

UNIVERSITY OF WAIKATO

Hamilton New Zealand

**An Analysis of Provincial Prices in New Zealand:
1885-1913**

Ekaterina Sadetskaya and Les Oxley

Department of Economics

Working Paper in Economics 15/13

October 2013

Corresponding Author

Les Oxley

Economics Department

University of Waikato

Private Bag 3105

Hamilton

NEW ZEALAND, 3216

Ekaterina Sadetskaya

Economics Department

University of Canterbury

Private Bag 4800

Christchurch

NEW ZEALAND, 8140

Email: loxley@waikato.ac.nz

Email: ekaterina.sadetskaya@pg.canterbury.

Abstract

The paper discusses the construction of a new Consumer Price Index (CPI) for New Zealand, 1885-1913, based upon aggregation of data from the four largest provincial districts: Auckland, Canterbury, Otago and Wellington. Using these new provincial data, we explore the degree of market integration within the New Zealand dairy and meat sectors, and consider whether anecdotal evidence on South-North price convergence is supported statistically.

Keywords

consumer price index
provincial districts
market integration
New Zealand

JEL Classification

N17, N97, C32, O56

Acknowledgments

The authors gratefully acknowledge the helpful comments received from Kris Inwood, Evan Roberts and David Greasley. In addition, the authors benefitted from the support from Marsden Fund Grant UoC807, 'The Long and the Short and the Tall: Measuring Health and Wellbeing in New Zealand' for funding this research.

1. Overview

Measuring prices, both in terms of levels and rates of change, plays a fundamentally important role in a wide range of economic applications. Whether we consider individual goods and services or baskets of commodity aggregates, price data allow us to explore changes in ‘real’ values, as well as measure, estimate and test a wide range of economic hypotheses and relationships including, for example, changes in the cost and standard of living, real wages, purchasing power parity, relative price changes, etc. In most developed economies, the recent, post-war, history has been one of universal price inflation, where the differences that we see are only in terms of the rates of inflation and global spatial variation. However, long term price series, where they exist (for example, Australia: Bambrick 1973, Mclean 1999; Britain: Mitchell 1988), remind us that these post-World War II experiences are far from typical. Long periods of price stagnation and significant periods of decline were punctuated with relatively short periods of inflation, often caused by the need for the State to finance wars. Furthermore, the recent economic downturns associated with the global financial crisis led some to consider the possibility that the world might return to the spiraling deflations of the 1930s, and renewed interest in historical analysis of prices including specific items such as housing and land. When we seek to undertake historical based analysis using New Zealand data, we immediately face a lack of data, at least in a readily usable form.

Summary measures such as Consumer Price Index (CPI) are based upon our ability to appropriately aggregate weighted combinations of goods and services to provide a summary cost of living measure. In New Zealand, the first cost of living index was created in 1915, by Fraser. His estimates were based on the records of people who were engaged in retail trade over the period 1891-1913. In 1982, Margaret Arnold constructed an alternate aggregate CPI by revising the weighting scheme used by Fraser and including additional Provincial data, which she extracted from Statistics New Zealand Annual Reports.

For many, the Arnold series remains the most reliable for that period and in our new work, reported here, we use Arnold’s series as a benchmark to reconstruct a New Zealand CPI for the period 1885-1913 from a spatial perspective, that is, disaggregated at the level of the four most populous provincial districts: Auckland, Canterbury, Otago, and Wellington¹. The starting point coincides with the availability of district level nominal price series reported in Statistics New Zealand Annual Reports. The construction of provincial CPIs is achieved by using nominal prices for a chosen basket of goods based on the Labour Department Household Survey of 1893 and other sources including (New Zealand Department of Statistics 1873-1935, New Zealand Department of Statistics 1965, New Zealand Department of Statistics 1893, Tremblay *et al.* 2005).

Using these new data, we then identify and analyze regional price movements and trends of the leading New Zealand sectors between 1885 and 1913 and then test for evidence of spatial convergence in prices using both simple coefficients of variation and more specific time-series methods² allowing us to establish the extent of regional market integration. From an economic perspective, we use these techniques to consider the integration of traded

¹ Statistics of New Zealand in its yearly publications reported average prices of produce, provisions etc. for each provincial district of New Zealand from approximately 1847-1849.

² Bernard and Durlauf (1995) and Johansen-type (1988) tests are used to test for common trends, which we refer to in more detail in Section 5.1.

commodity markets across Provinces to consider whether the findings support the story of a South-North convergence generated initially via the refrigeration boom and subsequent shift in population south to north.

The chapter is organized as follows. Section 2 provides a brief overview of previous work on New Zealand prices and is an adjunct to that provided by Briggs (2003). Section 3 presents the methods used, the choice of consumption basket, and a discussion of the various indices presented. Section 4 presents an analysis of Provincial sub-index and composite series with some theoretical implications highlighted. Section 5 considers the existence of convergence among Provincial traded commodity markets, commencing with a brief overview of the econometric testing methods employed. Section 6 considers the consistency of the derived CPI with the existing national level CPI. Section 7 draws some conclusions.

2. New Zealand's Historical Prices Series

2.1 McIlraith's Series (1861-1910)

The earliest price index for New Zealand (based on wholesale prices) was developed by McIlraith in 1911, most likely in response to heightened inflation prior to the World War I (Nesbitt-Savage, 1993). The objective of that series was to measure changes in the general level of prices from 1860. In particular, McIlraith was interested in examining changes in the purchasing power of money and to ascertain the causes of the changes in the local price level. McIlraith (1911) did not attempt to weight the commodities used in the series, but rather derived the un-weighted wholesale prices from the import and export schedules, including the prices of non-consumer items (for example, zinc, lead, bar iron). McIlraith (1911) further assumed that prices would deviate little among the largest centers, mainly, upon the assumption that transport and communication between the different commercial centers of New Zealand was frequent and cheap. He therefore adopted Wellington prices for the most frequently imported goods, and Christchurch retail prices for agricultural produce items such as cereals and meats.

McIlraith (1911) also used the Sauerbeck (1895) and '*Economist*' series³ to compare New Zealand and English price levels. He found 'a marked coincidence during 1880-89 between the two series' where the average prices were falling between 1880 and 1887 in both countries. McIlraith (1911, p.75) also compared his series to the U.S. Falkner series and found that:

...America, like New Zealand, did not experience the wave of inflated prices till 1872.

McIlraith was not always clear on the sources and references to the price series he used. As noted by Nesbitt-Savage (1993), the McIlraith wholesale price index is not an adequate consumer price series and provides only approximate measure of the annual rate of change in retail prices.

³ McIlraith (1911) claimed to derive the series from the *Economist* magazine.

2.2 Fraser Series (1891-1914)

Sudden price inflations in the 1890s reinvigorated the interest of the Department of Statistics in surveying relative price movements. In 1915, the Government statistician, Malcolm Fraser produced a report on the long-term cost of living index, based on the records of people who were engaged in retail trade over the period 1891-1913 (Nesbitt-Savage 1993). From that point on, regular monthly and quarterly surveys were undertaken to monitor consumer prices.

The expenditure for each individual item (the ‘mass-unit’) was ascertained by taking the average production of each commodity in New Zealand plus or minus the excess of imports over exports, or *vice versa*, all averaged over the past ten years. Fraser states that he used monthly sales for the various grocery items. The relative expenditure shares of the household budgets, collected by the Department of Labour in 1911-1912, were used to verify the results. The index numbers of retail prices for each sub-group were compiled from prices collected in the four ‘chief’ centers (Auckland, Wellington, Christchurch and Dunedin) between 1891 and 1914.

Fraser’s cost of living index is the first weighted retail price series index, and represents a more appropriate CPI estimate to that of McIlraith. Despite that, Fraser’s price series has its limitations. The retail prices for the grocery group in Christchurch were not collected prior to 1899 although series for other centers were collected from 1891. The expenditure weights used by Fraser only approximate the results obtained by the Department of Labour as he did not include certain items of fruit and vegetables (Fraser 1915). He also omitted the *other items/miscellaneous* section, which by the 1910 expenditure survey constituted about 40.34 percent of the household expenditure basket (Collins 1912). Most importantly, Fraser ‘neglected’ (Arnold, 1982b) the Statistics of New Zealand annual return of retail prices published for each year since 1847, with the number of items expanding from 1885⁴. Fraser’s series is therefore restrictive in scope (as it covered only food and rent) and was ‘further limited because the compilers relied on less than optimum sources’ (Arnold 1982b, Nesbitt-Savage 1993). Although both the McIlraith and Fraser price series are probably reliable in relation to the general trend, they appear to be less reliable in terms of annual fluctuations (Arnold 1982b).

2.3 Arnold’s Series (1870-1919)

In order to address problems with the Fraser series (for example, incomplete or limited expenditure basket and data source reliability), and to extend the series (the Fraser series commences in 1891), Margaret Arnold developed an aggregate CPI by revising the weighting scheme used by Fraser. To construct the new CPI she extracted annual average returns of prices reported in Statistics New Zealand from 1870 to 1919 (Arnold 1982b) where collection of these prices were apparently undertaken by the Police Force (NZOY, 1910).

Arnold’s long-term series consisted of the five major subgroups of expenditure: Food, Housing, Clothing, Fuel & Light, and Miscellaneous items. She collated the prices for

⁴ Statistics New Zealand expanded the range of prices published since 1885 e.g. farm yard produce (eggs, ham, bacon etc.), garden produce (potatoes, onions, carrots, cabbages etc.) and miscellaneous (such as coal, firewood).

individual items for the years 1870-1901 and then linked them to the Fraser series ‘as to provide an adequate overlap with the Fraser series’. She constructed the individual series by first taking the midpoint of each range of values given for each Province, and then weighting these midpoints by the proportion of population in the Province. To develop her final CPI, she linked the five sub-series together. Although, for her final series she used various weights (Karamea⁵, Department of Labour, and Fraser), Arnold (1982b) reports that using different weights ‘made relatively little impact on the series.’ Arnold concluded that the five subseries all move together, showing the same U-shape as the general trend. Arnold’s CPI series are probably the most commonly used index of changing consumer prices in New Zealand for the 1870-1919 period.

2.4 Nesbitt-Savage series (1847-1990)

Nesbitt-Savage (1993) used Arnold’s series from 1870 to 1919 as the basic starting point to construct his long run CPI series (1847-1990). Nesbitt-Savage (1993) developed two models to construct (rather than directly measure) a long run CPI from 1847-1992. The first model used an overlap between McIlraith and Arnold to construct the series for 1861-1869. The second model used the correlation between Sauerbeck’s (British wholesale Price Index) and Arnold’s series to derive an approximation for the 1847-1860 period. The first two models were then linked to Arnold’s (1870-1919) and Department of Statistics (1920-1992) CPI series. Nesbitt-Savage assumed the same consumption patterns (unchanged basket of goods) throughout that whole period (1847-1919). The models then used simple linear regression techniques to predict the series. The methods used to generate the long-term CPI series can probably be ameliorated using more sophisticated time series methods now available.

3. Methods and Data

This section describes the data sources used, the extent of the data coverage and the weight selection in the consumer price index basket.

3.1 Basket Choice

Construction of the CPI generally begins with compilation of the average prices of a wide range of commodities and their relative expenditure weights (shares). To gain a perspective on the historical pattern of the consumer basket composition, Table 1 reports consumer basket weights for three different time periods for New Zealand and other countries with comparable labour markets (that is, Australia and Britain). In New Zealand, the proportion of food in overall expenditure declined from 63.05% to 34.13% during the period 1875-1911. The relatively high proportion of expenditure on food in Australia can be noted from the earliest expenditure survey (1861), which subsequently declined to around 30% by 1911.

For both New Zealand and Australia, there is a shift from the dominant expenditure on food in the early years before 1900 to correspondingly larger shares spent on miscellaneous items after 1900. Similar to Australia, expenditure on housing/rent more than doubled in New Zealand between 1875 and 1911. For Australia, there is some divergence in the basket

⁵ Karamea Store Book, 1875-1876, NP Series 23, Box 5, item 6, Archives New Zealand (ANZ).

weights between the McLean (1999) and Knibbs (1911) series. Markedly, Knibbs's basket shows a very small share of income spent on food and correspondingly large share spent on 'other things'. McLean (1999), however, was sceptical as to the results of the first expenditure survey (Knibbs 1911), which he indicated were 'deemed unsatisfactory.' In Britain, interestingly, in Britain the expenditure on food has a reverse pattern: expenditure on food increased by 24% from 1900 to 1914. Given that the 1914 Shergold's Birmingham survey reports only a relatively small proportion of the miscellaneous items in the basket, it is possible that those were included in the food portion of the expenditure inflating the amount spent on food in the typical worker's budget.

The basket of goods chosen for construction of the New Zealand Provincial CPIs corresponds to that reported in Arnold, but with minor changes (that is, we include eggs, dried fruits, potatoes and vegetables, and omit fish from the grocery basket). Arnold used three different weighting schemes for different periods: *1875 Karamea weights* (for 1870-1893); *1893 basic expenditure weights* (1885-1919); *1910 Fraser Budget study weights* (1895-1919). However, Arnold (1982b) noted that the final aggregate series were robust to the use of different weighting schemes. Given that Karamea weights were potentially restrictive in representing the total population (the weights came from one store book), and Fraser's weights covered only a portion of the total expenditure, for the construction of Provincial CPIs we proceed with the *1893 basic expenditure weights* for the entire 1885-1913 period (the weights for the consumer basket are reported in Table A-1 of the Appendix).

There is limited knowledge as to whether the consumption patterns were different across Provinces for example, Collins (1912) estimated differences in the cost of living between Christchurch and Auckland using a simple basket (food and rent):

...the figures show an increase of 20 % in the cost of living (food and rent) in Christchurch as against an increase of about 34 % for Auckland. Auckland's budget shows an increase in food by 25 %, while Christchurch indicated an increase of about 21 % by 1910-11.

Based upon evidence from the Royal Commission Report, Collins (1912) included only specific items and not the weights of the whole basket. Furthermore, the expenditure weights were also limited to the two selected provinces. He also commented on the cost of living figures provided by the Royal Commission (1912-H.18, p. xii):

...the report of the Royal Commission represents a rudimentary summary of the statistics on prices in the Dominion at that time.

More recently, Greasley and Oxley (2004) reported that the prices of foodstuffs in 1896 were cheaper in New Zealand than in Manchester, while the overall cost of living in New Zealand was higher than in Manchester. Worker's living costs were, respectively, 23% and 28% higher in Auckland and Wellington than in Manchester. They suggested that such results may overstate the extent of living costs in New Zealand since there could be differences in expenditure patterns between the North and the South: 'much of the North Island is frost free for most of the year, which lessened the need for domestic fuel.' For the CPI construction, such assumptions would be difficult to incorporate since it is not clear how much more people who reside in South Island would spend on fuel. As such, the same consumption patterns are assumed across the four most populous Provinces.

**Table 1. Country-specific Expenditure Weights for Consumer Price Indices
Percent of Total Expenditure**

Items of Expenditure Country	New Zealand			Australia				Britain	
	Survey year	1893	1910-11	1875	1861	1900	1913	1911	1900
Source	Household Survey	Labour Depart.	Karamea Weights	McLean (1999)		Knibbs (1911)*		Prest (1954)	Shergold (1982)
Food	52.70	34.13	63.05	45.12	39.40	38.52	32.23	34.9	54.45
Rent (Housing)	10.38	20.31	6.14	12.09	15.54	19.43	13.7	11.6	17.65
Clothing	17.52	13.89	14.60	12.09	23.31	21.39	12.72	10	11.95
Fuel and Light	8.08	5.22	2.08				3.46	5.1	5.95
Tobacco							0.63	1.8	
Alcohol	1.16		3.22	14.27	13.46	12.12	0.74	12.8	2.6
Miscellaneous	10.16	26.45	10.91	16.43	11.82	8.54	36.52	23.8	7.4

*Notes and Sources:** Extracted from R. Allen (1994). Australia: Knibbs (1911: 14, 19), food includes non-food groceries and non-alcoholic beverages.

3.2 CPI Calculation

From approximately 1885, Statistics New Zealand published a wide range of product prices extending the vegetable and home produce section, as well as prices for fuel and light. Factories and manufacturing production series were also reported from 1885⁶. Grocery prices items such as jam and dried fruits were taken from the import schedule (1885-1890, until 1899 for Canterbury) and then linked with corresponding items reported in Fraser (from 1890 for most series). The breakdown of dried fruits into prunes and apricots was converted into a single price series for dried fruits⁷ (Fraser 1915). The fancy biscuit series was omitted since neither the household expenditure survey of 1893, nor Fraser's budget survey included this item. Expenditure items in the Dairy, Meat, Fuel & Light and Clothing series are identical to those reported in Arnold (1982b) and are discussed in greater detail in the next section. The composition of the Housing and Miscellaneous sub-series deviated slightly from that of Arnold.

In New Zealand, most people lived in a four or five-bedroom home and many owned a housing property. The practice of tenants leasing their homes at a fixed rent was more widespread than bargaining for weekly rents (Fraser 1916). The housing price index comprised two series: Statistics New Zealand pre-1902 (calculated from the number of Boroughs and the rental value of ratable property), and the prices reported in Fraser (from 1902 -1913 housing prices for 2,3,4, and 5 bedrooms homes were assigned different weights).

The *Miscellaneous* series consisted of the prices on soap (washing), books (the income of public libraries for the respective education district), furniture and medical expenses. A proxy for education is difficult to derive since primary education was free and compulsory from 1877. Thus expenditure on education only contained expenses on books and study materials. Arnold used the value of imported printing paper as a proxy for education, which is potentially misleading as the paper was mostly used for printing newspapers. As an alternative, we used public library subsidy data, derived from the *AJHR* (Appendices to the Journals of the House of Representatives), for each education district to proxy for education expenditure. Total income, or 'entitling subsidy,' (received from subscriptions and voluntary contributions)⁸ for each education district was divided by the total population at each successive Census. Other miscellaneous items for example, furniture prices, were estimated by applying equal weights to carpenters' wages (for each Province) and the average price for exported timber (dressed timber) at the national level. For medical expenses we used data on hospitals' receipts and expenditure. The total amount of contribution received from patients for each subsequent year was divided by the total number of patients in hospitals in each of the four respective boroughs.

The assigned individual weights for some items (the ones that imply variety e.g. dried fruits) were derived from consumption expenditure figures reported for individual items in Fraser. The base used for the indices was the average between 1909 and 1913 (1909-1913=100). The percentage breakdown of expenditure on individual items is presented in Table A1 of the Appendix. Food (combined Grocery, Dairy and Meat) and Housing sub-series were found to be positively correlated with the Fraser series. The negative correlation

⁶ The clothing series had to be extracted from that data.

⁷ 75% of expenditure was assigned to prunes, and 25% to apricots.

⁸ New Zealand. House of Parliament (1884).

coefficient for the Fuel & Light series is likely to be biased by the relatively limited time span of the Fuel & Light prices reported by Fraser, which were not available prior to 1893 for Wellington, 1903 - for Christchurch, and 1907 - for Auckland and Dunedin. Estimating the cost of housing prior to 1901 was also problematic. The Borough statistics (used to derive the new Housing series) did not necessarily reflect the cost of paying rent (the cost of ratable properties was divided by the number of people living in each of the main boroughs), but rather reflected the cost of upkeep and mortgage payments.

**Table 2. Pearson's Correlation
between the Fraser and New Sub-Series**

Index	Correlation Coefficient
Dairy	0.854
Grocery	0.28
Meat	0.31
Housing	0.42
Fuel and Light	-0.36

The descriptive statistics in Table 3 below show that the mean values of the Food and Housing sub-index series are not significantly different between the new estimates and those of Fraser. Mean values for all expenditure items in Fraser are consistently higher than in the New Series presented here, which can be explained by the use of different index formulas (Laspeyres tends to inflate the index values, see Table 3 and the discussion in Section 3.3). The standard deviations are much higher for the New Series, than for Fraser, which could serve as an indicator of the greater yearly variations within each sub-group.

3.3 Index Choice and Construction

The choice of an appropriate index for the analysis of our new Regional CPIs is constrained by data availability (prior to 1913 only annual data is reported) and the limited information on expenditure patterns across Provinces. Modern literature on index numbers offers several axiomatic approaches to the choice of a price index. Under the first axiomatic approach, the quantities and prices are independent variables (the cross-elasticity of demand is zero). There are approximately twenty tests under which indices are now evaluated (ILO *et al.* 2004). The Fisher index satisfies all twenty axioms, while the Young, Laspeyres and Paasche indices fail three time reversal tests. The Walsh index fails four tests, and the Tornqvist index fails nine tests.

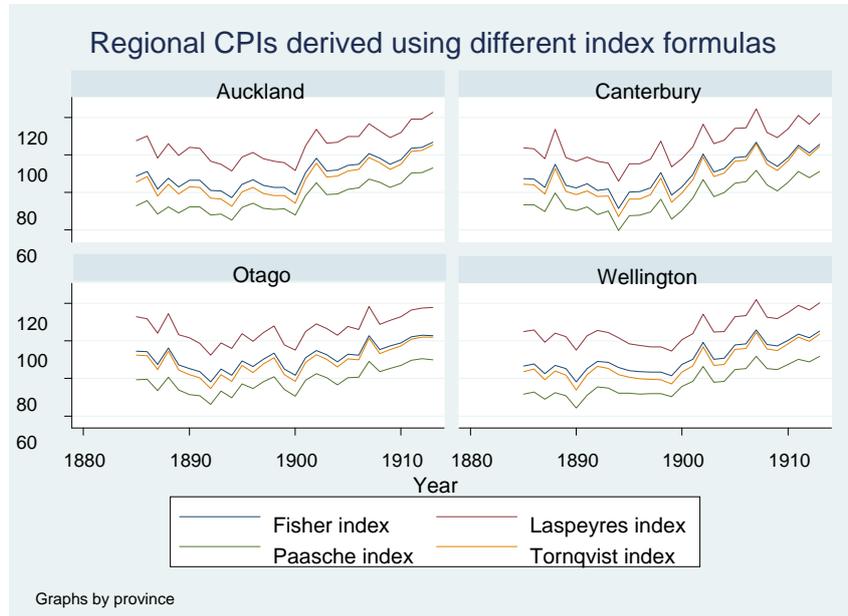
In the case where data follows relatively smooth trends, the Tornqvist and the Fisher are expected to approximate each other numerically (ILO *et al.* 2004). In the second axiomatic approach, in which a price index is defined as a function of the two sets of prices, or their ratios, and two sets of values, the Tornqvist is the only price index that satisfies all seventeen axioms. This is one of the many reasons why this index is currently favored by many researchers. Following the general consensus, we chose the Tornqvist index formula for the calculation of our new Provincial CPIs. Alternative index formulas were also considered, although due to the limited information available on the historical prices and consumer basket, we were not able to calculate the exact Tornqvist, Fisher, Laspeyres or Paasche indexes.

**Table 3. Descriptive Statistics
New Sub-Series and Fraser Series**

	New Dairy	Fraser Dairy	New Fuel & Light	Fraser Fuel & Light	New Grocery	Fraser Grocery	New Housing	Fraser Housing	New Meat	Fraser Meat
Mean	91.83	94.37	96.79	103.39	96.30	100.32	95.28	99.31	95.90	97.23
Median	94.11	96.30	97.45	107.65	95.63	100.25	98.76	93.40	97.95	98.20
Maximum	111.73	112.40	107.51	115.00	128.44	110.00	110.78	125.40	113.28	113.90
Minimum	65.19	79.90	82.05	84.00	75.11	92.70	72.08	85.70	65.59	81.70
Std. Dev.	10.44	8.07	5.85	9.19	12.31	4.06	9.76	11.85	11.68	7.92
Skewness	-0.66	-0.07	-0.71	-0.78	0.60	0.19	-1.10	0.85	-1.08	-0.15
Kurtosis	3.11	2.17	3.28	1.94	3.18	2.31	3.29	2.24	3.64	2.18
Jarque-Bera	3.41	1.35	3.98	6.81	2.80	1.18	9.39	6.60	9.69	1.46
Probability	0.18	0.51	0.14	0.03	0.25	0.55	0.01	0.04	0.01	0.48
Sum	4224.08	4341.00	4452.39	4756.00	4429.60	4614.50	4382.66	4568.30	4411.25	4472.70
Sum Squared Deviation	4904.10	2932.22	1541.56	3799.42	6822.43	742.92	4287.29	6320.95	6141.50	2819.88

Figure 1 shows that the CPI series constructed using alternative index formulas all follow a similar pattern; however, as predicted by the theory, some of them are at the higher bound, while others are at the lower bound. Estimates derived via the Tornqvist and Fisher index formulas are closely approximated, and are in between the lower and the upper bounds.

Figure 1. Provincial CPI Constructed via Alternative Index Formulas



The coefficient of correlation matrix (Table 4) shows that the Tornqvist and Fisher indexes are statistically identical. The Tornqvist price index is highly correlated with both the Laspeyres and Paache index estimates. Thus, the final price series are robust to the use of alternative index formulas.

Table 4. Correlation Coefficient Matrix for the Four Index Alternatives

	Laspeyres	Tornqvist	Paache	Fisher
Laspeyres	1.00			
Tornqvist	0.99	1.00		
Paache	0.96	0.99	1.00	
Fisher	0.99	1.00	0.99	1.00

4. Provincial Analysis

The period 1885-1913 is one of the most controversial and interesting in New Zealand's history exhibiting a period of depression and price deflation; rapid increases in production in the export industries (frozen meat and dairy) and intensive technological change in both agriculture and manufacturing. Such factors may be well known to some, but regional variations in such national trends are less well studied or understood. In addition to the construction of the regional CPIs, in this chapter we also aim to identify whether these national trends were mirrored regionally and whether there were any significant inequalities across the commodity markets at the Provincial level.

4.1 Sub-Index Series Provincial Analysis

Studies for other countries (Australia and Britain) identify the lack of convergence in commodity or labour markets between the mid-19th and the early 20th centuries. McLean (1999) for example, concluded that for the four capital cities in Australia 1870-1914, there was no clear trend towards greater integration of commodity markets with the exception of selected food items (bacon and potatoes). In New Zealand, Fraser (1915) also found divergence in the general grocery group series (the lowest prices were found in Canterbury and the highest in Dunedin). Significant disparities were also recognized in the meat series where Auckland was consistently above the other centers and Dunedin consistently below. The patterns also varied for the other sub-series, but overall Dunedin was identified as the least expensive city and Wellington as the most expensive. Aggregate expenditure series derived by Fraser (1915) did not show any signs of convergence by 1914. In this chapter, we derive new Provincial CPI series which are different in composition and in expenditure weights to those of Fraser, and subsequently test whether the inter-Provincial convergence patterns deviate from those in Fraser.

Certain assumptions, such as the relative stability of prices for imported items relative to the exported or home produced goods, expressed by Fraser (1915) are likely to remain valid in the new series. As raised earlier, our Provincial indexes consist of 7 sub-groups: *Grocery*, *Dairy*, *Meat*, *Fuel & Light*, *Clothing*, *Housing* and *Miscellaneous*. The individual items in each sub-group are supposed to comprise items that exhibit similar price trends and are related to the assigned group. Most of the grocery group items are goods that were either imported or produced for domestic consumption (for example, sugar, tea, coffee, potatoes) where only wheat and flour were exported to some extent. Frequent fluctuations in the grocery index series, see Figure 2(a), reflect the seasonal volatility of bread, potato and flour prices, which are highly dependent upon the weather and the harvest in a particular year. Bread and flour together comprised around 10 % of the overall expenditure and about a third of the grocery basket. Fraser found that the retail prices of home produce items such as bread, flour, oatmeal, potatoes and onions were largely responsible for the annual fluctuations in the grocery group.

Notable from the new Grocery series are the common peaks and troughs of the Provincial prices. The plot of the coefficient of variation, Figure 2 (b), shows no major local variation in prices (the dispersion slightly increased during 1889-1900 and declined thereafter), which points towards the existence of one general market for New Zealand groceries. The general trend is indicative of a price decline in the late 1880s-1890s and subsequent recovery, which seems consistent with the world price deflation of the 1890s. One distinction that can be drawn from the analysis of the descriptive statistics is the prevalence of low prices in the Canterbury region (on average the lowest among the four Provinces). During the nineteenth and early twentieth century, South Island farmers produced most of the country's agricultural produce (such as cereals and wheat) and Canterbury was predominantly the center of wheat production due to the abundance of fertile land, easily accessible and readily cultivable. Flour prices, which remained the lowest in Canterbury until 1901, serve as an indication of such a tendency.

Figure 2 (a) New Provincial Grocery Index Series

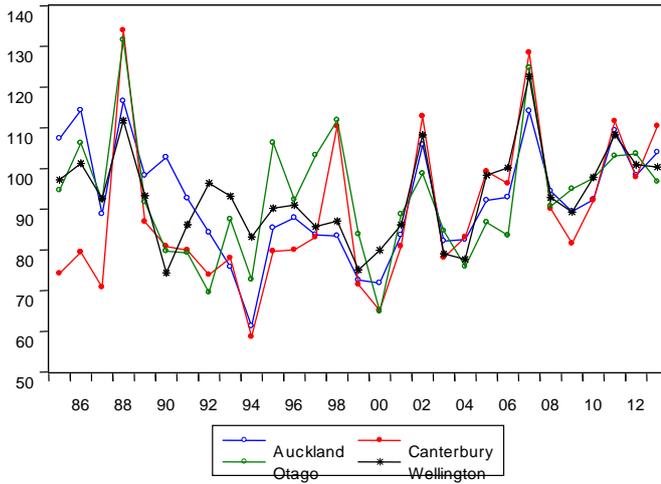
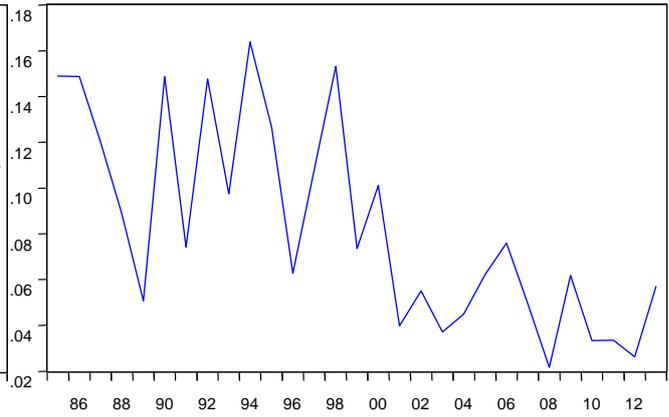


Figure 2 (b) Coefficient of Variation : Grocery Series



The second sub-group in the food group is dairy produce, which is more homogenous in its composition than the grocery group. Figure 3(a) shows that the fluctuations between provinces pre-1900 do not co-vary. Dairy prices experience considerable local divergence prior to 1900 (Figure 3(b)). Post 1900, however, prices begin to fluctuate together. Equivalent to the grocery series, relatively lower Canterbury prices prevail in the dairy market until 1900.

Prominently lower (than national average) nominal prices of butter and cheese existed in Canterbury until 1900. During the period 1885-1913, the largest quantity of butter came from Canterbury due to its large farming population and the large area in Banks Peninsula devoted to dairy farming (New Zealand. Ministry for Culture and Heritage, 2003). Unlike the grocery series, there exists a distinct increasing trend in dairy prices for all Provincial series post-1900. Under the dairy category, both cheese and butter were export commodities. The success of refrigeration prompted the establishment of the fast steam service between New Zealand and England, which also benefited both the butter and cheese industries. By 1890 dairy exports reached 7% of the total exports, which continued to increase in the 20th century.

Figure 3 (a) New Provincial Dairy Series

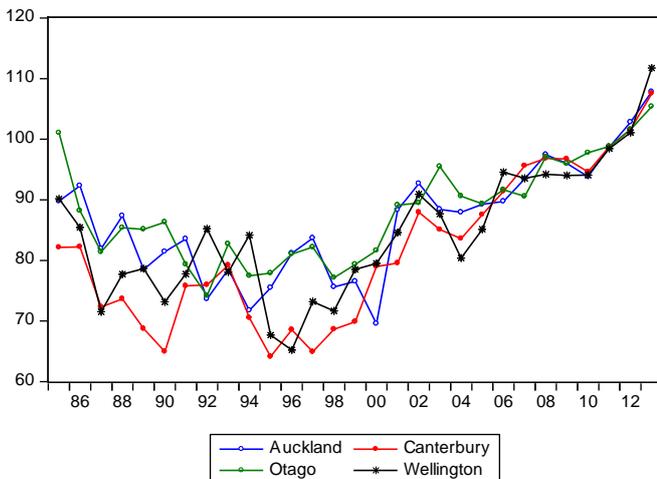
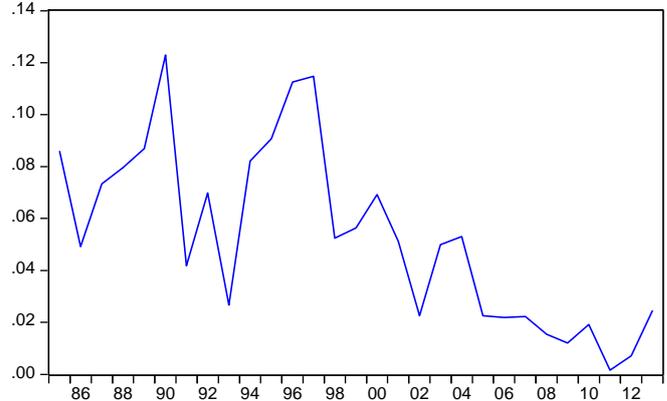


Figure 3 (b) Coefficient of Variation: Dairy Series



Apart from dairy, meat was an important export commodity in New Zealand. The experimental shipment of frozen meat in 1882 revolutionized the New Zealand economy and triggered the simultaneous development of freezing works in Dunedin, Christchurch, Wellington and Napier (New Zealand. Ministry for Culture & Heritage, 2003). The number of freezing establishments in the Colony gradually increased, and by 1891 the number had risen to approximately twenty-one, with twelve in the North Island and nine in the South. Most freezing works were located at ports since it was more expensive to transport frozen meat than live animals (Hawke, 1985). These works were collectively capable of freezing up to four million sheep per annum (New Zealand Department of Statistics 1893). However, it was not until the mid-1890s that the country began to experience any real economic benefit from the frozen meat trade. The yearly exports of frozen meat increased in volume from 19339 in 1883 to 1,033,377 pounds in 1892. As the frozen meat trade flourished, large areas in the South (Canterbury and Otago) that were growing crops switched to pasture with Canterbury dominating the frozen meat trade until the First World War. In 1900, 50% of the frozen sheep carcasses exported were shipped from Canterbury. Over 83% of lamb was shipped from the South Island and Canterbury's meat prices reached the low point in the 1890s (Figure 4(a)). Fraser's series, however, identified prices in Dunedin to be the lowest throughout the period 1891-1914. In both sources (Fraser and Department of Statistics retail price series), Auckland was consistently above the other regions or centers.

The world price of meat increased dramatically in 1895. Fraser noted that retail prices did not fluctuate according to the variation in exports prices, and the local causes, peculiar to the meat trade, did not have any connection with the variations in the price of dairy produce for instance. He also found that the local divergence in the 1890s was apparent across the four largest centers, which is consistent with the provincial results (Figure 4(b)).

Figure 4 (a) New Provincial Meat Series

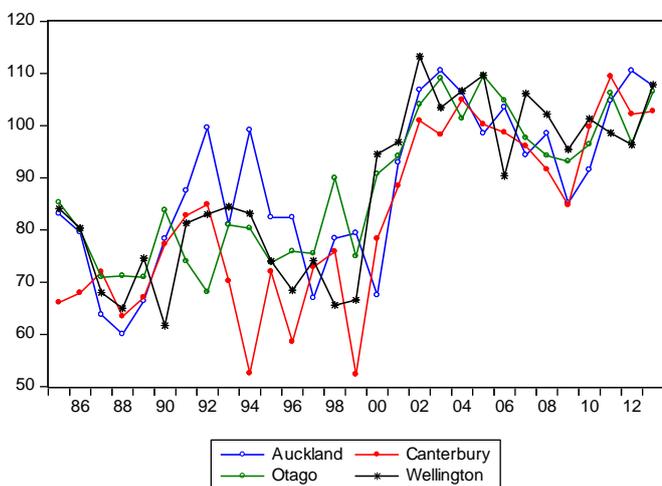
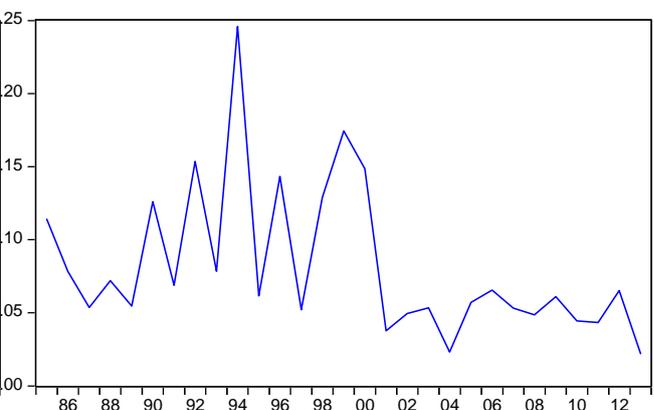


Figure 4 (b) Coefficient of Variation: Meat Series



Consistent housing price data were derived from two sources: Statistics New Zealand pre-1902 (calculated from the number of boroughs and the rental value of ratable property), and the prices reported in Fraser (from 1902-1913 rental prices, based on various number of rooms in the house, were assigned different weights and averaged). Expenditure on rent contributed about 10% of overall expenditure, which increased subsequently in 1910-11 to approximately 20%.

The Housing index identifies the greatest dispersion prior to 1900, see Figure 5(b). The relative absence of yearly fluctuations is due to fixed term leasing, common for that period (Fraser 1915). According to Fraser, the movement of rent over time tended to remain conservative even among those who rented on a weekly tenancy. Post 1898, Fraser recognized the greatest increases in rent for Auckland and Wellington where Dunedin experienced the steadiest rent movement, while Christchurch had a boom in 1906, followed by a sharp fall in 1912. The new Provincial housing series exhibit marked differences with the Fraser series. Dunedin's housing prices are consistently higher than those in other Provinces until 1898 (Figure 5(a)).

Data on dwelling density (Table 5), however, shows a significantly higher density in the Wellington region for 1874-1898 than Otago. If we draw the North-South comparison, Wellington's housing prices appear to be higher than those in Auckland, but lower than in Otago or Canterbury. In fact, Auckland's housing prices were consistently lower than those in other provinces pre-1898, but post-1898 the rapid increase in Auckland's housing prices was likely attributed to its rapidly growing population and positive rates of net inter-Provincial migration (see Appendices, Table A-4).

By the end of the 1890s Auckland's economy was booming mostly due to the pastoral land expansion in the North, which triggered the increase in dairy and meat production. In contrast, Otago and Canterbury housing and rental prices fell throughout 1885-1898. In 1897 regional economies underwent a general increase in the cost of living, where the prices for most exported goods increased (flour and bread prices were at their peak probably due to an increase in export flour prices). The spike in the Canterbury housing prices in 1906 is consistent with Fraser. Overall, housing prices exhibited the greatest dispersion during the period 1885-1898, subsequently converging in the 1900s (see Figure 5(b)). This is perhaps not surprising given the fixity of property once built.

Figure 5 (a) New Provincial Housing Series

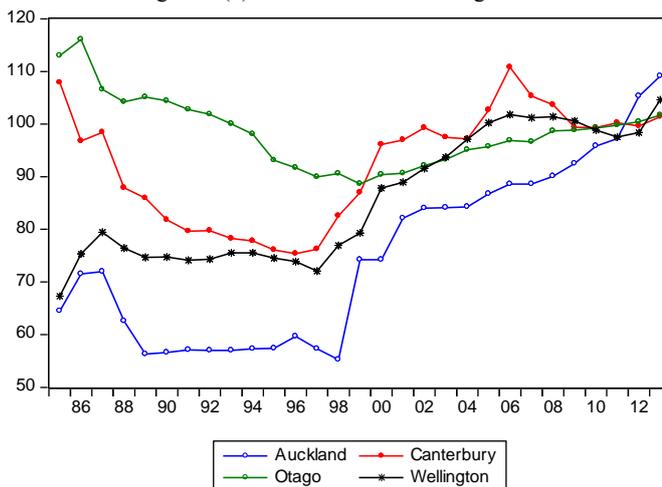


Figure 5 (b) Coefficient of Variation: Housing Series

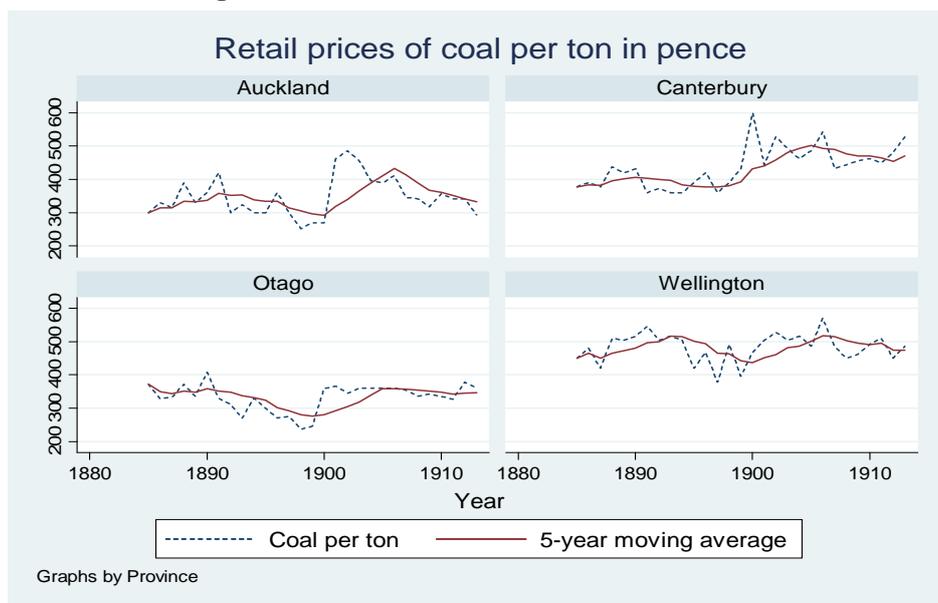


Table 5. Dwelling Density Descriptive Statistics
Persons per Dwelling

Period Covered: 1874-1898				
Province	Mean	Standard Deviation	Min	Max
Auckland	4.88	0.58	4.15	6.81
Canterbury	5.16	0.43	4.39	5.69
Otago	4.96	0.39	4.15	5.52
Wellington	5.49	0.20	5.07	6.06
Period Covered: 1899-1919				
Auckland	5.19	0.30	4.40	5.56
Canterbury	4.53	0.28	4.02	4.97
Otago	4.69	0.28	4.27	5.20
Wellington	5.11	0.41	4.20	5.97

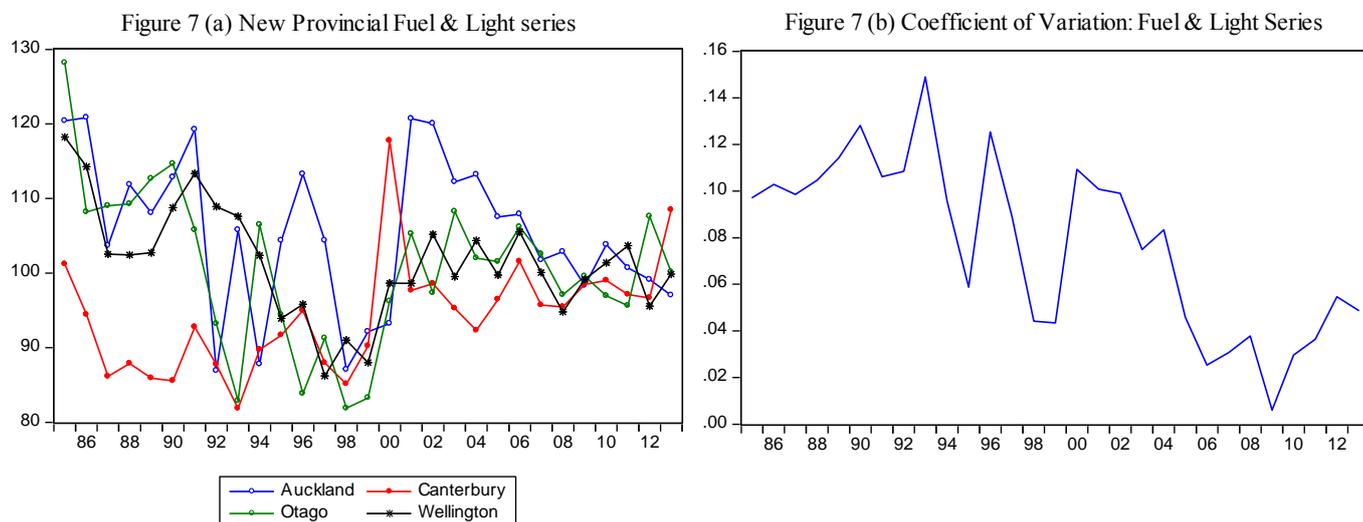
Fuel and light contributed around 8% of expenditure to the overall cost of living. With the wider use of electricity, the use of candles as the means of lighting ceased towards the beginning of the 20th century. Apart from candles, the fuel and light index included coal and firewood prices. Fraser’s Fuel and Light series commenced only in 1907, thus not much is known about the dynamics of prices prior to that. Fraser identified that coal was much cheaper in Dunedin and the charges for electricity were the lowest of the other centers. The bulk of New Zealand’s coal resources were located in the south of the South Island where billions of tons of mineable lignite resources were available in Otago and Southland, enough to provide a significant proportion of New Zealand’s energy needs (New Zealand. Ministry for Culture & Heritage, 2003).

Figure 6. Retail Coal Prices Per Ton (1885-1913)



Source: Statistics New Zealand Annual Report, 1885-1913.

Prices of coal and firewood were on average lower in Otago (Figure 6), and prices for candles were the lowest in Canterbury. Between 1885 and 1891 the combined cost of candles, coal and firewood was lower in Canterbury than elsewhere (Figure 7(a)). The use of candles and firewood declined over time with the increased use of alternative methods for heating and lighting.



The *Miscellaneous* series, the most heterogeneous series of the bunch, included prices of soap (washing); books (income from public libraries in each respective education district); furniture and medical expenses. Primary education was free and compulsory from 1877, thus the only expenses on education included the cost of books and other study materials. Arnold used the value of imported printing paper to proxy for books expenses, which can be potentially misleading as the imported paper was largely used for printing newspapers and not study books, which were generally imported as final goods. In contrast, our new miscellaneous series used public libraries subsidy data (income from subscriptions and voluntary contributions, *AJHR*, various years) for each education district to proxy book expenses. Then, total income for each education district was divided by the total population of the district at each successive Census. Furniture prices were estimated by taking equal weights for carpenters' wages (for each Province) and the average price for exported timber (dressed timber).

Finally, medical expenses were estimated using data on hospitals' receipts. The total amount received from patients was divided by the total number of patients in hospitals in the respective Provinces. The series were then combined and weighted to produce a new 'Miscellaneous' index series (Figure 8(a)). In conjunction with the other price index trends, the largest dispersion in the cost of miscellaneous items is observable in both the 1880s and 1890s (Figure 8(b)). Post-1898, the provincial *miscellaneous* series tend to move together and experience a common increasing trend.

Figure 8 (a) New Provincial Miscellaneous Series

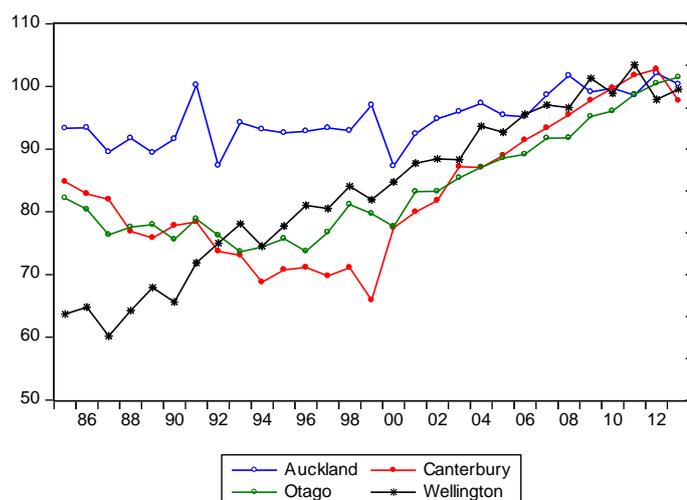
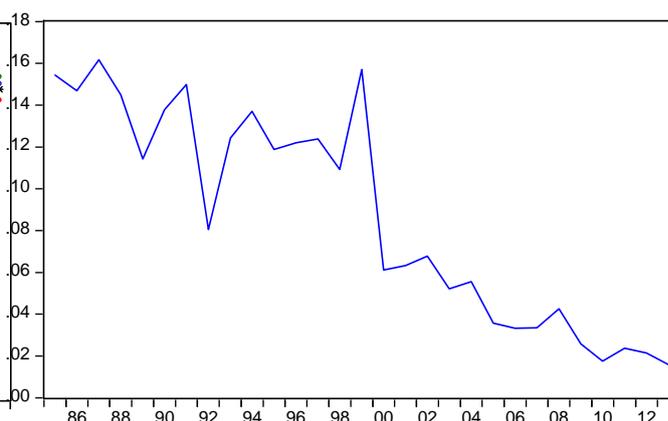


Figure 8 (b) Coefficient of Variation: Miscellaneous Series

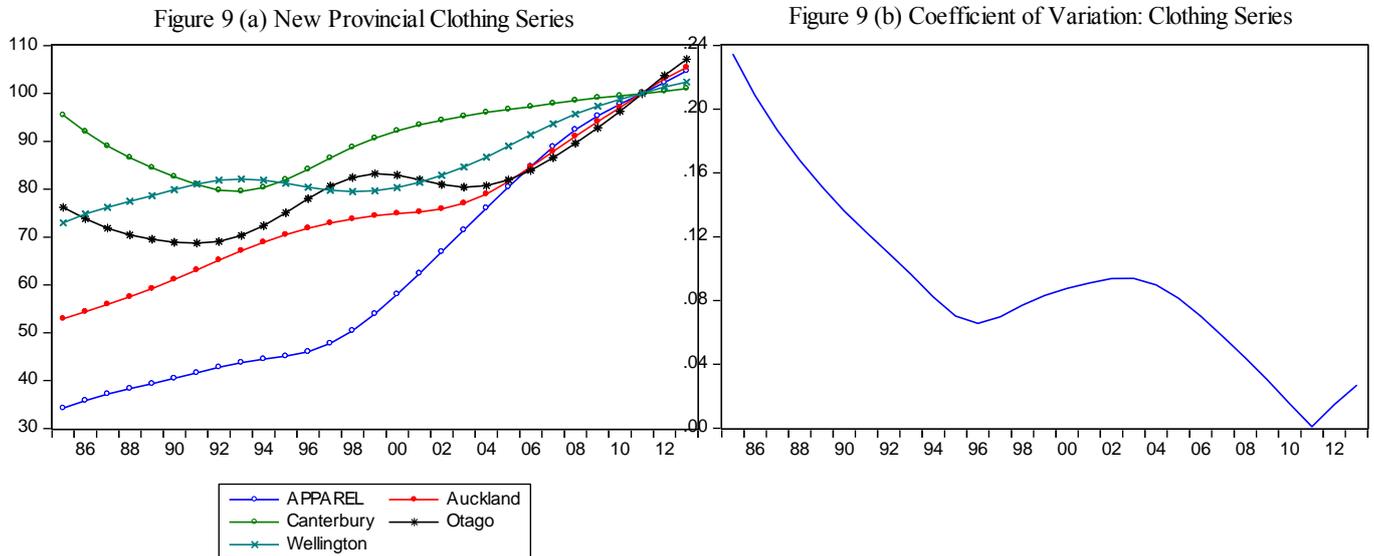


The *clothing* series were constructed from boots/shoes and clothing prices (derived from the Industrial Census' from 1885). Boot and shoe factories were established in the 1870s in part due to the Government imposing a duty of one shilling a pair on imported boots from the 1860s, making them more expensive and therefore encouraging domestic production. With New Zealand's population growing, the value of imports grew from 280,000 in 1870 to 500,000 in 1880. New Zealand boots and shoes were generally 'rougher' than those imported, and were generally made for the 'lower end of the market'. By 1895, New Zealand had 65 boot and shoe factories, producing more than a million pairs annually and by 1910, 74 factories produced 1.5 million pairs. There were some alterations to the customs tariff of 1907 (New Zealand. Dept. of & New Zealand, 1911) such that children's boots (for those aged up to three years old) were placed on the free list, while the duties imposed on boots, shoes and slippers used by the working class increased substantially. Boots generally demanded a much higher quality after 1900s causing an increase in relative prices. Tariff increases fell most heavily on the price of boots of the lower grade (Collins 1912). The average prices of boots and shoes had fell until approximately 1897, and the scale of boot manufacturing greatly increased from 1900⁹.

While boots and shoes constitute only 4.38% of total expenditure in 1893, clothing items contribute around 13%. The first New Zealand clothing factory was established in Dunedin in 1873 where The New Zealand Clothing Factory made basic, hardwearing clothing for men and boys. The Factories Act of 1891 created a system of factory inspections that resulted in improved working conditions. The tariff, which was raised to 20% in 1888, also offered some protection to local producers. In 1895 the government imposed an extra duty on manufactured items to protect infant industries, which was consistent with the gradual increase in prices after 1893 (Figure 9(a)). Woolen clothing increased in price more than any other clothing item over the period 1906-1910 (Collins 1912). Protected by high tariffs, the New Zealand clothing industry boomed and many new clothing factories were established in the North Island. The cost of clothing items in Auckland was reported to be the lowest of the four regions. By the end of 1890s, Auckland became New Zealand's main industrial center

⁹ Industrial census reported increase in domestic manufacturing.

that located the most furniture, boot and shoe, cheese factories, meat-preserving works and flax-mills. Overall, the cost of imported apparel (value of apparel imported in per capita terms) approximated the trend in Provincial prices of clothing items per capita (Figure 9(a)).



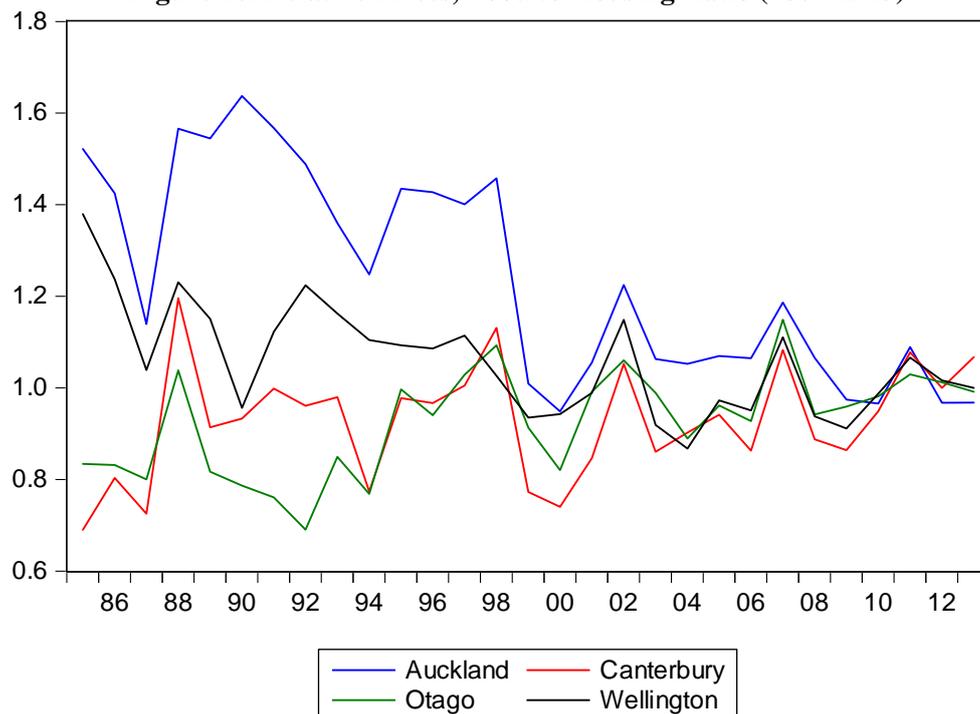
To summarize the above, local price discrepancies were the highest during the 1890s and world price deflation in the 1890s had the most impact on the New Zealand's traded sector. Food groups, in particular, underwent the most rapid decline of the seven sub-series considered. Grocery prices in 1889 were 20-30% higher compared to the average in 1909-1913, and by 1894 the cost of groceries in Auckland and Canterbury fell by 50% and in Otago and Wellington by 25-30%. Coefficient of variation analysis showed no major local variation in grocery prices where the common peaks and troughs in the grocery series might be best attributed to seasonal fluctuations in wheat/bread prices which constituted approximately 30% of the overall expenditure on grocery items.

Some dispersion in the cost of dairy produce was found across Provincial markets although they were not as widespread as for the grocery series. The Provincial Dairy series declined from around 1885 in contrast to the grocery series trend, with dairy produce increasing in 1891, only to decline again in 1895. The lowest prices for dairy produce were found in Canterbury, which was consistent with the lowest prices of butter and cheese in Canterbury compared to the other provinces. Dairy prices experienced considerable local divergence across regional markets prior to 1900, which was particularly apparent during the periods 1886-1891 and 1895-1898. The local costs of dairy produce appear to be converging by 1900, which is supported by an 80% decline in the coefficient of variation from 1897 to 1901.

It is interesting to note that meat prices show a different trajectory to dairy prices. Prior to 1889, the fluctuations in meat prices were fairly homogenous. Between 1889 and 1894 the level dispersion among Provinces greatly increased and reached 25% in 1894. As in the Grocery and Dairy series, a significant decline in the variation of prices among Provincial markets achieved by 1900, is also observed in the meat series.

The Housing price series declined in Canterbury and Otago and increased in Wellington and Auckland. Our findings deviate from those of Fraser (1915) who found that the highest prices existed in Wellington and the lowest in Auckland (until 1900). Our results, however, are consistent with population movements towards the North from the South. The cost of food relative to the cost of housing was declining in Auckland and Wellington, and slightly increasing in Canterbury and Otago (Figure 10). As housing prices in Auckland and Wellington were rising, a relatively larger proportion of the budget was spent on paying rent than buying food. The opposite was true for Canterbury and Otago. The relative price effects induced an increase in the housing share, which corresponds to the reported increase in the expenditure on Housing and decline on Food (see Table 1).

Figure 10. Relative Prices, Food to Housing Ratio (1885-1913)



Fuel & Light costs fluctuated considerably across Provinces and over time. The importance of fuel and light in New Zealand was perhaps not as high as was the case in other countries (Fraser 1915). Our series do not include electricity, which might, in part, explain the overall declining trend.

The Miscellaneous index is probably the most heterogeneous series in that it comprises items of expenditure not included elsewhere. The cost of miscellaneous expenditure in Canterbury and Otago had a similar pattern: relatively static until 1898 and an increase thereafter. Auckland’s prices were static throughout, and the cost of miscellaneous items in Wellington underwent a significant 40% increase by 1913. Despite different trajectories prior to 1900, the level dispersion in prices for miscellaneous items across Provinces significantly declined.

Clothing index series followed a smooth increasing trend across all Provinces. However, because the series were interpolated (between Census years), we are unable to identify

whether the series fluctuated together or not. Trends, however, portray two distinct patterns: Canterbury-Otago and Auckland-Wellington. As most clothing factories were established in the North Island, this may in part explain the lower prices of clothing there.

From the analysis above, it seems clear that some prices varied significantly across Provinces and time. Most price series converge or begin to converge by 1900, suggesting (via coefficient of variation analysis) that the markets became relatively more integrated by the beginning of the 20th century. This contrasts with McLean's findings on Australia, which reported that annual fluctuations in price levels between the pairs Sydney-Adelaide, Melbourne-Adelaide and Melbourne-Sydney moved less closely from 1890 than before. This was true for all items combined and food items separately. The only exceptions were the markets for bacon and potatoes, which became more integrated after 1890¹⁰. McLean suggested that these two food items were less perishable than butter or bread for instance, and the transport costs might have played a role here.

In the next sub-section, we examine the differences in the overall cost of living across Provinces, and whether the aggregate results for New Zealand correspond to and reflect those in other countries.

4.2 A New Provincial CPI Series

The final sub-series were combined and weighted to produce a new composite Provincial CPI series. From Figure 11(a), we can see that for the period 1888-1891, there is a universal (that is, common to all four Provincial Districts) decline in consumer prices. During the time when prices were falling, they were also diverging the most from the Provincial average (Figure 11(b)). Food items constituted the largest percentage in the overall expenditure basket such that peaks and falls in the composite series are typically mirroring the fluctuations in the grocery, meat and dairy prices. Bread and flour were heavily dependent upon the weather and the harvest in a particular year, as well as external shocks for example, the 1902, Australia wide, Federation drought drove up flour prices in 1903, and very large increases in flour prices in 1907 in New Zealand were in response to Australia's protective duties of 9d. per bushel of wheat¹¹.

New Zealand's protective legislation also had an effect on the prices of imported and manufactured products and from 1895, there was a steady movement towards a reduction on the duties levied upon imported foodstuffs, and an extension of the tariff levied upon imported manufactured goods. The Preferential and Reciprocal Trade Act of 1903 in New Zealand introduced preferential rates of duty in favor of the produce of the British Dominions by imposing extra duties on certain imports, which were the produce or manufacture of other countries. The list of preferential items was materially extended by the New Zealand Tariff Act of 1907, from the 31st March, 1908 (Knibbs 1911).

¹⁰ McLean (1999) used correlation coefficients for the two periods 1865-89 and 1890-1914 to compare the fluctuations in the price index series for the three metropolitan centers: Sydney, Melbourne and Adelaide.

¹¹ AJHR, 1912 H.-18, p.354.

Figure 11 (a) Composite Provincial CPI Series

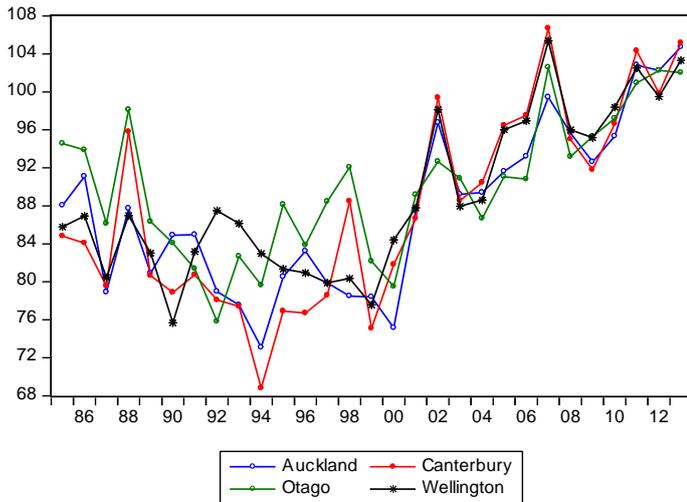
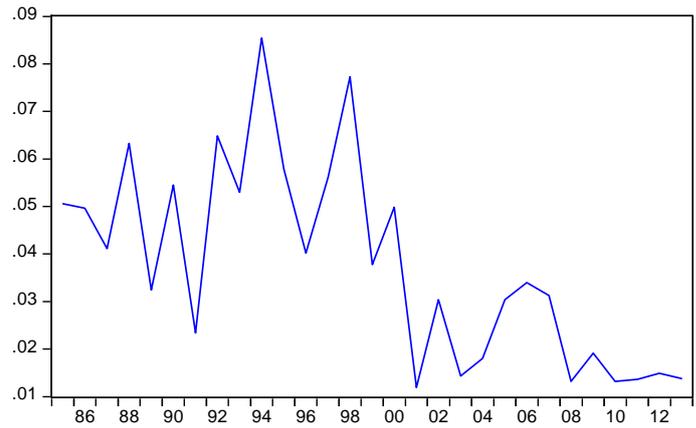


Figure 11 (b) Coefficient of Variation: Composite Provincial Series



Similar to the Australian experience, New Zealand’s economy emerged gradually from the integration of several regional economies, which initially were small and separated by significant transport costs. McLean suggested that a trend towards a more integrated market arises if disparities in the level of prices of a commodity across regions are reduced, or the fluctuations in prices become more highly (positively) correlated. McLean conducted pairwise comparisons for Adelaide, Melbourne and Sydney for two periods: 1865-89 and 1890-1914. The anticipated increase in the degree of market integration was not observed during 1890-1914. In New Zealand, 1900-1913 can be identified as the period of very different price experience compared to 1885-1899. The introduction of refrigeration from the 1880s led to substantial changes in the pattern of regional fluctuations where prior to 1900, Provincial differences were more apparent across all sub-index series. As opposed to Australia, turning points in price trends coincide across all sub-series.

Table 6. Measures of Market Integration
Correlation Coefficients

1885-1900				
Correlation	Auckland	Canterbury	Otago	Wellington
Auckland	1.00			
Canterbury	0.63*	1.00		
Otago	0.63*	0.80**	1.00	
Wellington	0.29	0.34	0.20	1.00
1900-1913				
Correlation	Auckland	Canterbury	Otago	Wellington
Auckland	1.00			
Canterbury	0.92**	1.00		
Otago	0.94**	0.88**	1.00	
Wellington	0.90**	0.98**	0.90**	1.00

Note: *, ** significant at 5% and 1% levels, respectively.

Table 6 demonstrates a marked increase in the degree of market integration among Provincial pairs of aggregate CPIs (combined sub-series). It is apparent that Auckland became more integrated with all Provinces between 1900 and 1913. Of particular interest is the change in significance of the correlation coefficient between Auckland and Wellington. Auckland was quite isolated until 1906 when the main trunk railway was built connecting Auckland to the other localities in the North Island, where the importance of railways rose around the time of the growth of the freezing works. Negative rates of net inter-Provincial migration in the South and positive in the North, indicate that during the period 1886-1911, the population was moving towards the North following the shift of economic activity northwards.

4.3 The South-North convergence story: Benefits from refrigeration

The historical literature emphasizes the key role refrigeration had on the economic development of New Zealand. Extensive exportation of pastoral products that began in the 1890s boosted the economy and helped it recover from 'the long depression'. While aggregate price and income trends are well known, regional analysis remains very limited and does not involve continuous time-series analysis. In the previous sub-sections, we presented regional price data on various grouped commodities where some common features for example, the general direction of trends in sub-series, mirrored the national trends in consumer prices. Previous findings point towards idiosyncratic markets pre-1900 and sharp Provincial inequalities, especially during the price deflation period (1879-1896). Particularly interesting is the central role of Canterbury prior to 1898, which was typified by low retail prices of traded commodities (meat, dairy, some grocery items, that is, bread, flour).

Prior to the refrigeration boom, most of the agricultural and pastoral produce was concentrated on the South Island. Canterbury had an abundance of fertile land, easily accessible and readily cultivable and large quantities of agricultural products (three-quarters of the wheat, half the barley and one third of the oats grown in New Zealand) were produced in Canterbury. Cereals were almost entirely neglected in the North Island where farming in general was not economically important pre-1900, owing partly to climatic and political conditions, but also the difficulty of bringing the more heavily timbered lands of that island under cultivation. The kauri harvest dominated the economy of the upper North Island until 1910 and with kauri gum, accounted for 58% of the Province's exports in 1885. Soils and climatic conditions in the North did not suit the pasturing of sheep, and there were only local markets for the production of butter and cheese.

For similar reasons (for example, the basic system of breeding and fattening suitable sheep breeds was already in place), the refrigeration boom initially benefitted the South more than the North. Historically, sheep farming was the principal economic activity in the South Island during the nineteenth century and as the frozen meat trade flourished, large areas in the South (Canterbury and Otago) that were growing crops switched to pasture and Canterbury dominated the frozen meat trade until the First World War. In 1900, 50% of frozen sheep carcasses exported were shipped from Canterbury and over 83% of lamb was shipped from the South Island, again mostly from Canterbury.

The response of dairying to refrigeration was less rapid than for the meat industry (Hawke, 1985). Some of the reasons related to the more advanced technology required for mass milk and cream separation, storage and cheese-making. As a result, the regional impact of dairying differed from that of meat freezing. Although, initially the response to intensive

dairy farming occurred in the far south (Otago/Southland), the better suited lands in Wanganui, South Auckland and Taranaki joined after 1900 (Hawke 1985). The role of transport in dairy farming played a very important role as milk fat had to be moved to dairy factories daily until refrigerated storage became available on the farm. Again, initially, the South Island was better connected prior to 1900 and Auckland was particularly isolated from the rest of the North Island until the main trunk railway was completed in 1906, connecting, by land, Auckland with Wellington and other localities.

The domination of the South began to diminish post 1898 as the new trade reshaped agricultural production and more land became suitable for farming. Dairying, beef and sheep farming became the predominant industries in the North Island (dairying expanded on the better lowlands, while sheep and beef into the hill country of the North Island). This transformation shifted production and farming to the North Island where the attraction was promoted by the progressive clearing of the bush for farmland¹², the cessation of overt Maori resistance to European land settlement, the mining of gold near Thames, and above all, unprecedented scope for new developments and rationalization of agriculture (Neville and O'Neill, 1979). The refrigeration boom stimulated diversification of agricultural production, which led to an expansion of farming in the North Island and encouraged more intensive settlement. However, Canterbury benefitted the most throughout 1885-1913 from the overseas trade, where the value of exports was higher than the value of imports (See Appendix Figure A-5). Wellington is another extreme, which experienced a trade deficit post-1900 (negative net exports).

The specificity of the New Zealand's regional climatic differences and economic development presupposes certain variability in consumer prices and living standards across provinces especially before 1900 when production and transportation costs were higher. As one of the leading New Zealand economic historians, Gary Hawke (1985), pointed out:

...despite the greater economic integration induced by Vogel's schemes (e.g. abolishing of the provinces in 1876), regional experiences were varied.

5. Time-Series Analysis: Common Trends and Leading Provinces

5.1 Unit Root Tests

In previous sections we considered the idea of whether regional prices were homogeneous and if not whether there was any evidence of convergence in prices representing spatial integration of markets. In those earlier sections we used the *coefficient of variation* as the measure of convergence and by implication, market integration. In this section we will consider the important issue of spatial price convergence over time using more sophisticated time series methods which, where appropriate, utilize the non-stationarity of price levels to create powerful time series tests. The 'work-horses' of time series tests of (price)

¹² During 1892-1900 the Liberal Government acquired 1.3 million hectares of Maori/native land which started a transformation of North Island hill country from bush to pasture.

convergence with potentially non-stationary data are based upon the original ‘unit root’¹³ tests of Dickey and Fuller (1979).

As we are interested in considering the integration of markets over time and space via tests of whether prices are converging, effectively what we have is a panel data structure where the Provinces represent space, and time is measured in years. Hence, our panel data have large T (number of years) and relatively small N (number of Provinces).

Examination of the time-series properties of the series typically begins with unit root testing to determine whether the series in question are stationary or non-stationary. Basically, stationary series ‘never wander far away from its mean’ or trend (if trend-stationary), while non-stationary series are characterized by long-term shocks that lead to idiosyncratic behavior (such could be the effects of tariff changes that lead to permanent increases in prices). In effect, stationarity allows for the regression estimates to be tested according to the well-known properties of a Normal distribution. Testing for non-stationarity in the variable is synonymous with the unit-root testing, and the Augmented Dickey Fuller (ADF) tests are perhaps the most commonly used individual unit root tests. In the case of structural breaks in the series (change in the direction of the trend or increase in the level of the series), discontinuities may lead to type I errors that will likely bias any further analysis. To account for any structural breaks, we include Perron-type unit root tests (Perron 1989, Zivot and Andrews 1992) in the pre-testing stage where appropriate.

Table 7. ADF Unit Root Tests in Levels for the Sub-Series in Each Province

Index Series by Province	Auckland	Canterbury	Otago	Wellington
Grocery	√	√	√	√
Dairy	××	××	√√	××
Meat	××	××	√√	××
Housing	××	××	×	××
Fuel and Light	√	√	×	×
Clothing	√√	√√	×	√√
Miscellaneous	√√	××	√√	√√

Notes: ‘√’: the series are stationary or I (0); ‘√√’: the series are trend-stationary; ‘×’: the series are non-stationary without a linear trend and ‘××’: the series are non-stationary with a linear trend

Individual (for each panel separately) unit root tests indicate that Dairy, Meat and Housing are non-stationary for Auckland, Canterbury (including Miscellaneous) and Wellington. Housing, Fuel & Light and Clothing are non-stationary in Otago, see Table 7 below. Other series appear to be stationary. An important result is that the export sectors (meat and dairy) seem to exhibit non-stationarity in the price series for more than one Province possibly due to changes in technology of production or tariff changes that had permanent and persistent effects.

13 A unit root is an attribute of a statistical model of a time series, autoregressive parameter of which equals to one.

To check the robustness of the individual unit root test results, we also use panel unit root tests where we consider four panels represented by the four Provincial districts. The Fisher-type (Maddala and Wu 1999) panel test is likely to be the most appropriate for our data as the effect of serial correlation is less severe for this test, and it has the highest power when performed in the presence of both stationary and non-stationary series in the group. In the panel environment, the test confirmed that the only non-stationary series are Dairy and Housing.

Table 8. Panel Unit Root Test (Fisher-ADF)

Panel Variable	Z-statistics
Grocery	-5.14*
Dairy	-1.53
Meat	-2.45*
Housing	0.645
Fuel and Light	3.672*
Clothing	-3.427*
Miscellaneous	-2.432*

Notes: Ho: existence of a unit root in the panel, H1: some cross-sections do not have a unit root. * indicated rejection of the null at the 5 % level of significance.

Despite certain advantages of panel tests, they still do not account for the possible structural breaks or discontinuities in the series. In section 4.1 we identified that most of the sub-series experienced a change in the trend by the late 1890s where the period 1880-1889 was characterized as a period of ‘depression’ in New Zealand¹⁴. The following decade (1889-1899) was ‘a normal period in the Dominion history’, where trade was stable and, agriculture and manufacturing reached a high state of efficiency, and the country was both politically and socially stable and prices expected to rise (McIlraith 1911). Furthermore, the protective tariffs and labour legislation changes¹⁵ were likely to contribute to the increased cost of commodities by the 20th century. To identify whether such changes could be responsible for the possible discontinuities in certain sub-series (only relevant for traded commodities), we utilize the Zivot and Andrews (1992) unit root tests. Table 9 shows that the Dairy, Meat and Housing sectors remain non-stationary for Auckland and Canterbury, while some changes are observed for the results in Otago and Wellington.

Structural changes in 1895 and 1900 were the most commonly identified breaks (i.e. Housing and Clothing series in Otago; Dairy and Meat in Wellington). The Provincial dairy series all experienced a structural change in 1895, which had permanent effects in Canterbury and Auckland. Refrigerated rail facilities became available by 1895, making it possible to transport dairy products more easily for example, Taranaki products were initially shipped to Wellington by coastal vessels for trans-shipment to ocean liners due to inadequate roads in Taranaki (Hawke 1985). As a consequence, the production of butter and cheese greatly increased from 1896 and for the period to WWI, butter production increased nearly five-fold, and cheese more than ten-fold.

¹⁴ A period of almost twenty million debt (from the previous decade), falling prices of agricultural and pastoral products, a decline in the production of gold and industry-wide stagnation.

¹⁵ In 1894 the first Industrial and Conciliation Act was passed, and amended in 1895, 1896, 1898, with the new act passed in 1900) (Collins 1912).

Table 9. ADF Unit Root Tests in Levels
Breaks Considered and First Differences

Index Series by province	Auckland	Canterbury	Otago	Wellington
Dairy	××	××		√√'
Meat	××	××		√'
Housing	××	××	√'	××
Fuel and Light			×	×
Clothing			√'	
Miscellaneous		××		

Notes: '××' – I (1) series (first-difference stationary) with a linear trend in levels. '×' – I (1) series without a linear trend in levels (constant trend). '√√'- I (0) series, stationary with a crash and trend in the data (when the crash and trend in the series are taken into account).

Earlier, we argued that the Dairy and Meat index had different growth trajectories due to differences in technology involved in production. Structural change in the Meat series across all Provinces occurred around 1900, which is consistent with what can be observed via Figure 4(a). By 1900, more land became available for pasture (Northland joined in 1900) and greater quantities of mutton were being exported. The conclusion here is that the break tests suggest that the series are stationary around the break in a trend and/or intercept.

5.2 Testing for Convergence in Prices: Bernard and Durlauf (1995)-Type Tests

The previous section explored the time series properties of the sub-index series. The most interesting series, identified as non-stationary, are Dairy, Meat, Housing and Fuel & Light. In this section, we consider the possibility of convergence or common trends, suggesting market integration, in those price series using time-series methods. Earlier, the coefficient of variation and simple correlation analysis revealed some interesting findings. These results suggest that New Zealand markets were relatively more integrated from 1900-1913 than 1885-1900. This tendency was mirrored in most of the Provincial sub-series.

However, the coefficient of variation analysis is limited as a tool to examine the degree of regional market integration and serves only as a guide to changes in variation among regions over time. Economically, investigation of issues such as the Law of One Price (LOOP) can assist in our understanding of the disparities across specific regional markets and how integrated they were by the beginning of the 20th century. The Law of one Price is more likely to occur for homogeneous, traded goods prices, and it is on these goods that we will concentrate. Tests for convergence typically differ depending on the time series properties of the data, therefore we draw upon the results in the previous section to guide the choice of tests employed.

As raised in Section 5.1, non-stationarity gives rise to several econometric problems, but most importantly, non-stationarity in the levels of variables implies that a stable long-run relationship is not possible. However, if both variables are integrated of order one (stationary in their differences) there may exist a linear combination of them that is stationary, which implies that the two variables could be 'cointegrated.' Thus, if variables are cointegrated, they tend to move together and (statistical) convergence may occur faster than is the case for stationary series.

We test for cointegration by applying unit root tests on the bivariate differences of Provincial prices, paired one at a time, following the Bernard and Durlauf (1995) approach. On the basis of the results (Table 10), the convergence hypothesis is not rejected for both the Dairy and Meat series for the Canterbury-Auckland pair, and Housing series for the Canterbury-Wellington pair.

It is also possible to test for convergence in a multivariate setting utilizing either panel-based unit root testing techniques or cointegration methods for example, Phillips and Ouliaris (1990) and Johansen (1988). Given that we do not have more than two Provinces that exhibit non-stationary for each price index, the bivariate testing is appropriate in this case, however, to check the robustness of the above results, we include estimates of the bivariate Johansen (1988) test for cointegration which confirms that both the Dairy and Meat series for the Canterbury-Auckland pair each exhibit one significant cointegrating relationship (Table 11). In addition, with the Johansen approach we can impose restrictions on the coefficients to identify if the series exhibit ‘absolute’ or ‘relative’ convergence (Bernard and Durlauf 1995). The likelihood ratio (LR) test for binding restrictions for the dairy series suggests that Auckland and Canterbury share a common trend, but do not converge to a common steady state equilibrium. The results for the meat price series indicate the opposite: Auckland and Canterbury meat series converge in a Bernard and Durlauf sense.

Table 10. Unit Root Test on the Difference between Each Pair of Provinces 1885-1913
Without Discontinuities

$y_{i,t+k} - y_{j,t+k}$	Dairy		Meat		Housing		Fuel & Light	
	ADF (2)	LM (SC)	ADF(0)	LM(SC)	ADF(0)	LM (SC)	ADF(0)	LM (SC)
Provinces								
Canterbury- Auckland	4.66* (T)	1.92476	-4.779*	0.2646	3.6287	1.194		
Canterbury- Wellington					-6.79*	0.0417		
Auckland- Wellington					2.4891	5.4307*		
Otago- Wellington							-3.486	0.225

Notes: *t-statistics denotes significance at the 5% level based on MacKinnon (1991), ADF (2) and ADF (0) indicate the number of lagged differences of the variables (based on SIC criterion). (T) relates to trend significance at the 5 %. LM test is a test for serial correlation: H0 (null hypothesis) implies no serial correlation.

As discussed in Section 4.3, the response of dairying to refrigeration was less rapid than for the meat industry where some of the reasons relate to the more advanced technology required for the mass milk and cream separation, storage and cheese-making. Transport also posed more difficulties for the dairy industry than the meat freezing. Sheep made only one journey to freezing works, but milk fat had to be conveyed to dairy factories daily until refrigerated storage was available on the farm. The regional impact of dairying thus differed from that of meat freezing.

Table 11. Cointegration Results: Auckland-Canterbury Pair, Johansen Estimates, 1885-1913

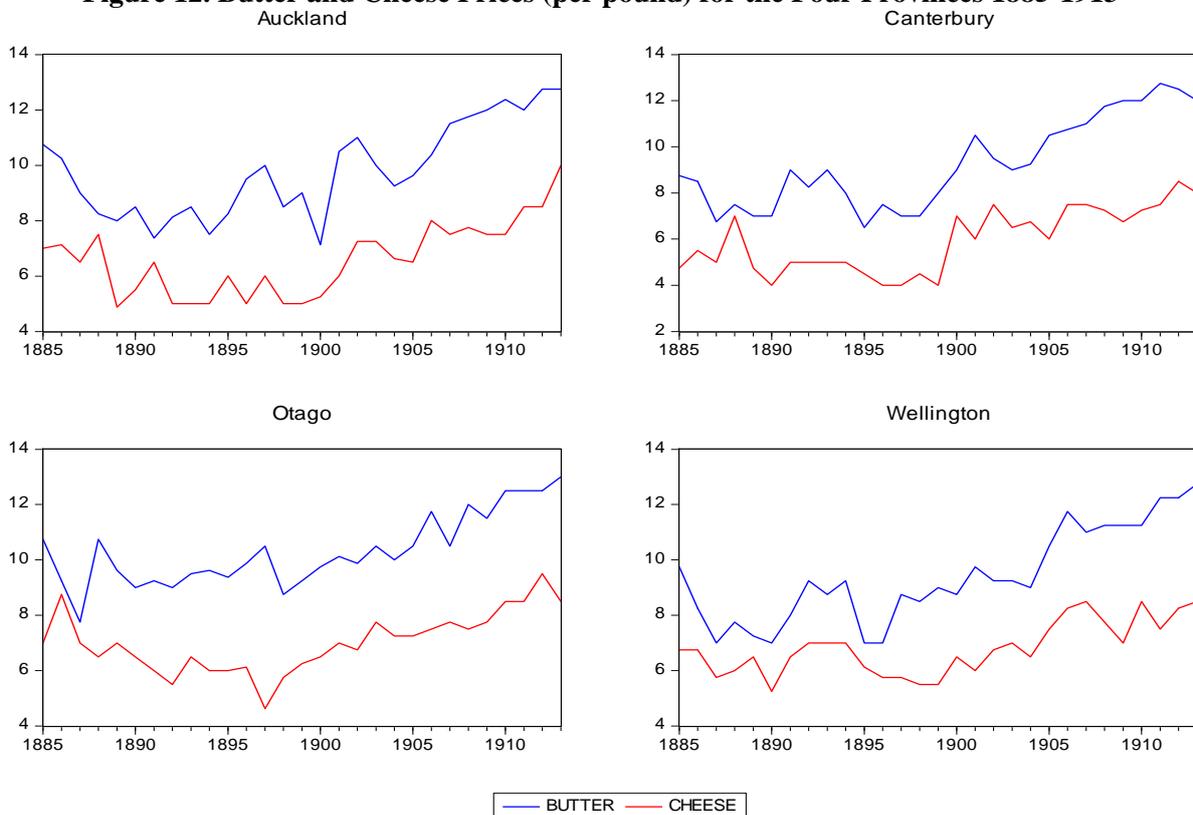
Unrestricted Intercepts and Trends in Levels

Number of Cointegrated Relations		Dairy (VAR=3) Lag Intervals: 2		Meat (VAR=1) Lag Intervals: 0	
H0	H1	Trace	Max Eigenvalue	Trace	Max Eigenvalue
r=0	r=1	21.25*	21*	23.07*	21.107*
r≤1	r=2	0.24	0.24	1.962	1.962

Note: *indicates the rejection of the null of no cointegrating relationship at the 5% level. Lags selected were determined by prior estimation of an unrestricted VAR model in levels for each system of equations.

As established previously by Greasley and Oxley (2010) both meat and dairy each had individual driving forces and formed separate development blocks: meat and cheese showed accelerating growth from the 1880s, whereas butter faster growth came in later from the mid-1890s. Butter and cheese require different production technologies, and their growth paths could be dissimilar. Most dairy factories were producing only butter for commercial purposes (export) in 1880s-1890s, and it was only in the late 1890s that many converted to produce both butter and cheese. Figure 12 shows the prices of butter and cheese as the lowest in Canterbury until around 1900. The common price increase in butter prices in 1890 could be attributed to extra costs from the change in technology of butter production: creameries were set up in the 1890s along with the skimming stations. By 1885, the manufacture of cheese was typically undertaken in factories, much more so than for butter. However, according to the Industrial Census, the returns from cheese factories were only 40 percent of the total factory produce (New Zealand House of Parliament, 1887). Both butter and cheese series exhibit comparable trends, but the yearly fluctuations do not always coincide.

Figure 12. Butter and Cheese Prices (per pound) for the Four Provinces 1885-1913



The same procedure of unit-root pre-testing was applied to cheese and butter prices as for the Dairy sector. The unit root test results revealed that non-stationarity of the dairy index (for Auckland and Canterbury) was driven by butter prices rather than cheese prices. The butter prices between Auckland and Canterbury appear to satisfy the properties of a long run equilibrium relationship. However, such results are conditional on the chosen period for example, cheese prices experienced accelerated growth earlier (the beginning of 1880s) than butter (in the mid-1890s), and it is possible that if we were to consider a longer period cheese prices would be driving the dairy sector (Greasley and Oxley 2010).

Moving to housing prices, Johansen’s bivariate test validated the Bernard and Durlauf (1995) convergence result where the Canterbury-Wellington pair exhibit a ‘cointegrating’ relationship. The implied restrictions for convergence suggest that, Canterbury and Wellington experience long-run convergence denoting that the long run effect of shocks to housing prices impact Canterbury and Wellington similarly. It is interesting to note that by 1910-11, the net inter-Provincial migration rate for Canterbury was negative 6, and in Wellington the opposite, positive 6. Christchurch rental prices boomed in 1906, followed by a sharp fall in 1912 (Figure 5(a)). Wellington is the only other province that had an increase in the cost of housing in 1906.

Table 12. Housing Index Series: Bivariate Cointegration Results, Johansen Estimates 1885-1913
Unrestricted Intercepts and Linear Trends in Levels

Hypotheses		Auckland- Canterbury		Canterbury- Wellington		Auckland- Wellington	
H0	H1	Trace	Max Eigenvalue	Trace	Max Eigenvalue	Trace	Max Eigenvalue
$r=0$	$r=1$	21.251*	21.009	23.07*	21.107*	13.643	13.289
$r\leq 1$	$r=2$	0.2416	0.2416	1.962	1.962	0.354	0.354

5.3 Testing for Causality: Leading Provinces

The historical literature argues strongly that pastoral products for example beef, mutton/lamb, wool, butter/cheese, were the export commodities that had the most influence on New Zealand’s economic performance for the period we are considering. New Zealand supplied almost half of the total quantity of frozen mutton and lamb imported into the United Kingdom 1885-1993, by comparison Australia contributed around one-tenth of that.

In Section 4.3 we discussed the leading position of the South Island, particularly Canterbury, during the 19th century, in both agricultural and pastoral produce. It was hypothesized that the refrigeration boom initially benefitted the South more than the North based upon its initial advantage of easily accessible and readily cultivable land. In addition, transport costs imposed restrictions on the exportation of meat from the more remote areas in the North Island. Railway and road construction was slow to progress in the North with large areas of the North Island covered in bush. Most freezing works were located at ports due to the cost of transporting frozen meat compared to live animals (Hawke 1985). The wholesale prices of frozen mutton for export were the lowest at the ports of Lyttleton (Canterbury) and Dunedin (Otago) in 1893 (New Zealand Registrar General, 1894). The quantity of frozen mutton exported was also the largest at the port of Lyttleton. Notably, Canterbury also benefitted the most from the overseas trade, which had absolute surplus in the net exports.

Previously, we noted that meat and dairy prices followed different time paths. The initial response of dairying to refrigeration originated in the far south, which only later included North Island areas. Nominal prices for all dairy (butter and cheese) and meat products (lamb, beef etc.) remained the lowest in Canterbury until 1900. Within the dairy sector, cheese and butter exhibited different growth paths. While meat and cheese showed accelerating growth from the 1880s, butter's faster growth came later from the mid-1890s. In Section 5.2, the unit root test results showed that non-stationarity of the dairy index (for Auckland and Canterbury) was driven by butter prices rather than cheese prices.

To explore whether Canterbury was, in fact, a leading Province in the Dairy price series, we can test for Granger causality. However, in the context of non-stationary data series the standard Wald test statistics does not follow its usual asymptotic Chi-square distribution. Therefore, we follow the Toda-Yamamoto (T-Y) procedure to test for Granger (non-) causality (Toda and Yamamoto 1995). Table 13 represents the pairs of Provincial dairy series, where a rejection of the null implies there is Granger Causality. We should point out that if the variables are cointegrated then there must be a causal relationship in at least one direction, however, the converse is not true (Johansen 1988). Table 13 shows that Canterbury is the leading Province in all variable pairs for the Dairy index.

Table 13. VAR Granger/Block Causality Exogeneity Wald Tests

Dairy			
Dairy Price Series Variable Pairs	Granger Causality Block Wald χ^2 Tests (First Variable: Leader)	Granger Causality Block Wald Tests (Second Variable: Leader)	Leading Province in a Granger Causality Sense
Auckland-Canterbury VAR=3	$\chi^2(3)=5.54$	$\chi^2(3)=7.68^{**}$	Canterbury
Canterbury-Otago VAR=1	$\chi^2(1)=4.103^{**}$	$\chi^2(1)=1.36$	Canterbury
Canterbury-Wellington VAR=1	$\chi^2(1)=18.82^{**}$	$\chi^2(1)=0.242$	Canterbury
Auckland-Otago VAR=1	$\chi^2(1)=0.0016$	$\chi^2(1)=5.83^{**}$	Otago
Otago-Wellington VAR=1	$\chi^2(1)=2.89^*$	$\chi^2(1)=6.6^{**}$	Bi-directional
Auckland-Wellington VAR=1	$\chi^2(1)=3.75^{**}$	$\chi^2(1)=0.054$	Auckland

Note: *, ** significant at 10 and 5 %, respectively

In the case of the meat series, Otago is revealed as the leading Province (Table 14). The first shipment of frozen meat was from Dunedin in 1882 and the number of carcasses of frozen mutton exported from Otago was the highest until at least the late 1890s and some of the earlier freezing works were also built there. Thus, it is reasonable to assume that the changes in fluctuations in Otago meat prices preceded those in other Provinces.

Table 14. VAR Granger/Block Causality Exogeneity Wald Tests

Meat Price Series Variable Pairs	Meat		
	Granger Causality Block Wald χ^2 Tests (First Variable: Leader)	Granger Causality Block Wald Tests (Second Variable: Leader)	Leading Province in a Granger Causality Sense
Auckland-Canterbury VAR=3	χ^2 (3)=1.556	χ^2 (3)=13.29**	Canterbury
Canterbury-Otago VAR=3	χ^2 (3)=0.86	χ^2 (3)=10.6**	Otago
Canterbury-Wellington VAR=1	χ^2 (1)=0.231	χ^2 (1)=3.64*	Wellington (weakly)
Auckland-Otago VAR=2	χ^2 (2)=0.27	χ^2 (2)=8.93**	Otago
Otago-Wellington VAR=3	χ^2 (3)=5.955	χ^2 (3)=7.44**	Otago
Auckland-Wellington VAR=3	χ^2 (3)=0.63	χ^2 (3)=18.37**	Wellington

Notes: *, ** significant at 10 and 5 % levels, respectively.

The South Island Provinces were undeniably the more economically and resource advantaged during the 19th century. When profits from refrigerated shipping were realized, it was much easier to convert the readily available farmland from agricultural to pastoral. Statistically, we find evidence of Canterbury dairy prices leading the dairy sector prices, and Otago leading the meat sector prices, which is consistent with the historiography on economic development in New Zealand.

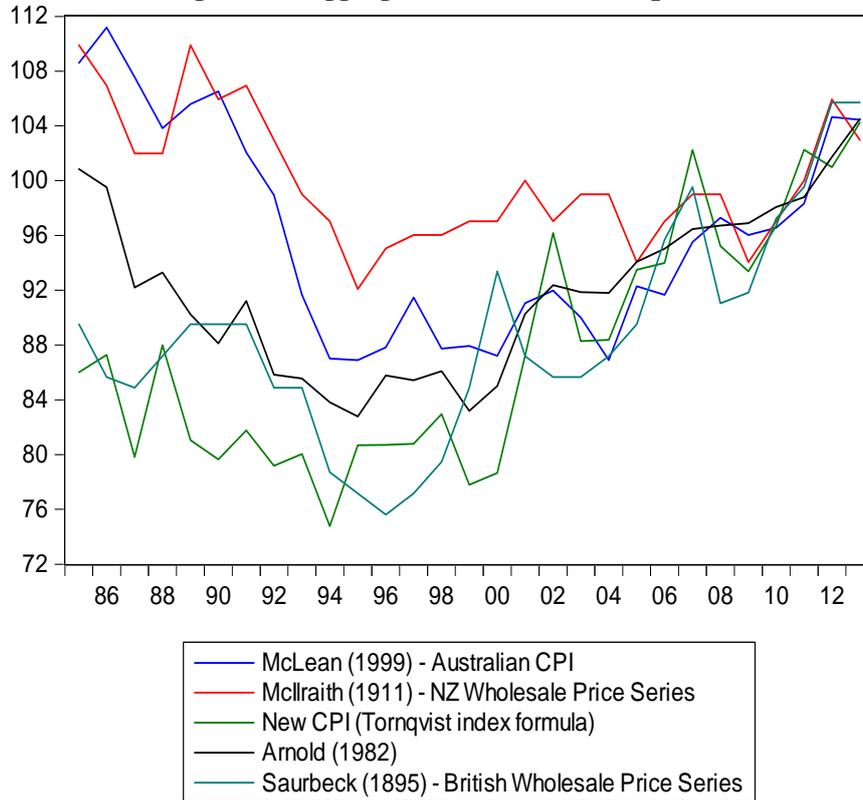
6. Consistency of the New Aggregate Index

Consistency of the new Provincial series can be assessed by comparing the new aggregate with the existing national CPIs (from Arnold 1982b, McIlraith 1911, Sauerbeck 1895). Potential differences may arise for several reasons in part due to different estimation of certain expenditure items in the basket, minor weight changes within the sub-series and an alternative index formula for our CPI calculation. In addition to the New Zealand CPI series, Figure 13 includes historical price indices for Britain (Sauerbeck 1895) and Australia (McLean 1999). Notably, all CPI series move in the same direction and have similar trends. McIlraith's wholesale price index for New Zealand resembles Australian CPI, while Sauerbeck's British wholesale price index movements have more in common with Arnold's and the new CPI series. Arnold's CPI is hypothesized to have the highest degree of correlation with the new index as opposed to earlier alternatives by way of construction and the same data source used.

Table 15 shows that fluctuations in the new CPI (Tornqvist index) are only significantly related to the fluctuations in the Arnold's CPI, but not to other indices. There are, however, marked differences between the new series and Arnold's series for example, the new CPI exhibits sharper falls and increases (those could be outliers that are not apparent from Arnold's index since her CPI is a weighted national average that included most provincial

districts). Spikes around 1902, 1907 and 1911 may be due to certain well documented in New Zealand history events, for example, manufacturing and some of the main export commodities were greatly affected by tariff changes in 1903 and 1907. Revision of the *Tariff Act* in 1907 imposed extra duties on manufactured items and equipment from countries other than Britain, which led to increased costs of production.

Figure 13. Aggregate Price Index Comparison



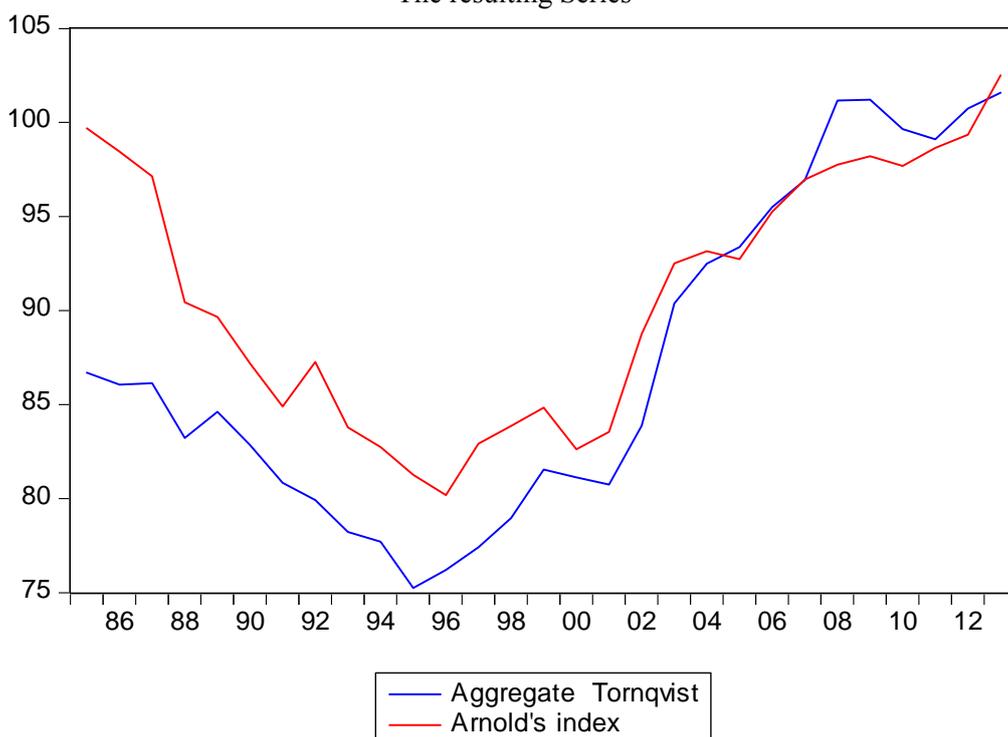
↕
↕
↕

**Table 15. Correlation Coefficient Matrix
First Differences**

Correlation Probability	Arnold	McLean	Tornqvist	Sauerbeck	McIlraith
Arnold	1.00				
McLean	0.35	1.00			
Tornqvist	0.07	0.23	1.00		
Sauerbeck	0.63	0.23	0.00	1.00	
McIlraith	0.15	0.13	0.14	0.46	1.00
	0.33	0.35	-0.07	0.36	0.09
	0.09	0.07	0.73	0.06	

To make further comparisons and identify whether our derived¹⁶ aggregated consumer index is 'similar' (in a statistical sense) to the Nesbitt-Savage/Arnold ('the best' existing historical CPI) index, we follow similar time-series analysis procedures introduced earlier. Unit-root pre-testing revealed that both series experience a common structural break around 1901. Exclusion of the other Provinces in the new aggregate CPI calculation made the series more volatile to fluctuations of the grocery and other food items. To smooth the effects of the outliers, we used Holt-Winters (no seasonality with the lowest RMSE) exponential smoothing technique (Holt 2004), with the results presented as in Figure 14.

Figure 14. Holt-Winters Exponential Smoothing
The resulting Series



We can test if the series co-move in the long run by using the Johansen method. The results revealed that the smoothed series do move together, but do not suggest a long-run equilibrium such that the series are effectively, statistically, identical.

7. Concluding Remarks

Historical statistics in New Zealand, particularly prior to the 1950s, are largely unavailable in a readily usable form. Compiling and analyzing historical data can assist us in better understanding the living standards in New Zealand, where the data on prices, wages, economic performance and health statistics were relatively consistently collected and published annually by the Department of Statistics for each Province since at least the 1850s.

¹⁶ Since the Tornqvist formula was used for deriving the aggregate index, we will refer to it as the 'Tornqvist index' for simplicity.

Prior to the abolition of Provinces in 1876, socio-economic and demographic data covered all New Zealand regions, but after 1876 the scope of data reporting for most indicators was restricted to the four largest (in terms of population) Provinces. Construction of regional deflator series and regional real wages¹⁷, allow us to explore differences in regional dynamics and how the standard of living of those living in different locations evolved over time. This work, in particular, focused on establishing the degree of market integration within the New Zealand dairy and meat sectors, and whether the theoretical assumptions on the South-North convergence were supported statistically.

Statistically, we found that both meat and dairy price series (traded goods) either exhibited convergent behavior in the long run (meat series) or ‘catching up’ (dairy series). This was only established for the Auckland-Canterbury pair, although the coefficient of variation analysis confirmed considerable declines in dispersion post-1900 across all Provinces. In addition, we established that Canterbury dairy prices were leading the dairy sector prices, and Otago led the meat sector prices. These findings are suggestive of South-North convergence, demonstrating that the refrigeration boom that initially benefitted the South gradually involved the North. The dominating position of the South began to diminish post 1898 as the new trade reshaped agricultural production and more land became suitable for farming. Dairying, beef and sheep farming became the predominant industries in the North Island (dairying expanded on the better lowlands, while sheep and beef - into the hill country of the North Island). This transformation has shifted the production and farming to the North Island.

Provincial analysis of the historical price series in this chapter highlights the disparities that existed among local markets due to a variety of reasons including transport, climate or geographical location. There were not only differences between the North and the South, but also within the two islands. Lack of reliable transportation was one of the reasons why Auckland was relatively more isolated within the North Island with the importance of railways rising around the time of the advancement of freezing works. The introduction of refrigeration from the 1880s led to substantial changes in the pattern of regional fluctuations and by 1900, New Zealand Provincial markets became more integrated, especially the North Island with the South Island provinces. Negative rates of net interprovincial migration in the South and positive in the North, indicate that during 1886-1911 population was moving North with the shift of economic activity.

Provincial analysis undertaken here is important in its own right, but also for comparison to other countries including Australia and Britain. McLean (1999) concluded that for the four capital cities in Australia there was no clear trend during the 1870-1914 period towards greater integration of commodity markets with the exception of selected food items (bacon and potatoes). Thus, it is likely that the timing of the emergence of a national market for goods in New Zealand was quite different from that in Australia, suggesting that greater persistent disparities existed among Australian regional markets well into the 20th century.

¹⁷ Not presented here, but constructed by the authors.

References

- Arnold, M.N. (1982b). *Consumer prices, 1870 to 1919*. Discussion Paper. Economics. Victoria University of Wellington. Wellington.
- Bambrick, S. (1973). Australian Price Levels, 1890-1970. *Australian Economic History Review*, 13(1), 57.
- Bernard, A.B. and Durlauf, S.N. (1995). Convergence in International Output. *Journal of Applied Econometrics*, 10, 97-108.
- Briggs, P. (2003). *Looking at the numbers: a view of New Zealand's economic history* (Vol. 69.). Wellington, N.Z: NZ Institute of Economic Research.
- Brosnan, O. (1986). Net interprovincial migration, 1886-1996. *New Zealand Population Review*, 12(3), 185-204.
- Collins, J.W. (1912). *Cost of Living in New Zealand (report and evidence of the Royal Commission)*: Department of Labour.
- Dickey, D.A. and Fuller, W.A. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association*, 74(366), 427-431.
- Fraser, M. (1915). Report on the cost of living in New Zealand: An inquiry into Retail Prices, 1891-1914: Prepared under the authority of the Government of New Zealand.
- Fraser, M. (1916). New Zealand Official Yearbook Retrieved from www3.stats.govt.nz/New_Zealand_Official_Yearbooks/1915/NZOYB_1915.htm
- Greasley, D. and Oxley, L. (2004). Globalization and real wages in New Zealand 1873–1913. *Explorations in Economic History*, 41(1), 26-47. doi: 10.1016/s0014-4983(03)00044-5
- Greasley, D. and Oxley, L. (2010). Knowledge, Natural Resource Abundance and Economic Development: Lessons from New Zealand 1861-1939. *Explorations in Economic History*, 47(4), 443-459.
- Hawke, G.R. (1985). *The making of New Zealand: An economic history*: Cambridge University Press.
- Holt, C.C. (2004). Forecasting seasonals and trends by exponentially weighted moving averages. *International Journal of Forecasting*, 20(1), 5-10. doi: 10.1016/j.ijforecast.2003.09.015
- ILO, IMF, OECD, UNICEF, Eurostat, & Bank, T. W. (2004). Consumer price index manual: Theory and practice. *International Labour Review*, 143(4), 403.
- Johansen, S. (1988). Statistical Analysis of Cointegrating Vectors. *Journal of Economic Dynamics and Control*, 12(1), 231-254.
- Karama Store Book, 1875-1876, NP Series 23, Box 5, item 6, Archives New Zealand (ANZ).
- Knibbs, G.H. (1911). Inquiry into the Cost of Living in Australia Vol. 5. *Year Book Australia* Retrieved from [http://www.ausstats.abs.gov.au/ausstats/free.nsf/LookupAttach/1301.0Publication01.01.11280/\\$File/13010_1912_CostofLiving.pdf](http://www.ausstats.abs.gov.au/ausstats/free.nsf/LookupAttach/1301.0Publication01.01.11280/$File/13010_1912_CostofLiving.pdf)
- MacKinnon, J. (1991). Critical values for cointegration tests. In R.F. Engle and C.W.J. Granger (Eds.) *Long Run Economic Relationships*. Oxford: Oxford University Press.
- Maddala, G. and Wu, S. (1999). A Comparative Study of Unit Root Tests and a New Simple Test. *Oxford Bulletin of Economics and Statistics*, 61, 631-652.
- McIlraith, J.W. (1911). The course of Prices in New Zealand: an Inquiry Into the Nature and Causes of the Variations in the Standard of Value in New Zealand. Wellington.
- McLean, I.W. (1999). Consumer prices and expenditure patterns 1850-1914. *Australian Economic History Review*, 39(1).
- Mitchell, B. (1988). *British Historical Statistics, 1845-1966*: Cambridge University Press.
- Nesbitt-Savage, R. (1993). *A long run consumer price index for New Zealand*. Working paper. Economics. University of Waikato. Hamilton.
- Neville, R.J.W. and O'Neill, C.J. (1979). *The Population of New Zealand: interdisciplinary perspectives*. Auckland: Longman Paul.
- New Zealand Department of Statistics. (1873-1935) New Zealand Census. Wellington.

- New Zealand Parliament (1965). Index to the Appendices to the Journals of the House of Representatives of New Zealand 1954 to 1963: being a continuation of indices 1854 to 1913, 1914 to 1922, 1923 to 1938, and 1939 to 1953. Wellington, N.Z
U6-ctx_ver=Z39.88-2004&ctx_enc=info%3Aofi%2Fenc%3AUTF-8&rft_id=info:sid/summon.serialssolutions.com&rft_val_fmt=info:ofi/fmt:kev:mtx:dc&rft.title=Index+to+the+Appendices+to+the+Journals+of+the+House+of+Representatives+of+New+Zealand+1954+to+1963&rft.date=1965-01-01&rft.pub=Govt.+Printer&rft.externalDBID=n%2Fa&rft.externalDocID=1763380 U7 - Government Document U8 - FETCH-canterbury_catalog_17633801: Govt. Printer.
- New Zealand. Department of Statistics (1893). The New Zealand Official Yearbook. Wellington: N.Z. Govt. Printer.
- New Zealand. Department of Statistics (1911). The New Zealand Official Yearbook. Wellington: N.Z. Govt. Printer.
- New Zealand. Department of Statistics and Registrar General's Office (1894). The New Zealand Official Yearbook. (Journal, Electronic). Retrieved from http://canterbury.summon.serialssolutions.com/link/0/eLvHCXMwY2BQMEtLA_ZkzYFVq4lxUIKSQYpBokVaqmVimqEhsGOAn7GN2OGKVJq7iTIOurmGOHvolkyNh45ixIOuTjIzNjYUY-BNBK39zisB7xFLAQD1bx2k
- New Zealand. Ministry for Culture and Heritage. (2003). Te Ara: the encyclopedia of New Zealand. (0478184514, 9780478184518). Retrieved from http://canterbury.summon.serialssolutions.com/link/0/eLvHCXMwY2BQMDRLM7RISUu0tEwzMDE0TDJNSTQ0TjKwSEkGlpdGKeYoO1yRSnM3UQYFN9cQZw9dhKnx0FGMeGAnztLc0FCMgTcRtPQ7rwS8RSyF70mHg_rqSsfGrV3HFGfaW6wAAPp9JNQ
- New Zealand. Parliament. House of Representatives (1884) Appendix to the Journals of the House of Representatives of New Zealand. Wellington
- New Zealand. Parliament. House of Representatives (1887) Appendix to the Journals of the House of Representatives of New Zealand. *Vol. HI*. Wellington.
- Perron, P. (1989). The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. *Econometrica*, 57(6), 1361-1401.
- Phillips, P.C.B. and Ouliaris, S. (1990). Asymptotic Properties of Residual Based Tests for Cointegration. *Econometrica*, 58(1), 165-193.
- Sauerbeck, A. (1895). 'Index numbers of prices. *The Economic Journal*, 5(18), 161-174.
- Thorns, D. and Sedgwick, C. (1997). *Understanding Aotearoa/New Zealand: historical statistics*. Palmerston North, N.Z: Dunmore Press.
- Toda, H.Y. and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1), 225-250.
doi: 10.1016/0304-4076(94)01616-8
- Tremblay, M.S. *et al.* (2005). Obesity, overweight and ethnicity. *Health Reports*, 16(4), 23-34.
- Zivot, E. and Andrews, D. (1992). Further evidence on the Great Crash, the oil price shock, and the unit root hypothesis. *Journal of Business and Economic Statistics*, 10, 251-270.

Appendices

Table A-1. Expenditure Basket based on 1893 Household Expenditure Survey
Labour Department, Percent (%)

Bread (2 lb)	8.955	Housing	10.38
Coffee (lb)	1.45	Clothing	
Flour per 25lb bag	0.995	Clothes	13.14
Rice (lb)	1.87	Boots and Shoes	4.38
Salt (lb)	0.97	Total	17.52
Sugar (56 lb)	4.03	Miscellaneous	
Tea (lb)	4.03	Washing	1.52
Oats (lb)	1.87	Books	2.83
Onions lb	1	Furniture	2.25
Carrots (dozen bunches)	0.2	Friendly Societies	3.56
Turnips (dozen bunches)	0.085	Total	10.16
Cabbages per dozen	0.085	Fuel and Light	
Potatoes per cwt. - retail	1.62	Candles	2.69
Jam lb	1	Coal/Firewood	5.39
Raisins lb	0.4	Total	8.08
Currants lb	0.13		
Dried Fruits lb	0.1		
Beer (hhd)	1.16		
Total	29.95		
Meat			
Beef	5.3088		
Mutton	2.212		
Pork	0.8848		
Lamb	2.212		
Veal	0.4424		
Total	11.06		
Dairy			
Milk	3.39		
Fresh Butter	2.305		
Salted Butter	2.305		
Cheese	1.07		
Eggs	1.31		
Bacon	1.47		
Ham	1		
Total	12.85		

Source: New Zealand Department of Statistics (1873-1935)

Table A-2. Total Population for All Provincial Districts
Urban-Rural Breakdown

Year	Urban	Rural	Total
1881	291,238	194,981	486,219
1886	327,328	245,612	572,940
1891	352,097	270,343	622,440
1896	391,735	307,294	699,029
1901	417,596	350,202	767,798
1906	458,797	424,614	883,411
1911	496,779	505,598	1,002,377
1916	501,259	585,306	1,086,565

Source: Extracted from Thorns and Sedgwick (1997).

Table A-3. Population in Provincial Districts at Successive Censuses

Exclusive of Maoris

Provincial District	March 1886	April 1891	April 1896	March 1901	April 1906	April 1911
Auckland	130379	133159	153,564	175938	211223	264520
Canterbury	121400	128392	135858	143041	159106	173185
Otago	113702	116088	119990	125341	127877	132402
Wellington	77536	97725	121854	141354	179868	199094

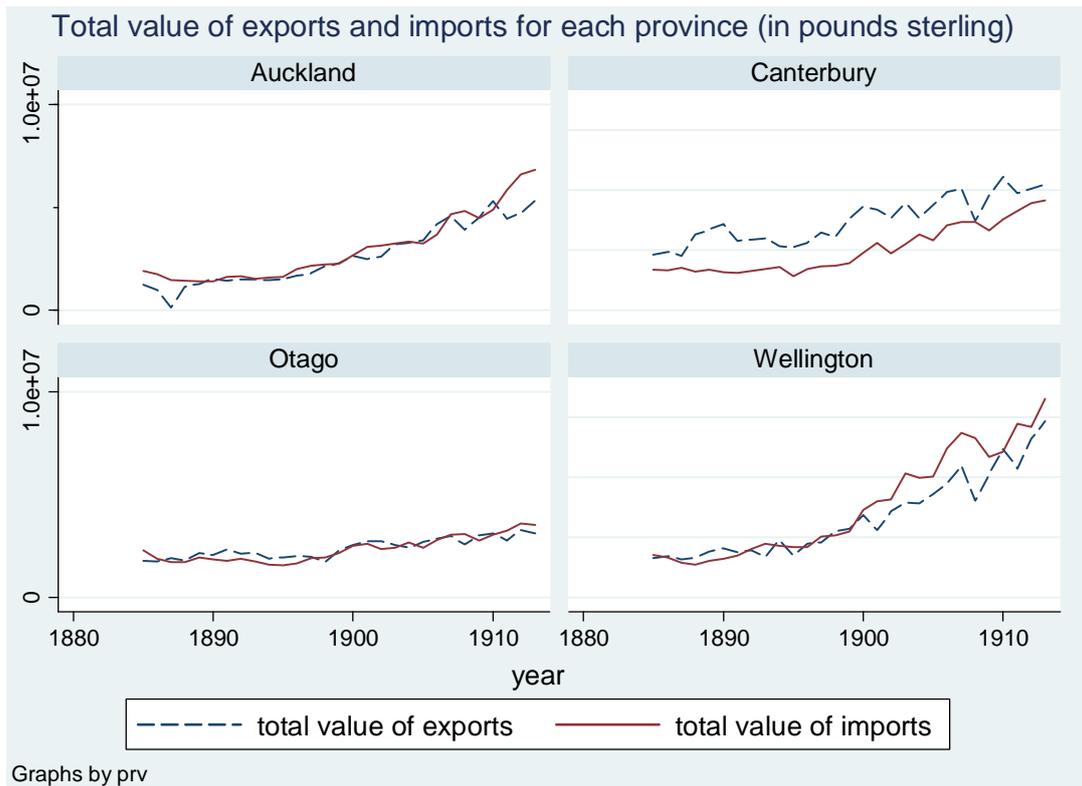
Source: Statistics New Zealand, 1911. Census, April, 1911, *Population and Dwellings*.

Table A-4. Annual Rates of Natural Increase and Net Migration 1886-1911
Net Interprovincial Migration and Total Population Increase

Period	Population Migration	Auckland	Wellington	Canterbury	Otago
1886-1891	Natural increase and Net migration	12	20	16	13
	Net interprovincial migration	-11	29	-5	-9
	<i>Total increase</i>	3	45	11	5
1891-1896	Natural increase and Net migration	18	26	21	21
	Net interprovincial migration	5	19	-11	-8
	<i>Total increase</i>	22	43	11	14
1896-1901	Natural increase and Net migration	20	22	17	16
	Net interprovincial migration	7	10	-7	-6
	<i>Total increase</i>	26	30	10	11
1901-1911	Natural increase and Net migration	28	28	24	22
	Net interprovincial migration	13	6	-6	-16
	<i>Total increase</i>	38	33	19	10

Source: Brosnan (1986).

Table A-5. Overseas Trade: Total Value of Exports and Imports



A-6. Tariff and Labour Legislation Changes

Under the Industrial Arbitration and Conciliation Act (1894), the regulation of wages in most industries was undertaken by Councils and a Court (this gave a legal recognition to Unions and their ability to dispute wages). Most of the unions benefited from this Act as it gave them the opportunity to dispute rates of pay and minimum working conditions. This led to an increase in wages, which were generally passed-on to the consumer in the form of higher prices for manufactured goods (for example, clothing, furniture) and other items.

The tariff introduced in 1879 extended the number of items that were charged a duty on an *ad valorem* basis, or as the percentage of the value of the goods. From 1895, there was a steady movement towards a reduction on the duties levied upon imported foodstuffs, and an extension of the tariff levied upon imported manufactured goods. These changes were typically made to protect infant industries. Later, The Preferential and Reciprocal Trade Act of 1903 of New Zealand introduced preferential rates of duty in favor of the produce of the British Dominions by imposing extra duties on certain imports which were the produce or manufacture of other countries. The list of preferential items was materially extended by the New Zealand Tariff Act of 1907 from the 31st March, 1908.¹⁸

¹⁸ Official Year Book of the Commonwealth of Australia, tom 47 by Sir George Handley Knibbs, Australia. Commonwealth Bureau of Census and Statistics.