CANADIAN TERMS OF TRADE, 1869-1913: A TIME SERIES ANALYSIS OF NEW ESTIMATES

by

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1 Introduction

A country's terms of trade are defined as the ratio of its export prices to its import prices. In the case of Canada, whose economy depended heavily on only a few significant raw materials for much of the nineteenth century, the prices of imports and exports could vary drastically if market conditions were volatile. Thus Canada's terms of trade were, for this period, a reliable indicator of the performance of the whole country. In particular, the years 1896-1913 have come to define what is known as the 'Wheat Boom', a time where many believe that massive growth in Canadian grain exports led to a permanent positive change in the growth of real income. In this paper, I develop new estimates of Canadian terms of trade from 1869-1913 using granular customs data on imports and exports with a high frequency of observations. Using these new estimates and other variables derived from a theoretical model by Caves (1965), I update the work done by Green and Sparks (1999), who use a Vector Error Correction Model (VECM) to identify long-run relationships between potential causes of income growth (terms of trade, exports, population, income and investment) during this time. I find that the 1999 results still hold. Mainly, the data show that population is a significant contributor to income growth, and that export growth is endogenous and may actually harm real income if it innovates in isolation. The Green and Sparks data are taken from older price indexes constructed by Urquhart and Buckley (1965). This research seeks to update and improve these terms of trade estimates and to see if the impact of the wheat boom on Canadian growth may be different than previously thought.

Caves's theoretical model is particularly useful for this exercise because it allows for the inclusion of cyclical growth. He models income growth as being driven by stable and unstable factors. The stable component is modeled by a simple neoclassical growth model, accounting for population growth, capital stock and labor productivity. He allows export growth to be unstable. As Green and Sparks (1999) remark, this instability allows for the series to have a stochastic trend (unit root), instead of the predominant belief that export series behave as trend-stationary; see Nelson and Plosser (1982).

The paper is organized as follows. The next section provides a historical context of the Canadian economy during the nineteenth and early twentieth centuries, emphasizing the early structure based on natural resource extraction and the country's gradual diversification leading up to the first world war. Section 3 provides a review of the literature, focusing on methods of index construction and different empirical techniques used to evaluate causal factors of trade and growth. Section 4 explains the construction of the import and export price indexes, and includes a comparison to the best available alternative estimates from the *Historical Statistics of Canada*; see Urquhart and Buckley (1965). This section also includes a discussion on the cointegration analysis and how it relates the five variables to the error correction model. Section 5 presents the coefficients, and discusses the behavior of the impulse response functions generated from the model. Section 6 discusses the meaning of the results in the context of the historical background of the time. The impulse-response functions and the tables of import and export price indexes can be found in the appendix.

2 Historical Context

In the beginning of the nineteenth century, Canada's export economy was very dependent on Britain. When the British parliament passed the Corn Laws in 1815, preventing importation of grain unless the English price was very high, it became both more expensive and riskier to send cereal crops or flour overseas. Since information took several weeks to cross the Atlantic, price changes could prevent Canadian goods that were marketable when they left from being sold once they reached England. Many merchant companies who could not afford to hold cargo in port for more favorable conditions declared bankruptcy.

As reliant as Canada was on her sovereign for grain exports, however, the colony did enjoy preferential treatment over other nations. The rest of the world could not sell to Britain unless English prices rose above 80s, but for Canada, goods became vendible at a price of only 67s; see Easterbrook and Aitken (1963). American merchants, aware of this preference, would often ship their cereals over the border to be milled in Canada, so that the resulting flour could be sold more easily to Britain. The impartiality was not as significant as it could have been though, mainly because the British enjoyed excellent harvests during these years, and demand for colonial grain was not extreme. When the Corn Laws were repealed in 1846, Canada needed a new economy to rely on. This planted the seeds for a stronger relationship with the United States.

Prior to the middle of the century, almost all of the trade from Upper to Lower Canada was done along the St. Lawrence River. American goods from the mid-west could be sent over the Great Lakes and down to Montreal, where it could be consumed locally or sent to England. This system was favorable to Canada, who was able to charge tariffs. Since direct taxation was very difficult during this time, customs duty collection comprised the bulk of government revenue. However, as the American railway system expanded into the mid-west, it became cheaper for farmers on the frontier (including some in upper Canada) to ship their grain south through America. It was easier to ship to England from New York than from Montreal. It wasn't until 1860, when the Grand Trunk Railway was completed, that Americans returned to regular use of Canadian waterways. Running from Portland, Maine to Montreal and then down to Sarnia, Ontario, this gave an inexpensive alternative to farmers of western Canada, who could bypass the Great Lakes.

Until this time, Canada had been a significant producer of only four main goods: furs, wheat, timber and fish. This meant the country was vulnerable to changing market conditions. Stronger ties with America, along with a brief period of reciprocity on natural goods from 1854-1866 allowed for other Canadian markets to develop. Canadian politicians began to picture a more diversified economy, similar to America, with provinces trading amongst themselves, and without dependence on Britain or America. Confederation in 1867 was a strong first step to achieving this. Meanwhile, the Pacific coast settlements of Red River and British Colombia were not opposed to joining unified Canada, but would not be allowed to do so until trade was profitable from coast to coast. The country needed a transcontinental railway.

In 1870, Manitoba became an official province. Unlike other provinces that retained ownership of all land, however, Manitoba transferred much of its north-western prairie to the Dominion. It was parceled out to farmers on the condition that they settle the land permanently. This offer brought a flood of immigration, and the main result was an increase in wheat production. With Rupert's land and the Northwest Territory (the modern areas of Alberta and Saskatchewan) now unified with the east coast provinces, British Colombia joined confederation later that year. Once the country ran from coast to coast, plans for a country-wide railway system were feasible.

At the same time, falling manufacturing prices in Britain and America threat-ened Canadian factories. In response, the Conservative Party, led by Sir John A. MacDonald, enacted the National Policy in 1879, which called for increased tariffs on almost all goods, but with special attention paid to the manufacturing industry. This brought even more immigration in the form of skilled labor. However, most immigrants were only staying in Canada temporarily before settling in the United States. Only when the American frontier became closed off, and the U.S. could not meet its demand for food and other goods did the benefits of the National Policy accrue. This would not occur until the end of the century.

In 1885, the Canadian Pacific Railway was completed, stretching from Vancouver to Montreal, and uniting the country. Yet growth was not as fast as expected. Between 1871 and 1899, Canada's population only grew from 3.6 million to 5.4 million; see Easterbrook and Aitken (1963). It wasn't until 1896 that Canadian prosperity emerged; see Ward (1994). The country flourished as export prices rose and the cost of shipping wheat fell. Across the Atlantic, the English wheat price rose substantially, while increasingly urban populations caused a large increase in the demand for foodstuffs. At the same time, British domestic investments had become less profitable. With the only unsettled lands belonging to Canada, there followed large increases in both prairie settlement and capital inflows due to land speculation. This, combined with cash inflows from securities sold by the railway companies, led to massive technological change in Canadian mining and agriculture. Wheat became the most important good produced to an extreme level. For such a resource-dependent economy, the terms of trade began to swing heavily in Canada's favor, and would remain so until the interwar period. This period, from 1896-1913, is today called Canada's 'Wheat Boom'. The larger background, inclusive of America and Europe, has been referred to as the 'first globalization'. With this sudden change in the composition of Canada's economy in mind, several authors have attempted to identify exactly how prices changed, and to what extent this shift impacted future growth. The next section reviews the different ways in which price indexes have been constructed, and also discusses the different empirical methods that have been used to evaluate the impact of the wheat boom on future growth.

3 Literature Review

The Canadian economy underwent a significant, permanent change near the end of the nineteenth century. 1896-1913, a period known as the 'wheat boom', saw a massive growth in the relative importance of Canadian agricultural goods as farmers began to settle the country's western prairies. There is an abundance of literature quantifying the impact of the shift toward this staple, with some estimates over subsequent decades reporting income increases as high as 30 percent; see Bertram (1973). While argument persists over exactly how important Canada's agricultural dependency was during this period, evidence suggests that the country's reliance on natural resources certainly did not constrain increases in income over the long run. In fact, resource industry output may have accounted for as much as 10 percent of Canada's per-capita GNP growth over the 20th century; see Keay (2007).

This sudden shift in income suggests that, during the boom years of 1896-1913, Canada was a prime example of the staples thesis, using raw materials (staples) to bolster growth through exports with overseas trading partners like Britain and France. However, later works suggest that wheat production may not necessarily be the direct cause of the permanent growth shift. Rather, it was the ability of farmers to respond quickly to changes in profitability when non-land agricultural input productivity rose, despite decreasing yields on arable land, that allowed the country to prosper; see Lewis (1981) and Dick (1980). In the early years after the expansion, some researchers argued that the 'wheat boom' was not wheat at all. The manufacturing sector had been growing rapidly since the middle of the nineteenth century, and this boom was not comprehensive. However, this 'gradualist' interpretation was quickly amended, once more thorough estimates of manufacturing became available; see Altman (1987) and McDougall (1971). The consensus became that manufacturing growth was not constant throughout the second half of the nineteenth century; rather, the growth only began near the turn of the century, after the wheat boom had started. The introduction of the National Policy in 1879 had succeeded in shielding manufacturers. However, it took around 15 years for its effects to fully emerge.

The accompanying flow of immigrants to western Canada at the beginning of the twentieth century provided an even larger boost to agriculture. Recent works reveal that the distortionary nature of the tariffs may have had adverse effects, however, the impact on terms of trade may have led to positive welfare gains; see Alexander and Keay (2018). Moreover, most of the largest tariffs were placed on exotic goods of which Canada produced very little; see Beaulieu and Cherniwchan (2014). This indicated that the growth caused by gains in manufacturing largely manifested itself through increased exports.

In recent decades, there were several attempts to value Canadian exports through this 'first globalization'. One method used to avoid differences due to the changing value of currency is the construction of price indexes. Although I elaborate more on this in the data section, a few examples are worth mentioning here. Perhaps the most generic form of index is a fixed-base one. This involves measuring the value of exports each year relative to some prespecified base year. One problem with this approach is that the consumption basket (ie. the set of goods being compared across time) needs to remain identical across years for the comparison to have any real meaning. This often results in substantial amounts of information being excluded from the calculation, or in the averaging of prices where individual measures would be more accurate; see MacDonald (2008,2017) or Minns and MacKinnon (2007). In the case of multiple stages of aggregation, the index may lose its consistency; see Diewert (1978). The exclusion of certain goods on these grounds alters the total expenditure on which the relative importance of industries is based. To correct for this, some use fixed weights to better reflect the more important categories. In the case of national statistics, these weights often come from consumption or wholesale expenditures; see Urquhart and Buckley (1965). The same weights are often used throughout entire periods, which may not paint a complete picture, because the relative importance of different goods changes multiple times across long time horizons. The only way to truly get an accurate measure of changes in consumption and relative importance of goods is to use a chained index. This type of index does not rely on a fixed base year (although it can be computed relative to one), and instead uses smaller links multiplied together. The advantage is that less information is lost through averaging, and the consumption bundle can change across links. The smaller the link size, the more robust is the index. I use a link size of one year, which is the smallest possible in the case of the annual product data.

There are many examples of chained indexes being used to compute export prices and other related variables in Canada and other countries. Hill (2004) discusses several methods for constructing such figures and computes indexes for 15 countries within the European Union. Paterson and Shearer (2003) build very detailed estimates of Canadian wholesale prices just prior to the period of this paper. Dridi and Zieschang (2002) discuss the need for frequent chaining especially in the case of macroeconomic variables because conditions change so often. With continual changes such as these some indexes are non-stationary, or at least trend stationary. If the wheat boom had as strong an effect as believed, it is unreasonable to expect that Canadian import and export prices should follow a common mean with constant variance for 1870-1913. This is because the known, sudden growth in grain production beginning in 1896 would result in a permanent change in the structure of the prices, making reversion to the original mean impossible. Therefore, several papers have been written attempting to model structural breaks in macroeconomic variables such as import and export prices, several of which apply directly to the wheat boom.

Most statistical methods testing for structural breaks or changes during the late nineteenth century came after the seminal work by Perron (1989), who created a formal procedure to test for unit roots. Using these methods for the years 1870-1985, Serletis (1992) finds that Canadian real GNP does indeed resemble a random walk, and that there is a large trend break just before the beginning of the expansion in 1896. Similarly, several works test the causal relationship between aggregates like GDP and GNP, and trade variables like imports, exports, investment, etc. The error correction model I use here has been used to evaluate relationships between imports, exports and income in many different countries; see Zestos and Tao (2002) or Henriques and Sadorsky (1996). The fact that, for a resource dependent economy like Canada, these variables are related is evident; what remains up for debate is exactly how they impact each other. The striking result from Green and Sparks is that, in the context of their five factors, population innovations seemed to have the most substantial impact on real income. I confirm this result later. This next section discusses the construction of the indexes used to compute terms of trade, compares the indexes to existing estimates, and discussed why using cointegration is necessary in this case.

4 Data and Methodology

These new indexes are an improvement over existing ones because of the high number of products in each year. Prior to these results, the most detailed indexes for Canadian import and export prices for 1869-1913 come from Urquhart and Buckley (1965). Furthermore, those indexes are constructed from import and export accounts originally compiled over 20 years before that; see Taylor and Michell (1931). This means that our understanding of import and export prices is based on information collected over 80 years ago. The original construction (1931) uses classification methods based on only only 9 groups; I report indexes for almost twice as many industries. Additionally, the Urquhart and Buckley indexes use a common basket of only 53 goods for all years. Prices average across each of those groups. The number of products I use in the least detailed year is 72 (1869 exports), with most years having more than 500. The additional detail leads to important differences.

4.1 Index Construction

These indexes are a significant improvement on previous works because of the high frequency of observations. Geloso (2016) constructs a long Quebec price index, from 1688-1850, using just over 4100 observations in total, which is much more detailed than any other for that region and time period. However, my indexes take this a step further. The import data is much more detailed than the export data, but both sets contain large numbers of products. After cleaning, the import price index contains a total of 29,737 product-year data points, with the most and least detailed years containing 869 and 156 unique products. The export series contains 7,137 observations with highest and lowest yearly totals of 213 and 72 products.

To achieve higher consistency across time, the final calculation is a geometric mean of two different indexes, representing upper and lower bounds. The single-year formulas for chained Paasche and Laspeyres price indexes are given by the following equations:

$$P_t^P = \frac{\sum_{c=1}^{C}(p_{c,t}) * (q_{c,t})}{\sum_{c=1}^{C}(p_{c,t-1}) * (q_{c,t})} \qquad P_t^L = \frac{\sum_{c=1}^{C}(p_{c,t}) * (q_{c,t-1})}{\sum_{c=1}^{C}(p_{c,t-1}) * (q_{c,t-1})}$$

Where the basket is composed of C goods. The main criticism of these indexes is that they do not take into account the reaction of quantity to a change in price; see Forsyth (1978). Consequently, the Laspeyres and Paasche indexes are maximum and minimum inflations, and may be slightly inaccurate if agents react to price changes on imports and exports. To correct for this, I use the Fisher Index, also called Fisher's Ideal index, which combines the two indexes above:

$$P_t^F = \sqrt{P_t^P \ \times \ P_t^L}$$

To calculate the price level in any year P_t, relative to some base year P_0, I chain together the prices of sequential years in that interval ($P_0 \times P_1 \times ... \times P_t$).

I use this method to go both forward and backward in time, beginning at 1900 for appendix tables 1 and 2. Chained indexes are preferred in this case because the products are not identical across years. Direct comparison of identical baskets across long periods is inaccurate because it excludes goods that do not appear until later in time (in these indexes, this is true of electrical goods, which do not appear until 1890). Also, fixed indexes do not reflect that tastes change, and businesses adjust their behavior according to changing conditions.

4.2 Imports

From the *Trade and Navigation Tables* of the Sessional Papers of the Dominion of Canada, I obtain, for the years 1869-1913, the quantity, value and unit measures of all products imported into Canada for home consumption. Products are not listed individually, but are aggregated into very specific, detailed categories (for instance, "Fish skins and fish offal, imported by manufacturers of glue for use in their factories (no units listed)" and "Glycerin for explosives (lbs)"). Before any observations are removed, the data total 49762 product-year observations. However, not all products are recorded in every year. Using the value and consumption, I derive the unit value for each product (which I consider the price) by simply dividing total value by quantity.

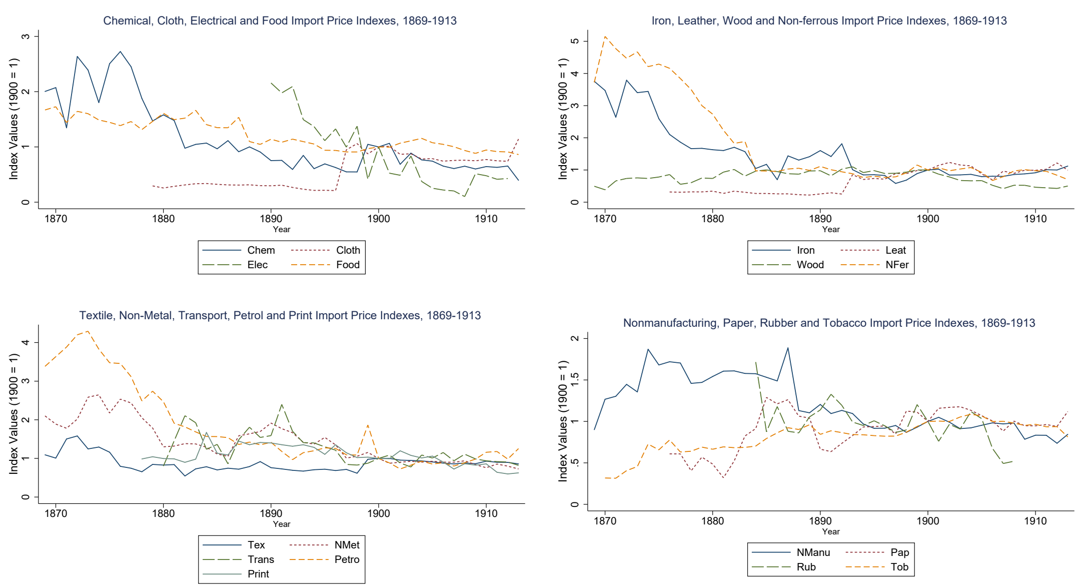
Since not all products listed in the tables have quantities, I omit those products for which only value is recorded. Without the quantity, a price index is not constructible. HS6 product codes are matched to each observation to link closely related goods across years. Reported in the appendix, the 'total' columns for imports and exports are used in the replication of Green and Sparks (1999), but I also report 19 separate indexes by industry. The breakdown of these sub-indexes matches categories used in previous work on Canadian manufacturing; see Harris, Keay and Lewis (2015). The chosen categories are listed in the tables. Most are self-explanatory (ie. chemicals, clothing, tobacco,..). Non-ferrous goods include most jewelery and pure precious metals (gold, silver,copper, etc). Non-manufacturing goods include most animals, usually livestock. Non-metallic goods include stones, granites, bricks and sand. This also includes china ware and some luxury goods, like amber and terra cotta. Non-traded goods include coins, artisan works (eg. cabinets) and any goods produced specifically for import or export. A portion of this last case comprises personal effects of deceased foreign citizens residing in Canada. Miscellaneous goods range from watches and billiard tables to scientific and musical instruments. Printed goods include charts, maps, newspapers, books and printed currency, amongst other things. Lastly, transportation includes both the mechanical (i.e. fire engines) and the non-mechanical (ie. sleds).

Working pairwise by year beginning with 1869, I match products common to sequential years using name and HS6 Code. The indexes reported contain only goods matched between the labeled year and the one preceding it (ie. the 1872 index contains only products common to 1872 and 1871). As mentioned before, this allows for the basket to change across time, which is expected across such an extended period. This method is more accurate than other indexes that only use goods common to all years or that use links in the chain longer than one year; see Geloso (2016) , MacDonald (2017), or Valiant and Miller (1989).

In each year I drop products that do not match the subsequent year. Additionally, certain products do match according to label and HS6 code, but their units do not. This means that their prices are not directly comparable. Even products that seem identical but have no units cannot be considered equivalent. Also, some products have multiple units of measure listed. For example, "prunella" is counted in packages in 1874, but the units switch to yards in 1876 and 1877. Since the exact dimensions of the package are not listed, I cannot be certain how the two measures differ. To correct for this, I also match across units in sequential years. This does not guarantee uniform product measurement across sequential years, since products measured in identically diverse ways across sequential years may still enter the calculation as one good. This allows for products to be measured differently in separate links while still contributing to the index.

Given a price and quantity for each link (1869/70, 1870/71,. . . , 1912/13) individual link indexes are calculated per the formulas given in section 4.1. I take 1900 as the base year, and multiply subsequent link indexes forward or backward in time to obtain the tables presented. The base year of 1900 is chosen to match the convention of Urquhart(1965) and (1986). This allows for an easier comparison between my indexes and those found in the *Historical Statisics of Canada*, which is the closest alternative estimate for this period; see Urquhart and Buckley (1965). If, in any given year, the link index does not contain any products from one of the industries (for example, electrical products before 1890), the chain is broken, and construction of the index relative to 1900 prices is impossible from that point onward (or backward, in the case of pre-1900 years). However, just because there is no chained industry index listed for a given year, does not mean that products of that type are not included in the calculation of the total number.

Figure 1: Import Price Indexes by Industry, 1869-1913



Note: Industries are unique to each product. This means for instance, although a fire engine could fall into the manufactured or iron categories, it belongs only to the transportation category. The same is true for the classification of exported goods.

Figure 1 shows plots of each of the industries, except for non-traded and miscellaneous. The data suggest that overall import prices have declined steadily over time. This general pattern matches other price indexes for imports and for all goods; see Geloso (2018) and Macdonald (2017). The prices of chemicals, clothing, leather, petroleum, wood and non-manufacturing goods also decline over time. However, the prices of food, iron, non-ferrous metals and tobacco increase. Prices for all other industries remain fairly constant. In general, the number of products used in the calculation increases over time, meaning the index itself is more comprehensive in later years. Notice too, that import prices across all industries converge after 1900 to levels smaller than the beginning of the period. This is indicative of Canada's expansion into non-staple goods markets, which lessened the country's dependence on imports.

4.3 Exports

The Sessional Papers of the Dominion of Canada also report total exports for the years 1967-1913. These data are less detailed than the import records. Before alterations, they total 11217 product-year observations. Again, I keep only those observations with non-zero quantities and values. The product categories are slightly less granular (e.g "gunpowder and other explosives", and "candles and soap") but are still very detailed. Not all products appear in every year, however I use a chain link length of one year as before to allow for the consumption basket to change. Since some units are direct multiples of each other (cwt = 100 lbs), I convert the quantities into the more common units where possible.

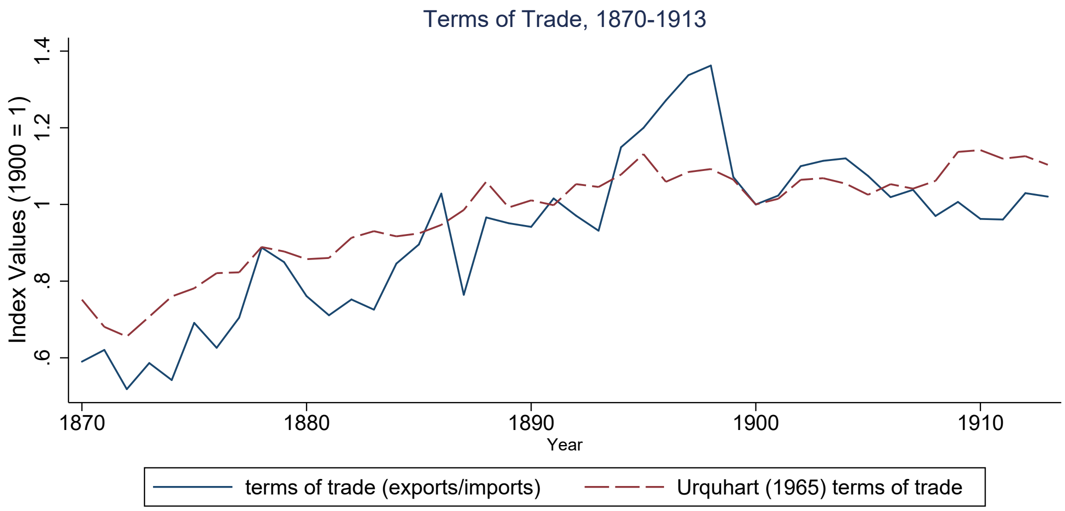
Unit prices are calculated as before, and HS6 codes provide an easier method of matching products across years. I drop the products that are not pairwise matched, and I also drop identical products whose units do not match. I use the same 19 subcategories as in the import index. However appendix table A2 does not report the clothing, electrical, non-trade, print or rubber export indexes because they were not constructible in 1901 or 1899. Of those industries reported, however, a missing value does not indicate that goods of that type are not included in the total. It just means the chain could not be completed.

Table 2 of the appendix reports these export indexes. We see a slight increase in the total export price index until around 1900, then a slight decline into the period preceding the first World War. This trend is well documented; see Firestone(1960) and others. The export prices of chemicals, non-manufacturing, non-metallic and transportation goods increase over time. The prices of iron and non-ferrous metals decline slightly. The food, tobacco, textile and wood industries also decline. We see that total export prices fall in the first decade of the twentieth century and so do total import prices. These results show an improvement in Canadian terms of trade over this period.

Figures 2-4 show the import index, export index, and terms of trade plotted with the the Urquhart (1965) counterparts. The indexes I construct appear to follow the Urquhart data reasonably well, but with a bit more volatility year to year. Consequently, so does the terms of trade series. However, the series diverge at the turn of the twentieth century, when my index shows decreasing import and export prices. Since import prices fall lower than export prices, the terms of trade series does not decline, but it does grow at a much slower rate. To test for a change in trend, I use a Wald test for a single unknown structural break on each of the three series I construct. In each case, the null hypothesis is that there is no change in trend, with the alternative being the trend is not constant over time. For terms of trade, exports and imports, the test statistics are 98.98, 148.04 and 76.78. All three statistics have p-values below 0.001, with highly significant linear time coefficients in each initial regression. Interestingly, the test identifies the break year as 1899 for imports and terms of trade, but 1896 for exports. This is evidence in favor of the permanent effect on the Canadian economy that is believed to have occurred in 1896 at the start of the wheat boom. However, the change in trend shown here would have hindered growth, not accelerated it. Canadian terms of trade still increase after 1896, but at a smaller rate than before.

Overall, my terms of trade index seems to agree with that of Urquhart and Buckley (1965) until about the end of the nineteenth century. For the years of 1900-1913, both import and export price indexes appear to be slowly decreasing, instead of increasing as the old indexes would indicate. Referring to appendix tables 1 and 2, note that these years also contain the most observations. It appears that the addition of new products leads to a different conclusion about terms of trade in the beginning of the 20th century. Canadian terms of trade, although still favorable compared to the earlier years, were not as high as previously thought.

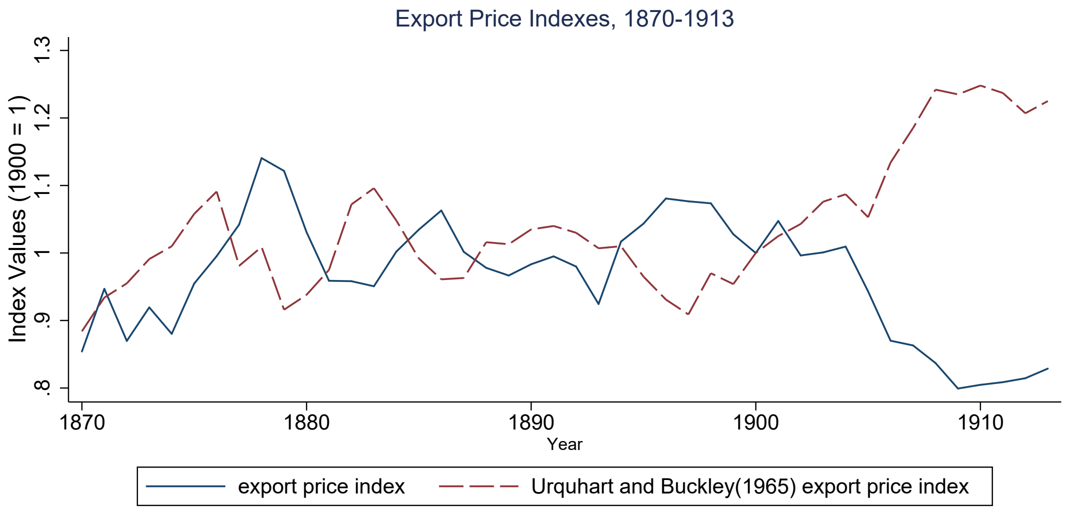
Figure 2: Canadian Terms of Trade, 1870-1913



4.4 Model and Cointegration Analysis

For many years, development economics has supported the theory that exportation of natural resources was an effective way of increasing the real income in developing countries; see Green and Sparks (1999). In 1966, a seminal paper by Chambers and Gordon used prairie rents in Western Canada between 1900 and 1910 to determine how much of the income growth was due to wheat exports. There results showed that exports accounted for very little (about 8.5% of total growth during that decade) and it was technology change that drove prosperity. This called into question the staples thesis and the wheat boom, and sparked controversy. The later work by Green and Sparks (1999) on which this empirical

Figure 3: Canadian Export Price Indexes, 1870-1913

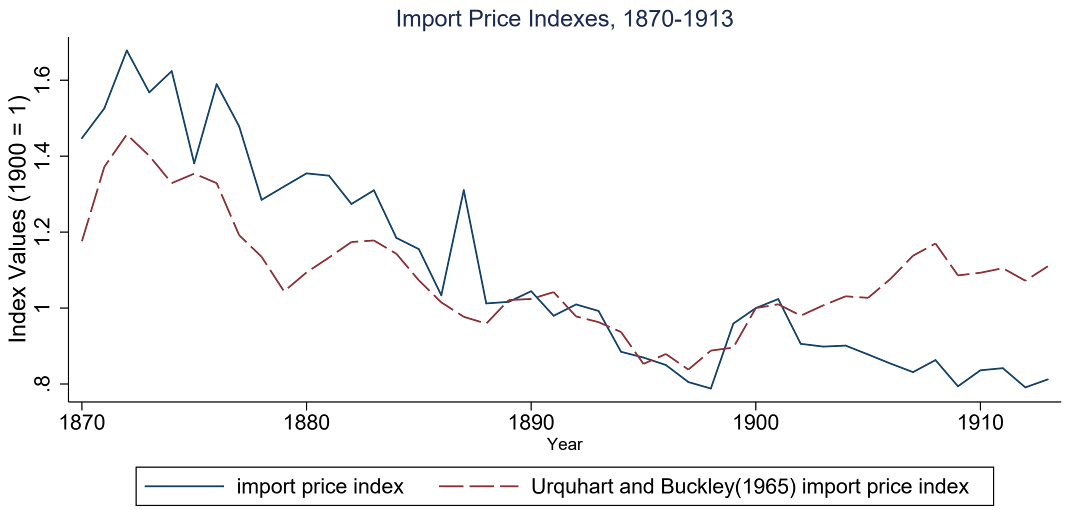


Note: Series are reported in levels, not logarithms.

methodology is based was an attempt to determine whether or not export growth really did drive Canadian income growth during the first globalization, or whether the increase in grain exports was endogenous.

The terms-of-trade series I compute from the indexes I construct (export price index divided by import price index), along with estimates of population, exports, and investment are used to examine the effect of exogenous shocks on gross national product. This analysis closely resembles the work by Alan Green and Gordon Sparks (1999). Results now include a more finely constructed terms of trade. Each series contains annual values from 1870-1913. The income, investment (gross fixed capital formulation) and export data are taken from Urquhart(1986). Pop-

Figure 4: Canadian Import Price Indexes, 1870-1913



Note: Series are reported in levels, not logarithms. Urquhart and Buckley(1965) do not use chained links, and instead use 1900 as a fixed base.

ulation is taken from Urquhart and Buckley (1965). All series are converted into logarithmic form.

When, as is the case in the dynamic model presented by Caves (1965) on which the GS methods are based, there are multiple variables that all relate to one another, a good approach to modeling the interdependencies is to use a Vector Autoregressive model (VAR). This allows for each variable to depend on past and previous values of itself and other variables in the system. The addition of error correction allows for measurement of how quickly these variables return to equilibrium when different innovations are imposed. When cointegration is present, the variables may never return to their previous values. Per Green and Sparks, I can then view differences in income across time as "reflecting the changing relative importance of different innovations"(1999). Unlike stationary Vector Autoregressions, the impulse response functions of a cointegrating Vector Error Correction Model (VECM) do not necessarily die out over time, because the series are not mean reverting. This means that some innovations may cause variables to remain permanently above or below their steady-state values in the long run. To allow the matrix of contemporaneous interactions to be more easily identifiable and the impulse response functions calculable, I specify an ordering of the variables. The order (identical to Green and Sparks) is:

Population

Terms of Trade

Exports

Investment

Income

This ordering means that GNP is contemporaneously affected by each of the four proceeding it, Investment is only affected by the three above it, exports only by population and terms of trade, and so forth. Green and Sparks use the Caves (1965) model as evidence to support the exogenous population variable (exogenous because it affects all other variables but is not itself affected by them). These restrictions ensure that the matrix of contemporaneous interactions, B_i, will be lower triangular. I only use 2 lags in this model as suggested by a Lagrange

Multiplier test for serial correlation among the residuals, so $i = 2$. Notation for the VECM model is reported in the results section. Later in the paper, I re-order the variables to allow for population to interact contemporaneously with all other variables (it moves to the bottom of the list). This allows for the possibility that population is endogenous (for instance, investment drives immigration). The method of ordering was first suggested by Sims (1980).

The work by Engle and Granger (1987) requires that each series in the system be identically integrated and non-stationary (non-mean reverting) for the application of cointegration. This is because cointegration involves finding a linear combination of non-stationary variables that is itself stationary. Consequently, I use Phillips-Perron and Augmented Dickey-Fuller unit root tests to determine the order of integration. I expect at most one order of integration, because these variables often follow similar trends at the level. There is little evidence of correlation in growth or acceleration. The unit root test results can be found in Table 1. In both tests, the null hypothesis is that the series is I(1). The test statistics include both a constant and a trend term, and I report the statistics in absolute value. For the series to be appropriate for cointegration, not only must there be evidence of non-stationarity, but each must be exactly integrated of order one. To confirm this, I run the same tests on the first differences of each series, to show that they are not of some higher order of integration. The data indicate that all levels retain the unit root null hypothesis. Each series also rejects the unit root null after first differencing. This indicates that each of the five variables is not integrated above degree one. For example, a series that is I(3) would need to be triple-differenced to reject the unit-root null in favor of the stationary alternative; see Hendry and Juselius (2001). Having confirmed that each series is I(1), I formally test for cointegration.

Table 1: Dickey-Fuller and Phillips-Perron Unit Root Tests

Series	Lags	Dickey-Fuller		Phillips-Perron	
		Level	First Difference	Level	First Difference
Terms of Trade[b]	0	2.443	8.747***	2.315	9.068***
	1	1.702	5.359***	2.271	8.753***
Exports	0	0.059	4.074***[a]	0.165	3.763**
	1	1.085	6.263***	0.457	4.210**
Population	0	2.696	3.275*	1.270	3.141*
	1	0.777	2.130	2.006	3.060*
Investment	0	0.486	4.484***	0.849	4.422***
	1	1.274	3.831**	0.746	4.476***
Income	0	0.097	4.272***	0.526	4.179***
	1	1.207	3.890**	0.435	4.274***

[a] Note: *, $p \leq 0.10$; **, $p \leq 0.05$;***,$p \leq 0.01$.
[b] All reported statistics contain both a constant and trend term. Numbers presented are absolute values.

The cointegration test comes from Johansen(1991) and is shown in Table 2. The testing procedure is recursive. It begins with the null hypothesis of no cointegration (maximum rank of zero) against the alternative of at most one equation. Likelihood ratio tests iterate as each preceding alternative hypothesis becomes the new null. Once the null is retained, the rank (less one) at that point indicates the number of cointegrating equations. In the case of Table 2, the data suggest,

Table 2: Johansen Tests for Cointegration

Rank	Log-Likelihood	Eigenvalue	Trace Statistic	No. of Hypothesized CEs (H_A)[c]
0	386.065	-	-	None
1	402.781	0.549	80.193**	At Most 1
2	413.269	0.393	46.760*[a]	At Most 2
3	421.428	0.322	25.784	At Most 3[b]
4	425.221	0.165	9.466	At Most 4
5	426.161	0.044	1.881	At Most 5

[a] Note: *, $p \leq 0.10$; **, $p \leq 0.05$;***,$p \leq 0.01$.
[b] The test fails to reject the null of at most 2 cointegrating equations.
[c] These results allow for linear trends in the data and in the cointegrating equations, but the evidence still supports 2 equations when no trends are used.

since the null hypothesis of at most 2 equations is not rejected in favor of 3, that there are at most two cointegrating equations. Green and Sparks arrive at the same conclusion (1999).

Thus, I proceed under the assumption of two cointegrating equations across the five factors. I use two lags for the procedure because that is what minimizes Akaike's Information Criterion. The tests also allow for linear time trends in both the variables and the cointegrating equations, but the conclusions do not change when I omit those terms. The last step in Johansen's procedure is to fit the error-correction model.

5 Results

If no error correction was needed, and a Regular vector autoregression could be used, it would take the following general form:

$$y_t = \nu + B_1 y_{t-1} + B_2 y_{t-2} + ... + B_p y_{t-p} + \epsilon_t \tag{1}$$

where y_t is a K x 1 vector of variables (in this case, terms of trade, exports, population, investment and income, so K = 5), ν is a is a K x 1 vector of parameters, B_j is a K x K parameter matrix, and ϵ_t is a K x 1 vector of innovations. This can be rewritten to include the error correction term. The general form of the VECM model I fit takes the following form:

$$\Delta y_t = \nu + \Pi y_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta y_{t-i} + \epsilon_t \tag{2}$$

where all notation is identical to equation (1). We can see that using first differences in a regular VAR would be a misspecification because the Πy_{t-1} term would not be accounted for. If Π has reduced rank, $0 < r < K$, I can write $\Pi = \alpha\beta^T$. From Table 2, I already know that $r = 2$. In this case, α represents the short-run adjustment parameters, or how the variables respond to sudden shocks from each other over time. β represents the long-run relationships between the variables, and is the vector of parameters in the cointegrating equations. These two coefficients are necessary to compute the impulse response functions I present. Table 3 presents the beta coefficients in the two cointegrating equations.

Table 3: Beta Coefficients on Cointegrating Equations

Variable	Equation 1	Equation 2
Terms of Trade	$1^{\dagger}$	$0^{\dagger}$
Exports	$0^{\dagger}$	$1^{\dagger}$
Population	3.873**	-6.840***
Investment	2.138***	-0.042
Income	-4.666***	2.354

[a] Note: *, $p \leq 0.10$; **, $p \leq 0.05$;***,$p \leq 0.01$.

† Johansen's normalization is necessary to identify the free parameters in β. For 2 cointegrating equations, it is necessary to have 4 such restrictions in the absence of theoretically justified constraints.

These coefficients represent the relative weights needed for a linear combination of the five variables to achieve stationarity, given that each series is integrated of order one. The choice of parameters to normalize (here I normalize terms of trade and exports) would have affected the value of the coefficients in table 3, but not their weights relative to each other. Apart from the population coefficient in the second equation, which has a p-value of 0.164, all coefficients are significant, which is a good confirmation that the variables are related. Also, all coefficients in the adjustment parameter matrix (α) are between zero and one in absolute value, which is a good indication that the resulting combination of variables is stationary. It is important to identify these cointegrating relationships when they exist, because these variables may be wrongly treated as causal, when in fact they just share a common unit root, or a confounding variable is present.

Using these coefficients, I compute impulse response functions for innovations the size of one standard deviation for all possible impulses and responses. Figure 4 shows the responses of each of the five series when population is the innovation variable. Long-term, the population innovation leaves terms of trade at -7.9%, below the previous steady-state value. This is different than the effect derived by Green and Sparks (hereafter referred to as GS), who find an increase of at most 1.2%. This suggests that, in the Canadian context, increased immigration may have caused a small but negative permanent decline in Canadian terms of trade.

The export response is initially small, but steadily increases at a decreasing rate, gradually converging to 17.4%. This is closer to the GS result of around 8% and matches the gradual increase of their response function. The income response is very similar in shape to exports, with a gradual increase, converging to 15.2% above the original steady state. This is larger than the 4% found by GS. Investment response grows quickly to 6.2% after only 4 years before falling to 5.8%, but then converges eventually to 23.1%. GS report a convergence of just above 3%. Lastly, in response to its own innovation, population gradually converges to 7.6%. GS find convergence to just under 2%. The population innovation causes large increases that confirm the finding of Green and sparks that population is a substantial contributor to income growth.

Figure 5 shows similar functions when the innovation is exports. A particularly striking result is the massive decrease to terms of trade, which converges to -41.9 percent below steady state. The long-term response by GS is only 1%. Exports and income also respond aggressively, converging to 121 and 93.2%. These numbers are much larger than the 8 and 2 percent in GS. The investment response is again smoothly shaped, rising quickly to 131% above steady state. GS find a much smaller impact of only 4%. Population increases steadily in response to the export innovation, converging to 48.7%. This is very different from the GS results, who find a convergence below the steady state of -0.4%. These responses are strikingly large. What is interesting here is that export innovations on their own lead to a decline in terms of trade, but, in concert with population growth, may lead to increases in investment and income. This is evidence for the endogeneity of export growth, which supports the GS theory that immigration led to improvements in economies of scale.

Although I do not show the impulse response functions for the terms of trade innovation, they are worth mentioning. The terms of trade impulse on itself shows a gradual increase from steady state, converging at 6.5% in the long run. Population and investment responses show opposite behavior, with end results of -0.35 and -5.30 percent below steady state. The responses of exports and GNP to terms of trade are unique. Exports reach as high as 1.0% above steady state but finish at around 0.03%. The response of GNP reaches as low as -2.8% but converges to -1.3%.

Figure 6 shows responses to innovations in income (GNP). The response for terms of trade gets as low as 0.7% before increasing slightly to converge to 2.4 percent. The export response to an income innovation is negative, converging to -5.2%. This is different from GS, who find a positive export response that converges to around 3%. The population, investment and income responses to an income innovation converge to small but negative numbers below steady state. Population switches from positive to negative, moving from 0.02% to -1.1%. Investment and GNP are, in the long run, -1.1 and 0.87 percent below steady state. The GS results have investment and income converging to around 5 and 4.5%.

Like the terms of trade innovations, I do not show the response functions for the investment innovation, but I report their trends here. The terms of trade and population responses converge to large numbers. These are -36.5% and 39.5% respectively. The other three responses grow gradually to large positive values. Exports ends at 92.9% above steady state, while investment reaches 116%. GNP converges to 78.1%. These values are some of the largest of all innovations, apart from the impact of export innovations on terms of trade.

Figures 7 and 8 show impulse response functions under the reordering I describe earlier. I place population at the bottom of the ordering, so that terms of trade are not contemporaneously affected by any of the other variables. The export series is affected only by itself and population, while investment is affected by itself, exports and terms of trade, and so forth. I find that the reordering causes very little change to the long-run effects of the variables on each other. Figures 6 and 7 are nearly identical to the impulse response functions for investment and terms of trade innovations under the original scheme. This result matches Green and Sparks, who also find that reordering makes little difference. In total, most of these response functions are identical in shape and direction to GS, but much larger. The differences in the magnitude may be due to the fact that I report exports in the thousands, whereas GS use full counts.

These responses indicate a different story than what has been previously told. Innovations in population and exports both had negative effects on the terms of trade (-7.9% and -41.9%), which would explain why my new terms of trade series declines after the end of the nineteenth century, when there was heavy growth in both variables. However, this model suggests that both population and export growth (but not terms of trade) were significant contributors to increases in real income, as opposed to only exports as was previously thought. This is due to the endogeneity of exports, as population innovations on exports have a large positive effect (17.4%).

6 Conclusion

In this paper, I present new Fisher indexes for the prices of Canadian imports and exports for the years 1867-1913. Highly granular data from the *Trade and Navi-*

gation Tables of the Sessional Papers of the Dominion of Canada allow for price calculations that are much less aggregated than previous estimates. I calculate total indexes, but I also deconstruct the total into indexes for 19 subcategories. Using the two measures to construct terms of trade (export price/import price), I find that Canada's terms of trade gradually increased during most of the nineteenth century, but that growth slowed in later years. This is because import prices were gradually declining, but decreased less in later years. Also, export price growth slowed after the beginning of the wheat boom. Using the terms of trade series, and other data from Urquhart(1965) and (1986) on investment, income, population and exports, I construct a Vector Error Correction model to quantify the interactions between these variables in the presence of cointegration. This model is very similar to the one used by Green and Sparks (1999).

From this model, I compute impulse response functions to see how disturbances in each of the variables affect each other dynamically. These results are very similar to the GS ones. I confirm their surprising finding that population is a significant contributor to the growth path of income, with long-run convergence of 15.2 percent above steady state. One surprising finding is that, with this model, export innvations alone cause a negative impact on terms of trade. Only with population innovations working through export growth does the evidence support the staples thesis. I also find that, like the GS model, reordering the endogeneity of the variables makes almost no difference in the shape or long-term outcome of the impulse-response functions. Overall, these results confirm the work of Green and Sparks, who speculate that population's contribution is due to an increase in the supply of immigrants from American and Europe. It appears that the growth of wheat exports was not the direct cause of income growth from 1896-1913, but was endogenous.

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8 Appendix: Price Indexes and Impulse Responses

Figure 4: Impulse-response functions with a one s.d. population innovation.

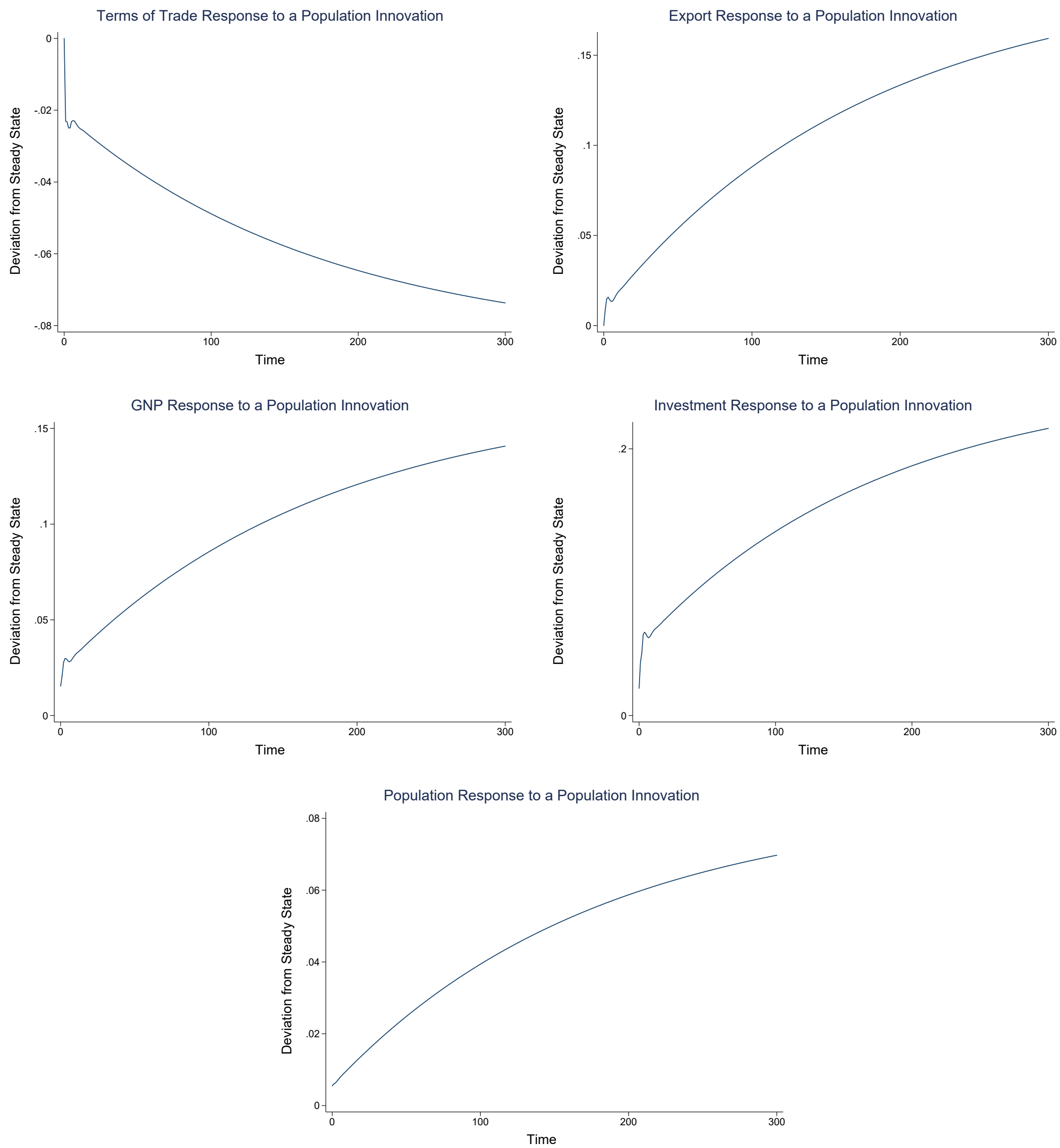

Figure 5: Impulse-response functions with a one s.d. export innovation.

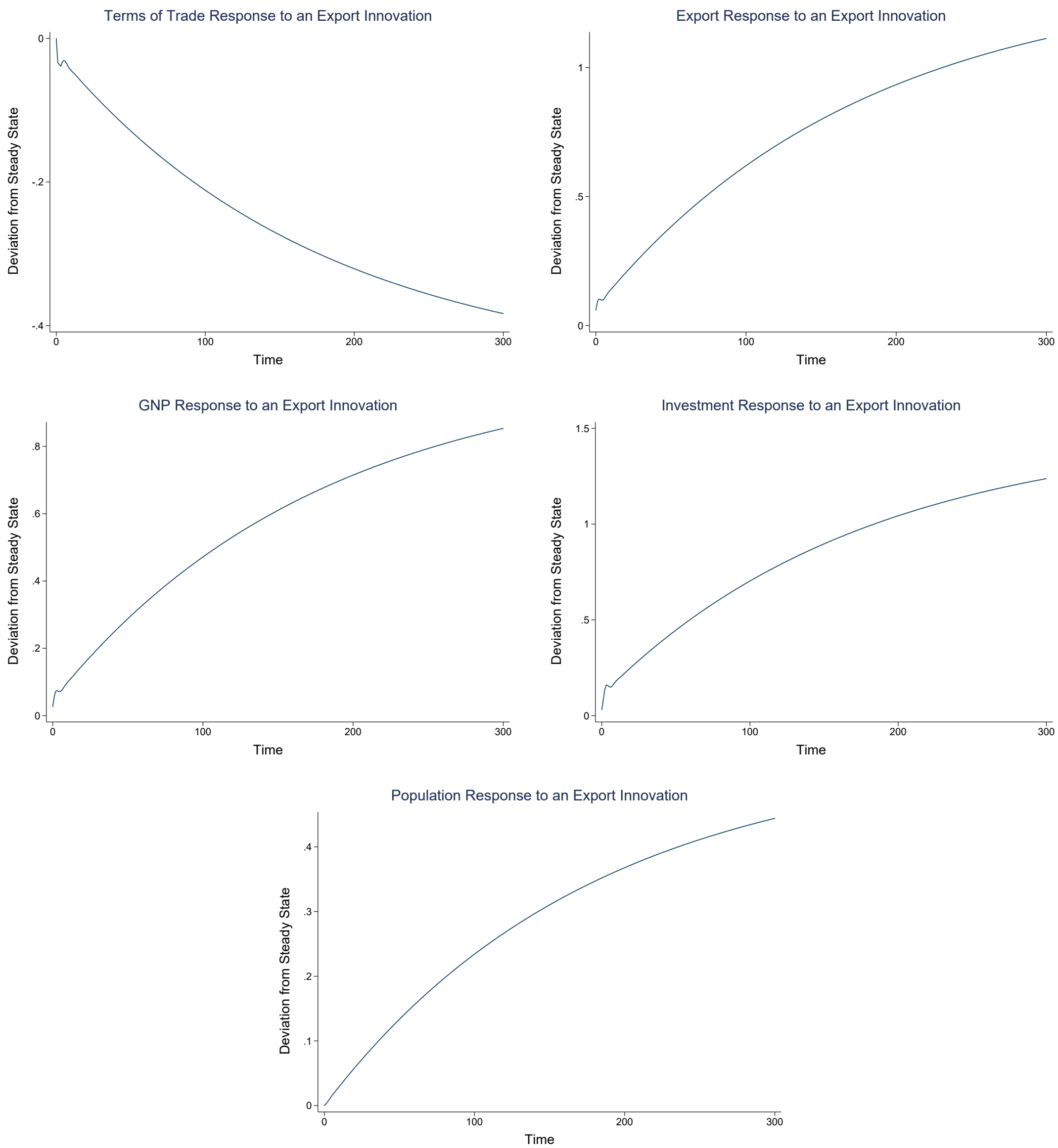

Figure 6: Impulse-response functions with a one s.d. GNP innovation.

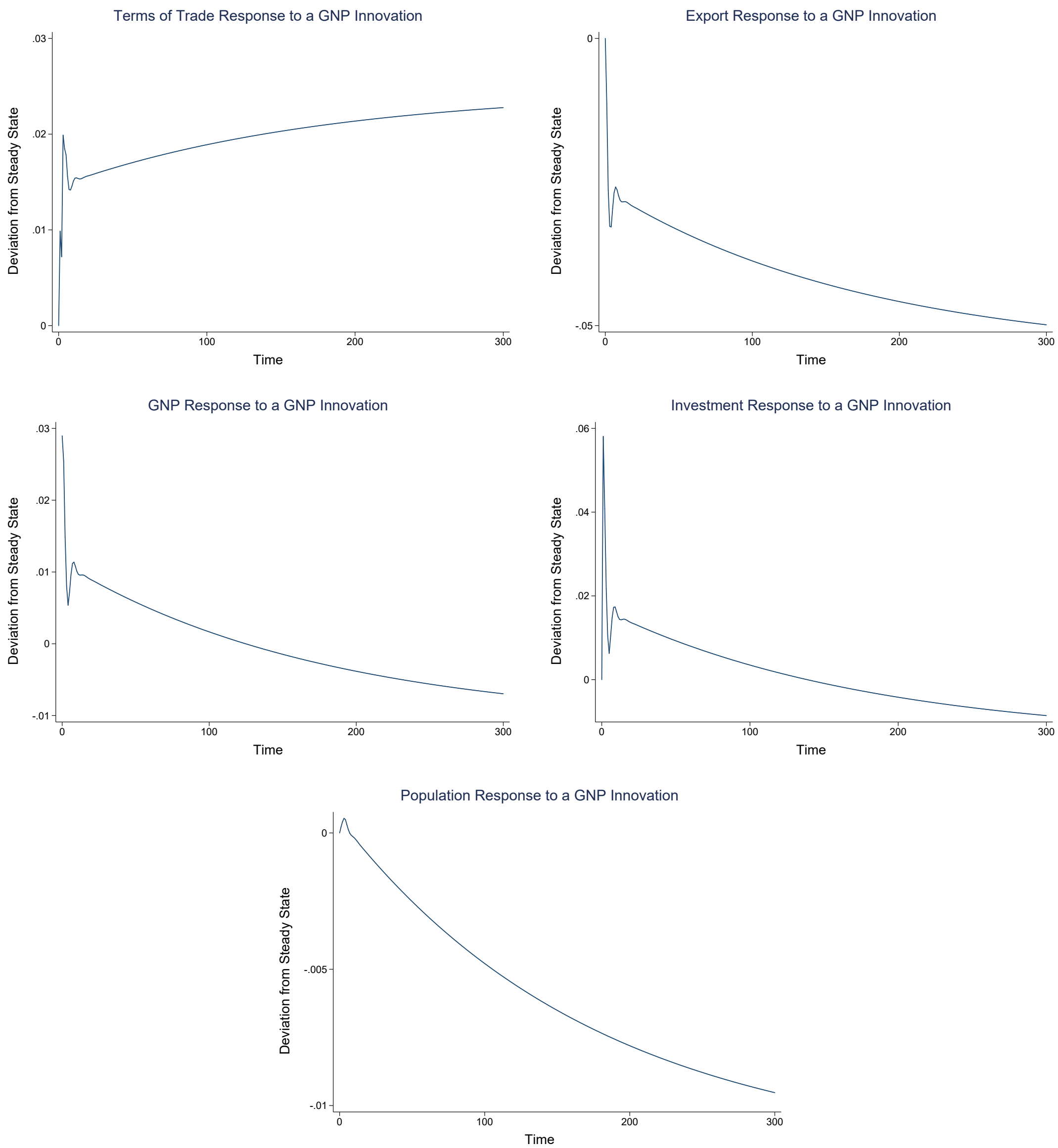

Figure 7: Impulse-response functions with a one s.d. terms of trade innovation (under reordering).

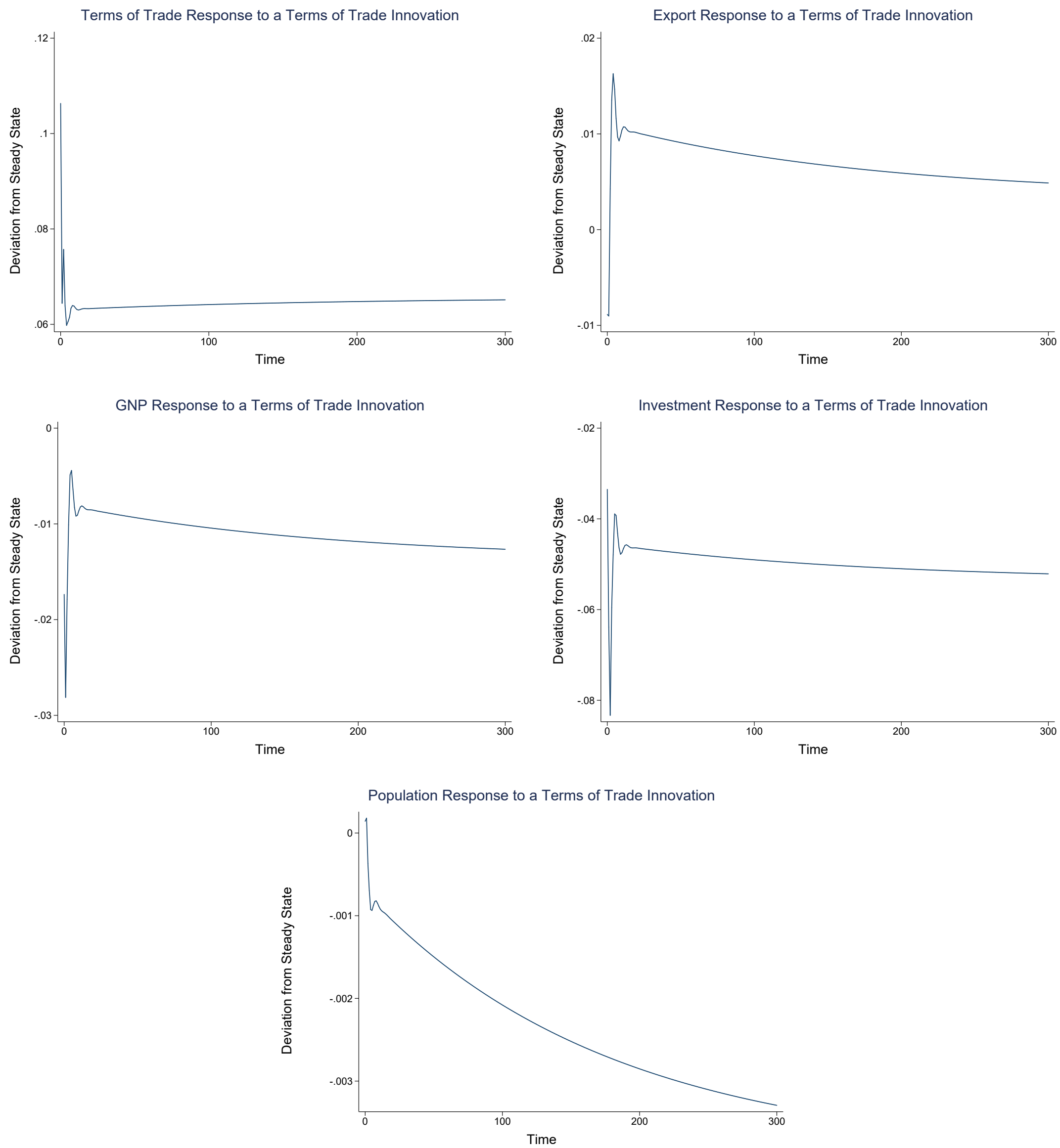

Figure 8: Impulse-response functions with a one s.d. investment innovation (under reordering).

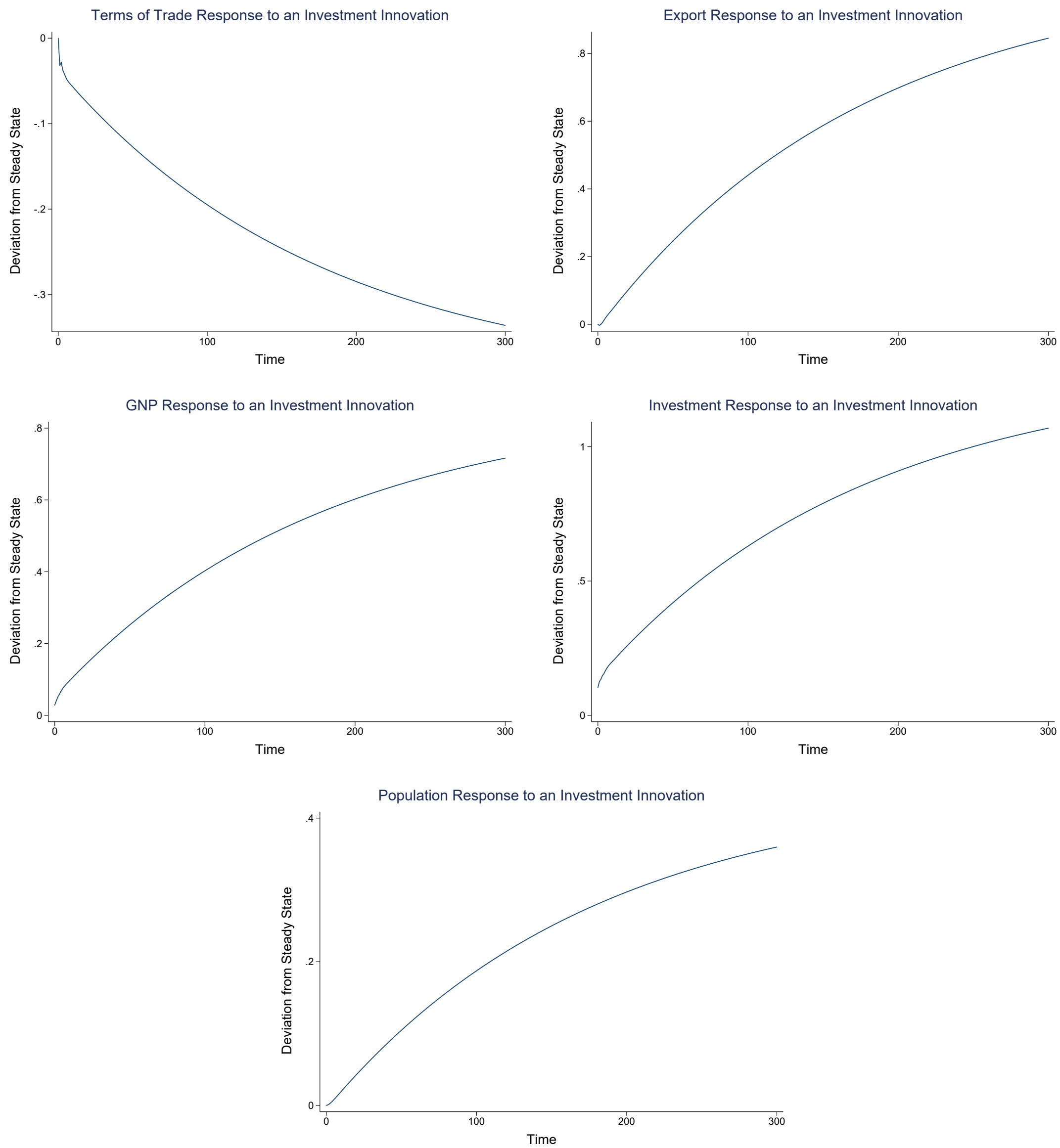

Table A1: Chained Canadian Import Price Indexes, 1869-1913 (1900 = 1)

Year	Tot	N	Chem	Cloth	Elec	Food	Iron	Leat	Misc	NFer
1869	1.236	178	2.004	.	.	1.669	3.756	.	10.639	3.723
1870	1.447	225	2.074	.	.	1.728	3.472	.	10.158	5.152
1871	1.526	239	1.346	.	.	1.442	2.640	.	11.313	4.770
1872	1.678	276	2.637	.	.	1.644	3.791	.	10.417	4.472
1873	1.568	258	2.390	.	.	1.602	3.404	.	9.531	4.671
1874	1.624	156	1.803	.	.	1.488	3.443	.	9.756	4.212
1875	1.381	244	2.506	.	.	1.445	2.594	.	5.191	4.291
1876	1.590	350	2.726	.	.	1.386	2.104	0.318	1.099	4.161
1877	1.479	306	2.450	.	.	1.459	1.865	0.310	0.818	3.842
1878	1.285	365	1.878	.	.	1.314	1.664	0.321	0.710	3.502
1879	1.320	453	1.470	0.295	.	1.463	1.673	0.320	0.929	3.000
1880	1.355	500	1.580	0.257	.	1.609	1.630	0.344	0.957	2.736
1881	1.349	538	1.478	0.287	.	1.494	1.604	0.273	0.997	2.236
1882	1.274	567	0.977	0.313	.	1.521	1.706	0.343	0.946	1.827
1883	1.310	622	1.046	0.334	.	1.663	1.571	0.309	1.153	1.887
1884	1.185	616	1.069	0.338	.	1.404	1.048	0.271	1.430	0.975
1885	1.155	703	0.966	0.323	.	1.348	1.176	0.271	1.257	0.969
1886	1.034	771	1.114	0.313	.	1.347	0.699	0.259	1.215	0.954
1887	1.311	771	0.913	0.310	.	1.535	1.439	0.260	1.083	1.031
1888	1.012	785	1.001	0.315	.	1.097	1.308	0.233	0.977	1.054
1889	1.016	816	0.908	0.299	.	1.046	1.414	0.222	1.350	0.986
1890	1.044	869	0.753	0.297	2.157	1.140	1.603	0.256	1.049	1.113
1891	0.980	821	0.756	0.307	1.978	1.085	1.419	0.292	1.101	1.008
1892	1.010	848	0.593	0.267	2.093	1.141	1.815	0.253	1.507	0.944
1893	0.992	848	0.846	0.235	1.494	1.096	1.010	0.856	1.441	0.884
1894	0.885	846	0.607	0.213	1.368	1.052	0.848	0.706	1.496	0.766
1895	0.870	843	0.693	0.215	1.114	0.939	0.854	0.737	1.348	0.806
1896	0.850	806	0.628	0.210	1.326	0.936	0.830	0.715	1.491	0.769
1897	0.805	839	0.548	0.947	0.996	0.909	0.583	0.891	1.047	0.788
1898	0.788	848	0.547	1.061	1.375	0.909	0.686	0.891	1.018	0.911
1899	0.959	857	1.047	0.874	0.415	0.969	0.889	0.983	1.045	1.156
1900	1.000	858	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1901	1.024	853	1.065	1.012	0.525	0.996	1.025	1.145	1.149	1.068
1902	0.906	818	0.686	0.866	0.487	1.068	0.844	1.235	1.052	0.977
1903	0.899	819	0.888	0.876	0.836	1.110	0.848	1.156	1.037	1.031
1904	0.901	808	0.766	0.782	0.375	1.155	0.865	1.128	0.886	1.076
1905	0.878	769	0.743	0.788	0.252	1.076	0.794	0.881	0.815	0.926
1906	0.854	811	0.653	0.743	0.220	1.047	0.807	0.691	0.701	0.673
1907	0.831	822	0.608	0.756	0.203	1.003	0.802	0.966	0.737	0.795
1908	0.863	835	0.652	0.760	0.102	0.936	0.861	0.896	0.731	0.971
1909	0.794	809	0.601	0.749	0.515	0.884	0.880	0.994	0.808	1.011
1910	0.836	825	0.645	0.772	0.479	0.944	0.915	0.991	0.752	0.976
1911	0.842	860	0.630	0.749	0.415	0.915	1.009	1.022	0.775	0.960
1912	0.791	856	0.654	0.740	0.428	0.910	1.001	1.221	0.671	0.837
1913	0.812	830	0.396	1.143	.	0.862	1.122	0.993	0.521	0.703

Note: Number of products refers to the total series, and not to any individual industry.

Table A1(Continued)

Year	NManu	NMet	Pap	Petro	Print	Rub	Tex	Tob	Trans	Wood
1869	0.900	2.101	.	3.384	.	.	1.093	.	.	0.495
1870	1.267	1.889	.	3.634	.	.	1.008	0.317	.	0.386
1871	1.303	1.780	.	3.884	.	.	1.504	0.315	.	0.661
1872	1.447	2.018	.	4.201	.	.	1.582	0.406	.	0.738
1873	1.356	2.585	.	4.293	.	.	1.246	0.456	.	0.755
1874	1.871	2.646	.	3.829	.	.	1.295	0.727	.	0.737
1875	1.681	2.175	.	3.477	.	.	1.161	0.657	.	0.782
1876	1.720	2.535	0.609	3.458	.	.	0.795	0.776	.	0.858
1877	1.704	2.434	0.608	3.115	.	.	0.745	0.631	.	0.557
1878	1.459	2.053	0.405	2.488	0.986	.	0.654	0.640	.	0.606
1879	1.470	1.787	0.570	2.740	1.043	.	0.845	0.690	.	0.751
1880	1.542	1.300	0.485	2.468	0.997	.	0.828	0.665	0.802	0.737
1881	1.607	1.320	0.321	1.909	0.989	.	0.840	0.693	1.454	0.934
1882	1.609	1.383	0.523	1.817	0.899	.	0.545	0.683	2.105	1.017
1883	1.579	1.375	0.824	1.687	0.980	.	0.729	0.687	1.924	0.812
1884	1.575	1.289	0.914	1.568	1.672	1.716	0.785	0.703	1.236	0.966
1885	1.532	1.114	1.290	1.565	1.135	0.874	0.702	0.794	1.364	1.003
1886	1.488	1.054	1.212	1.539	1.088	1.179	0.747	0.862	0.859	0.951
1887	1.887	1.587	1.262	1.360	1.448	0.881	0.721	0.924	1.483	0.884
1888	1.131	1.636	1.063	1.423	1.355	0.862	0.789	0.903	1.807	0.872
1889	1.104	1.696	1.041	1.351	1.412	1.055	0.918	0.960	1.543	0.970
1890	1.204	1.915	0.665	1.418	1.401	1.138	0.760	0.844	1.590	0.978
1891	1.095	1.770	0.635	1.181	1.354	1.328	0.729	0.887	2.399	0.819
1892	1.133	1.667	0.735	0.968	1.315	1.194	0.693	0.865	1.703	1.027
1893	1.095	1.416	0.829	1.149	1.354	0.993	0.671	0.841	1.408	1.099
1894	0.969	1.371	0.933	1.199	1.286	0.951	0.707	0.839	1.400	0.921
1895	0.917	1.544	0.938	1.274	1.106	1.008	0.721	0.829	1.300	0.981
1896	0.918	1.350	0.946	1.260	1.353	0.947	0.686	0.822	1.214	0.891
1897	0.951	1.008	0.849	1.093	1.147	0.867	0.716	0.823	0.845	0.898
1898	0.868	1.057	1.125	1.087	1.021	0.897	0.617	0.871	0.828	0.934
1899	0.931	1.155	1.112	1.865	1.033	1.203	0.978	0.940	0.875	1.002
1900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1901	1.049	0.875	1.159	0.884	0.991	0.760	1.000	1.004	1.085	0.871
1902	0.991	0.901	1.170	0.727	1.197	0.965	0.956	0.999	0.882	0.785
1903	0.913	0.925	1.177	0.826	1.079	0.908	0.947	1.053	0.778	0.675
1904	0.922	0.903	1.134	0.928	1.012	1.119	0.935	1.087	1.088	0.664
1905	0.954	0.926	1.069	0.855	1.060	1.033	0.909	1.066	1.010	0.670
1906	0.983	0.903	1.006	0.888	0.905	0.675	0.879	0.999	1.153	0.525
1907	0.970	0.901	0.884	0.803	0.724	0.492	0.857	1.002	0.938	0.422
1908	0.980	0.938	1.004	0.888	0.862	0.520	0.882	0.979	1.109	0.526
1909	0.785	0.839	0.948	0.982	0.826	.	0.862	0.952	0.988	0.525
1910	0.834	0.759	0.947	1.159	0.859	.	0.929	0.965	0.938	0.464
1911	0.833	0.854	0.962	1.179	0.641	.	0.900	0.936	0.917	0.447
1912	0.737	0.799	0.940	0.983	0.598	.	0.897	0.937	0.907	0.427
1913	0.845	0.727	1.119	1.254	0.626	.	0.857	0.812	0.820	0.503

Table A2: Chained Canadian Export Price Indexes, 1867-1913 (1900 = 1)

Year	Tot	N	Chem	Food	Iron	Leat	Misc	NFer	NManu	NMet	Petro	Tex	Tob	Trans	Wood
1867	0.888	80	0.544	1.175	1.853	1.471	.	2.809	0.762	.	5.996	.	2.375	0.230	0.951
1868	0.865	80	0.562	0.974	2.460	0.674	.	3.857	0.772	.	6.563	.	1.674	0.212	0.952
1869	0.963	72	0.556	0.995	2.084	0.843	.	4.047	0.884	.	5.946	.	1.700	0.215	1.078
1870	0.854	77	0.564	0.920	1.589	0.800	.	5.036	0.694	.	6.613	.	1.537	0.223	1.009
1871	0.947	81	0.410	1.002	2.161	0.522	.	8.309	0.853	.	7.125	.	2.662	0.203	1.068
1872	0.870	97	0.386	1.003	1.276	0.902	.	3.010	0.812	.	6.223	.	1.469	0.171	0.935
1873	0.919	100	0.514	0.948	3.971	0.995	.	4.514	0.766	.	5.177	.	1.481	0.155	1.099
1874	0.880	103	0.469	0.925	1.893	0.572	.	4.296	0.821	.	7.513	0.980	1.295	0.170	0.967
1875	0.955	113	0.572	0.944	2.059	1.138	.	1.227	0.910	.	2.983	1.319	1.683	0.249	1.047
1876	0.995	126	0.587	0.990	2.381	1.108	.	0.962	0.904	1.050	5.108	1.266	1.596	0.249	1.125
1877	1.042	133	0.804	1.011	2.584	1.320	0.585	1.059	0.940	0.889	8.311	1.155	1.395	0.242	1.195
1878	1.141	136	0.850	1.198	2.845	1.329	0.632	0.961	0.937	0.804	9.713	1.088	1.905	0.307	1.346
1879	1.122	136	0.795	1.126	2.915	1.130	0.559	7.556	0.951	1.071	6.517	0.910	2.313	0.306	1.293
1880	1.031	139	0.719	1.067	3.038	0.961	0.624	25.499	0.897	0.573	4.603	0.794	2.616	0.401	1.096
1881	0.959	140	0.656	0.992	3.329	0.972	0.649	62.238	0.788	0.777	5.756	0.652	1.523	0.331	1.091
1882	0.958	140	0.585	0.942	2.920	0.932	0.622	5.666	0.903	0.611	4.570	0.922	2.851	0.386	0.989
1883	0.951	138	0.624	0.987	1.900	0.864	0.703	1.518	0.854	0.466	4.942	0.617	1.292	0.344	1.017
1884	1.002	143	0.685	1.060	3.035	0.929	0.798	0.989	0.962	0.560	3.740	1.011	1.017	0.438	1.000
1885	1.035	141	0.757	1.191	3.276	1.016	0.780	3.472	0.930	0.455	0.918	1.267	1.131	0.440	1.015
1886	1.063	144	0.735	1.152	3.158	1.002	0.800	5.619	0.996	0.340	2.979	1.107	1.311	0.540	1.027
1887	1.002	151	0.748	1.028	3.003	1.024	0.742	3.058	0.949	0.453	0.728	1.104	0.833	0.416	1.028
1888	0.978	153	0.829	1.010	3.013	1.009	0.743	1.448	0.930	0.436	0.629	1.204	0.964	0.491	0.995
1889	0.967	155	0.894	1.033	2.945	1.016	0.847	2.257	0.900	0.445	2.421	1.116	1.152	0.426	0.973
1890	0.983	152	0.786	1.074	2.282	0.931	0.858	2.392	0.866	0.404	2.425	1.184	1.179	0.450	1.037
1891	0.995	154	0.723	1.002	1.958	0.887	0.873	2.306	0.909	0.479	2.497	2.199	1.091	0.557	1.076
1892	0.980	161	0.600	1.022	1.145	0.846	0.764	2.086	0.927	0.484	2.725	1.934	1.227	0.668	0.972
1893	0.924	168	1.044	0.976	0.923	0.932	0.857	1.525	0.835	0.576	2.813	0.965	1.099	0.700	0.948
1894	1.017	169	1.149	1.069	0.790	0.936	0.903	1.561	0.963	0.566	2.218	1.043	0.792	0.846	0.988
1895	1.043	166	1.012	1.151	0.801	0.958	0.916	1.853	0.989	0.688	1.474	1.220	1.111	0.971	0.939
1896	1.081	171	0.930	1.134	0.975	1.110	0.915	1.858	1.161	0.659	1.916	1.306	1.229	0.869	0.897
1897	1.077	170	1.021	1.118	1.125	1.163	0.968	1.626	1.018	1.099	0.940	1.530	1.069	0.959	1.070
1898	1.074	180	0.973	1.119	0.984	1.243	1.010	0.926	1.069	1.077	0.713	1.349	0.885	0.929	0.999
1899	1.028	179	0.960	1.027	1.001	1.088	0.989	1.006	1.031	1.209	0.831	1.071	0.891	0.984	1.020
1900	1.000	180	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1901	1.047	181	2.714	0.992	1.741	1.128	1.044	1.026	1.094	1.101	0.784	0.940	0.875	0.994	0.898
1902	0.996	179	2.217	0.949	1.346	1.166	1.005	1.029	1.041	1.206	0.843	0.802	0.706	1.031	0.845
1903	1.001	188	2.377	0.983	1.489	1.163	0.963	1.002	1.050	1.197	0.697	0.663	0.828	1.275	0.802
1904	1.009	187	2.744	1.000	1.522	1.298	0.980	0.801	1.008	1.066	0.622	1.262	0.678	1.121	0.870
1905	0.943	189	4.322	0.910	1.407	1.156	0.970	0.644	0.952	1.196	0.615	1.217	0.705	1.598	0.815
1906	0.870	189	3.737	0.788	1.537	1.094	0.958	0.542	0.906	1.119	0.549	0.717	0.459	1.240	0.816
1907	0.863	191	3.583	0.824	1.364	1.055	0.949	0.728	0.875	1.071	0.770	0.679	0.765	1.110	0.748
1908	0.837	206	3.096	0.814	1.314	1.001	1.162	0.821	0.858	1.143	0.501	0.750	0.978	1.082	0.697
1909	0.799	208	3.040	0.807	1.884	1.111	1.083	0.912	0.821	1.148	0.870	0.752	0.663	0.991	0.600
1910	0.805	203	3.118	0.820	1.690	1.127	0.951	0.918	0.833	1.192	0.685	0.567	0.653	1.161	0.593
1911	0.809	205	2.911	0.795	1.683	1.233	0.870	1.034	0.847	1.294	1.370	0.636	0.538	1.457	0.608
1912	0.815	213	2.971	0.754	1.626	0.983	0.942	1.238	0.870	1.604	1.091	0.519	0.610	1.765	0.619
1913	0.829	196	2.987	0.794	1.673	0.897	0.890	0.933	0.897	1.565	1.123	0.433	0.327	1.931	0.579