AN ANALYSIS OF THE TOTAL FACTOR PRODUCTIVITY PERFORMANCE OF CANADIAN MANUFACTURING ESTABLISHMENTS IN 1871

by

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1 Introduction

The early years following Confederation (1867) are viewed by many economists as the beginning of the industrial era in the Canadian economy. Having broken away from the British mercantile system in the mid-nineteenth century the Canadian economic system became increasingly tied to the fortunes of the U.S. economy, which by 1870 was already rapidly enroute to industrialization. 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. This paper examines the productivity performance of the Canadian manufacturing sector in 1871 and thus sheds light on the initial factors and influences that may have determined the development of this important sector of the Canadian economy.

My objective in completing this project is to answer the following question: How can we account for the differences in the total factor productivity (TFP) performance across Canadian manufacturing establishments in 1871? That is, I aim to identify the factors that were most influential in determining a Canadian manufacturing establishments's level of technical efficiency in 1871. A complementary objective of my project is to estimate the inter-provincial differences in the TFP performance of Canadian manufacturing establishments during this era.

There are three sources of data used in this project. First are the Census manuscripts from the April 1871 enumeration of Canadian manufacturing establishments. These manuscripts were rendered into machine readable form by (Inwood, 1995). The second source of data is the 1870-71 Census of Canada. The third source of data is the 1969 Canada Land Inventory Level I Latitude/Longitude Digital Data. For my measurement of productivity, I use the Tornqvist approach to calculate establishment specific TFP. Linear regression analysis is used to estimate the effects of the various determinants of establishment specific TFP.

My results indicate a positive correlation between TFP performance and establishment size, establishment's capital labour ratio, and the quality of land in the region where the establishment resided. The social and cultural attributes of the district where the establishment resided are also found to be important determinants of the TFP performance of manufacturing establishments in 1871. In the uncontrolled analysis the average establishment's TFP level in Ontario, New Brunswick and Nova Scotia are found to be roughly equivalent, while the average TFP level in Québec is found to be considerably lower than in the rest of Canada. In the regression analysis New Brunswick and Nova Scotia manufacturers' TFP levels are found to be higher than that of Ontario manufacturers, while Québec manufacturers' TFP level is found to be lower than that of Ontario manufacturers, after controlling for the other determinants of TFP. An important implication of my results is the finding that in 1871 the average productivity performance of Maritime manufacturing establishments was at least as strong as that of Ontario manufacturers. This conclusion differs from earlier research on this topic.

The only other empirical study of intra-Canadian productivity performance of the manufacturing sector in this era was completed by Inwood (1991). Inwood's (1991) study uses Census data to determine the inter-Provincial differences in the productivity performance of the Canadian manufacturing sector in the years 1870 and 1910. My project extends the work of Inwood (1991) in two important respects. First, the use of manuscript level data allows for analysis at a greater level of disaggregation. That is, the determinants of TFP performance are specified and estimated at the level of the individual establishment. Second, the use of regression modeling enables conditional analysis of the determinants of establishment specific TFP performance.

The structure of the remainder of this paper is as follows: Section II is the literature review, which is divided into two sub-sections. In the first sub-section I provide a summary of literature pertaining to the structure and performance of the Canadian manufacturing sector in 1870. In the second sub-section of the literature review I present an overview of the theoretical determinants of total factor productivity. Section III describes the data that is used in my analysis. Section IV presents the methodology of the project. In this section I describe both the Tornqvist TFP calculation and the regression model. Section V presents my results and section VI concludes.

2 Literature Review

2.1 The Canadian manufacturing sector at the dawn of the Canada's industrial revolution

While a precise date is difficult to specify, the decades following Confederation (1867) marked the onset of a period of transition in Canadian economy towards a more urban and industrial structure. (Keay, 2009) To provide context of the environment in which this transition took place, I begin this sub-section by describing a number of important economic developments that occurred during the lead-up to Confederation.

Norrie and Emery (2002) note that the dismantling of the British mercantile system began with the annulment of timber duties in 1842. This policy change was followed by extensive liberalization of British trade policy throughout the mid-nineteenth century. As a result Canadian exporters could no longer rely on preferential access to British markets and increasingly looked to the U.S. as a destination for their products. The success of the Canadian economy in weathering this transition favourably was thanks in large part to the high demand in the U.S. economy for Canadian exports, particularly during the U.S. Civil War (1861-1865) and post-war reconstruction period. (Norrie and Emery, 2002)

Canada's first experience with industrialization occurred during the first boom in Canadian railway construction (1850-1857). Railway construction demanded complex financial structures and encouraged domestic production of the goods and services that were used in the operation and maintenance of the railway. However it would be inaccurate to characterize Canada's economy in 1870 as industrialized. As of 1867, approximately 80% of the country's population lived in rural communities. Furthermore, agriculture still comprised the largest share of gross domestic product (GDP) in 1870 at 37.1%. By comparison, manufacturing accounted for 22.5% of GDP in 1870. In 1870 Canadian manufacturing lacked diversity in its spheres of production as evidenced by the fact that four sub-sectors (herein referred to as sectors) accounted for over 65% of Canadian manufacturing GDP: wood, iron/steel, leather, and food and beverage. The lead sector was wood, which alone accounted for greater than 20% of all manufacturing output. Beyond the top four, a handful of other sectors accounted for more modest contributions to manufacturing output. The most substantial sectors from this latter group included transportation equipment and clothing, each representing approximately 7% of manufacturing GDP. The remaining sectors each represented less than 5% of Canadian manufacturing output in 1870. (Norrie and Emery, 2002, pp.173,190,215)

A small number of studies have been completed with the objective of comparing the productivity performance of Canadian relative to U.S. manufacturers in the late nineteenth century. A brief overview of the key findings from this literature is useful as it provides international context for my intra-Canadian analysis. Using a Tornqvist-based approach to measure TFP differentials, Inwood and Keay (2008) find that in 1870/71 U.S. manufacturers enjoyed only a slight productivity advantage over their Canadian counterparts. Inwood and Keay's results are contrary to much of the earlier research on this topic that has suggested that U.S. manufacturing firms had a much greater productivity advantage over Canadian firms during this era. (Norrie and Emery, 2002) In an earlier study Inwood and Keay (2005) note that in 1870/71, relative to the U.S., Canadian manufacturers had lower intermediate input productivity and labour productivity, but higher capital productivity. The authors' note that the higher level of Canadian capital productivity is reflective of the limited use of capital in the Canadian manufacturing sector during this era, as evidenced by much higher capital labour ratios for the manufacturing sector in the U.S. relative to Canada.

Only one previous empirical study has been completed with the objective of analyzing the intra-Canadian productivity performance of the manufacturing sector in the late nineteenth century. Inwood's (1991) study was carried out with the purpose of explaining inter-Provincial differences in the productivity performance of the Canadian manufacturing sector. More precisely, Inwood's (1991) objective is to examine the 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 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 found to be 12% less productive than Ontario based manufacturers, while Québec manufacturers were found to be 14% less productive. Nova Scotian manufacturers were found to be the least productive with a TFP level 22% below that of Ontario.

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[1]. Inwood (1991) categorizes theorists into two camps on this issue, those who draw from the staples thesis in their line of reasoning, and those who appeal to structuralism in their line of argument. The staples thesis of economic development in Canada emphasizes the importance of the

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

country's geographic endowment and export-based economy[2]. 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, and that the concentration of the manufacturing sector in Central Canada primarily reflects political and not economic factors.

One method for assessing the validity of the structuralists' argument is to consider the evidence regarding the competitive position of Maritime manufacturers at the time of Confederation. For example, Inwood's (1991) study reveals that in 1870 Maritime manufacturers trailed Ontario manufacturers in TFP performance. It is reasonable to assume that in the three years following Confederation federal public policy decisions had very little measurable impact on the inter-provincial manufacturing productivity differentials. Therefore, the research of Inwood (1991) provides evidence against the structuralist argument in that it suggests that at the time of Confederation Maritime manufacturers trailed Ontario manufacturers in productivity performance. Based on Inwood's (1991) results, the development of an industrial heartland in Central Canada may have in fact occurred because of economic rather than political influences.

Inwood's (1991) inter-Provincial analysis provides insight into how the productivity performance of the manufacturing sector varied across Canada in 1870. However, there are several interesting questions that are left unanswered in Inwood's study. For example, would the TFP level for New Brunswick have been closer to that of Ontario had the two Provinces shared the same population density? In 1870 the Grand Trunk Railway (GTR) operated a pan-Canadian service between Rivière-du-Loup, Québec

[2]A more thorough explanation of the staples thesis is provided in section 2.2 of the literature review. It should also be noted that since the work of Inwood (1991), economic historians have increasingly appealed to contemporary economic growth theory to explain the origins of industrialization in North America. Extensive treatment of this topic is also provided in section 2.2.

and Sarnia, Ontario. Would the TFP performance of Nova Scotia have improved had the GTR expanded its railway service east to Halifax? Without question there are many factors that affected the productivity performance of Canadian manufacturing establishments during this era. If we are interested in isolating the influence of any one factor (such as province of residence, for example), it is necessary to control for the influence of the remaining factors. It is precisely this exercise which I undertake in this project through the use of regression analysis. As the first intra-Canadian regression analysis of the productivity performance of Canadian manufacturing establishments in 1871, this project represents a unique and valuable contribution to Canadian economic history literature.

2.2 An overview of the theoretical determinants of total factor productivity

Total factor productivity is defined as the portion of output that is unexplained by the quantity of inputs used in production. (Comin, 2008) 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 in addition to physical technology, a more complete 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. Inwood and Keay (2008) In the remainder of this sub-section I present an overview of the theoretical determinants of total factor productivity.

Internal Scale Effects (Firm Size): Internal scale effects are present whenever a firm exhibits increasing returns to scale in production. Internal scale effects are commonly associated with industries that feature a high level of fixed costs in production, and thus exhibit falling average costs over a wide range of production levels. When an increase in the production of a given quantity requires a less than proportionate increase in all inputs, the cost savings amassed to the firm is reflected in a higher level of TFP.

External Scale Effects (Agglomeration effects): There are two types of external scale effects that may affect TFP performance: population density, and industrial density. Inwood and Keay (2005, p.1345) note that TFP performance may be positively correlated with population density as a result of "transportation cost saving, marketing and distribution saving, local policy influence, increased supplies in local input markets (particularly labour), and possibly increased demand inelasticity (market power) in local output markets due to distinct community or cultural characteristics". Two measures of industrial density are: the number of industrial establishments per square mile, and aggregate industrial value added per square mile. TFP performance may be positively correlated with industrial density as a result of cost savings arising from factors such as labour market pooling, input sharing, and knowledge spill-over. (Strange, 2008)

Physical Capital Accumulation: The nineteenth century was an era that featured significant and continuous technological progress. (Maddison, 1991) The incorporation of new technologies in the production process occurs primarily through the accumulation of capital that embodies the new technologies. The capital accumulation process also generates further technological progress through improvement engineering and learning by doing. (Maddison, 1991) Thus the capital labour ratio serves as a proxy for investment in technology (Tchakerian, 1992) and is theorized to be positively correlated with the level of TFP.

Human Capital: In their seminal paper, Mankiw et al. (1992) illustrated that human capital accumulation is an important determinant of economic growth. Common metrics for human capital accumulation include the average level of educational attainment and the average literacy rate of the population. Whereas the implicit production function used in my TFP calculation does not model the relationship between human capital and output, the contribution of human capital to the level of output is absorbed in TFP.

Labour Force Size: TFP is postulated to be positively correlated with the size of the labour force. An increase in the size of the labour force reduces the search costs facing firms and enables better matching of job vacancies with appropriately skilled individuals. This results in a higher level of human capital in the work force and since TFP is theorized to be positively correlated with human capital, an increase in the labour force is theorized to be associated with a higher level of TFP.

Institutions: Maddison (1991) notes that the substantial and sustained growth achieved by Canada and the U.S. (amongst other nations) between 1820-1989 was achieved, in part, thanks to the existence of a range of institutions that supported the process of capitalist development. Maddison presents an extensive list of institutions that facilitated the impressive economic growth that characterized this period. Maddison's list includes: the establishment of institutions that define and protect private property; the emergence of Western science; the advancement of fiscal systems of governance; the advancement of financial institutions and intermediation; the rise of factory-based production; the development of a system of nation states; and the existence of an atomistic family structure. The existence of strong institutions are theorized to be correlated with higher output levels, and by extension higher TFP levels.

Social and Cultural Attributes of the Labour Force: The social and cultural attributes of a population include factors such as religion, ethnicity, gender composition, and language. These attributes may be correlated with TFP performance however the nature of the relationship is difficult to predict a priori.

Geography: According to the staples thesis, a theory articulated by early twentieth century Canadian economists William A. Mackintosh (Queen's University) and Harold A. Innis (University of Toronto), the history of economic development in Canada is intrinsically linked to the country's geographic endowment and export-based economy. The staples thesis argues that in the periphery economies of the nineteenth century (such as Canada, Argentina, and Australia) economic development was characterized by growth around the base natural resource sectors of the economy. The diversification of peripheral economies was accomplished through backward linkages (i.e. the development of inputs and infrastructure for the natural resource sector) and forward linkages (i.e. the development of primary and secondary manufacturing industries for processing the raw materials exploited by the natural resource sector). Based on the staples thesis, the TFP levels of 1870 Canadian manufacturing establishments located in regions of rich natural resource endowment should be higher than the TFP levels of establishments located in poorly endowed areas. More precisely, according to the staples thesis those manufacturing establishments which had access to higher quality inputs should have higher intermediate input productivity and thus higher TFP levels.

3 Data

The data that I use for this study comes from three sources. First are the manuscripts from the April, 1871 enumeration of Canadian manufacturing establishments. These manuscripts were rendered into machine readable form by Inwood (1995). Inwood and Keay (2008) describe a sequence of aggregations, exclusions, filters, and reconstitutions that were used to prepare the raw manuscript data for use in their analysis. Kris Inwood and Ian Keay have provided me with access to a *sub-sample* of the cleaned[3] manuscript data that they used in their 2008 study. The sub-sample that I use is censored to include only the 20 largest Canadian manufacturing industries. The 20 largest manufacturing industries are defined as the 20 industries having the greatest number of establishments in Canada.

In total the data set that I begin with includes observations on 27,111 establishments representing the 20 largest manufacturing industries in Canada in 1871. 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 my sample represent approximately two thirds of the total number of manufacturing establishments listed in Inwood's (1995) reconstituted version of the 1871 manuscripts.

The objective of my study is to determine the factors that had the greatest influence on Canadian manufacturing establishments' productivity performance in 1871. In order for my analysis to be meaningful, it is imperative that each unit of observation (manufacturing establishment) has characteristics that are relatively similar across the entire sample, apart from the differences that I incorporate and control for in my model. Inwood (1995) notes that the 1871 enumerators were given instruction to enumerate a broad spectrum of establishments ranging from small farm-based operations to large factories. Clearly there are fundamental differences between such small and large scale operations that require, for the purposes of my study, a narrowing of the definition of what it meant to be a Canadian manufacturing establishment

[3]The data that I use has been cleaned as per the data preparation procedures described by Inwood and Keay (2008, pp.89-91). The one exception is that Inwood and Keay (2008) filter their sample to exclude establishments reporting a total value of production less than $500 to facilitate Canada-US comparison. This filtering procedure was not completed for my data, which is appropriate given that my study is an intra-national Canadian analysis.

in 1871. I am interested in isolating those manufacturing establishments that might be characterized as the late 19th century precursors to 20th century medium and large scale manufacturing establishments. I aim to eliminate from my sample establishments that would be characterized as cottage industries in the modern sense. To eliminate such establishments from my sample I rely on the assumption that these latter type of establishments were predominantly located in rural municipalities. 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 people per square mile[4]. 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 grand total of 3,787 manufacturing establishments available for use in my analysis.

Geographically, the 3,787 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 symbols (dots) to distinguish municipalities that have many manufacturing establishments from those municipalities having few establishments. 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 2 Maritime municipalities (Saint John and Halifax). The median sub-district population density for the sample is 3359 people per square mile, which suggests that the population density threshold is successful in isolating the urban manufacturing establishments from the manuscript data. However, caution should be exercised in drawing this conclusion since sub-districts could surpass the population threshold by having a high population, a low geographic area, or some combination of the two. There are examples of municipalities that would be classified

[4]The threshold of 1000 people per square mile was chosen following Inwood and Keay's (2005) use of this threshold to distinguish between rural and urban Census sub-districts.

by all measures as villages that survive the sub-district population density cut-off of 1000 people per square mile. The most extreme example in the sample is the village of Côteau Landing, Québec which had a population of only 400 in 1871. However since the total surface area of the village was enumerated to be 0.1672 square miles, Côteau Landing's population density of 2393 people per square mile easily surpasses the threshold. In total 6.68% of the establishments in the sample (a total of 253 establishments) are reported as residing in sub-districts having a population less than 1000 inhabitants. Thus my sample can be accurately characterized to feature predominantly urban based manufacturing establishments.

The second source of data that I use in this study is the 1870-71 Census of Canada. In constructing my model I work from the assumption that sector specific establishments residing within the same geographic area faced a common set of market conditions. For example, I assume that all sector specific manufacturing establishments in the same Census district faced a common labour market. Accordingly the district specific quantitative and qualitative aspects of the labour market are assumed to have the same effect on the productivity performance of all sector specific manufacturing establishments that reside within that district. From the 1870-71 Census of Canada I collect district specific and sub-district specific data that allows me to construct a set of explanatory variables that are theoretically associated with productivity performance. I describe in detail how these independent variables are specified in the methodology section.

The final source of data is the 1969 Canada Land Inventory (CLI) Level I Latitude/Longitude Digital Data. The CLI was an initiative administered by the Canadian federal government's Agricultural Rehabilitation and Development Act of June 1961. To construct the land quality variable I use the CLI data on soil capability for agricultural use. The CLI's soil capability for agriculture classification scheme groups soil into 7 categories based on the soil's productivity and limitations for agricultural use. (DREE, 1969) By using the 1969 CLI data I am implicitly assuming that the CLI data serves as a good proxy for land quality for agricultural use in 1871.

4 Methodology

In this section I begin by presenting the regression model that is used in my analysis and then proceed to define how the dependent and independent variables in the model are defined. Specifically, my regression model takes the following form:

$$ln(A_{ij}/A_{\bar{j}}) = \alpha + \mathbf{prov}\beta_1 + \mathbf{X}\beta_2 + \epsilon_{ij} \qquad (1)$$

In equation (1) i identifies establishment, j identifies sector, and $\bar{j}$ identifies the sector specific national average. The matrix **prov** includes 3 dummy variables corresponding to the province in which each establishment resides (Québec (QC), New Brunswick (NB), and Nova Scotia (NS))[5]. Ontario (ON) is specified as reference group. The **X** matrix contains the remaining right hand side variables that will be defined in detail later in this section.

In total, five separate sector specific regression models are specified for the chemical, clothing, food, mineral, and wood sectors. The industries belonging to each sector and the corresponding number of establishments in each industry is detailed in Table 1. In addition to the five sector specific models I also estimate an aggregate manufacturing sector model that serves as a summary regression. One obvious advantage of the aggregate manufacturing sector model is that specifying a single model guarantees the largest sample size possible, which is desirable from a statistical point of view. The weakness of the aggregate model is that it requires making

[5] I could have also specified a Maritime dummy variable instead of defining separate dummy variables New Brunswick and Nova Scotia. As part of my sensitivity analysis regressions were run using the Maritime dummy variable. The qualitative conclusions drawn from this alternative specification are consistent with those drawn from the model using separate dummy variables for New Brunswick and Nova Scotia, while the quantitative results vary only slightly.

the unlikely assumption that the coefficient estimates for the explanatory variables are constant across all establishments in the manufacturing sector. In the end I have decided to include the aggregate manufacturing sector model because it provides a summary of the results across all sectors, while the sector specific models allow for the identification of idiosyncratic results that are specific to certain sectors.

4.1 The dependent variable: establishment specific TFP

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 primary 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. That is, commonly referenced production functions such as C.E.S. and Cobb-Douglas are simply special cases of the translog production function. (Diewert, 1976). 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.

The Tornqvist TFP calculation takes the following form:

$$TFP_{ij} = A_{ij}/A_{\bar{j}} = \left[\frac{Q_{ij}/L_{ij}}{(Q/L)_{\bar{j}}}\right]^{0.5(SL_{ij}+SL_{\bar{j}})} \cdot \left[\frac{Q_{ij}/K_{ij}}{(Q/K)_{\bar{j}}}\right]^{0.5(SK_{ij}+SK_{\bar{j}})} \tag{2}$$

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

Inwood and Keay (2008) note that Tornqvist TFP calculations are highly sensitive to variable specifications and that both quantitative and qualitative conclusions can depend crucially upon how variables are defined. In the following paragraphs I present the variable specifications that are, from my perspective, the most defensible definitions of the variables to be used in equation (2).

For my output variable (Q) I have chosen to use a reconstructed value added. There are strong arguments for using gross output as the measure output in the TFP calculation. Inwood and Keay (2005) note that intermediate inputs accounted for the largest share of total costs for Canadian manufacturing industries in 1871. They argue that, for the purposes of their Canada-US manufacturing productivity comparison, gross output is the preferred output measure for the Tornqvist TFP calculation since using value added would entail excluding the manufacturing sectors' most costly category of inputs. The above noted drawback of value added is only an issue if it is believed that intermediate input intensity is not constant across all establishments. However since my models are sector and nation specific, it can reasonably be assumed that intermediate input intensity was approximately constant within each sector. The main advantage of using a reconstructed value added measure of output is that it allows me to avoid making assumptions regarding the quality of enumeration of intermediate inputs. From my perspective the dangers associated with assuming quality enumeration of intermediate inputs are greater than those associated with assuming constant sector specific intermediate input intensity, and therefore reconstructed value added is preferred to gross output as my measure of output. Specifically I calculate establishment specific reconstructed value added as the sum of the establishment's annual wage bill and 30% of the establishment's nominal value of fixed capital. The weight of 30% is chosen to allow 15% for users costs of capital and 15% for depreciation of capital.

The output measure in equation (2) is intended to measure the physical units of output produced by an establishment. Since value added is a measure of income and not physical output, I would ideally deflate reconstructed value added by a market specific output price index to obtain an output measure that is adjusted for cross-sectional price variation. Although an 1871 Canadian manufacturing output price index is not available, using the Census manuscripts Inwood and Keay (2008) constructed a district and industry specific product unit value index. However, despite the availability of this index I have decided that it is unsuitable for my analysis for a number of reasons. First, the index is based on product unit values that were self-reported by establishments and it is reasonable to assume that these values may have differed significantly from actual market prices. Second, the index is incomplete and has missing values for 20.76% of the establishments in my sample. Third, there are questions regarding the reliability of the index since there are numerous examples of neighbouring districts that feature highly variable product unit values for the same industry. For example, the adjacent districts of Brockville and Grenville South have vastly different product unit values in the carpentry industry. Product unit values for Brockville are listed as being well over 2 times the industry specific national average, while in neighbouring Grenville South carpentry products are listed at approximately 60% of the national average. Finally, Inwood and Keay's (2008) product unit value index implicitly assumes that the size of the market for each industry coincided with the area encompassed by the Census district, however there is no economic justification as to why the extent of the market would be defined by Census district boundary lines. Based on the above noted aspects of the Inwood and Keay (2008) product unit value index, I have decided that it is more defensible to avoid using the index and rely on the assumption that the systematic variations in prices are captured by the fixed effects dummy variables included in equation (1)[6].

I now turn to the specification of labour (L) and physical capital (K) inputs. In calculating labour input I use a measure of male equivalent employment multiplied by the number of months that an establishment was in operation. The justification for weighting by months in operation is straightforward: an establishment that operates 9 months of the year and has 3 employees uses less annual labour input than a firm that operates 12 months a year and has 3 employees. In order to generate a measurement of labour that is adjusted for the productivity differentials between men, women and children, it is also necessary to assign a weighting scheme to the number of men, women and children employed by an establishment. Following the example of Inwood and Keay (2008) I assign a weight of 1 to male labour, 0.75 to female labour, and 0.5 to child labour. This weighting scheme is consistent with the estimated differences in wages paid to men, women and children in the United States during the mid-nineteenth century as reported in Goldin and Sokoloff (1982). For my measurement of physical capital input I use the establishment specific nominal value of fixed capital as reported in the 1871 Census manuscripts. Having defined my measures of output, labour and physical capital, the establishment specific partial factor productivities (Q_{ij}/X_{ij}) can be calculated as the ratios of establishment specific output to labour, and output to capital respectively. The sector specific national average partial factor productivities ($(Q/X)_{\bar{j}}$) are calculated as the sector specific national average partial productivity of labour and capital respectively.

Under the assumption of perfect competition and constant returns to scale, the input elasticities in equation (2) (SL and SK) are equivalent to the income shares to labour and capital respectively. Inwood and Keay (2005) note that even if the

[6]As part of my sensitivity analysis regressions were run using an alternative specification of output in which I deflated reconstructed value added by the Inwood and Keay (2008) product unit value index. The qualitative conclusions drawn from this alternative specification are consistent with those drawn from the model using non-deflated reconstructed value added, while the quantitative results vary only slightly.

assumptions of perfect competition and constant returns to scale are violated, it is still permissible to use income shares to proxy the input elasticities. If the above noted assumptions fail to hold the presence of scale and market power effects are reflected in the TFP ratios. In my regression analysis I will be able to test for the strength of the relationship between these factors and TFP performance. In order to avoid relying on assumptions regarding the quality of enumeration I use reconstructed income shares to proxy the input elasticities. The income share to labour (SL) is defined as the total annual wage bill divided by reconstructed value added. The income share to capital (SK) is defined as the 30% of nominal value of fixed capital divided by reconstructed value added. By definition the two input elasticities are constrained to sum to 1 for each establishment in the sample. The sector specific national average input elasticities ($SX_{\bar{j}}$) are calculated as the sector specific national average income share to labour and the sector specific national average income share to capital respectively.

Having generated all of the variables to be used in equation (2) it is possible to calculate TFP levels for every establishment in my sample. One method for comparing inter-provincial differences in productivity performance is to simply generate average TFP levels by province ($TFP_{\bar{prov}}$) from the establishment specific TFP values. Table 2 presents the average TFP level in each province relative to that of Ontario for each of the five main sectors and the aggregate manufacturing sector. The provincial average TFP level in Québec falls well below that of Ontario in four of the five sectors. The final column of Table 2 indicates that on average Québec manufacturing establishments were 21.69% less productive than their Ontario counterparts. A difference in means test was performed on the provincial TFP averages for Ontario and Québec using the aggregate manufacturing sector TFP estimates. The results of this test indicate that the average TFP level in Québec was statistically different from that of Ontario at the 1% level of significance. New Brunswick establishments are found to be slightly more productive than Ontario establishments in two of four sectors and slightly less productive in two of four sectors. On average, New Brunswick manufacturers are found to be 1.13% more productive than Ontario manufacturers. A difference in means test was performed on the provincial TFP averages for Ontario and New Brunswick using the aggregate manufacturing sector TFP estimates. The results of this test indicate that the average TFP level in New Brunswick was not statistically different from that of Ontario. Nova Scotia establishments are more productive in two of the four sectors and less productive in two of the four sectors. On average, Nova Scotia manufacturers are found to be 3.97% more productive than Ontario manufacturers. A difference in means test was performed on the provincial TFP averages for Ontario and Nova Scotia using the aggregate manufacturing sector TFP estimates. The results of this test indicate that the average TFP level in Nova Scotia was not statistically different from that of Ontario. Before comparing the results of Table 2 to those of Inwood (1991) it should be noted up front that the two anlyses used different samples with Inwood (1991) using census data and no population density threshold. From comparing the two analyses two notable results can be drawn with respect to the effect of using a sample of urban manufacturing establishments and disaggregated data: first is that Québec manufacturers' TFP performance significantly worsens, and second is that the TFP performance of manufacturers in both of the Maritime provinces significantly improves.

4.2 The independent variables

In this sub-section I present the right hand side variables that are used in equation (1). The variable lnQ is defined as the natural logarithm of establishment specific output. The output measure used is reconstructed value added and is specified as described above. This variable measures establishment size and captures internal scale effects. Three measures of external scale effects are included in the regression equation: the natural logarithm of sub-district[7] specific population density (lnpopden), the natural logarithm of sub-district specific establishment density (lnestden), and the natural logarithm of sub-district specific industrial activity density (lnindden). Sub-district specific establishment density is defined as the total number of manufacturing establishments divided by the geographic area of the sub-district in square miles. Sub-district specific industrial activity density is defined as the aggregate reconstructed value added divided by the geographic area of the sub-district in square miles[8].

The rr variable is a dummy variable that takes a value of 1 if the Grand Trunk Railway passed through the district where an establishment resided[9]. The urb variable is another dummy variable that takes a value of 1 if an establishment resided in a sub-district with a population density that was greater than 5000 people per square mile. This variable is included to capture the agglomeration effects associated with establishments residing in the most densely populated municipalities in Canada in 1871.

The variable lnK/L is defined as the natural logarithm of the establishment specific ratio of physical capital to labour. The capital labour ratio is constructed by dividing the nominal value of fixed capital by male equivalent months of labour. This variable will capture the effect of investment in technology.

[7] I could have also defined the three external density measures at the Census district level instead of the sub-district level. As part of my sensitivity analysis regressions were run using the district specific external density measures. The qualitative conclusions drawn from this alternative specification are consistent with those drawn from the model using the sub-district specific density measures, while the quantitative results vary only slightly.

[8] The sub-district specific establishment and industrial activity density measures are calculated from my sample which includes observations on establishments from the 20 largest manufacturing industries in Canada.

[9] The main line of the Grand Trunk Railway ran from Sarnia, Ontario to Rivière du Loup, Québec. The rr variable takes a value of 1 for establishments residing in districts serviced by the Grand Trunk Railway's main line. However the Grand Trunk Railway also operated subsidiary lines in Canada in 1871. As part of my sensitivity analysis regressions were run using an alternative specification for the railway variable that assigned a value of 1 to establishments residing in districts serviced by *either* the main line or a subsidiary line of the Grand Trunk Railway. The qualitative conclusions drawn from this alternative specification are consistent with those drawn from the model using the rr variable, while the quantitative results vary only slightly.

Next are a series of district specific demographic variables that are included in the model to capture the quantitative and qualitative aspects of the labour market. These district specific demographic variables include: the natural logarithm of the district specific proportion of population that is over the age of 20 and unable to read (lnIL); the natural logarithm of the district specific proportion of population that is female (lnFEM); the natural logarithm of the district specific proportion of the population that is male and of age 16-61 (lnAGE), the natural logarithm of the district specific proportion of the population that is Catholic (lnCATH), the natural logarithm of the district specific proportion of the population whose country of origin of decent is France (lnFRA)[10], and the natural logarithm of the district specific proportion of the population that is foreign born (lnFOR).

The variable lngeo is the natural logarithm of agricultural land quality. The land quality variable was created through a series of steps using Geographic Information System (GIS) analysis. First the latitude and longitude coordinates for the 82 municipalities where the establishments in my sample resided were identified and digitally mapped over top of a map of Canada. Next the CLI data was imported and overlayed over the 82 municipalities. The next step was to create a digital buffer (radius 20 KM) around each of the 82 municipalities. These buffers were used to calculate municipality specific zonal land quality statistics with the zonal area for each municipality being defined by the 20 KM buffer. 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))[11]. For each municipality, the mean value of land quality within the 20 KM buffer is used to define the land quality vari-

[10]The lnFRA variable serves as a proxy for the French speaking population. The 1870-71 Census did not report language spoken.

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

able. 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.

Two dummy variables are included to identify the type of power used by establishments. The dummy variable steam takes a value of 1 if the establishment used steam power. The dummy variable water takes a value of 1 if the establishment used water power[12]. Hand power is designated as the reference group. Finally a set of industry specific dummy variables are included in each sector specific model to control for the fixed effects associated with each industry within a sector.

As part of my diagnostic procedures, statistical tests revealed that each model exhibited heteroskedasticity. The models were re-estimated using robust standard errors to correct for heteroskedasticity.

5 Results

The linear regression estimation results are provided in Table 3[13]. Prior to discussing the results in detail I will begin by making a few general comments. In addition to the five sector specific models I have included the summary regression results in Table 3 under the heading *Manufacturing*. For a number of the variables the sign and significance of the coefficient estimates are similar across the five sectors, while for other variables there is considerable variability. The chemical sector stands apart

[12] As part of my sensitivity analysis regressions were run using an alternative specification in which I combined the water and steam variable into a single power variable which took a value of 1 if an establishment used either water or steam power. The qualitative conclusions drawn from this alternative specification are consistent with those drawn from the model using separate dummy variables for steam and water, while the quantitative results vary only slightly.

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

from the other four sectors in that only one of the model's coefficient estimates is statistically significant. The lack of significant results for the chemical sector can be attributed to the small number of observations that were available for this sector[14]. In my discussion, I will refer to the clothing, food, mineral and wood sectors as the four main sectors, to distinguish these sectors from the chemical sector.

The coefficient estimates for the provincial variables indicate that after controlling for the other determinants of TFP there were significant differences in the inter-provincial TFP performance of manufacturing establishments in 1871. The provincial variables isolate the institutional and other social and economic factors that were province specific but not controlled for by the other explanatory variables included in equation (1). The province variables may 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 or region.

My results indicate that after controlling for the other determinants of TFP New Brunswick manufacturers had the strongest productivity performance of all four provinces. In three of the four main sectors the coefficient estimates are found to be positive and statistically significant at the 5% level. Across these three sectors, the exact percentage change[15] in the predicted TFP level associated with residing in New Brunswick (as compared with Ontario) ranges from a low of 31.84% (mineral) to a high of 40.21% (clothing). The summary regression indicates that New Brunswick manufacturers were 30.63% more productive than Ontario manufacturers, after controlling for the other determinants of TFP.

For the Nova Scotia variable, in three of the four main sectors the coefficient estimates are not statistically different from zero. For the clothing sector the coefficient estimate on the Nova Scotia variable is positive and statistically significant at the 5%

[14]Recall that the chemical sector includes only one industry (asheries). The post-estimation degrees of freedom are included at the bottom of Table 3.

[15]For right hand side variables that are not in logarithmic form I use the expression *exact percentage change* $(100 \cdot [\exp(\hat{\beta}) - 1])$ to distinguish from *approximate percentage change* $(100 \cdot \hat{\beta})$.

level. In this sector the exact percentage change in the predicted TFP level associated with residing in Nova Scotia (as compared with Ontario) is found to be 23.97%. In the summary regression the coefficient estimate for the Nova Scotia variable is statistically significant, but only at the 10% level of significance. The summary regression indicates that Nova Scotia manufacturers were 12.38% more productive than Ontario manufacturers, after controlling for the other determinants of TFP.

The coefficient estimates for the Québec variable is found to be negative and statistically significant at the 5% level across each of the four main sectors. The exact percentage change in the predicted TFP level associated with residing in Québec (as compared with Ontario) ranges from a low of -28.01% (mineral) to a high of -17.14% (food). The summary regression indicates that Québec manufacturers were 23.15% less productive than Ontario manufacturers, after controlling for the other determinants of TFP.

Previous literature on the Canadian manufacturing sector in the late nineteenth century has identified that the Maritimes were an important manufacturing region during this era[16], thus the strong productivity performance of the Maritime provinces is not a complete surprise. However the finding that, after controlling for the other determinants of TFP, Maritime manufacturers out-performed Ontario manufacturers is a surprising result. When compared with the unconditional inter-provincial productivity differentials reported in Table 2, the results of the regression analysis project a much more favorable depiction of the productivity performance of the Maritime provinces. Specifically New Brunswick manufacturers' productivity advantage over Ontario improves by 29.5 percentage points in the controlled analysis[17]. By the same comparison, Nova Scotia manufacturers' productivity advantage over Ontario increases by 8.41 percentage points in the controlled analysis. There is little differ-

[16] See for example: Norrie and Emery (2002, p.168), and Savoie (2001, 15-32).

[17] For this comparison I use the Manufacturing TFP ratios from Table 2 and the exact percentage change as calculated from the summary regression results (i.e. the Manufacturing column) in Table 3.

ence in the overall portrayal of Québec manufacturers between the conditional and unconditional analysis. In the unconditional inter-provincial analysis Québec manufacturers trail Ontario manufacturers by 21.69%, while in the regression analysis the gap is 23.15%. It is interesting to question which control variables in equation (1) account for the significant improvement in the depiction of Maritime manufacturers' TFP performance in the conditional versus unconditional analysis. In discussing the remaining signficant variables from the regression results I will contextualize my comments by highlighting those variables that are most likely to account for the improved portrayal of Maritime manufacturers' productivity performance in the controlled analysis.

The results indicate that internal economies of scale were present in the Canadian manufacturing sector in 1871. In each of the four main sectors the coefficient estimate for the natural logarithm of establishment specific output is positive and statistically significant at the 1% level. The summary regression indicates that a 1% increase in reconstructed value added is associated with a 0.1249% increase in a manufacturers' level of TFP. That establishment size is an important determinant of productivity in the Canadian manufacturing sector in 1871 is consistent with the earlier research of Inwood and Keay (2005). Inwood and Keay found that a 1% increase in gross output was associated with a 0.045% increase in 1871 Canadian manufacturing establishments' TFP level relative to U.S. manufacturing establishments. Based on the manufacturing establishments in my sample, the average reconstructed value added for Ontario manufacturers was 8.73% below that of the average Nova Scotian manufacturer. In contrast the reconstructed value added of the average Ontario manufacturer was 30.56% higher than the average New Brunswick manufacturer. By means of a counterfactual exercise it can be predicted that, had New Brunswick manufacturers' average reconstructed value added been equal to that of Ontario, the average New Bruswick manufacturer's TFP level would have improved by approximately 3.82

percentage points[18]. Controlling for establishment specific output *improves* the depiction of the productivity performance of New Brunswick manufacturers, since had I not controlled for this variable the correlation between the smaller New Brunswick establishments and lower TFP levels would have been absorbed by the New Brunswick variable and reflected in a smaller coefficient estimate.

For each of the four main sectors, the three measures of external scale effects are found to be not statistically significant at the 5% level[19]. Additional evidence against the existence of agglomeration economies is found in the fact that the urban dummy variable (urb) is not statistically significant in each model[20]. The results suggest that external economies of scale were not available to Canadian manufacturing establishments in 1871. However caution should be exercised in drawing this conclusion since my sample only includes manufacturing establishments that resided in sub-districts having a population density greater than 1000 people per square mile. There remains the possibilty that establishments residing in sub-districts falling below the population density threshold were at a disadvantage due to their lower density levels. Yet the earlier findings of Inwood and Keay (2005) suggest that a more general conclusion may in fact be warranted regarding the absence of agglomeration economies in the 1871 Canadian manufacturing sector. In their analysis of the TFP performance of Canadian (relative to U.S.) manufacturing establishments, Inwood and Keay used the same three external scale measures and found two of the measures (establishment

[18] All counterfactual exercises are calculated based on the results from the the summary regession.

[19] The three measures of external scale were found to be highly positively correlated. The high degree of correlation among these three variables allows for the possibility that the variables are jointly signficant even though they were not found to be statisically significant individually. To evaluate this possibility two post-estimation tests were performed. In the first I tested against the null hypothesis that the three variables were jointly equal to zero ($H_0 : lnpopden = 0; lnestden = 0; lnindden = 0$). In the second I tested against the null hypothesis that the sum of the effects of the three variables was equal to zero ($H_0 : lnpopden + lnestden + lnindden = 0$). In each sector model, there was insufficient evidence to reject the null hypothesis for both tests which suggests that the three external scale variables are neither individually nor jointly significant.

[20] An alternative model specification was also run in which I excluded the urban dummy variable from the model. The qualitative conclusions drawn from this alternative model specification are consistent with those above, while the quantitative results vary only slightly.

and industrial activity density) to be not statistically significant, while the third measure (population density) was actually found to be negatively correlated with TFP performance. In contrast with my project, Inwood and Keay did not use a population density threshold in defining their sample. In sum, the evidence indicates that external scale effects were not an important determinant of the TFP performance of Canadian manufacturing establishments in 1871.

In two of the four main sectors (clothing and wood) the natural logarithm of the capital labour ratio is positive and statistically significant at the 1% level. This suggests that for these two sectors investment in technology was an important determinant of TFP performance. The summary regression indicates that a 1% increase in the capital labour ratio is associated with a 0.0297% increase in establishment specific TFP performance. Based on the manufacturing establishments in my sample the average capital labour ratio of Ontario manufacturers was 15.72% less than that of Nova Scotian manufacturers. In contrast the average capital labour ratio of Ontario manufacturers was 94.56% higher than that of New Brunswick manufacturers. Had New Brunswick manufacturers' average capital labour ratio been equal to that of Ontario, it is predicted that the average New Brunswick manufacturer's TFP level would have improved by approximately 2.81 percentage points. Controlling for manufacturers' capital labour ratio improves the depiction of the TFP performance of New Brunswick manufacturers. Had I not controlled for this variable the correlation between the lower capital labour ratio of New Brunswick establishments and lower TFP levels would have been absorbed by the New Brunswick variable and reflected in a smaller coefficient estimate.

The results in Table 3 indicate that the district specific social and cultural attributes of the population had an important influence on the TFP performance of Canadian manufacturing establishments in 1871. In the summary regression the coefficient estimates for the lnCATH, lnFRA, and lnFOR variables are each statistically significant at the 1% level. The summary regression indicates that a 1% increase in the district specific proportion of the population that was Catholic is associated with a 0.0808% decrease in establishment specific TFP level. The summary regression also indicates that a 1% increase in the proportion of the district population whose country of origin was France is associated with a 0.0488% increase in establishment specific TFP level. This result suggests that, after controlling for the other determinants of TFP performance, establishments residing in districts having a high francophone population were associated with higher TFP levels. The summary regression results also suggest that establishments residing in districts having a higher proportion of immigrants were assoicated with higher TFP levels, after controlling for the other determinants of TFP performance. Based on the summary regression results, a 1% increase in the proportion of the population that was foreign born is associated with a 0.0771% increase in establishment specific TFP level. The improvement in the portrayal of the TFP performance of Maritime manufacturers in the controlled analsysis can also be partially attributed to the inclusion of the social and cultural variables. For example, the average district specific proportion of the population that was Catholic was considerably higher in both Nova Scotia and New Brunswick as compared with Ontario. Had I not controlled for this variable the correlation between the higher proportion of Catholics in the Maritime provinces and lower TFP levels would have been absorbed by the Maritime province variables and reflected in smaller coefficient estimates.

The agricultural land quality variable is found to be positive and statistically significant for the clothing sector and summary regression at the 5% level of significance. The summary regression indicates that a 1% increse in land quality is associated with a 0.0474% increase in establishment specific TFP level. On average land quality in Ontario is much higher than land quality in the Maritime provinces. Therefore including a land quality control variable vastly improves the depiction of the TFP performance of Maritime manufacturers. Had I not controlled for land quality the correlation between the lower land quality in the Maritime provinces and lower TFP levels would have been absorbed by the Maritme province variables and reflected in much smaller coefficient estimates. For comparison purposes an alternative model specification was run in which I dropped the lngeo variable from the list of right hand side variables. As predicted, omitting the lngeo variable results in a substantial drop in the coefficient estimates for the New Brunswick and Nova Scotia variables. More precisely, omitting the lngeo variable results in a decrease of 9.83 percentage points in the productivity advantage of New Brunswick over Ontario, after controlling for the other determinants of TFP performance. Similarly Nova Scotia's productivity advantage over Ontario drops by 10.26 percentage points, holding constant the other determinants of TFP performance. Therefore the improvement in the portrayal of the TFP performance of Maritime manufacturers in the regression analysis is largely due to the inclusion of the land quality control variable.

There are a number of other interesting results in Table 3 that I will discuss briefly, though none of the variables discussed below are likely to account for the improved depiction of the TFP performance of Maritime manufacturers in the controlled analysis. It is surprising that the illiteracy variable is found to be *positive* and statistically significant at the 1% level in both the wood sector and summary regression. This result is surprising in that it contradicts the theory that human capital is positively correlated with productivity performance. Another unexpected result is that the coefficient estimate for the steam dummy variable is *negative* and statistically significant at the 5% level in the clothing and summary regression. It is difficult to explain why firms that had adopted steam power would have been assoicated with lower levels of TFP performance, holding all other factors constant. Finally the results for lnAGE variable are mixed in the sense that the coefficient estimates for this variable are negative and statistically significant at the 5% level in two sectors (clothing and food), and positive and statistically significant at the 1% level in the mineral sctor. It is hard to explain what accounts for the negative correlation between lnAGE and TFP performance in the clothing and food sectors, while the positive coeffient estimate for the mineral sector is a logical result since the physical nature of the industries in this sector would have required a youthful work force. The above results raise several additional questions that could be pursued in greater depth in future research. For example, the positive coefficient on the illiteracy variable may explained by there having been certain industries within the Canadian manufacturing sector in 1871 that simply required a large pool of low skilled labour. One potential avenue for future research would be to split the sample by separating manufacturing industries into two groups: low skill industries and high skill industries. It would be interesting to investigate if the positive associtation between illiteracy and TFP performance persisted under such a specification.

6 Conclusion

The objective of my project was to discover the determinants that were most influential in accounting for differences in TFP performance across Canadian manufacturing establishments in 1871. The results of the regression analysis indicate a positive correlation between TFP performance and establishment size, establishment's capital labour ratio, and the quality of land in the region where the establishment resided. The social and cultural attributes of the district where the establishment resided were also found to strongly influence the TFP performance of manufacturing establishments.

Inter-regional differences are also important in explaining the TFP performance of Canadian manufacturing establishments during this era. In my uncontrolled analysis I generated provincial average TFP ratios which indicated that the average establishment's TFP level in Ontario, New Brunswick and Nova Scotia were roughly equivalent. In contrast, the average TFP level for Québec manufacturers was found to be considerably lower than that of Ontario manufacturers. In comparison with the earlier research of Inwood (1991) my results illustrate that excluding rural establishments and using disaggregated data results in a less favourable depiction of Québec manufacturers' TFP performance and a more favorable portrayal of Maritime manufacturers' TFP performance.

The regression results illustrate that moving from an uncontrolled to a controlled analysis further improves the depiction of Maritime manufacturers' TFP performance, while the bleak portrayal of the productivity of Québec manufacturers persists. The vast improvement in the depiction of Maritime manufacturers' TFP performance is largely accounted for by the inclusion of a control variable for land quality in the regression model. Other control variables that improve the portrayal of Maritime manufacturers' TFP performance include the district specific social and cultural variables, and for New Brunswick, the control variables for establishment size and capital labour ratio.

My results have important implications for the debate concerning the historical roots of the legacy of decline in the Maritime manufacturing sector. Drawing from the staples thesis, some have suggested that the failure of the Maritime provinces to keep pace with the process of industrialization in Central Canada is owing to the poor natural resource endowment of the Maritime region. My results provide some support for this line of reasoning in that the land quality variable is found to be positively correlated with TFP performance. However despite exceptionally low land quality, the TFP performance of Maritime manufacturers was found to be at least as strong as Ontario manufacturers in both the controlled and uncontrolled analysis. This suggests that despite the fact that the Maritime region was handicapped by its lack of quality land, the region's manufacturers had nonetheless found the means to compete on an equal footing with Ontario manufacturers in 1871.

The failure of the Maritime region to industrialize at the same pace as Central Canada might also be explained by the determinants of TFP that are frequently cited by contemporary economic growth theorists such as establishments' size and capital labour ratio. My results provide support for this perspective in that both of these variables are found to be positively correlated with TFP performance. However, Nova Scotia manufacturers had higher mean values for these variables as compared with Ontario; and in New Brunswick, while manufacturers had lower mean values for these variables, the provincial average TFP performance was found to be at least as strong as that of Ontario in both the controlled and uncontrolled analysis. This again suggests that New Brunswick manufacturers were competitive with Ontario manufacturers despite their small size and limited use of capital in production.

Those of the structuralist perspective have argued that the demise of the manufacturing sector in the Maritime region was the result of political rather than economic forces. The scope of my analysis does not allow me to fully assess the merits of the structuralists' perspective. In particular the fact that my data pre-dates the National Policy (1879) and the other federal policies often cited by structuralists prevents me from assessing their argument in any detail. I can only conclude that the structuralists' arguments can not be ruled out entirely because at the time of Confederation the competitive position of Maritime manufacturers was at least even with that of Ontario manufacturers, as proxied by the TFP performance of the establishments in my sample. That is, the structuralists' argument cannot be rejected outright based on the argument that uneven inter-provincial industrial development occurred as a result of Maritime manufacturers having *always* been less productive than Central Canadian manufacturers.

In my analysis I have uncovered a host of variables that influenced Canadian manufacturers' TFP performance and demonstrated that there existed considerable inter-provincial variation across these variables during this era. Despite these findings, my results provide no clear cut answers to the question of why the Maritime provinces failed to industrialize at the same pace as Central Canada in the late nineteenth and early twentieth century. The overwhelming conclusion of this paper is that the precipitous drop in the competitive position of the Maritime manufacturing sector relative to that of Ontario manufacturers had not yet occurred as of 1871. Although I cannot identify the events and/or factors that eventually led to the demise of the Maritime manufacturing sector, I can conclude with confidence that as of 1871 the influence of these events and/or factors had not yet fully taken effect. In future research I would encourage further analysis of this question using panel data for the post-Confederation period, provided that such data exists.

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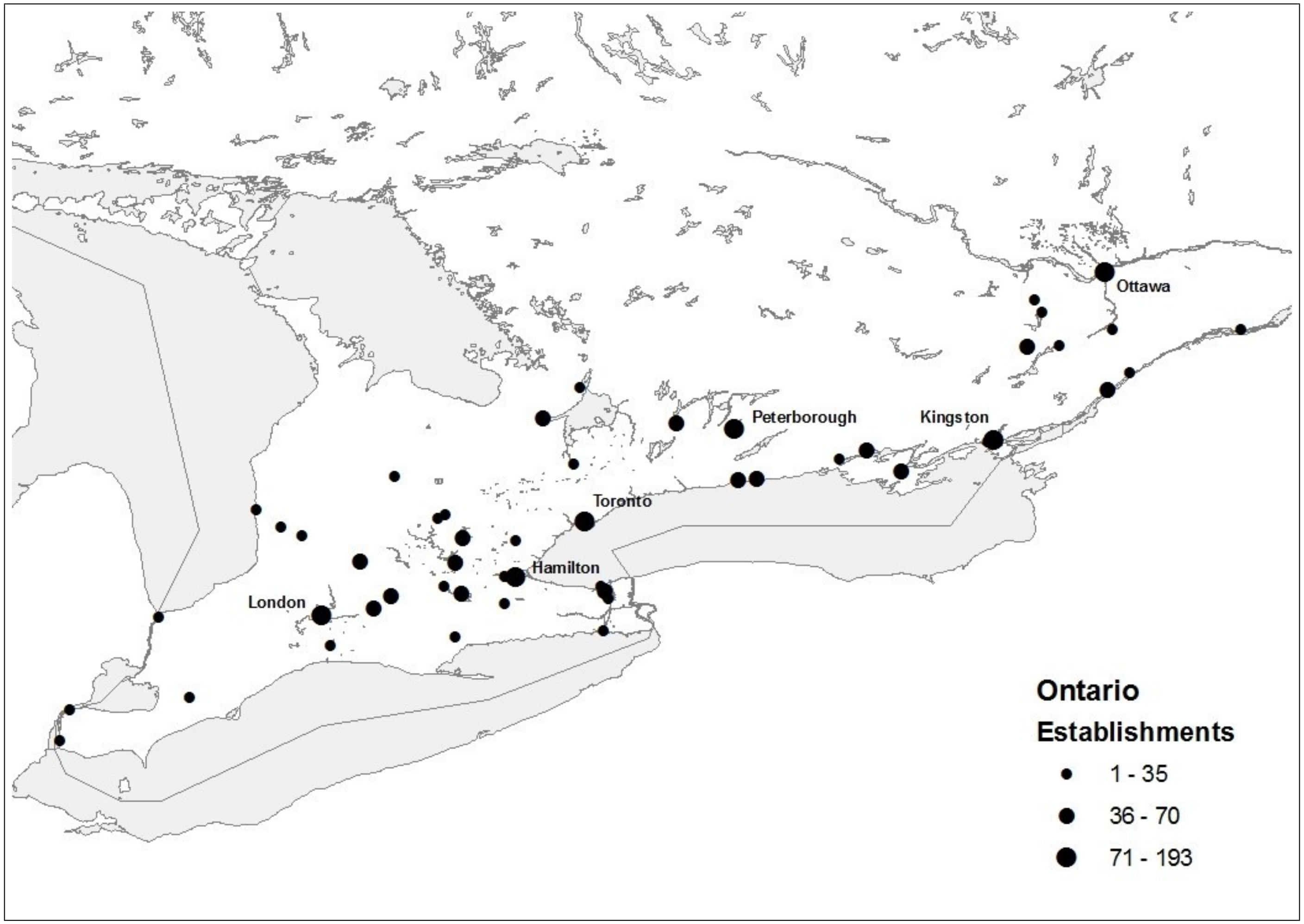

Figure 1: Manufacturing Establishments by Municipality - Ontario

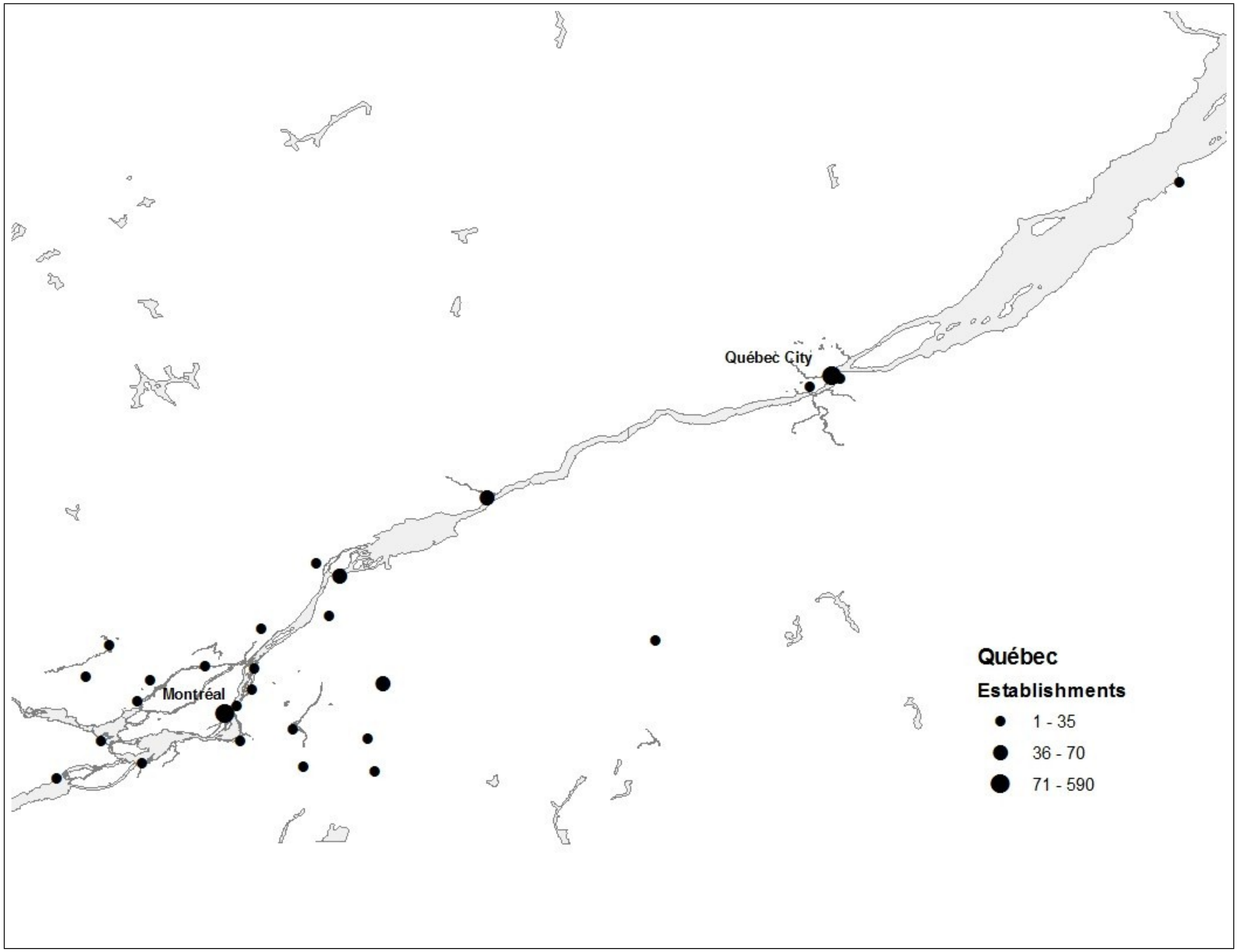

Figure 2: Manufacturing Establishments by Municipality - Québec

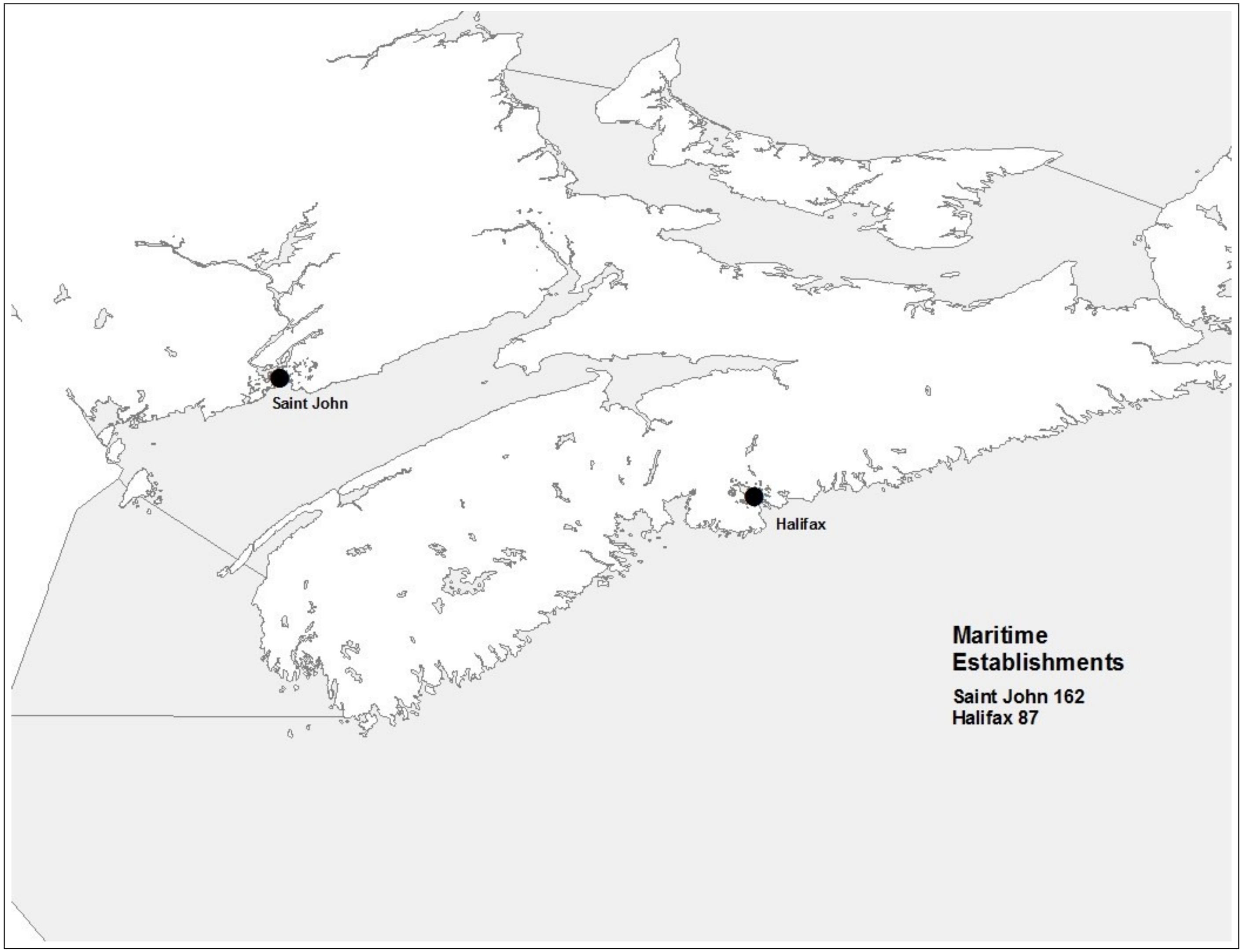

Figure 3: Manufacturing Establishments by Municipality - Maritimes

Tables

Table 1: Industries and Number of Observations by Sector

Clothing		**Food**		**Mineral**		**Wood**		**Chemical**	
Shoes	580	Bakeries	380	Blacksmithing	354	Boat Building	29	Asheries	33
Harnesses	197	Flour Mills	55	Foundries	181	Carpernters	94		
Tailors	687			Furnaces	245	Carriages	308		
Tanneries	129			Lime Kilns	19	Cabinets	193		
Weavers	44					Cooperage	111		
						Doors	66		
						Saw Mills	41		
						Shingle	41		
Total	1637		435		799		883		33

Table 2: Provincial Average TFP Ratios Relative to Ontario

	Clothing	Food	Mineral	Wood	Chemical	Manufacturing
$TFP_{\bar{QC}}/TFP_{\bar{ON}}$	0.7868	0.8470	0.7484	0.7924	1.0024	0.7831
$TFP_{\bar{NB}}/TFP_{\bar{ON}}$	0.9986	1.0717	1.0525	0.9599		1.0113
$TFP_{\bar{NS}}/TFP_{\bar{ON}}$	1.0822	0.8951	1.1062	0.9795		1.0397

TFP provincial averages are calculated based on establishment specific TFP relative to a national sector specific aveage

None of the chemical sector establishments in my sample resided in either Nova Scotia or New Brunswick

Table 3: OLS Estimates of the Determinants of 1871 CND Manufacturing Establishment TFP

	Clothing	Food	Mineral	Wood	Chemical	Manufacturing
lnQ	0.1258***	0.1559***	0.1457***	0.1079***	0.0646	0.1249***
	(0.0090)	(0.0201)	(0.0145)	(0.0127)	(0.0838)	(0.0060)
lnpopden	-0.0343	0.0682*	-0.0115	0.0208	0.1367	0.0054
	(0.0264)	(0.0372)	(0.0354)	(0.0325)	(0.1631)	(0.0160)
lnestden	0.0291	-0.0140	-0.0023	-0.0388	-0.4077**	-0.0050
	(0.0243)	(0.0301)	(0.0265)	(0.0249)	(0.1854)	(0.0135)
lnindden	-0.0160	-0.0244	-0.0098	0.0183	0.1560	-0.0082
	(0.0172)	(0.0196)	(0.0170)	(0.0169)	(0.0943)	(0.0092)
QC	-0.2083***	-0.1880**	-0.3286***	-0.2718***	-1.1248	-0.2633***
	(0.0550)	(0.0746)	(0.0558)	(0.0609)	(0.7472)	(0.0304)
NB	0.3380***	0.3129**	0.2764***	0.2049*	dropped	0.2672***
	(0.0901)	(0.1421)	(0.1035)	(0.1054)		(0.0527)
NS	0.2149**	-0.0232	0.1210	0.0989	dropped	0.1167*
	(0.1062)	(0.1703)	(0.1125)	(0.1053)		(0.0602)
rr	0.0350	0.0650*	-0.0273	0.0064	0.0873	0.0207
	(0.0254)	(0.0377)	(0.0309)	(0.0324)	(0.1138)	(0.0154)
urb	0.0873	-0.0430	0.0221	-0.0462	0.4557	0.0201
	(0.0539)	(0.0672)	(0.0617)	(0.0588)	(0.6148)	(0.0303)
lnK/L	0.0257***	0.0115	0.0147	0.0488***	0.1235	0.0297***
	(0.0097)	(0.0169)	(0.0137)	(0.0138)	(0.0828)	(0.0063)
lnIL	0.0603	0.0305	0.0561	0.1284***	0.3502	0.0795***
	(0.0464)	(0.0618)	(0.0555)	(0.0466)	(0.2513)	(0.0262)
lnFEM	0.2974	-1.2990	-0.7124	-0.0476	-0.6347	-0.2205
	(0.6566)	(0.8872)	(0.7436)	(0.6809)	(3.5612)	(0.3660)
lnAGE	-0.8341**	-0.9728**	1.4598***	0.4415	-0.7259	-0.0190
	(0.3657)	(0.4628)	(0.4432)	(0.3787)	(1.7523)	(0.2083)
lnCATH	-0.1314***	-0.0418	-0.0304	-0.0533	-0.2027	-0.0808***
	(0.0311)	(0.0443)	(0.0405)	(0.0401)	(0.2189)	(0.0193)
lnFRA	0.0514***	0.0345	0.0752***	0.0308	0.0549	0.0488***
	(0.0185)	(0.0267)	(0.0217)	(0.0195)	(0.0763)	(0.0106)
lnFOR	0.0954***	0.0426	0.0652***	0.0876***	-0.2967	0.0771***
	(0.0220)	(0.0327)	(0.0233)	(0.0261)	(0.3449)	(0.0125)
water	0.1348	0.0130	-0.0313	-0.0020	dropped	-0.0428
	(0.1868)	(0.0824)	(0.0586)	(0.0466)		(0.0335)
steam	-0.1996***	0.0481	-0.0004	0.0105	0.0243	-0.0479**
	(0.0441)	(0.0651)	(0.0472)	(0.0342)	(0.1894)	(0.0224)
lngeo	0.0814**	0.0547	0.0178	0.0490	-0.0555	0.0474**
	(0.0395)	(0.0631)	(0.0406)	(0.0433)	(0.2426)	(0.0223)
$r2_a$	0.3524	0.2962	0.3607	0.3348	0.3105	0.3660
df_r	1613	414	776	856	16	3748

* p< 0.10, ** p< 0.05, *** p< 0.01

Standard errors are in parentheses.

Variables in all caps are proportions of the district population

Adjusted R^2 and degrees of freedom (post-estimation) are listed at bottom of table