A New Measure of New Zealand's GDP

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Abstract:
Official estimates of New Zealand's national income are available on an annual basis for the years since 1948. As for most OECD economies retrospective, non-official, estimates are available for earlier years, and in the case of New Zealand date from 1859. In the absence of continuous time series data, various measures of New Zealand National Income have been constructed including the work of Hawke (1975), Rankin (1992) and Cashin (1995). In this paper we add produce estimates of New Zealand real GDP per capita using cointegration methods. This new, continuous, annual time series fits well the independent benchmarks reported in Rankin (1992), and conforms to the historiography of the pre-1914 period. However, the data suggest a different interpretation for New Zealand's World War One and post-war growth experience, which contrasts with that of Australia and that of previous researchers, who ostensibly fit their models to the Australian experience.

1. Introduction.

Official estimates of New Zealand's national income are available on an annual basis for the years since 1948. As for most OECD economies retrospective, non-official, estimates are available for earlier years, and in the case of New Zealand date from 1859. Although New Zealand was a British Australasian colony, she declined to join the Commonwealth of Australia in 1901, and was not incorporated in Butlin's GDP estimates for Australia. Retrospective GDP estimates for New Zealand rest largely on proximate monetary-based data, and are regarded by Maddison (1995, p.119) as among the weakest of the estimates for OECD countries. However, Maddison (1995) does include an annual GDP series for New Zealand for the years since 1870.

Some direct data for New Zealand's national income are available for years before 1948. Lineham (1968) utilised sectoral income estimates to piece together a nominal GDP series from 1918, and Easton (1990) deploys these data with a constructed GDP deflator to derive real GDP. Furthermore, spot estimates for New Zealand national income have been made for the years 1865, 1898/99-1902/03, 1925/26, 1932-33, and 1938/39. Rankin (1992) questions the year to year accuracy of Lineham's data, especially for the 1920s, since some interpolation of employment levels between census dates was used. Rankin's own preference involves using proximate money-derived national income estimates, partly because such data may capture annual movements more effectively, and his data are incorporated in Maddison (1995).

Rankin uses a 3-piecewise estimate of Australian velocity, based upon New Zealand data, as the starting point for his calculations. By forcing his estimates through chosen national income benchmarks via a series of *ad hoc* weights, Rankin "fits" these benchmarks perfectly.

Cashin (1995), utilises two recently available data sources. The first is a new price (CPI) series for New Zealand created by Nesbitt-Savage (1993). The second relates to New Zealand monetary data produced by Sheppard, Guerin and Lee (1990), which provides series for the conventional monetary aggregates, M1 and M3, and avoids Rankin's simple reliance on bank deposits. However, in contrast to Rankin, Cashin chose to follow Hawke[1] (1975) by taking the (average) calculated velocity of Australian money balances, in Cashin's case for M1, and simply multiplying this by New Zealand M1 balances from Sheppard *et al.* (1990). Cashin reports results only for selected years, and these do not always coincide with Rankin's measures, especially for the years around World War One. Neither Rankin, nor Cashin, considered how the statistical time series properties of the data may influence their estimates. Recent work in this area by for example, Dickey and Fuller (1979) and Granger and Newbold (1974) explain the need for careful examination of such issues prior to estimation.

Our approach to deriving estimates of New Zealand GDP, 1859-1933 utilise developments from the analysis of non-stationary series based upon the concept of cointegration proposed by Engle and Granger (1987). As will be seen, we adopt the new price and money data used by Cashin, but choose to follow Rankin in allowing New Zealand factors to produce an estimate of the

[1] Hawke (1975) uses bank deposits (like Rankin) rather than M1 (Cashin). However, both Cashin and Hawke use the actual (rather than an estimated) value for Australian velocity.

Australian velocity inevitably required for the calculation of New Zealand GDP. The resulting measures avoid the need for interpolation to match the occasional contemporary income benchmarks, and put monetary-based GDP estimates for New Zealand on a firmer statistical footing. The new estimates of New Zealand GDP for the years to 1933, can be spliced readily with the semi-official income estimates for the 1930s, and Easton's (1990) data for the period 1938 to 1960 to provide a link with New Zealand's official national income estimates. Maddison (1995), alternatively, uses Clarke's (1940) data to join Rankin's estimates with the official post-1950 series.

2. Methodology

The starting point of the money-based approach to estimating national income is the Equation of Exchange and the subsequent Quantity Theory of Money:

$$MV \equiv PT$$

Where M is the stock of money; V the velocity of circulation; P the price level; and T the volume of transactions. For New Zealand measures of velocity cannot be made independently of some measure of national income (which does not exist).

In order to create a velocity series Rankin follows a three-stage process. In stage one he creates a measure of Australian velocity, from the trading bank deposits and Butlin's (1962) income data. This measure of velocity is then used in a series of regression equations where (Australian) velocity is regressed on (Australian) prices (PRI) and MPC (plus a dummy variable for the inter-war years 1919-39). Omitting the years 1914-1918, three separate regression equations are produced which although they have 'good' fit exhibit serial correlation as denoted by a low Durbin-Watson (DW) statistic indicative of a "spurious regression" problem (see Granger and Newbold (1974)).

In the second stage, New Zealand data are used to predict Australian velocity for the periods, 1861-1900; 1900-1913; 1919-1939. The results show a generally good fit, with low DW statistics.

Stage three entails using New Zealand data-based estimates of Australian velocity to create a series for New Zealand velocity, and hence New Zealand GNP, using New Zealand measures of PRI and MPC. Three models are estimated for the periods, 1859-97, 1895-1913, and 1922-33.

2.1 Comments:

(i) Omission of the period 1914-21 leads to the *ad hoc* creation of GNP data for these years.

(ii) Structural discontinuities are imposed on the regression equations resulting in three separate models.

(iii) The high R2 - low DW in Rankin's results is indicative of spurious regression.

(iv) In contrast, Cashin's (1995) use of Australian velocity in conjunction with New Zealand monetary aggregates to calculate New Zealand GDP assumes that New Zealand's velocity experience mirrors Australia's

2.2 An alternative methodology

Effective use of Quantity Theory-based calculations to measure national income requires that the time series properties of the individual elements are calculated, and that the implications of their values understood. In this study we propose the following approach:

i. Establish the time series properties of the individual series, using Dickey-Fuller (1979) tests, to determine the use of appropriate estimation methods.

ii. Consider the relationships (cointegration if the data are non-stationary) between the data, both for Australia, and between New Zealand and Australia.

iii. If the Australian and New Zealand data are "related" (cointegrated with I(1) variables), estimate Australian-based and New Zealand-based estimates of Australian velocity.

iv. From the New Zealand-data based velocity estimates, calculate a measure of New Zealand GDP.

2.3 Data

The data used in this study come from four main sources. Firstly, the Rankin (1992) data for Australian GNP, prices, population, trading bank deposits and velocity, and New Zealand population, trading bank deposits and prices are used. Rankin cites Butlin (1962), Butlin, Hall and White (1971); Maddock and McLean (1987) and the *Official Year Book of the Commonwealth of Australia (1910)* for Australian data and McIlraith (1911), Easton and Wilson (1984), Bloomfield (1984) the *New Zealand Official Year Book (NZOYB), various issues, New Zealand Statistics for Population and Buildings (1922/23-1939-40)* for New Zealand data. The second source relates to the Nesbitt-Savage (1993) price series used by Cashin (1995). Following Cashin, thirdly we utilise the recently created series for New Zealand monetary data in Sheppard, Guerin and Lee (1990). Finally, for Australia we utilise the monetary data published in Vamplew (1987), chap. 14., and measures of Australian GDP in Vamplew (1987), chap. 8.

2.4 Results[2]

Without *ad hoc* weights and splicing, Rankin's data cannot approximate the independent benchmark income measures on which he sets store, even when statistically valid estimation methods are used.

Australian money, income, velocity and price data is integrated or order 1, I(1) and cointegrated. Table 1 below represents the best fitting, cointegration-based model of Australian M1 velocity using New Zealand M1 per capita and the Nesbitt-Savage (1993) measure of New Zealand prices as explanatory variables. These results provide our preferred measure for velocity from which the new estimates for New Zealand GDP are constructed, Model #5 below[3].

Table 1
Cointegration results using New Zealand Data to explain Australian M1 velocity, 1861-1933

Johansen (var=2)				Variable.	P-H
H0:	H1:	Max. eigen	Trace	velocity	-
r=0	r=1	46.9*	79.3*	intercept	**-4.94**
r≤1	r=2	28.6*	32.4*	NZPrice	**0.57**
r≤2	r=3	3.76	3.76	NZM1cp	**-0.38**

P-H = Phillips and Hansen (1990) method results. These coefficients are used in the simulation exercise. NZPrice relates to the Nesbitt-Savage measure; NZM1cap refers to NZM1 per capita. Normalised coefficients from second significant cointegrating vector are shown.

3. Implications for New Zealand GDP

The various models used in the study and others illustrated in this section, are defined in Table 2.

Our preferred, new, cointegration-based GDP estimates are labeled Model #5, and are now considered in relation to the contemporary benchmarks, and to Rankin's and Cashin's modern measures. Looking initially at nominal values, #Model 5's coincide reasonably well with the contemporary benchmarks, with values ranging between 89.3% and 107.8% relative to those of the spot estimates. The Model #5 estimate for 1932 matches near exactly the benchmark, to provide a firm basis for splicing the money-based data with the semi and official income estimates for later years. Turning to the Cashin estimates, the largest discrepancy with Model #5 arises for 1920. The nominal Rankin data also exceed Cashin's figure for 1920, by around 40%, even though Rankin imposed an arbitrary downward adjustment on his data.

Table 2.
The Alternative Models

Model	Description
#1	Original Rankin (1992)
#2	Rankin (1992) deflated by Nesbitt-Savage (1993) price index
#3	"Best-fit" cointegration-based model using Rankin data (no breaks). Nesbitt-Savage (1993) price index.
#4	Vamplew (1987), monetary data for Australia. Actual Australian GNP-based velocity multiplied by NZ M1 (as per Cashin (1995))
#5	Estimated velocity based on Table 8 multiplied by NZ M1.
#6	Australian GNP per capita (Rankin (1992))
#7	Australian GDP per capita (Vamplew (1987))

Figures 1 below compares the preferred Model #5 GDP measures with the original Rankin, Model #1.

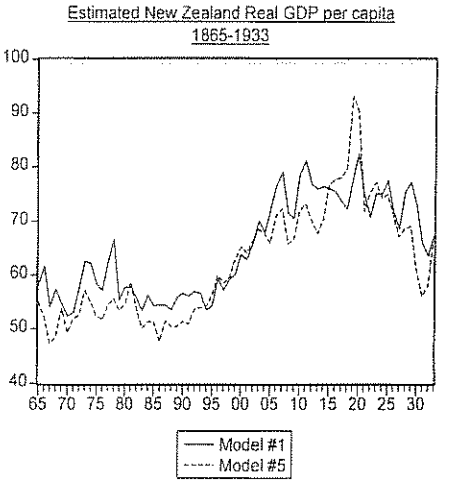

Figure 1.

The modest obvious divergence between Models #1 and #5 occurs during the years of World War One. Our preferred model shows strong per capita growth, around a 39% increase, between 1913-1919, whereas the Rankin index appears essentially static over the same period. To some extent the alternative price deflators are responsible, but Model #5 does show a considerably stronger post-war boom. Rankin's income estimates for 1919-20 were arbitrarily

[2] Throughout, the results are based upon the original variables transformed to natural logarithms. Furthermore, coefficients from the Phillips and Hansen (1990) approach are used to construct the New Zealand GNP series.

[3] The data for models #1 and #5 is presented as Table A1 in the Appendix.

deflated to coincide with his views on the post-war economy.

New Zealand's economic history offers evidence, which supports the idea of a strong postwar boom. Exports surged in 1919, with their nominal values doubling, see Mitchell (1988, p.536). Wool exports leaped in value from £7.5 million to £20 million between 1918 and 1919, to account for nearly 40% of exports. Over 80% of New Zealand exports in 1919 went to the UK, and their high prices, together with the resettling of returning soldiers, contributed to a land boom, Hawke (1985, p. 101), which offers further testament to the strength of New Zealand's post-war recovery. But, most importantly, the estimates from Model #5 are statistically well-founded, based on appropriate data and avoid arbitrary assumptions. Thus, they appear preferable to those from Models #1 or #2, both for the war period and more generally. Rankin's reliance on interpolation appears particularly suspect between 1902/3 and 1925/6, given the large span of years without a benchmark and the macroeconomic shocks associated with World War One.

Finally, consider the relative performance of Australia and New Zealand based upon the new estimates of New Zealand GDP created by Model #5.

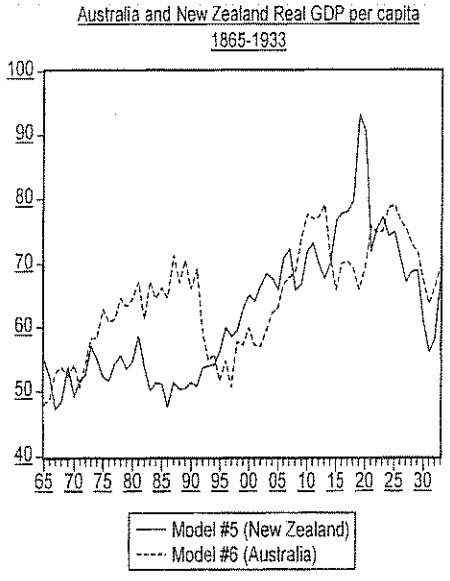

Figure 2.

Figure 2 presents results for Australian GDP per capita taken from Vamplew (1987) and Model #5-based GDP for New Zealand incorporating a measure of New Zealand population used in Greasley and Oxley (1999)[4]. Essentially, Figure 2 above presents the best estimates of both Australian and New Zealand GDP per capita. From this figure we can see that Australia first leads then, from the 1890s, (generally) lags behind New Zealand until the late 1920s. First World War and immediate post-war experiences appear significantly different in the two countries. This is to be contrasted with Rankin's (1992, p.54) Figure 2 which shows a similar 1900-25 experience for the two countries, ostensibly obtained by assuming that New Zealand mirrored the Australian growth record during this period since benchmarks are not available.

4. Concluding Remarks.

The new estimates of New Zealand incomes from Model #5 are founded upon a thorough and consistent methodology, which considers the time series properties of the data and appropriate estimation methods. With an absence of data on New Zealand velocity some "statistical association" has to be established between New Zealand and Australia, if the Australian data are to proxy the non-existent New Zealand data. Cointegration analysis and the results in this paper provide just that evidence. The new estimates produced here do not involve *ad hoc* adjustments, splicing, scaling, or interpolation. Nevertheless, they track the contemporary benchmarks closely. The greatest uncertainty surrounding New Zealand's income estimates concerns the period 1902-25, which has no benchmarks. The ability of Model #5 to track the benchmarks in the earlier and later years militates against using *ad hoc* adjustments for the intervening years.

In this paper we build on the pioneering work of Hawke, Rankin, and Cashin to provide rigorously derived, validly estimated measures of New Zealand GDP utilising the powerful implications of cointegration analysis. The latter identifies strong statistical links between the monetary transmission mechanisms in Australia and New Zealand necessary for the approach used here, but also incorporates distinctive elements from New Zealand's experience. Using consistent measures of prices and a new series on New Zealand M1 in an interpolation-free, break-free approach, we construct an income series that tracks the occasional contemporary benchmarks well, and

[4] This measure is derived from NZOYB (1990, 1995), *New Zealand Official Year Book*, Wellington and incorporates Maori in the population. This, in part, overcomes some of the worries expressed in Maddison (1995), p. 134, regarding the exclusion of Maori.

produces statistically robust estimates for the whole period.

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Appendix

Table A1

OBS	Model 1 (RPC)[5]	Model 5 (RPC)
1865	58.1498	53.65280
1866	61.6194	51.04878
1867	54.0917	46.15006
1868	57.3448	47.42118
1869	54.7038	52.8269
1870	52.3607	47.8668
1871	52.9600	50.8541
1872	57.5878	51.6723
1873	62.538	56.2205
1874	62.1801	54.0372
1875	58.4746	51.3454
1876	57.0654	50.7055
1877	62.4524	53.2027
1878	66.6062	54.6111
1879	55.383	52.7495
1880	57.6496	53.9489
1881	57.8388	58.0475
1882	55.8031	52.9969
1883	53.3106	49.3785
1884	56.2273	50.693
1885	54.2521	50.5571
1886	54.411	47.0533
1887	54.4020	50.9415
1888	53.5014	49.7587
1889	55.8165	49.8746
1890	56.5937	50.9969
1891	56.0417	50.3839
1892	56.9851	53.2455
1893	56.6175	53.5318
1894	53.4162	53.7237
1895	54.3080	55.9067
1896	59.3249	59.6435
1897	57.2201	58.1550
1898	59.2499	59.2821
1899	60.1600	62.4951
1900	63.8863	64.674
1901	62.8894	63.4380
1902	65.8868	65.9221
1903	70.1489	67.8943
1904	67.8190	67.0959
1905	71.9661	65.4010
1906	76.4471	70.4128
1907	79.0595	71.8393
1908	71.5068	65.5291
1909	70.5593	66.3204
1910	78.5432	71.4017
1911	81.1777	72.7255
1912	76.8107	69.5167
1913	75.9525	67.0701
1914	76.4296	69.6499
1915	76.0875	75.8936
1916	75.5088	76.5671
1917	73.6930	76.6873
1918	72.3013	78.4364
1919	77.6188	91.5005
1920	82.4172	88.4654
1921	74.9757	69.540
1922	70.8163	73.4932
1923	75.1615	76.0344
1924	75.0719	73.4140
1925	77.5274	74.9784
1926	71.9050	69.916
1927	68.7562	66.0474
1928	75.4888	67.3038
1929	77.2644	67.4192
1930	72.9818	56.9443
1931	65.8617	42.4312
1932	63.7224	45.7796
1933	67.5146	57.5322

[5] RPC=Real Per Capita.