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Abstract

It is well known that by the end of the 19th century, the French inhabitants of Canada (mostly located in Quebec) were appreciably shorter than English natives of Canada (Cranfield and Inwood 2007). Nothing, however, is known as to the extent and the causes of those differences at earlier points in time. This paper uses a novel dataset of heights collected from the records of the Quebec City prison between 1813 and 1847 to survey ethnic differences in heights within the population of Quebec – which was then known either as Lower Canada or Canada East. Using a birth-cohort approach, we find that the French-Canadian prisoners were smaller than their English, Scottish and Irish counterparts. All ethnic groups in our dataset exhibit a decline in heights during the time period in question. This gap was not as big as it would come to be later in time. French-Canadians are also significantly shorter than Americans, roughly equal to those who remained in the United Kingdom, and taller than the inhabitants of France and Latin America. We highlight the key structural economic changes and shocks and discuss their possible impact on the anthropometric data.

Keywords: Canadian history, anthropometric history, antebellum puzzle, stature

JEL Codes: N31, O10, I14

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Introduction

Across Canadian provinces, there are substantial differences in income measurements. Provinces are also distinct when compared in terms of anthropometric data concerning stature. Generally, these differences can be accounted by population density, income differences and proximity of trade networks, with "one striking exception" (Cranfield and Inwood 2014: 234): the predominantly catholic and French-speaking province of Quebec.

Generally, scholars do not believe the average height of large populations to be heavily affected by genetics (Steckel 1995), since most differences found across regions boil down to socio-economic factors. However, this might not hold in certain cases. If a population migrated to a new area and this initial pool of settlers had a markedly different genetic composition from other populations while refusing to marry across ethnic lines, differences could persist over time in spite of socio-economic differences. This possibility has been entertained in the context of Quebec, in order to explain lasting stature differences. However, since there is no stature data prior to the mid 19th century, this remains hypothesizing (Cranfield and Inwood 2015). Finding new data to tackle this issue is the prime motivation of our research.

However, in the process we can also answer two additional (and important) questions. The first relates to a thorny issue in Canadian history. After the conquest of Quebec by the British in 1760, the French (and Catholic) inhabitants of the colony were economically and politically subordinate to their new rulers. In the decades that followed (the starting point is subject to debate), the living standards of the French would begin to diverge from those of the English population in Canada. However, little is known about the comparative standard of living of French-Canadians. The use of stature data for the early days of British rule in Canada may provide a first step towards tackling this issue. The second question relates to statures in the New World relative to those in the Old World. The example of the Thirteen Colonies and later the US, and also the later 19th century comparisons of Britain and Canada, lead us to think that New Worlders were always in better health and taller than Old Worlders (on average). The question we ask is whether or not this was consistently true. We believe that stature data for French-Canadians from the late 18th century and early 19th century can help answer those issues.

At present, the data available for French-Canadians is limited to the late 19th century. To move further back in time and use the registers of the prison of Quebec City between 1813 and 1847, coupled with a cohort-based approach, would allow us to extrapolate to birth cohorts in the

1760s – at a point well before French-Canadians began to intermix with other groups. This means that we can find data for individuals born between 1780 and 1830 – making this dataset the earliest available measurement of heights in Canada. The great advantage of the Quebec City data is that there is a large contingent of French-Canadian prisoners who were born in North America. The second major advantage is that it contains a sizeable sample of heights of Irishmen, Scotsmen and Englishmen jailed in the prison with which to compare our data to assess quality. As a result, we can create a comparison between the heights of French-Canadians with the heights of the inhabitants of the United States, France and the United Kingdom.

French-Canadians were quite short from the beginning of our dataset, and shorter than the same cohorts of different ethnicities (English, Irish and Scottish). Throughout the time period we study, all ethnic groups share the same movements in stature (mostly associated with war shocks), but French-Canadians remain consistently shorter. These initial differences suggest that the economic subordination of the French-Canadian population following the conquest did not initiate this difference, but it may have widened it. We also find that French-Canadians are taller than their French counterparts (by an appreciable margin). Given that France was the mother society of Quebec, this suggests that the genetic explanation provides only a minor share of the answer to the causes of height differences. The declining stature of French-Canadians while there were signs of positive economic growth (Bédard and Geloso 2014; Paquet and Wallot 2007) inscribes this population in the well-documented tendency of heights in other countries to fall for large parts of the 19th century. Finally, we find that French-Canadians were shorter than both white Americans and black Americans, taller than Latin Americans, and roughly as tall as the Irish, the Scots and the English who remained in the United Kingdom.

Literature review

The inhabitants of Quebec have a peculiar history when compared to the rest of North America. Unlike people in the American colonies or the British settlements in Canada, most of the current 8 million inhabitants of Quebec can be linked to a very small number of settlers (roughly 10 000) who migrated from France (Moogk 1989; Charbonneau, Desjardins, Légaré and Denis 2000). The population that descended from French settlers tended to marry within the community, and marriages with English settlers who arrived after the conquest of Quebec in 1760 were generally shunned (although they did occur). This has led to "founder effects,"

meaning that the genetic traits of this group have a relatively large impact in determining differences in health outcomes (Laberge et al. 2005; Gagnon and Heyer 2001).

Founder effects are well admitted in demography, but since the initiation of settlement in the 17th century, they are believed to have diluted as a result of immigration. However, in Quebec, the key point to underline is that intermarriage across ethnic lines was not common, although it did occur between Irish and French-Canadians, as both ethnic groups were Catholic (Tremblay et al. 2009), which facilitated intermingling. As a result, some scholars argue that founder effects were potentially a stronger factor, which could translate into differences in *potential* stature. This genetic factor could explain why Quebecers tend, even after controlling for other variables, to be shorter than other Canadians.

The problem is that the data available with regards to heights – as it currently stands – cannot tell us much about whether founder effects did indeed apply. The earliest data point now available is provided by Cranfield and Inwood (2007 and 2015). They find that French-Canadians born in the late 19th century were indeed shorter than other Canadians. In their work, they summarize the data that follows these initial differences and they persist to the present day (see their 2015 work).

However, the late 19th century is marked by disappointing economic performance on the part of Quebec (Geloso 2013), and the gap in heights could have emerged in the course of the 19th century as a result of Quebec's poverty relative to the rest of Canada. Cranfield and Inwood's work suggests that genetics does not appear to be a "promising" factor (2015: 248) to account for the differences. Aware of the limitations of their data, they argue that socioeconomic factors can only explain a small share of the differences and that cultural factors should not be disregarded. In order to establish the proper importance of cultural, genetic and socioeconomic factors, they propose a multi-prong research agenda that focuses on genetic markers for heights.

We believe that there is an easier solution: to move back in time to find data on height. Finding a dataset of height measurements at earlier points in time, before the population of the British Isles and the descendants of the initial French settlers began to intermarry, would allow us to determine the importance of genetics as a factor. A comparison with the heights of inhabitants of France (the mother society of Quebec) would then be possible. If French-Canadians were taller than the French, then the genetic factor would be relegated to a minor role.

In addition, we could learn whether or not the height gap between French- and English-Canadians is a product of socioeconomic evolution in the 19th century. This second beneficial effect of constructing a database of heights in earlier periods would also provide additional measures of the evolution of living standards in Canada at a crucial point in time. In 1760, the British conquered Quebec and, although they tolerated the legal and religious institutions of the colony (Geloso 2015), they economically subordinated the French-Canadian inhabitants of the region. Thereafter, socio-economic outcomes for French-Canadians would differ from the rest of Canada. The impact of this subordination has been disputed. Some, like historian Fernand Ouellet (1966), believe that the conquest had little to do with the divergence, while others, including Séguin (1947), Frégault (1955) and Egnal (1996; 1998), hold the opposite viewpoint, and believe that 1760 was the beginning of divergence. Solving this issue is problematic, in that there is little data with which to measure the actual amplitude of the divergence (some, such as Paquet and Wallot 2007, refute the idea of divergence altogether). At present, we have evidence regarding wages and income in Quebec relative to the rest of Canada from the 1870s onward (Green 1969; Inwood and Irwin 1993; Altman 1988; Geloso 2013; Brown and MacDonald 2015). We also have a significant quantitative effort deployed by Geloso (2015), which covers living standards by reconstructing GDP, real wages and agricultural productivity from the late 17th century up to 1760. However, for everything between 1760 and 1870, we face a void. There exists a substantial gap in information for this period concerning the level and evolution of living standards – although *some* evidence does exist, but only at one later point in time (McInnis 1992). In finding stature data to compare French-Canadians with the French in the late 18th century, we can also assess the gap in socio-economic outcomes early after the beginning of British rule. In doing so, we provide a first step in assessing the role of the conquest.

Simultaneously, the provision of early data for stature in Canada could also provide evidence of whether or not individuals in the New World were consistently taller than those in the Old World. In the last decades, the use of anthropometric data related to height and body mass has grown substantially among economists, economic historians and development experts (Deaton 2013; Fogel 2004; Floud et al. 2011; Steckel 1995) in order to complement the measurement of national income. A short summary of the stylized facts that emerged can be made: individuals in the New World are taller than those in the Old World and, for many countries, the early decades of the 19th century were not associated with improvement in heights,

even though there was significant economic growth (Steckel and Costa 1987; Fogel 2004; Komlos 1998; Haines 2004; Floud et al. 2011). Obtaining Canadian data for the same time period could reveal whether it is consistently true that New Worlders were taller than Old Worlders, and whether Canada also saw a decline in heights in the 19th century.

In this paper, we use data from the prison of Quebec City, which allows us to provide answers on all three fronts.

Prison data

The Bibliothèque et Archives Nationale du Québec (National Library and Archives of Québec) have recently made available the database of prison records digitized by genealogists and Mormon visitors to Quebec (BANQ 2015). This database was kindly made available to us by Rénald Lessard of the BANQ, which rendered the production of the present article possible. Two prisons kept extensive records: the prison of Montreal and the prison of Quebec City. The former was established after the latter and only the latter contains data on heights. As a result, our data comes only from Quebec City – a port city with a large fluctuating population (sailors, workers from outside the city doing seasonal work, etc.) (Fyson and Fenchel 2015:4). The prison, operative between 1814 and 1867, is located in downton Quebec City (on a street called *Chaussée des Écossais* – "the Scottish causeway").

One advantage of this database is that there exists a set of guidelines concerning the upsides and downsides of using prison records. These guidelines take the form of a very exhaustive article by Fyson and Fenchel (2015), who review the quality of prison registers and expound on the pitfalls and potential uses of this source. In a way, their work offers a road map to our using the data for Quebec City. The use of prison registers is not new for economic historians and, as a result, the road map to properly using them is now complete (Ó'Gráda 1991).

The record-keeping quality is in line with what one could expect from 19th-century sources. The colonial government did not prescribe the manner by which information was to be registered. Progressively, as a result of the requests of the Colonial Office in London, an increasing amount of information was recorded in a more detailed manner.

Nonetheless, there are problems. For example, heights of admitted prisoners were not recorded between 1827 and 1834. In addition, age was not consistently reported. Not all data points were associated with an observation about age, which is problematic in an attempt to recreate birth cohorts. In the period between 1813 and 1847, there were 28 419 prison records.

Of those, 28 387 specified the year of admission, while only 17 909 specified prisoners' ages. Observations about heights were matched with an observation about age and age of imprisonment in 15 957 cases. Of those, 11 786 are male. We will not consider female prisoners. The reason for excluding them does not stem from their numbers (3,766), but to the segregated measurement of heights by gender. Fyson and Fenchel highlighted how height heaping did not appear to be a problem for men, but that it was indeed an issue for women – 40% of height observations for women reported exactly 62 inches (Fyson and Fenchel 2015: 14). Fyson and Fenchel explained that when female prisoners were measured, measurements were taken by a female official. Most of the 62 inches observations are observed under the tenure of one single official, who measured heights very poorly. (Ibid: 14–17). Table 1 below presents the features of the entire prison population we used.

Table 1: Descriptive statistics of the database when observations for heights were available (entire database and selection for this paper)

	Number (entire database)	Number (males aged 20 to 50)
French-Canadian	3005	1542
English	4128	3112
Irish	6154	2976
Scottish	1448	1055
Others[a]	1270	Not used
Born prior to 1780s	201	Not used
Born 1780s	772	269[c]
Born 1790s	1395	931[c]
Born 1800s	2455	1509[c]
Born 1810s	6553	3782[c]
Born 1820s	4478	2194[c]
Born after 1820s	805	Not used
Male	12414	8685
Female	3860	-
Age below 20[b]	1800	-
Age 20 to 30[b]	7658	5495[d]
Age 30 to 40[b]	2494	2164[d]
Age 40 to 50[b]	911	1066[d]
Age above 50[b]	1371	-

Notes: a) Others is composed of Italians, Americans, French, Other British North American Colonies, Germans, Swedes and unreported ethnicities. b) the sum of all groups will be less than the sums of all ethnicities and birth for the entire database and that issue does not apply for the male population we use for this paper. c) the cohorts are limited to those we study in this paper, thus French-Canadians, the Irish, the Scots and the English. d) the age cohorts concern only the ethnic groups we consider.

Before proceeding to presenting the results, we deem it necessary to underline what we believe to be the limitations of our dataset. In terms of limitations caused by the data explicitly contained in the registers, the two main problems pertain to the absence of occupational data and the impossibility to distinguish Canadian-born Englishmen. The occupations of prisoners were not properly recorded until the 1860s (Fyson and Fenchel 2014: 4). Consequently, we do not possess information about the socio-economic background of prisoners beyond their ethnicity. If there were large differences in the socio-economic background of prisoners along ethnic lines, the differences in stature observed across ethnic groups might be biased (this issue is discussed further below). Secondly, we can be certain of birthplaces for only one ethnic group: French-Canadians. Individuals from France were recorded as "French" and not as "Canadian," which means that it is safe to assume that all people with French last names who were registered as "Canadians" were natives of Canada. For all the other groups, we cannot ascertain with certainty whether they were born in their ethnic group's native country or in Canada. Although we believe that these problems should not discourage an analysis of the data as it stands, future research should aim to try to create "census-linked" entries in order to match prisoner entries with enumerated individuals in the census, so as to identify place of birth and socio-economic background.

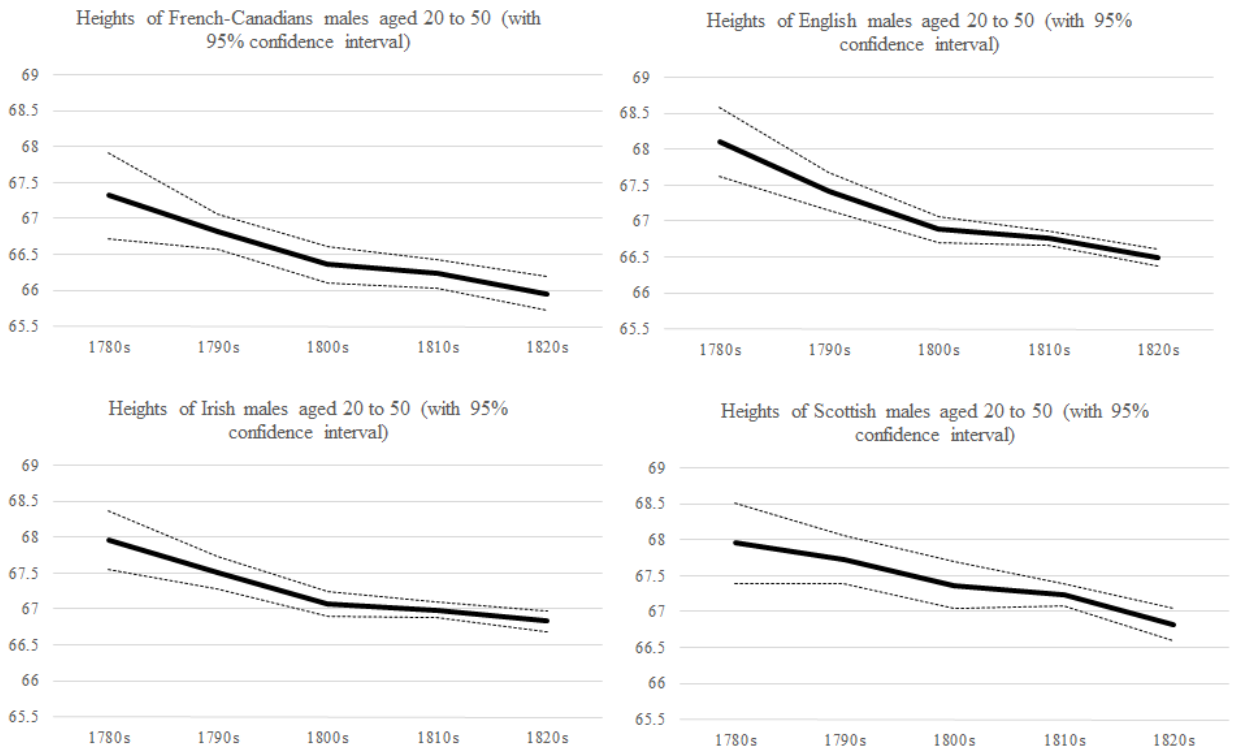
There is another limitation: selection bias. Fortunately, we do not have to deal with the issue of truncation of heights, unlike those who work with military enrolment data. However, there could be endogenous selection bias, potentially due to two factors. First, prisoner heights could vary as a result of economic shocks: in poorer times, shorter individuals (who are themselves poorer than the average individual) might be more likely to commit a crime and be sent to jail. However, since we are considering birth cohorts over five decades and we are also interested in the trend, this selection problem is limited. The sole issue remaining is that the height disadvantage of French-Canadians could merely stem from the fact that poorer individuals are likelier to be shorter than the average population, and also likelier to commit a crime. Hence, we believe our data to be a conservative estimate of the stature of French-Canadians. The second selection problem does not affect French-Canadians, as it pertains to differential selection in migration. The English, Irish and Scottish populations could capture selection effects as these individuals had to migrate to Canada, and the characteristics of migrants might differ from those of the people who remained behind, and also differ from those of the native population French-

Canadian population. By virtue of being secluded, French-Canadians were always natives of Canada, limiting the extent of this problem. We will deal with this issue by comparing with other samples of heights for the English-speaking groups.

Results

We have opted to concentrate our attention on the population above the age of 20 and below the age of 50, under the assumption that there would be no significant changes in stature past that point in time. The data is illustrated in figure 1 below. Our results show that for the 1820s birth cohort, French-Canadian males were on average 65.95 inches tall (with a 95% confidence interval between 65.71 inches and 66.19 inches). By comparison, Cranfield and Inwood (2007: 207) find that Quebeckers born between 1820 and 1849 measured at the Kingston Penitentiary (in Ontario) were 66.6 inches tall. This makes us confident with regards to the data for French-Canadians. For residents of the British Isles, we also find reassurance in the quality of our work by comparing with Nicholas and Steckel (1991, 1997) and Meredith and Oxley (2014:123), in which heights for Irish and Scottish individuals are very close to those we found. However, it seems that our heights, compared to the British population, are roughly an inch higher than what was observed in similar sources for England (see Johnson and Nicholas 1996). In figure 1, stature is presented with a 95% confidence interval for all ethnic groups.

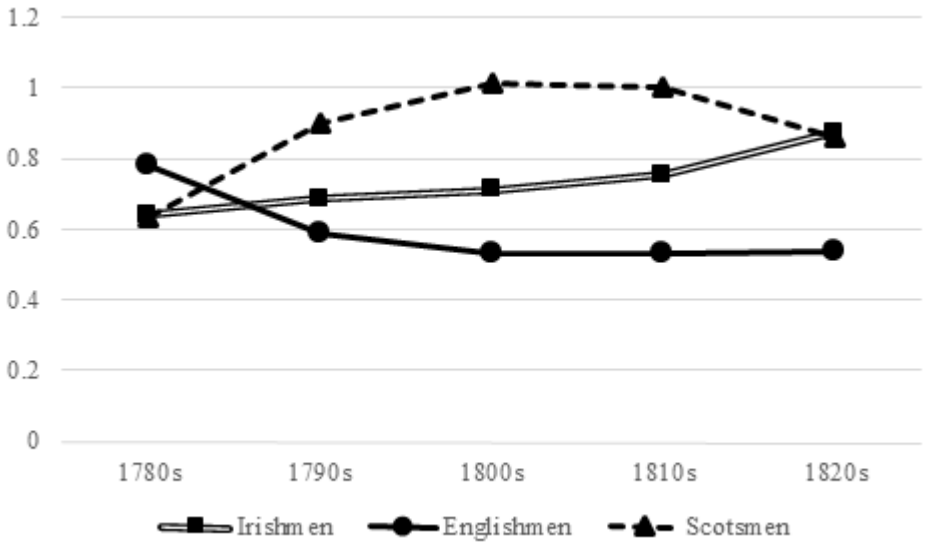
Figure 1: Height (inches) of adult (20 years to 50 years old) male prisoners by birth cohort



Two key observations arise from Figure 1: a) French-Canadians were shorter from the very beginning and remain the shortest throughout the period, and; b) throughout the period, stature falls regardless of ethnicity. The commonality of the trend among all ethnic groups is quite reassuring. Although the data for the 1780s birth cohort is more limited in number for all ethnic groups (resulting in a wider confidence interval), this similarity in trend suggests that the fall in heights was not limited to one ethnic group, and that there is strong evidence to support the finding that French-Canadians were shorter than all the other groups. In fact, it ought to be mentioned that except for the 1780s birth cohort, the upper bound estimate for French-Canadians is always below the lower bound estimate of all the other ethnic groups.

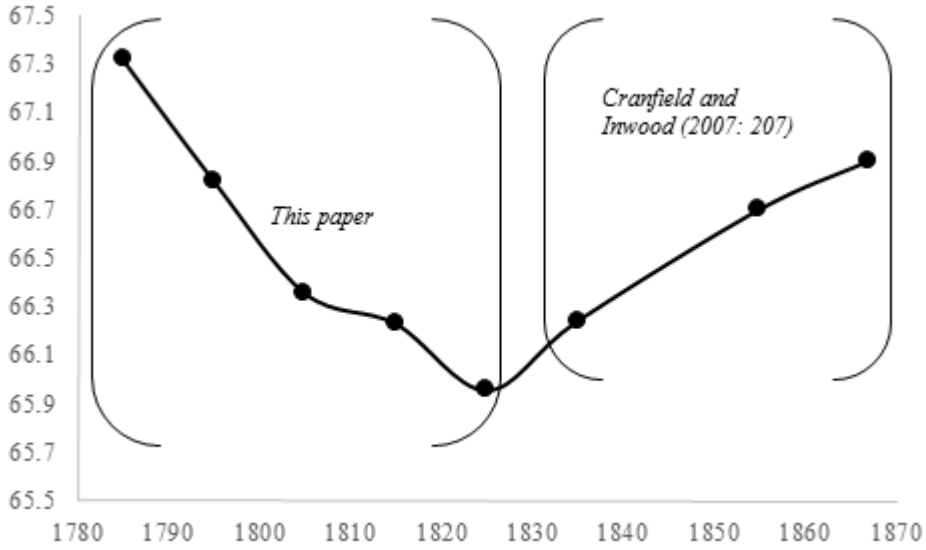
At all times, French-Canadians remained the shortest by somewhere between 0.5 and 1 inches. However, while heights dropped across all ethnic groups, they fell more slowly for French-Canadians up to the 1820s birth cohort than for the English. As a result, by the 1820s, the height differential between French-Canadians and Englishmen shrank, while the differential between Irishmen and Scots grew over time (see figure 2).

Figure 2: Difference in inches of adult (20 to 50 years old) male French-Canadian prisoners by birth cohort relative to other ethnic groups



If we combine this data with the comparable data drawn from prison admissions at Kingston Penitentiary (Cranfield and Inwood 2007: 207), the height level of the 1820s birth cohort is the low point of a period spanning up to 1874 (see figure 3). This phenomenon coincides with the "antebellum puzzle" (referring to the anomalous experience of pre-civil war America when growth was positive and heights declined). This has been the subject of numerous papers, and it seems that some countries such as England, Sweden and Austria-Hungary followed a similar pattern as the United States, while France, the Netherlands and Italy experienced no such pattern (Bodenhorn, Guinnage and Mroz 2015: 9). Our data suggests that Canada can be added to the former list. It is not surprising to find that British, Irish and Scottish heights recorded in Quebec fell throughout that period, as many of these people were born in the British Isles, and our data does not enable us to separate the foreign-born from the native-born.

Figure 3: Heights of French-Canadians in our paper linked with the existing data from Federal Penitentiary at Kingston (inches)



Note: The data is presented as decades. For the French Canadians stature from this paper, we merely established the mid year of each cohort as the datapoint for graphing purposes. As our cohorts end in the 1820s, the last datapoint of ours is 1825 on this graph. The mid-points from Cranfield and Inwood we used are 1835 (for the cohort born between 1820 and 1849), 1855 (for the 1850s cohort) and 1867 (for the cohort between 1860 and 1874).

Although comparisons within Quebec show French-Canadians were relatively short, comparisons with other countries show them not to be particularly short in absolute terms. In table 2, the results from this paper are boldened and compared, when possible, with sources that also use prison data (although this was not always possible). Table 2 shows that French-Canadians are very short when compared to other North-Americans. Compared with the military recruit data from Floud et al. (2011:331), French-Canadians are systematically shorter, and the gap widens over time. Compared with prison-based datasets (Tatarek 2006; Maloney and Carson 2008), the gap is in fact slightly larger. The data produced by Maloney and Carson (2008) also allows comparison across American ethnic lines (blacks and whites). French Canadians were shorter than both white and black Americans, with a wider gap separating them from the former group. The poor comparison stops there, as French-Canadians were taller than the inhabitants of Latin America (although the data for this region is not as exhaustive as for other regions). The most important comparison, in our opinion, is the one that concerns France, given that it is the mother society of French-Canadians. Relative to inhabitants of all regions in France, French-Canadians are significantly taller (in general by more than one inch). Relative to the population

of the British Isles, they tend to compare less favourably, but the evidence is not as to whether or not they are shorter. However, the Irish, English and Scottish data we found for this paper suggests that those who were imprisoned in Canada (and thus migrated to Canada or worked as sailors on ships trading between Canada and England) were taller than those who stayed behind in the United Kingdom. Overall, if we compare with the compilation of anthropometric studies made by Baten and Blum (2012:S74), the French-Canadians were amongst the tallest in the world even though they were the shortest in North America.

Table 2: Comparison of heights of adult males (inches)

	1780s	1790s	1800s	1810s	1820s
French-Canadians (this paper)	**67.3**	**66.8**	**66.4**	**66.2**	**66.0**
Americans[a] (military recruits)	68.2	68.1	68.1	68.1	68.1
White American prisoners[b]	-	68.6	68.3	68.4	68.5
White American prisoners[c]	67.9	67.8	68.4	68.4	68.4
Black American prisoners[c]	-	-	68.1	68.1	67.5
France (Brie)[d]	64.7 to 65.1	64.3 to 65.3	65.4	65.0 to 65.2	65.4
France (Saint Yiriex and Bellac)[d]	63.7	63.1 to 64.1	63.4	63.9[e]	63.6
France (Mulhouse)[d]	-		65.3[f]	64.9	65.3
France (Sélestat)[d]	63.1 to 64.4	64.4 to 64.7	65.2	65.4	65.1
France[g]	-	-	64.4	64.4	64.6
Englishmen (this paper)	**68.1**	**67.4**	**66.9**	**66.8**	**66.5**
Irishmen (this paper)	**68.0**	**67.5**	**67.1**	**67**	**66.8**
Scotsmen (this paper)	**67.9**	**67.7**	**67.4**	**67.2**	**66.8**
England[h]	-	-	64.8	64.9 to 67.5	65.2 to 66.7
England[i]	66.0	66.3	67.4	67.4	67.4
England[i]	66.3	65.9	66	65.7	-
England[i]	65.2	65.0	65.2	65.4	65.8
Scotland[h]	-	-	-	67.7	66.5 to 67.9
Ireland[h]			65.4	65.2 to 67.3	65.1 to 67.1
Argentina[j]		66.1		-	-
Central Mexico[j]	-	-	63.8	-	-

Notes about sources: A) Floud et al. (2011 :331). B) Tatarek (2006 :230). C) Maloney and Carson (2008). D) the periods in Heyberger (2007) are not full decades; we merely presented all the periods covered by Heyberger in each decade. Moreover, the data for Heyberger is height at age 20.5, while we are dealing with the entire population from age 20 to 50. E) the period covers 1810 to 1822. F) for Mulhouse, Heyberger covered the period from 1796 to 1811. G) Weir (1997:191). The Weir data is the median height at age 20-21, and the data starts in 1804. The data for the 1810s is missing the years from 1813 to 1816. H) Mokyr and Ó'Gráda (1996:159), we used the adults panel of the table reported in this source. I) The data is from Komlos and Küchenhoff (2012), who compiled from numerous sources. J) Dobado-Gonzales and Garcia Montero (2014:314).

Discussion

We have highlighted three key observations from our results: a) French-Canadians are consistently shorter than other ethnic groups in our dataset, b) there was a significant decline in heights up to the 1820s and, assuming that Cranfield and Inwood's data for the Kingston prison is accurate, French-Canadian heights recuperated slightly after the 1820s and, c) French-Canadians are taller than their counterparts in France and than the inhabitants of South America. However, they are shorter than both white and black American prisoners, and shorter than the inhabitants of England (but by a smaller margin than when compared with British individuals from our dataset).

These observations warrant discussion. Our results do show that differences in heights did not simply appear in the 19th century – they were there from the start. Our data suggests a small gap at the beggining. However, in the data of Cranfield and Inwood, English prisoners from Ontario at Kingston prison were far taller than the English-speaking individuals in our sample (by approximately one and a half inch). That gap did not seem to shrink up to the mid-20th century. In fact, there are signs that the gap widened in the 1890s, and for cohorts who fought in World War Two (Cranfield and Inwood 2015). Furthermore, when combined with the Kingston prison data, heights of French-Canadians after 1830 seemed to increase slightly. As a result, the explanation of the difference between ethnic groups at the end of the 19th century found its roots in what allowed English-Canadians to grow much taller than their French counterparts. Hence, the gap in stature was probably at its smallest in the early years of British rule, and it expanded thereafter. As a result, we believe that the role of the Conquest of 1760 as a breaking point is reinforced as a determining factor.

During the last decade of the 18th century and the first decades of the 19th century, Quebec suffered a series of significant economic shocks in the form of wars and military invasion (between 1792 and 1815), the wheat midge, the Hessian fly, and a series of instances of insurrection in the late 1830s. Quebec is generally believed to have experienced no economic growth or to have in fact experienced economic regression (Ouellet 1966, 1972, 1980; McCallum 1980; Dechêne 1986). Some contend that there was positive economic growth (McInnis 1982; Paquet and Wallot 2007; Bédard and Geloso 2014). However, even if economic growth was indeed positive, the annual rate of growth proposed was very slow (between 0.28% and 0.36% in real per capita income according to Bédard and Geloso 2014).

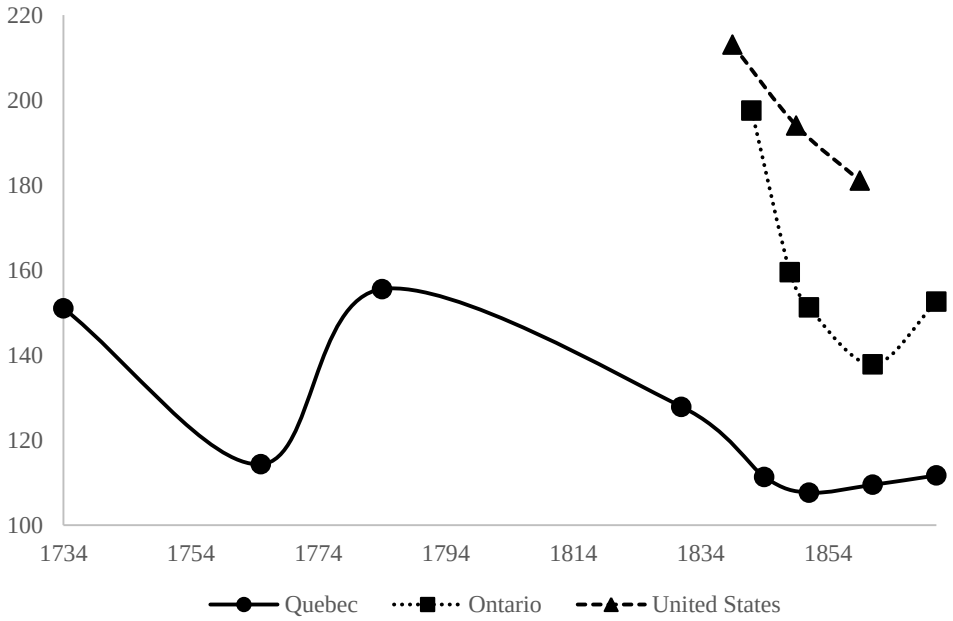
By comparison, it is widely believed that the neighboring colony of Ontario (predominantly English-speaking) experienced faster growth and if not, living standards were clearly at a higher level than those in Quebec (McCalla 1993). A good indicator of this difference is provided by McInnis (1992: 79), who shows that the average net income per farm in Ontario in 1851 was 34% higher than in Quebec. Therefore, relative to Ontario, Quebec was poorer. In addition, the data from the Maddison-Project (www.ggdc.net/maddison/maddison-project/data.htm, 2013 version) shows that in 1820 and 1840, the United States were 54% and 45% respectively richer than Canada as a whole. Hence, Quebec was the poorest area in North America.

These lower living standards observed in Quebec and the slower pace of growth could have resulted in shorter stature relative to the rest of North America, especially if the differences in living standards translated into differences with regards to nutrition (Heyberger 2011; Floud et al. 2011). More importantly, they could have translated into differences in protein consumption (Baics 2015) through the supply of meat. Given the strength of the relation between protein intake and stature, varying access to protein could lead to differences in stature.

Using the fourth volume of the 1871 census of Canada, which comprises the recollection of all censuses from 1665 to that date, we can create an approximate measure of meat production per capita in different regions of Canada. The result, seen in figure 4, shows that there are substantial differences in meat production between Quebec, Ontario (predominantly populated by English-speaking settlers) and the United States in the years when the data overlaps. In 1851, meat production of Ontario on a per-capita basis was 40% greater than it was in Quebec – which would explain the findings by Cranfield and Inwood that Ontario (English) prisoners were taller than Quebec (French) prisoners. When we combine with the data made available by Baics (2015) for the United States, the gap is even greater. The trend of the meat supply per capita for Quebec also supports the height data we collected: as meat supply falls, stature falls as well. Furthermore, the level for Quebec observed in figure likely *overstates* the production of meat in French areas. Indeed, pastoral production was mostly concentrated in English areas of Quebec that operated under free and common tenure, rather than in areas in which French-Canadians lived under seigneurial tenure. Most of the pastoral production was centered around dairy products. This is an important factor in determining stature. Milk provides twice as much protein as meat, but fewer calories (Heyberger 2011: 50), and even cheese provides roughly as much

protein as meat. According to Fernand Ouellet (1988: 326), production of butter and cheese per farm in 1861 in French-speaking rural areas stood at 47.4 pounds and 3.6 pounds respectively. By comparison, the respective figures in areas operating under British tenure stood at 236 pounds and 17.2 pounds. Using the census of 1851 (Canadas 1853), we see that areas under British land laws had per capita consumption figures for butter and cheese at 18.1 pounds and 2.63 pounds. In French areas, the figures are lower: 11.51 pounds and 0.51 pounds. Such differences in the consumption of protein-rich items very likely translated into stature differences, and they clearly tip the scale against the French-Canadian population.

Figure 4: Meat supply (in pounds) per capita in Quebec, Ontario and the United States



Note: the supply of meat is an approximate measure and relies on the dressed weights and slaughter rates of animals (cows, steers, oxen, swine and sheep) drawn from the work of Winifred Rothenberg (1979). The only exception is sheep, as Rothenberg provides no information on them. Thus, we relied on Lewis and McInnis (1984), who say that one out of three sheep was slaughtered, and that each had a live weight of 75 pounds. Since dressed weights tend to hover around 60% of live weight, we took 60% of 75 pounds to obtain the meat supply from sheep. We are aware that her work concerns the case of farm animals in Massachusetts. However, using her assumptions actually forces us to make a *conservative case.* If animals were smaller in Quebec, as there is evidence that they were (Ouellet 1966, 1972 and 1980), then the dressed weight would not be the same across regions, and using the Rothenberg weights for Massachusetts would overstate the availability of meat in Quebec. The figures for the United States are taken from Baics (2015). The data for Canada is drawn from the fourth volume of the 1871 census, which compiles all censuses prior to that one.

Another way to illustrate the differences in living standards that could have affected stature differences is to look at "meat wages" (daily wage rates divided by the price of beef). Table 3 below does just that. The data available shows that "meat wages" in Quebec are lower than for every region compared, except France and England.

Overall, differences in socio-economic factors explain very well the small stature of French-Canadians. Low living standards limited the access to proteins relative to other areas, except France and England, and this access declined throughout the late 18th and early 19th centuries. The initially low level of heights (the level observed for the 1780s birth cohort) can also be explained by socio-economic factors. Geloso (2015) has shown that living standards in Quebec under French rule were highly volatile up to 1760, with dramatic shocks when the colony was invaded and/or conquered. In addition, Geloso used a welfare ratio approach showing that the colonists of Quebec under French rule were poorer than comparable segments of the English population, but richer (by a respectable margin) than comparable segments of the population of France. He also showed that Americans were substantially richer than the inhabitants of Quebec. As a result, it is not surprising that French-Canadians are shorter than the British and Americans, but taller than the French. As a result, the level of stature observed might simply be the result of poor economic performance in the past. Demographic evidence also supports this contention. Vital statistics provided by Gentil (2009) show a substantial increase (by a factor of three) in infant mortality rates between 1688 and 1779, which reinforces our point. It also suggests that future research should investigate the causes of the divergence between French-Canadians and the others, with a special focus on the role of the conquest.

However, this increases the doubts regarding the predominance of founder effects, which persisted by virtue of low intermarriage levels. We believe that this possibility should be discarded. The significant advantage in heights observed relative to the populations in France, from whom the French-Canadian descend, suggest that socio-economic factors were probably the lead determinants.

Table 3: Meat (beef) wages (in pounds per day) in different regions

	1831	1836
Lower Canada (Quebec)	4.95[a] to 9.46[b]	6.73 to 8.33[d]
Montreal	6.15[a] to 9.75[b]	7.2 to 10.29[e]
Québec City	6.38[a]	-
Upper Canada (Ontario)	10.68[b] to 17.85[c]	13.50 to 17.42[f]
England[g]	3.26 to 4.29	2.85 to 4.50
Paris[h]	4.12	4.74
Strasbourg[h]	3.46	3.46
Vermont[i]	16.99	17.38
West Virginia[j]	17.59	9.52
Pennsylvania[k]	10.71	12.84

Notes about sources: A) The lower estimates are based on the wage rates obtained from the compilation of the 1831 census of Lower Canada, which are available at the sub-district level in the appendix to the journals of the House of Assembly of Lower Canada (1832: app.O.o). The wage rates concern agricultural work. The prices used for the lower estimates are the average of the Montreal and Quebec price, and come from the work of Fernand Ouellet et al. (1982:104). B) The wage rates for these estimates are drawn from the *Present State of the Canada*, a volume of information for merchants, tourists and migrants to Canada published in 1833 in London, but whose author is unknown (p.173 and 175). The prices are extracted from the same sources. This source provides a high-point estimate for Lower Canada, as the farm work wage rate proposed is higher than in the census of 1831, and the price of meat lower than in Ouellet and al. (1982). For the upper bound of the Montreal estimate, we used the census wage with the lower price found in the *Present State of the Canadas.* For lower estimate of Upper Canada, the wage rate is for common workers (uncertain as to whether or not they are about farmers), and we used the highest price of beef found, which appears in McCalla (1993:339). C) The wage rate for the upper bound of Upper Canada is for the period 1830-1834 and is drawn from the work of Russell (1983:70) and is above the one found in the *Present State of the Canadas.* The price used is from the *Present State of the Canadas* since it is lower than the one found in McCalla (1993:339). D) The wage rate for Lower Canada is drawn from Evans (1836:132), and the lowest price found concerns Montreal and was found in Evans (1836:139). The highest price is the average of the Montreal and Quebec City prices provided by Ouellet et al. (1982:104). E) The wage rate for Montreal is found in Martin (1839:178), while the lowest and highest prices for the same city are found in Evans (1836:139). F) The wage rate is for 1830–1834 and provided by Russell (1983:70), while the low and high prices are from McCalla (1993:339) and Martin (1839:210). G) All of the England data comes from Clark (2005). The low estimate is based on farm workers, and the high estimate is based on building laborers. H) The wages and prices for Paris and Strasbourg are drawn from the work of Allen (2001). I) Wages and prices for Vermont were assembled by the Global Price and Income History Group and are available at http://gpih.ucdavis.edu/Datafilelist.htm (consulted January 21st 2016. J) Wages and prices for West Virginia were assembled by the Global Price and Income History Group and are available at http://gpih.ucdavis.edu/Datafilelist.htm (consulted January 21st, 2016). K) Wages and prices for Pennsylvania are drawn from a variety of sources compiled by Peter Lindert, Salvador Puente, Will Ambrosini and Leticia Arroyo Abad of the Global Price and Income History Group and are available online at http://gpih.ucdavis.edu/Datafilelist.htm.

Conclusion

Our results show that French-Canadians were already shorter than the other ethnic groups who would eventually settle down in Quebec. This gap was present for individuals born in the early years of British rule in Canada – well before there was any significant form of intermarriage across groups. This suggests that differences in heights seen in the late 19th century to mid-20th century were already present before the end of the 18th century. As a result, we can rule that height differences did not simply emerge during the 19th century.

However, we do not believe that this confirms beyond all reasonable doubt that there was a genetic predisposition to shortness. The fact that French-Canadians were significantly taller than their French counterparts in the mother country, even after decades under British rule, limits the potency of the genetic argument. We believe that other factors – war shocks, low living standards, changes in the availability of protein-rich items – probably explain a much larger share of the height differences between ethnic groups and relative to other societies such as the United States.

Although our results have shed light on the historical issue of the shortness of French-Canadians, they should not be taken as the final word on the issue. Our results suggest that although French-Canadians shared the decline in heights that British individuals suffered, they were affected more dramatically, and the gap seems to have widened after the 1820s (when we link up our data with other existing datasets). This suggests that the role of the economic subordination of French-Canadians should be considered. The conquest of Quebec in 1760, which marked the beginning of the economic subordination of French-Canadians, may not have initiated the differences in stature, but it may have contributed to widening those differences. We believe that future research should tackle that issue.

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