** |
|---|---|---|---|---|---|
| **Food** | **20** | **12** | **160** | **220** | **412** |
| Bakeries | 19 | 12 | 155 | 180 | 366 |
| Flour Mills | 1 | 0 | 5 | 40 | 46 |
| **Clothing** | **66** | **30** | **618** | **811** | **1525** |
| Shoes | 33 | 15 | 238 | 282 | 568 |
| Harnesses | 3 | 3 | 62 | 122 | 190 |
| Tailors | 26 | 11 | 247 | 319 | 603 |
| Tanneries | 4 | 1 | 61 | 55 | 121 |
| Weavers | 0 | 0 | 10 | 33 | 43 |
| **Mineral** | **31** | **20** | **260** | **442** | **753** |
| Blacksmithing | 10 | 12 | 142 | 176 | 340 |
| Foundries | 8 | 2 | 40 | 118 | 168 |
| Furnaces | 8 | 2 | 76 | 133 | 219 |
| Lime Kilns | 0 | 0 | 2 | 15 | 17 |
| **Wood** | **39** | **24** | **309** | **495** | **867** |
| Boat Building | 12 | 2 | 15 | 0 | 29 |
| Carpenters | 0 | 0 | 62 | 31 | 93 |
| Carriages | 9 | 5 | 97 | 192 | 303 |
| Cabinets | 7 | 10 | 65 | 110 | 192 |
| Cooperage | 6 | 6 | 27 | 69 | 108 |
| Doors | 0 | 0 | 25 | 40 | 65 |
| Saw Mills | 2 | 0 | 10 | 27 | 39 |
| Shingle | 3 | 1 | 8 | 26 | 38 |
| **Total** | **156** | **86** | **1347** | **1968** | **3557** |

The TFP level of each of the 3,557 establishments in my sample is calculated from the Census manuscript data. Each firm's TFP level is measured relative to the national average TFP level for the establishment's sub-sector of manufacturing. I have grouped 19 of the 20 industries in the

[8]Inwood and Keay (2008)

[9]Diewert (1976)

sample into 4 manufacturing sub-sectors: food, clothing, mineral, and wood.[10] The number of observations by industry, sector and province are listed in Table 1. Grouping industries into sectors is not entirely desirable from the standpoint of the TFP calculation. By doing so I am implicitly assuming that all industries within a sector employed the same production technology, and also that the Census manuscript values for inputs and outputs that are comparable across industries within a sector. As an alternative, I could have made the TFP calculations industry specific, however this would have resulted in extremely small samples for calculating mean industry TFP levels in the Maritime Provinces (see industry totals by province in Table 1). Since my paper involves a comparative analysis of regional productivity levels it is desirable to have as large a sample as possible from each province. Therefore, I use sector specific TFP calculations, recognizing the shortcomings of grouping industries into sub-sectors.

The Tornqvist TFP calculation takes the following form:

$$TFP_{ij} = A_{ij}/A_{\bar{j}} = \left[\frac{Q_{ij}/L_{ij}}{(Q/L)_{\bar{j}}}\right]^{0.5(SL_{ij}+SL_{\bar{j}})} \left[\frac{Q_{ij}/K_{ij}}{(Q/K)_{\bar{j}}}\right]^{0.5(SK_{ij}+SK_{\bar{j}})} \left[\frac{Q_{ij}/M_{ij}}{(Q/M)_{\bar{j}}}\right]^{0.5(SM_{ij}+SM_{\bar{j}})} \quad (1)$$

Where:
$A_{ij}/A_{\bar{j}} \equiv$ Establishment $i$'s TFP level relative to the national average TFP level in sector $j$
$Q_{ij}/X_{ij} \equiv$ Partial factor productivity of input $X$ for establishment $i$
$(Q/X)_{\bar{j}} \equiv$ Sector $j$'s national average partial factor productivity for input $X$
$SX_{ij} \equiv$ Input elasticity of input $X$ for establishment $i$
$SX_{\bar{j}} \equiv$ Sector $j$'s national average input elasticity for input $X$

In specifying the variables for my TFP calculation, I followed the preferred method that was proposed by Inwood and Keay (2008) for working with the 1871 Census manuscript data. Specifically, I use the following variable specifications:

- $Q \equiv$ Gross value of production deflated by a district and industry specific product unit value index.[11]
- $L \equiv$ Male equivalent months in operation.[12]
- $K \equiv$ Value of fixed capital employed.
- $M \equiv$ Value of intermediate inputs employed deflated by a district and industry specific raw material unit value index.
- $SL \equiv$ Total wage bill divided by total reconstructed cost.[13]
- $SK \equiv$ Value of fixed capital employed divided by total reconstructed cost.
- $SM \equiv$ Value of intermediate inputs employed divided by total reconstructed cost.

Having calculated the TFP level for each establishment in my sample, I next calculate the average TFP level in each province for each sector, which I will denote $TFP_{\bar{prov}}$. Table 2 presents the

[10]The 20th industry (asheries) belonged to a 5th sub-sector (chemical) that had no establishments in either St. John or Halifax. Therefore all establishments from this industry are excluded from the analysis.

[11]The product unit value index and raw material unit value index were sourced from Inwood and Keay (2008).

[12]Male equivalent months in operation are calculated as the number of months a firm operated multiplied by the sum of weighted male, female and child labour. Following Inwood and Keay (2008) I use the weights: 1 for male labour, 0.75 for female labour, and 0.5 for child labour.

[13]Total reconstructed cost is equal to the sum of 30% of the value of fixed capital employed, the total wage bill, and the value of intermediate inputs employed.

ratio of the average TFP level in each province relative to that of Ontario for each sector. The TFP ratios are presented for a range of population density thresholds ranging from zero (the complete sample), to 2500 persons per square mile. The values for my preferred threshold ($\frac{persons}{mile^2} > 1000$) are in bold. Recall that at the preferred threshold the only two Maritime establishments in my sample are St. John and Halifax.

Analyzing the results in Table 2 at the preferred population density threshold, the evidence suggests that productivity levels in the Maritime cities was greater than in the urban centres of Ontario. Relative to Ontario, the mean TFP levels in St. John are higher in the food, mineral, and wood sectors, and lower in the clothing sector. For each sector a difference-in-means test was conducted to determine if the mean level of TFP in St. John is statistically different from that of Ontario. At the 5% level of significance, the difference was found to be statistically significant for the food and mineral sectors.[14] Thus, the average TFP level was significantly higher in St. John in two of the four sectors (50% higher for food, and 38% higher for mineral), and not statistically different from Ontario in the remaining two sectors.

Continuing the analysis of Table 2 at the preferred population density threshold, the mean TFP levels in Halifax are higher in the food, clothing and mineral sectors, and lower in the wood sector. A difference-in-means test was conducted for each sector to determine if the mean level of TFP in Halifax is statistically different than the mean level of TFP in Ontario. At the 5% level of significance, the difference was found to be statistically significant for the food and clothing sectors.[15] As in St. John, the mean TFP level was significantly higher in Halifax in two of four sectors (88% for food and 26% for clothing), and not statistically different from Ontario in the remaining two sectors.

Finally for Québec, the mean TFP level is lower in food, and marginally higher in the remaining three sectors. The difference-in-means tests indicate that food is the only sector where the mean level of TFP in Québec is statistically different from Ontario at the 5% level.[16]

At the preferred threshold, the conclusions drawn from Table 2 differ from Inwood (1991) Gerriets and Inwood (1996) in that productivity in the Maritimes is found to be higher than Ontario. Of course, in comparing my results with these early works it is important to note the differences in the methodology used in each respective study. In particular, Table 2 illustrates that the population density threshold has important consequences for the comparison of productivity in the different regions. Importantly, when the threshold is set to 0, the TFP ratios for Nova Scotia are lower in all four sectors as compared with the preferred threshold. While in New Brunswick, the TFP ratios are lower in 3 out of 4 sectors (with the clothing sector being the exception).

I offer two explanations as to why lowering the population density threshold forces down the TFP ratios for New Brunswick and Nova Scotia. I have already noted that in the 1871 manuscripts the proportion of manufacturing establishments residing in rural areas is *much* higher in the Maritimes as compared with Ontario and Québec. This fact, combined with Inwood and Keay's (2012) finding that Canadian rural manufacturing firms were less productive than urban firms, provides an explanation as to why the productivity performance of the Maritime region falls relative to Ontario when the population density threshold is dropped. However, there is a second explanation that must also be considered. In addition to there being a greater proportion of rural establishments in the Maritimes, it may have been the case that these establishments were also less productive rela-

[14] For the food, clothing, mineral, and wood sectors, the respective p-values for the tests are: 0.0000, 0.0816, 0.0118, and 0.1922 (the p-values here and elsewhere in the paper are rounded to 4 decimal places).

[15] For the food, clothing, mineral, and wood sectors, the respective p-values for the tests are: 0.0002, 0.0142, 0.0559, and 0.4482.

[16] For the food, clothing, mineral, and wood sectors, the respective p-values for the tests are: 0.0000, 0.1942, 0.4407, and 0.7734.

Table 2: TFP Ratios Varied by Population Density Threshold

| **New Brunswick** | | $TFP_{\bar{NB}}/TFP_{\bar{ON}}$ | | | |
|---|---|---|---|---|---|
| **Threshold ($\frac{persons}{mile^2}$ >)** | **Observations** | **Food** | **Clothing** | **Mineral** | **Wood** |
| 0 | 2069 | 0.9570 | 1.0096 | 1.2239 | 0.7489 |
| 10 | 1439 | 1.0616 | 1.0798 | 1.2523 | 0.7451 |
| 25 | 783 | 1.3689 | 1.0050 | 1.4424 | 0.8152 |
| 50 | 429 | 1.5301 | 1.0237 | 1.8514 | 0.8850 |
| 100 | 266 | 1.5122 | 0.9741 | 1.7109 | 0.9148 |
| 500 | 156 | 1.5109 | 0.9064 | 1.3511 | 1.0823 |
| **1000** | **156** | **1.4985** | **0.9082** | **1.3884** | **1.1682** |
| 2500 | 145 | 1.4936 | 0.9323 | 1.4085 | 1.3291 |
| **Nova Scotia** | | $TFP_{\bar{NS}}/TFP_{\bar{ON}}$ | | | |
| **Threshold ($\frac{persons}{mile^2}$ >)** | **Observations** | **Food** | **Clothing** | **Mineral** | **Wood** |
| 0 | 2691 | 0.8256 | 1.0259 | 1.1198 | 0.7885 |
| 10 | 2389 | 0.9031 | 1.0262 | 1.1375 | 0.7726 |
| 25 | 1395 | 1.0834 | 1.0620 | 1.2446 | 0.7987 |
| 50 | 449 | 1.5786 | 1.0768 | 1.6506 | 0.8558 |
| 100 | 260 | 1.5894 | 1.0831 | 1.4338 | 0.7871 |
| 500 | 86 | 1.8953 | 1.2626 | 1.1819 | 0.8684 |
| **1000** | **86** | **1.8760** | **1.2642** | **1.2133** | **0.9370** |
| 2500 | 85 | 1.8195 | 1.2499 | 1.2440 | 1.1130 |
| **Quebec** | | $TFP_{\bar{QC}}/TFP_{\bar{ON}}$ | | | |
| **Threshold ($\frac{persons}{mile^2}$ >)** | **Observations** | **Food** | **Clothing** | **Mineral** | **Wood** |
| 0 | 7990 | 0.7242 | 1.0304 | 0.9149 | 1.0768 |
| 10 | 7513 | 0.7230 | 1.0324 | 0.9151 | 1.0913 |
| 25 | 6483 | 0.7247 | 1.0436 | 0.9236 | 1.1500 |
| 50 | 4564 | 0.6870 | 1.0610 | 0.9702 | 1.1243 |
| 100 | 2299 | 0.6610 | 1.0455 | 0.9716 | 0.9640 |
| 500 | 1543 | 0.6778 | 1.0549 | 0.9955 | 0.9219 |
| **1000** | **1347** | **0.6374** | **1.0324** | **1.0332** | **1.0249** |
| 2500 | 1004 | 0.6683 | 1.0277 | 1.0494 | 0.9621 |

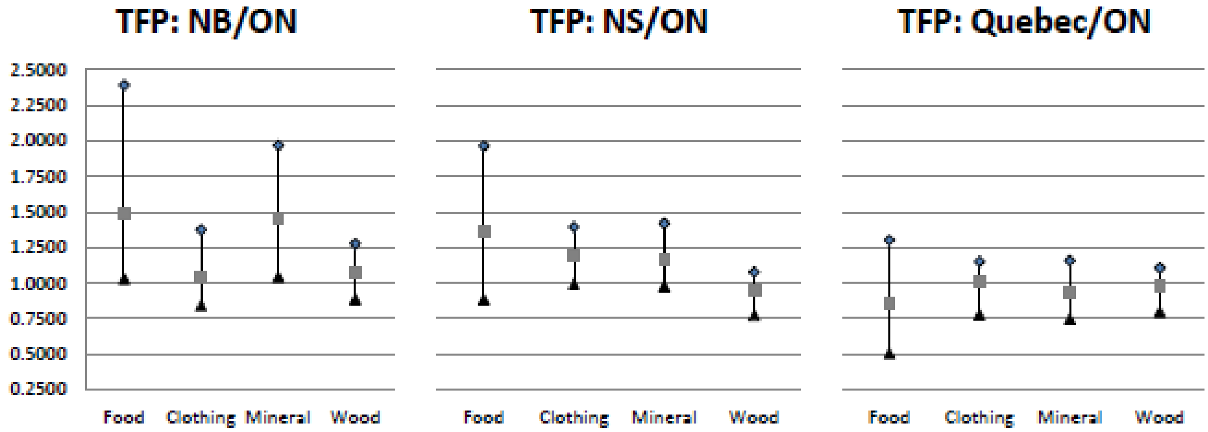


Figure 4: Sensitivity of TFP Ratios. Population Density Threshold: $\frac{persons}{mile^2} > 1000$

tive to rural manufacturing establishments in Ontario. To investigate this possibility I calculated another set of TFP ratios for rural manufacturing establishments, using the population density threshold $\frac{persons}{mile^2} < 1000$ to define the rural establishments.[17] Overall, my results indicate that rural manufacturers in the Maritimes were *less* productive when compared to rural establishments in Ontario. In both New Brunswick and Nova Scotia the average TFP level in the food and wood sectors are found to be lower than Ontario, and the differences are statistically significant at the 1% level. In both provinces the mean TFP level in the mineral sector is found to be higher than in Ontario, and the difference is statistically significant at the 5% level. Finally, in the clothing sector there is no statistically significant difference between the average level of TFP in Ontario in and New Brunswick and Nova Scotia.

To summarize my findings, in 1871 the level of manufacturing productivity in St. John and Halifax is found to be higher than comparable urban centres of Ontario. However, when one shifts perspective to the level of the province, the depiction of productivity in the Maritime region is significantly worsened. Lowering the population density threshold results in a drop in the mean TFP level in both New Brunswick and Nova Scotia relative to Ontario. I have argued this drop can be explained by two factors: 1. Rural manufacturers in the Maritimes were less productive relative to rural establishments in Ontario; 2. There was a much greater proportion of rural establishments in the Maritimes, and rural establishments *everywhere* in Canada were less productive than urban establishments.

Inwood and Keay (2008) note that Tornqvist TFP calculations are highly sensitive to the variable specifications and that both quantitative and qualitative conclusions can depend crucially upon how variables are defined. It is important to question the extent to which the qualitative conclusions I have drawn from Table 2 depend on how the variables in the TFP calculation have been specified. To test the robustness of my findings I calculated the TFP ratios using 44 different specifications.[18] The results are illustrated in Figure 4 for the preferred population density threshold. Figure 4 illustrates that the TFP levels in the Maritime cities are high relative to Ontario in a majority of the sub-sectors of manufacturing. The mean value of the TFP ratios across the 44 specifications is greater than one in each of the four sectors for New Brunswick, and greater than one for Nova

[17]The TFP ratios for the rural establishments are not listed but are available upon request from the author.

[18]The 44 different specifications were developed based on the range of possible TFP specifications that are discussed in Inwood and Keay (2008). A list of the 44 different specifications I use is available upon request.

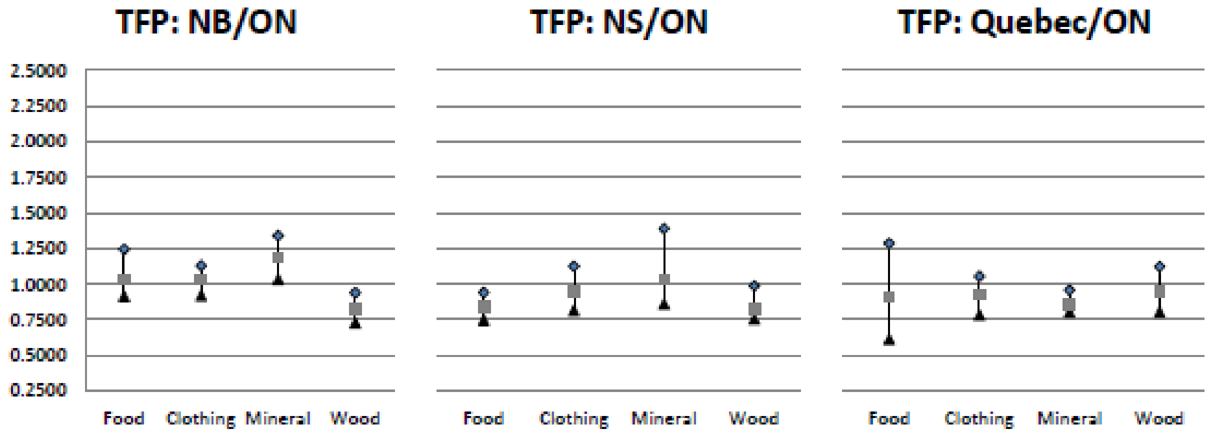


Figure 5: Sensitivity of TFP Ratios. Population Density Threshold: $\frac{persons}{mile^2} > 0$

Scotia in the same 3 sectors as in my preferred specification (food, clothing, and mineral). Figure 5 plots the 44 specifications of the TFP ratios again, although this time with the population density threshold dropped to zero. In both New Brunswick and Nova Scotia the distribution over the 44 different TFP specifications shifts towards zero (the minimum and maximum values are lower in each of the four sectors in both provinces). The mean value of the TFP ratios also drops in both provinces in all sectors with one exception (clothing in New Brunswick), which exactly mirrors the results for my preferred specification. I conclude that my qualitative conclusions are robust to the specification of the TFP calculation.

What factors account for the inter-provincial differences in the 1871 productivity performance of the Canadian manufacturing establishments? I address this question by testing the relationship between TFP performance and the theoretical determinants of productivity using regression analysis. Specifically, my regression model takes the following form:

$$log\frac{A_{ij}}{A_{\bar{j}}} = \alpha + X\beta + \epsilon_{ij} \tag{2}$$

In equation (2) the dependent variable is the natural logarithm of establishments $i$'s TFP level relative to the national sector specific average, and the matrix $X$ contains the explanatory variables that are theorized to be correlated with productivity performance.

The relationship between internal and external scale economies and TFP performance has been an important focus in the literature on regional productivity differentials in the late nineteenth century.[19] Internal scale economies are present whenever an increase in production requires a less than proportionate increase in all inputs. Under internal scale economies larger firms are more productive, and the cost savings amassed to the firm from expansion are reflected in a higher level of TFP. For my measure of internal scale I use natural logarithm of the each firm's gross value of production. External scale economies are present whenever market agglomeration affords firms a productivity advantage. External scale economies may be present in multiple markets simultaneously and therefore I include two measures to capture this effect: the natural logarithm of the population density in the sub-district where the establishment was located; and the natural logarithm of the industrial density. Industrial density is defined as the aggregate value of manufacturing output (for all sectors) in the district where the establishment resided, divided by the area of the

[19]See for example Tchakerian (1992) and Inwood and Keay (2005)

district in square miles.

McCallum (1980) links the process of industrialization in Ontario during the nineteenth century to the wealth that was generated by agricultural income from wheat production throughout the middle part of that century. The presence of an agricultural wealth effect may have resulted in greater availability of investment capital, higher levels of capital investment and infrastructure development, higher levels of output, and ultimately higher levels of TFP. A second theoretical link between land quality and TFP is through the partial factor productivity of intermediate inputs. That is, firms having access to higher quality inputs have higher levels of output, and thus higher TFP levels. The sectors most likely to exhibit evidence of such an effect are the food and wood sectors. To capture this effect I create a agricultural land quality variable using a geographic information systems (GIS) methodology and data from the 1969 Canada Land Inventory (CLI). To create the land quality variable, I digitally map the coordinates for the 82 municipalities where the establishments in my sample resided. The CLI data is then imported and layered over the 82 municipalities. Next I create a digital buffer (radius 20 km) around each of the 82 municipalities. These buffers are used to calculate municipality specific zonal land quality statistics with the zonal area for each municipality being defined by the 20 km buffer.[20] The classification scheme ranges from a low of 0 (indicating that soils have "no capability for arable culture or permanent pasture" DREE (1969, p.9)) to a high of 6 (indicating that soils have "no significant limitations in use for crops" DREE (1969, p.5))[21]. For each municipality, the mean value of land quality within the 20 km buffer is used to define the land quality variable. Examining the summary statistics reveals that Halifax has the lowest mean land quality at 0.464869, while the south western Ontario municipality of Seaforth has the highest mean land quality at 5.82871. The land quality variable follows a clear east-west distribution with the lowest quality land being concentrated in the Maritimes, moderate land quality in Québec and south eastern Ontario, while the highest quality land is concentrated in south western Ontario.

The CLI was an initiative administered by the Canadian federal government's Agricultural Rehabilitation and Development Act of June 1961. Gerriets (2002) uses the same CLI data to examine the relationship between agricultural resources and the extent of settlement of Ontario, Québec and the Maritime provinces in the late nineteenth century. An obvious difficultly with using the CLI for my purposes is that changes to the quality of land have occurred between 1870 and 1969. Factors that may have led to changes in land quality include urbanization, land improvement and degradation due to farming practices, climate change, and advancement in agricultural technology.[22] Serious concerns have been raised by Inwood and Irwin (2002) regarding the precision of the CLI data as well as its suitability for inter-provincial comparisons. On the basis of these criticisms, there is a risk of measurement error in the land quality variable. Measurement error has the undesirable statistical effect of yielding biased and inconsistent coefficient estimates. However, if land quality is in fact a determinant of TFP performance, then omitting the land quality variable amounts to omitted variable bias, which also results in biased and inconsistent estimates. To address this issue I estimate the regression with and without the land quality variable (Table 3 presents the results *with* the land quality variable). None of the qualitative conclusions that are drawn from Table 3 change when I omit the land quality variable (except of course for the conclusions with respect to

[20]Ideally the size of the buffer would vary from sector to sector reflecting the actual geographic extent of the market. Unfortunately, to my knowledge there is no existing research that describes how the extent of the market may have varied across sectors during this era. In the absence of this information, I have chosen the 20 km buffer as an estimate of the distance that resources could be drawn from, given the limited transportation capacity during this era.

[21]The classification scheme presented above is actually a re-classification of the original CLI classification scheme in which a value of 7 was assigned to the poorest quality land and a value of 1 to the highest quality land.

[22]Gerriets (2002)

the relationship between of land quality and TFP).

To model the potential effect of labour quality on productivity, I include in my explanatory variables the natural logarithm of the literacy rate in the district where the establishment was located. The literacy rate is used as a proxy for human capital which theory suggests should be positively correlated with productivity. To measure the effect of market accessibility, I include an indicator variable for rail transportation that tales a value of one if the district was serviced by the Grand Trunk line (or a subsidiary line of the Grand Trunk) in 1871. I also include an indicator variable for inanimate power, which takes a value of one if the firm used either water or steam power in its operations.

I include three indicator variables corresponding to the province in which each establishment resided (Ontario is specified as reference group). These variables isolate the institutional and other social and economic factors that were province specific but not controlled for by the other explanatory variables. The province variables capture the effects of provincial attributes such as financial institutions, local governance, entrepreneurial spirit, and methods of production that were specific to a particular province. Finally, a set of industry specific indicator variables are included in each sector specific model to control for the fixed effects associated with each industry within a sector.

Regression equation (2) is estimated by ordinary least squares using the sub-sample of firms satisfying my preferred population density threshold ($\frac{persons}{mile^2} > 1000$). The results are provided in Table 3[23]. The results indicate that internal economies of scale were present in the Canadian manufacturing sector in 1871. In each of the four sectors the coefficient estimates for the natural logarithm of establishment output is positive and statistically significant at the 1% level. The positive correlation between establishment size and productivity in the Canadian manufacturing sector in 1871 is consistent with the earlier research of Inwood and Keay (2005). In each of the four sectors, the coefficient for the natural logarithm of population density is not statistically significant at the 5% level. The coefficient for the logarithm of industrial density is also not statistically significant in the food and clothing sectors, and is *negative* and statistically significant in the mineral and wood sectors. This suggests that external economies of scale were not present in the manufacturing sector in Canada's urban centres in 1871.

The coefficient for the logarithm of land quality is positive and statistically significant at the 1% level for the food sector. In addition to being highly significant, the coefficient for the land quality variable has the second largest magnitude of all explanatory variables in the food sector. This provides strong evidence in support of the theory that higher agricultural input quality improved the productivity performance of food sector industries. Interestingly, the land quality coefficient is negative and statistically significant at the 1% level for the mineral sector. The negative correlation may be explained by the fact that the industries in this sector (especially foundries and lime kilns) required a high proportion of heavy mineral inputs in production. Given the high cost of transporting these inputs, there may have been efficiencies available to firms that were located in regions with rich deposits of these minerals. The fact that regions that are rich in heavy mineral deposits tend to yield poor soil for agriculture may explain the negative correlation between the coefficient for land quality and TFP in the mineral sector. Aside from the food sector the coefficient on the land quality variable is negative in every other sector. This provides little support for the theory that an agricultural wealth effect improved productivity in the manufacturing sector.

It is surprising that the coefficient estimate for the literacy variable is found to be *negative* and statistically significant at the 5% level in both the mineral and wood sectors. The trades people in

[23]For brevity I have omitted from Table 3 the coefficient estimates for the sector specific industry indicator variables. These results are available upon request.

Table 3: The Determinants of Canadian Manufacturing TFP in 1871

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| VARIABLES | Food | Clothing | Mineral | Wood |
| Log(Output) | 0.130*** | 0.113*** | 0.190*** | 0.226*** |
| | (0.0183) | (0.00762) | (0.0168) | (0.0163) |
| Log(Population Density) | -0.0245 | -0.0158 | 0.00900 | -0.0488* |
| | (0.0162) | (0.0130) | (0.0220) | (0.0293) |
| Log(Industrial Density) | -0.00455 | 0.00306 | -0.0163** | -0.0647*** |
| | (0.00843) | (0.00596) | (0.00799) | (0.0104) |
| Log(Land Quality) | 0.311*** | -0.0129 | -0.222*** | -0.0339 |
| | (0.109) | (0.0319) | (0.0481) | (0.0610) |
| Log(Literate) | -0.0518 | 0.216 | -0.950** | -1.337** |
| | (0.550) | (0.330) | (0.434) | (0.614) |
| Power | -0.0577 | -0.223*** | 0.0163 | 0.0271 |
| | (0.0895) | (0.0458) | (0.0662) | (0.0759) |
| Rail Access | 0.171*** | 0.0125 | 0.0203 | -0.0685 |
| | (0.0377) | (0.0253) | (0.0359) | (0.0519) |
| New Brunswick | 1.084*** | -0.0465 | -0.170 | 0.427*** |
| | (0.199) | (0.0793) | (0.133) | (0.131) |
| Nova Scotia | 1.354*** | 0.166* | -0.398*** | -0.0515 |
| | (0.265) | (0.0998) | (0.128) | (0.183) |
| Quebec | -0.339*** | 0.0501 | -0.0808 | 0.0906 |
| | (0.0647) | (0.0512) | (0.0707) | (0.0951) |
| Observations | 412 | 1,525 | 753 | 867 |
| R-squared | 0.587 | 0.202 | 0.265 | 0.365 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Industry dummy variables and constant are not shown

these sectors (blacksmiths, carpenters, etc.) would have required a highly specialized skill set. A possible explanation for the negative correlation is that the skilled labourers in these sectors may have entered into apprenticeship at young age at the expense of not acquiring basic literacy skills. The negative and statistically significant coefficient on the power variable in the clothing sector is another puzzling result. It may simply be the case that in the clothing sector emerging technologies using inanimate sources of power were slow to overtake traditional methods that relied exclusively on hand power. This logic is consistent with Inwood and Keay (2012) who find that proto-industrial manufacturing establishments achieved efficiencies through making technological choices that were well suited to their environment. The rail access variable is found to be positive and statistically significant at the 1% level in the food sector. This suggests that in at least one sub-sector of manufacturing, having greater access to distant markets through railroad transportation improved productivity.

The coefficient estimates for the provincial variables provide further evidence that St. John and Halifax had a productivity advantage in some sub-sectors of manufacturing over Central Canadian urban centres. After controlling for the other determinants of productivity, the results suggest that there were institutions in place that increased productivity in Maritime cities. This is particularly true in the food sector, where the coefficient on the New Brunswick and Nova Scotia variables are found to be positive and statistically significant at the 1% level. St. John also enjoyed a productivity advantage in wood product manufacturing, with the coefficient in that sector being positive and statistically significant at the 1% level. However, the negative and highly significant coefficient for Nova Scotia in the mineral manufacturing indicates that there were institutions in Halifax that diminished the city's productivity in this sector. Finally in Québec, the food sector coefficient is found to be negative and statistically significant at the 1% level, indicating that the province had lower productivity in this sector relative to Ontario after controlling for the other determinants of TFP performance.

There is an extensive body of research that attempts to link the sub-par economic performance of Maritime provinces during the twentieth century to the initial conditions in the region during the nineteenth century[24]. Inwood (1991) categorizes theorists into two camps on this issue: structuralists, and those who draw upon the staples thesis in their line of reasoning. Structuralists argue that the poor economic performance of the Maritime provinces during the twentieth century is ultimately rooted in the loss of political control that occurred as a result of the region's decision to join Confederation in 1867. Proponents of this perspective, such as Savoie (2001), argue that Canadian public policy has always favoured the development of an industrial heartland in Ontario and Québec on the basis of political and not economic factors.

However by combining my TFP calculations with data from the 1891 Census, I am able to demonstrate that in St. John and Halifax the growth of the manufacturing sector in the late nineteenth century can be rationalized as the outcome of economic forces acting on initial conditions. Table 4 presents the evidence that will support my argument. The top two tiers of the second column of Table 4 ($TFP_{1000}$) presents the initial TFP level in each respective city relative to the average TFP level in Ontario (evaluated at the preferred population density threshold: $\frac{persons}{mile^2} < 1000$). These values are taken directly from Table 2. In the bottom tier of the second column I have also included a TFP measure of the two cities combined, evaluated as the mean TFP level in the Maritime cities relative to the mean level of TFP in Ontario. The top two tiers of the third column ($TFP_0$) are also taken directly from Table 2, and are the provincial TFP ratios for each respective province calculated from the complete sample (evaluated at the population density threshold: $\frac{persons}{mile^2} < 0$). The third column is presented to contrast the initial productivity level in the province as whole with the productivity level in the two urban centres. The bottom tier of the second column again provides a TFP measure for the Maritime region combined, evaluated as the mean TFP level in the Maritime region relative that of Ontario (evaluated at the population density threshold: $\frac{persons}{mile^2} < 0$). The top two tiers of the fourth column calculates each city's share of national output in each sector, and the bottom tier calculates this value for the two cities combined. The fifth column makes the same calculation as the fourth but uses the 1891 census tables as its source of data. The final column is the difference of the fifth from the fourth column, and thus calculates the percentage point change in each locations share of national output in each sector. The output measure that is used in the final three columns is the gross value of production, with no inter-regional or inter-temporal price adjustments.[25]

[24] For summaries of this literature see Inwood (1991) and Savoie (2001).

[25] Ideally, I would deflate gross output by a location and sector specific price index. Unfortunately, to my knowledge no such index exists for this time period. Since I am ultimately interested in the *change* in each locations share of national output, *intra-temporal* price variation across regions is not a huge concern. However, the final column of Table 4 is only a valid measure if the changes that occurred in the prices at each location were proportional to the change in prices that occurred at the national level. In lack of better information, I proceed under this assumption.

Table 4: Initial Conditions and Change in Share of National Output

| **St. John** | **TFP: NB/ON** | | **Share of National Output** | | |
|---|---|---|---|---|---|
| **Sector** | $TFP_{1000}$ | $TFP_0$ | **1871** | **1891** | $\Delta_{1891-1871}$ |
| Food | 1.4985 | 0.9570 | 0.59% | 1.34% | **0.76%** |
| Clothing | 0.9082 | 1.0096 | 2.21% | 1.29% | **-0.91%** |
| Mineral | 1.3884 | 1.2239 | 1.40% | 4.69% | **3.29%** |
| Wood | 1.1682 | 0.7489 | 4.67% | 3.53% | **-1.14%** |
| **Halifax** | **TFP: NS/ON** | | **Share of National Output** | | |
| **Sector** | $TFP_{1000}$ | $TFP_0$ | **1871** | **1891** | $\Delta_{1891-1871}$ |
| Food | 1.8760 | 0.8256 | 0.82% | 0.95% | **0.12%** |
| Clothing | 1.2642 | 1.0259 | 1.30% | 1.75% | **0.45%** |
| Mineral | 1.2133 | 1.1198 | 1.95% | 1.88% | **-0.07%** |
| Wood | 0.9370 | 0.7885 | 1.14% | 1.53% | **0.38%** |
| **Maritime Cities** | **TFP: NS/ON** | | **Share of National Output** | | |
| **Sector** | $TFP_{1000}$ | $TFP_0$ | **1871** | **1891** | $\Delta_{1891-1871}$ |
| Food | 1.6401 | 0.8875 | 1.41% | 2.29% | **0.88%** |
| Clothing | 1.0195 | 1.0168 | 3.50% | 3.04% | **-0.46%** |
| Mineral | 1.3197 | 1.1603 | 3.35% | 6.57% | **3.22%** |
| Wood | 1.0801 | 0.7737 | 5.82% | 5.06% | **-0.76%** |

The provincial TFP ratios $TFP_{1000}$ and $TFP_0$ are taken from Table 2 (the subscripts correspond to the population density thresholds $\frac{pop}{mile^2} > 1000$ and $\frac{pop}{mile^2} > 0$ respectively). The Maritime TFP ratios were calculated following the same specification as the provincial ratios, with the region mean in place of provincial mean. The final three columns refer to each city's/region's share of national manufacturing output in each sector. The final column gives the *percentage point change* in each city's/region's share.

On the strength of high productivity, St. John and Halifax's share of national output in the food sector increased by 0.76 and 0.12 percentage points respectively between 1871 and 1891. Low productivity in St. John's clothing sector resulted in a reduction in its share of national output of 0.91 percentage points. Nova Scotia had considerably higher productivity in the clothing sector as compared with New Brunswick and gained 0.45 percentage points. Some of the gain in Nova Scotia's clothing sector output may have been business that was lost by New Brunswick clothing manufacturers. However, overall the Maritime cities saw a 0.46 percentage point reduction in their share of national output in the clothing sector. St. John manufacturing enjoyed its greatest gain in the mineral sector with an impressive 3.29 percentage point increase its share of national output. Some of this gain may have come at the expense of Nova Scotia manufacturers, who suffered a small reduction of 0.07 percentage points in their share of national output. Once again, this result can be rationalized by the higher initial productivity levels in St. John relative to Halifax.

The wood sector presents as an interesting case. The wood sector was hugely important to both St. John and Halifax in 1871. In the two cities combined, gross production in the wood sector accounted for 46% of the aggregated manufacturing output of the four sectors. St. John was clearly the regional leader in the wood sector with a share of 4.67% of national output and high initial productivity. Acheson (1972) notes that ship building accounted for more than one third of New Brunswick exports at confederation. How then can we explain the 1.14 percentage point drop in the city's share of national output? The answer may be found by adjusting the lens of perspective to the level of the province. For the province as a whole, the initial productivity in the New Brunswick wood sector was dismal (25% lower than in Ontario). Despite strong potential in St. John, it is plausible that a lack of depth in New Brunswick's wood manufacturing sector beyond St. John's city limits failed to support the growth that might have otherwise occurred. Some of the city's lost wood manufacturing production may have been picked up by Halifax producers, who increased their share of national output by 0.38 percentage points. However, overall the 0.76 percentage point drop in the Maritime cities' share of national wood manufacturing output represented the largest decline across the all four sectors. Given that the wood sector was the largest and most important sector, this was a particularly unfortunate result for the Maritime cities.

The stylized facts in Table 4 provided additional evidence that initial productivity at the *regional* level can help to explain the path of growth that occurred in the Maritime cities. For example, the sector with the greatest gain in its share of national output *was not* the food sector, despite the fact that this was the sector with the highest initial productivity in both St. John and Halifax. As with the wood sector, the strong growth potential in the highly productivity Maritime cities may have been offset by lower overall productivity in the food sector at the provincial level. The mineral sector provides further evidence that a combination of high productivity at both the urban and provincial level was necessary to achieve growth. The initial productivity ratios at both the urban and provincial levels in New Brunswick and Nova Scotia were well above one, strength that translated into the region's greatest single sector gain in share of national output. The evidence suggests that productivity in the rural regions was important on account of supporting role that this population provided for the industrial development that occurred in the urban centres.

The Maritime provinces had two star performers in St. John and Halifax with the productive capacity to compete with Central Canadian manufacturing firms in 1871. Although these stars burned brightly in the east they stood alone against a rural landscape where the overall productivity performance was poor. In contrast, Ontario and Québec featured large industrial centres supported by an extensive network of densely populated satellite municipalities, each with a well established industrial sector. The Canadian industrial revolution of the late ninetieth century presented an opportunity for growth in the every region of the country. Whereas growth in Central Canada occurred naturally, the Maritimes lacked a depth of industry in its hinterland and perhaps because of this the region failed to grow its manufacturing industries at the same pace as the rest of the country.

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