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Gross National Product Estimates for New Zealand; 1859 - 1939

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GROSS NATIONAL PRODUCT ESTIMATES FOR NEW ZEALAND: 1859-1939*

This paper follows from that of Gary Hawke in 1975, who used Australian and New Zealand monetary data to estimate New Zealand's gross domestic product from 1870 to 1918, and whose data has been incorporated into international studies through the work of Paul Bairoch. It also provides an alternative set of national income estimates for the inter-war years to those published by BT Lineham in 1968. The important findings of the paper are: (i) that there is a significant relationship in the Australian data between the velocity of money and price level; (ii) that New Zealand's GNP was significantly higher in the 1860s, 1870s and early 1880s than Hawke's estimates indicate; (iii) that previous gross product estimates for the inter-war period have failed to reflect the fluctuations of the New Zealand economy in the 1920s, and the extent to which it was operating below its production possibilities frontier during the Great Depression of the 1930s.

INTRODUCTION

In 1962, Noel Butlin published an extensive set of estimates of Australia's gross domestic product (GDP), gross national product (GNP), and gross fixed capital investment (GFCF).[1] His estimates covered the period from 1861 to the first official estimates of GNP in the year to June 1939. He also published price deflators for GDP/GNP and GFCF. Unfortunately Butlin's work did not extend to New Zealand, despite the fact that until 1900 New Zealand was an Australasian colony. The only published time series of New Zealand's gross product before 1918 is the GDP series Gary Hawke published in 1975.[2] Hawke used an indirect method, constructing estimates from monetary data and by assuming comparability between New Zealand and Australian financial data. For the inter-war years, the only complete time-series of GDP or national income are the 1968 estimates of BT Lineham.[3]

In this paper I have utilised Hawke's monetary technique, but essentially as a means of interpolating between (and extrapolating from) independently derived national income estimates which are available from contemporary sources for a few specific years, the earliest of which is 1865. The estimates presented here cover the 80 years of New Zealand's history prior to the first official GNP estimate which was published for the year to March 1939.[4]

Hawke based his estimates on the Quantity of Money Identity:

$MV \equiv PQ \equiv Y$ where M = Quantity of Money
V = Velocity of Circulation of Money
P = the Price Level
Q = Real Gross Domestic Product
Y = Gross Domestic Product

Thus, once an estimate for velocity can be found, a country's income can be computed from the size of its money stock, however money is defined. With velocity data for Australia from 1861 being available,[5] Hawke assumed that

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Australian velocity trends would be about the same as New Zealand's, given the closeness of the two economies and the shared banking system. As a check he derived independent velocity estimates for New Zealand for the years 1918-1933, based on the GDP estimates of Lineham and regressed them against Australian velocity estimates for the same years.

He came up with the formula:

$$\text{LOG } V_{NZ} = 0.43 + 0.19\ V_A \qquad R = 0.52$$

His New Zealand velocity estimates were multiplied by the quantity of money to give GDP estimates. Hawke's data were broadly in line with national income estimates produced by contemporaries between 1886 and 1903, but incompatible with the 1865 Knight estimate to which Hawke himself gives a considerable degree of prominence.[6] Comparisons with Australian real incomes suggest that Hawke's data understates New Zealand's GDP before the 1880s and after the mid-1900s. Hawke's series is also suspect because New Zealand's business cycles were not fully synchronised with Australia's,[7] especially in the 1880s and 1890s. An equation derived from the velocity comparisons taken in the 1920s cannot be expected to hold for the years before 1900 without making allowances for the different pattern of fluctuations.

While Hawke was careful to state that his 1975 estimates of New Zealand's GDP were no better than "plausible" or a "stop-gap"[8] they have nevertheless found their way into the international literature. Estimates for New Zealand's per capita income in 1860 and 1870 have been published by Paul Bairoch and Bradford de Long.[9] Both are sourced from Hawke's 1975 paper, and are serious underestimates of New Zealand's GDP. De Long's 1870 New Zealand estimate, taken from Bairoch, is only half of the value given for Australia. New Zealand is in fact an excellent supporting example for WJ Baumol's "convergence" hypothesis which de Long's study refutes.[10]

METHOD

In trying to discover why Hawke had underestimated New Zealand's GDP for the 1870s, it became apparent that the Australian velocity estimates were correlated to the general price level. With New Zealand prices falling more rapidly from the 1860s to the 1880s than Australian prices, it seemed likely that Hawke's velocity estimates for New Zealand in the 1870s were too low.[11] An estimation function for velocity could be improved, evidently, by including a price variable. Further examination of the Australian velocity data showed that velocity was not particularly high in the late 1880s, the period of "Marvellous Melbourne"[12] in which Victoria's economy was characterised by a speculative investment boom. A reason for the low velocity statistic during the boom becomes apparent from a consideration of the quantity identity.

Strictly speaking, $MV \equiv PT$, where "T" is the volume of transactions rather than

Fig.1

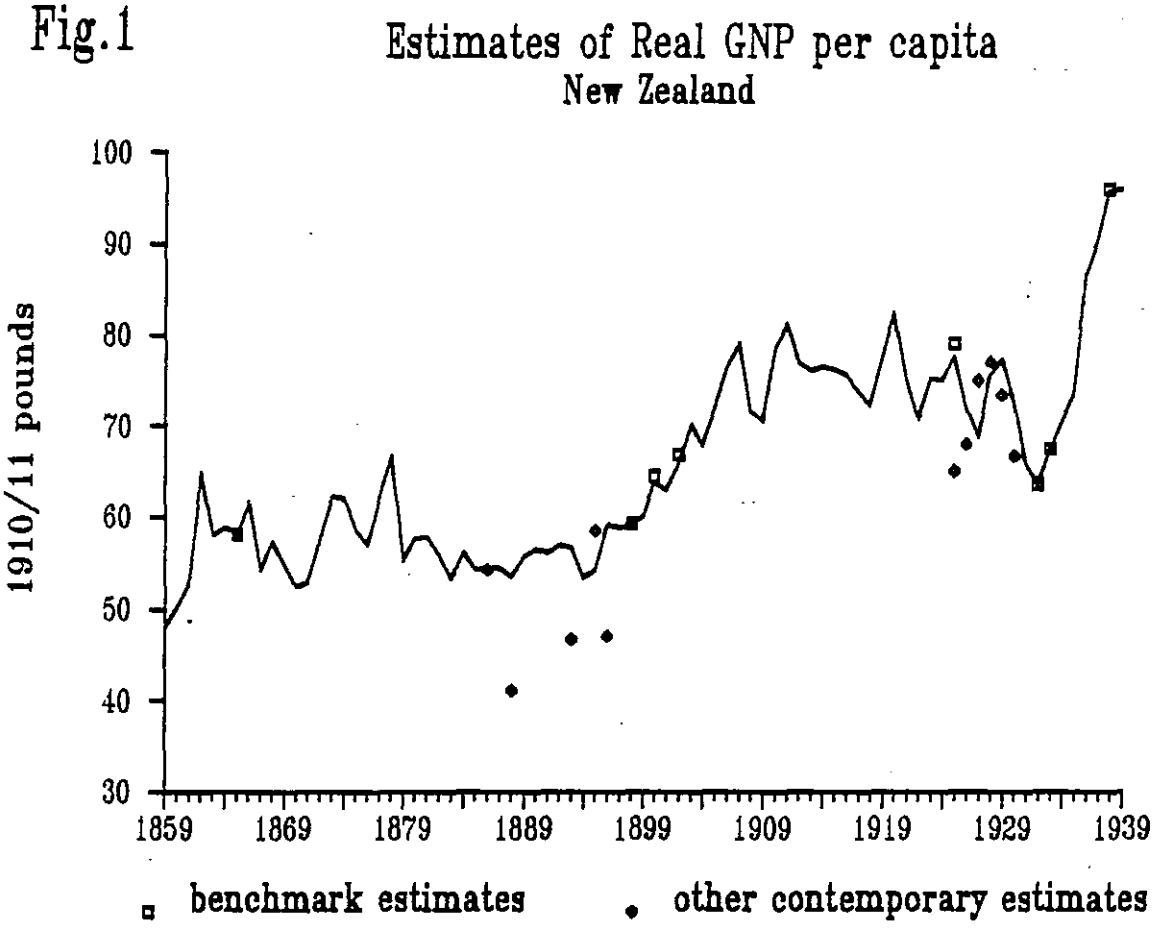
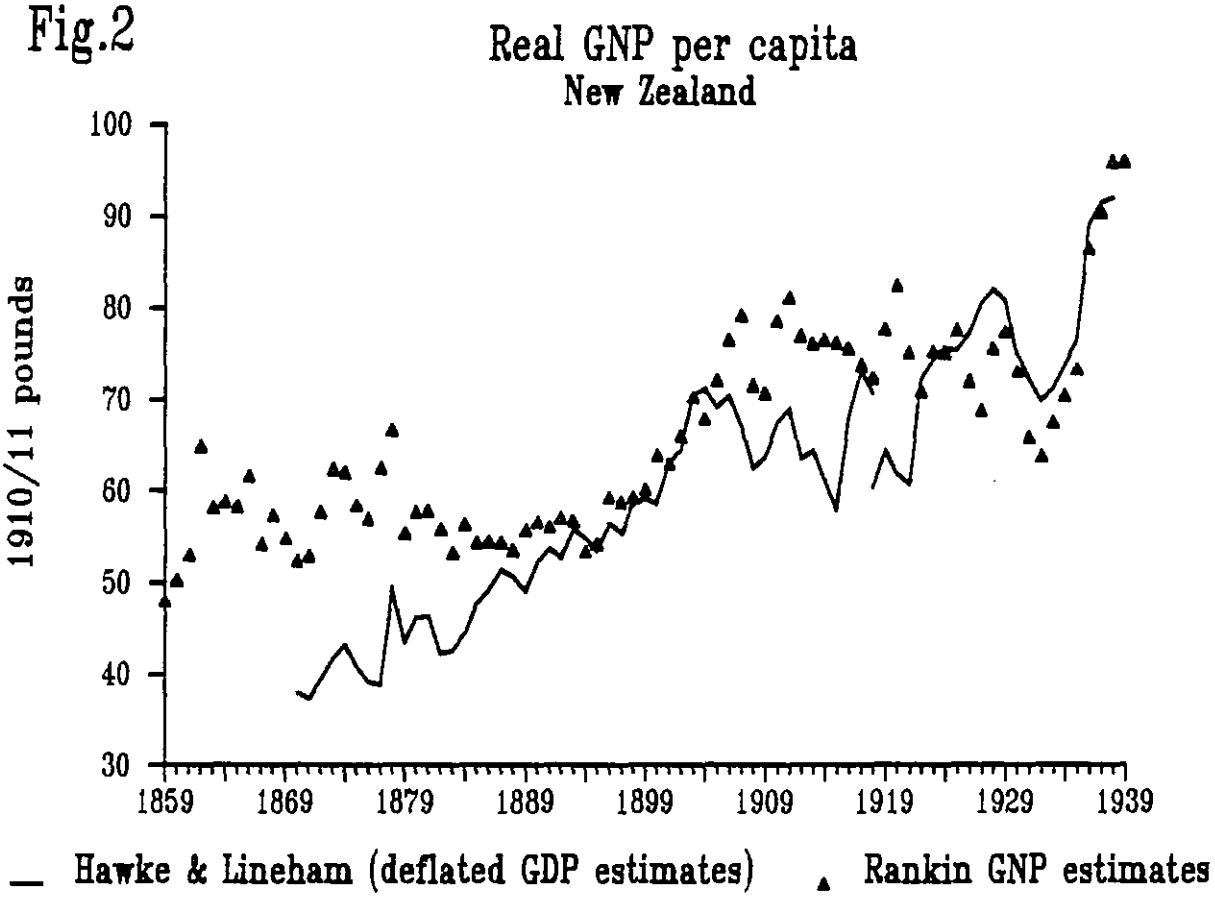

Estimates of Real GNP per capita
New Zealand
1910/11 pounds
100
90
80
70
60
50
40
30
1859
1869
1879
1889
1899
1909
1919
1929
1939
benchmark estimates
other contemporary estimates

Fig.2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1909
1919
1929
1939
Hawke & Lineham (deflated GDP estimates)
Rankin GNP estimates

output. Thus:

$$
\begin{aligned}
& MV \equiv PT \\
\Leftrightarrow\ & MV \equiv PQ.(T/Q) \\
\Leftrightarrow\ & V' \equiv PQ/M \qquad \text{where} \quad V' = V.(Q/T) \\
& \equiv Y/M
\end{aligned}
$$

for this exercise:

$$
VEL \equiv Y/M \qquad \text{where} \quad VEL = \text{"velocity"}, \; Y = \text{gross national product}, \; M = \text{trading bank deposits}
$$

The velocity required to estimate GDP is thus defined as gross national product divided by an appropriate monetary aggregate. (I have chosen to estimate gross national product at market prices, rather than gross domestic product, in order to link up with the official GNP estimates for 1938/39.) Velocity can be expected to be comparatively low at times in which there is much trade in existing assets; that is, when the volume of transactions is high relative to the level of production. The quantity of money tends to be high during such periods because of a high speculative demand for money. Prices also tend to rise ahead of production costs during periods of high speculative demand for assets.

It is therefore proposed that, *ceteris paribus*, the quantity of money is negatively related to its velocity. This should not be a surprise. The essence of Hawke's technique is that the monetary data is scaled up by a velocity parameter to produce GDP estimates. With velocity inversely related to money, the derived GDP series fluctuates less than the quantity of money series. My GNP estimates - pictured in Figure 1 and tabulated in Table 4 - are based on estimating velocity (VEL) from the two regressors, *trading bank deposits per capita* (MPC) and the *price level* (PRI). Hawke's and Lineham's GDP series, deflated by the price series given in Table 3, are compared in Figure 2. And Butlin's Australian GNP series - adjusted to calendar years and linked to official estimates[13] - is compared with my New Zealand series in Figure 3.

The regression equations are derived from the Australian data displayed in Table 1. All time series relating to financial years have been converted to calendar years. The adjusted Australian GNP series used here is, for most years, close to Butlin's published series for GDP at market prices. I have used Butlin's price series[14] and monetary data from SJ Butlin, Hall and White.[15] The Australian population data - averages of the December 31 official estimates - is taken from R Maddock & IW McLean[16] and the 1910 Commonwealth Yearbook.[17]

TABLE 1; AUSTRALIA -- Regression Data

	population (000)	prices (1910/11) "PRI"	current GNP £m	trading bank deposits £m	£ p.c. "MPC"	Velocity "VEL"	Dummy "IW"
1861	1,157	1208	70.22	14.16	12.24	4.96	0
1862	1,188	1218	69.48	14.83	12.48	4.69	0
1863	1,233	1160	68.42	15.05	12.20	4.55	0
1864	1,292	1076	70.01	15.72	12.16	4.45	0
1865	1,358	1088	70.86	17.01	12.53	4.17	0
1866	1,417	1111	77.01	17.78	12.55	4.33	0
1867	1,464	1003	77.54	17.96	12.27	4.32	0
1868	1,512	1017	82.64	20.09	13.29	4.11	0
1869	1,566	1005	82.42	20.14	12.86	4.09	0
1870	1,620	1002	87.83	20.24	12.49	4.34	0
1871	1,674	999	84.55	21.02	12.55	4.02	0
1872	1,722	1077	100.67	24.48	14.21	4.11	0
1873	1,769	1133	116.79	27.46	15.52	4.25	0
1874	1,822	1107	117.85	29.16	16.01	4.04	0
1875	1,874	1081	127.40	33.02	17.62	3.86	0
1876	1,928	1075	126.23	36.78	19.08	3.43	0
1877	1,995	1056	129.20	41.57	20.84	3.11	0
1878	2,062	1010	134.62	42.16	20.44	3.19	0
1879	2,127	1013	136.52	42.79	20.12	3.19	0
1880	2,197	1002	142.15	44.58	20.29	3.19	0
1881	2,269	994	151.59	51.77	22.82	2.93	0
1882	2,347	1095	157.63	57.90	24.67	2.72	0
1883	2,447	1064	175.24	61.65	25.19	2.84	0
1884	2,556	1038	171.42	67.85	26.55	2.53	0
1885	2,650	1042	183.09	74.17	27.99	2.47	0
1886	2,741	1012	179.59	76.90	27.69	2.37	0
1887	2,835	978	197.84	80.99	28.57	2.44	0
1888	2,932	1031	202.82	89.03	30.37	2.28	0
1889	3,022	1045	223.09	93.24	30.85	2.39	0
1890	3,107	1050	215.55	97.89	31.51	2.20	0
1891	3,196	958	211.84	97.89	30.63	2.16	0
1892	3,273	922	178.53	98.87	30.21	1.81	0
1893	3,334	873	159.54	91.42	27.42	1.75	0
1894	3,394	818	154.88	84.28	24.83	1.84	0
1895	3,459	822	146.50	83.76	24.22	1.75	0
1896	3,522	867	167.18	85.87	24.38	1.95	0
1897	3,585	883	160.39	83.62	23.33	1.92	0
1898	3,641	887	186.70	80.50	22.11	2.32	0
1899	3,690	903	190.73	82.64	22.40	2.31	0
1900	3,741	888	199.11	87.43	23.37	2.28	0
1901	3,796	941	204.42	88.34	23.27	2.31	0
1902	3,855	947	208.02	89.59	23.24	2.32	0
1903	3,905	948	220.49	88.36	22.63	2.50	0
1904	3,956	948	233.91	88.67	22.42	2.64	0
1905	4,018	956	242.50	95.85	23.85	2.53	0
1906	4,086	979	267.53	103.59	25.35	2.58	0
1907	4,158	998	281.80	109.47	26.33	2.57	0
1908	4,236	988	288.27	110.49	26.08	2.61	0
1909	4,300	983	313.20	115.30	26.81	2.72	0
1910	4,404	999	341.63	127.21	28.88	2.69	0
1911	4,526	1045	363.85	140.49	31.04	2.59	0
1912	4,651	1086	390.00	145.14	31.21	2.69	0
1913	4,803	1121	425.86	144.48	30.08	2.95	0
1914	4,907	1217	422.62	154.18	31.42	2.74	
1915	4,937	1299	422.67	164.09	33.24	2.58	
1916	4,904	1384	475.93	178.89	36.48	2.66	
1917	4,905	1485	512.36	189.22	38.58	2.71	
1918	4,983	1566	540.48	210.47	42.24	2.57	
1919	5,167	1733	590.60	225.36	43.62	2.62	1
1920	5,358	1832	681.30	240.24	44.84	2.84	1
1921	5,462	1759	727.55	239.97	43.94	3.03	1
1922	5,572	1763	735.77	244.90	43.95	3.00	1
1923	5,692	1814	775.28	263.33	46.26	2.94	1
1924	5,812	1841	841.95	262.79	45.22	3.20	1
1925	5,933	1860	872.98	275.74	46.48	3.17	1
1926	6,052	1855	861.84	283.93	46.92	3.04	1
1927	6,173	1871	871.18	289.12	46.84	3.01	1
1928	6,296	1885	868.21	299.60	47.59	2.90	1
1929	6,396	1796	824.56	309.65	48.41	2.66	1
1930	6,468	1626	709.04	290.96	44.99	2.44	1
1931	6,527	1488	618.71	288.43	44.19	2.15	1
1932	6,579	1418	618.55	314.27	47.77	1.97	1
1933	6,630	1432	657.85	315.81	47.63	2.08	1
1934	6,681	1480	700.97	336.10	50.31	2.09	1
1935	6,730	1536	755.76	334.31	49.67	2.26	1
1936	6,780	1616	828.69	339.35	50.05	2.44	1
1937	6,837	1675	901.68	368.64	53.92	2.45	1
1938	6,899	1709	933.39	382.87	55.50	2.44	1
1939	6,964	1757	975.00	384.21	55.17	2.54	1

The regression equations for the whole period exclude the years 1914-1918, and includes a dummy variable (IW) for the inter-war years 1919-1939. There were 74 observations. I have compiled three equations, using respectively the current year's (MPC), the previous year's (MPC_{-1}), and both years' *per capita* monetary aggregates. The equations found are, with t-statistics in brackets:

a): $LN(VEL) = \underset{[12.1]}{-7.94} + \underset{[17.5]}{1.57} * LN(PRI) - \underset{[20.8]}{.602} * LN(MPC) - \underset{[6.97]}{.429} * IW$

$R^2 = 0.944$
$DW = 0.99$
$F = 394$

b): $LN(VEL) = \underset{[11.0]}{-7.27} + \underset{[16.3]}{1.47} * LN(PRI) - \underset{[21.0]}{.608} * LN(MPC_{-1}) - \underset{[5.93]}{.371} * IW$

$R^2 = 0.945$
$DW = 1.46$
$F = 402$

c): $LN(VEL) =$

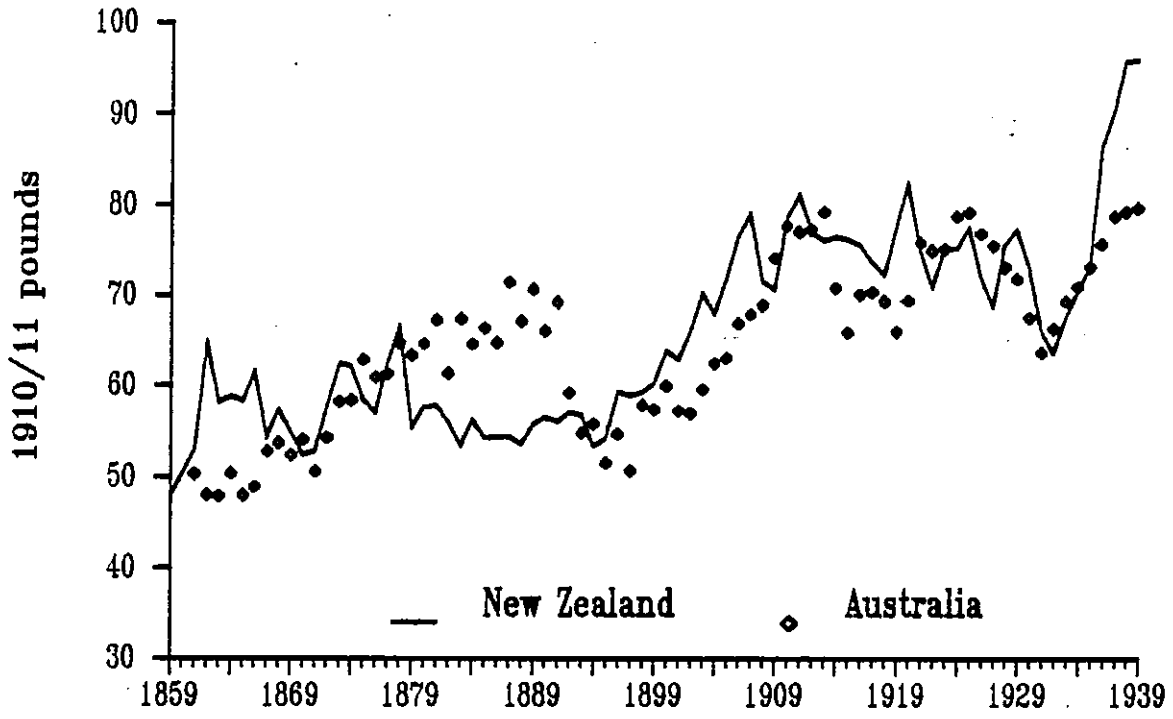
$\underset{[11.2]}{-7.52} + \underset{[16.4]}{1.51} * LN(PRI) - \underset{[1.64]}{.27} * LN(MPC) - \underset{[2.01]}{.34} * LN(MPC_{-1}) - \underset{[6.20]}{.39} * IW$

$R^2 = 0.947$
$DW = 1.23$
$F = 309$

The statistical relationship between the price level and velocity is very strong, and the postulated inverse relationship between money supply and velocity is equally strong. Lagged money supply is a slightly better regressor than current-year money supply. Thus a more robust function for New Zealand's velocity can be constructed by giving both monetary aggregates equal weight. It is also clear from the dummy variable that structural changes in the relationships between the regression variables occured during the war. These differences between the inter-war years and the pre- World War I years raise further doubts about Hawke's technique of adopting a function to estimate velocity which was based on inter-war monetary data.

Regression equations based on Australian data should not be directly applied to New Zealand data because of local differences in the demand for banking services, based on factors such as differences in income distribution and economic geography. That is, New Zealand velocities are likely to reflect some factors that do not apply to Australia; factors which can be grouped together as "institutional". Institutional differences are not likely to be the same in 1939 as they were in 1860. Thus, more accurate New Zealand velocity estimates can be found by using separate regression equations for separate periods. The 80 year time-frame was divided into three sub-periods, and separate regressions on the Australian data were taken for each.

Fig.3


Real GNP per capita
1910/11 pounds
100
90
80
70
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50
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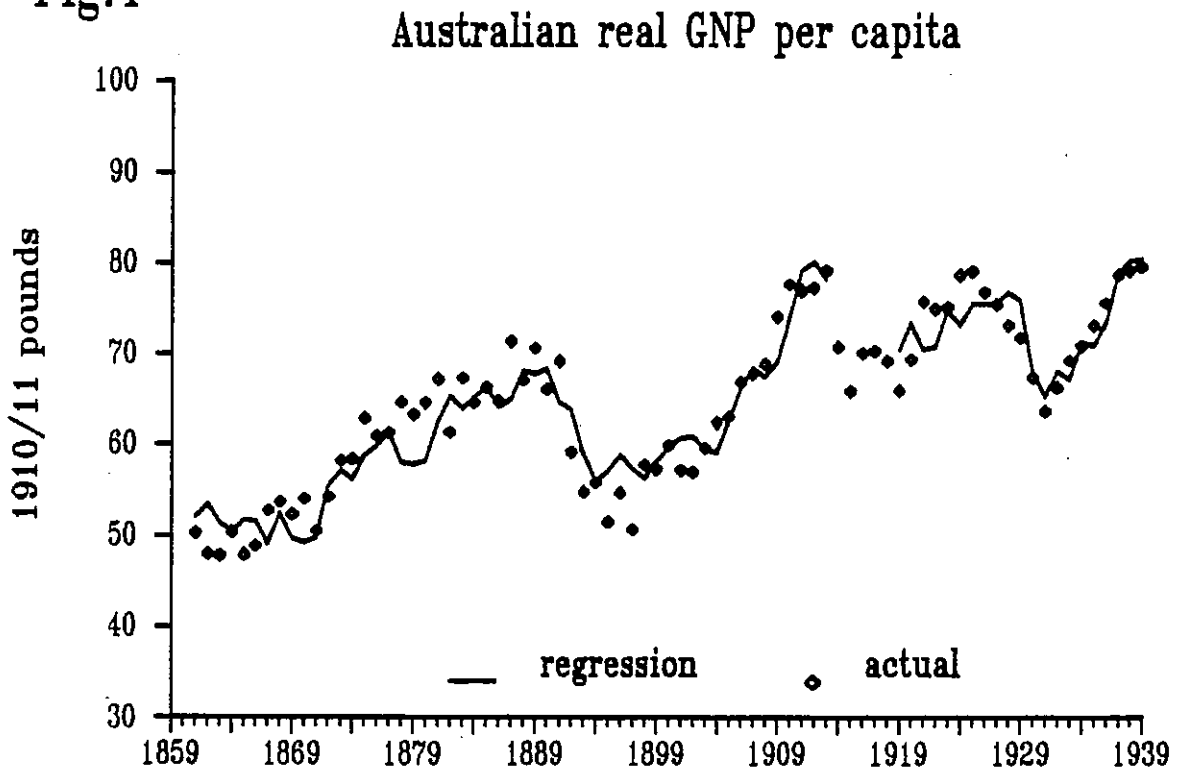
30
1859
1869
1879
1889
1899
1909
1919
1929
1939
New Zealand
Australia

Fig.4


Australian real GNP per capita
1910/11 pounds
100
90
80
70
60
50
40
30
1859
1869
1879
1889
1899
1909
1919
1929
1939
regression
actual

The periods chosen for the three regressions were 1861-1900, 1900-1913, and 1919-1939. The fitted equations are as follows:

d): <u>1861-1900</u>

$$LN(VEL) = \underset{[5.75]}{-6.10} + \underset{[9.23]}{1.33} * LN(PRI) - \underset{[.858]}{.190} * LN(MPC) - \underset{[2.15]}{.491} * LN(MPC_{-1})$$

$R^2 = .964$
DW = 1.48
F = 320

e): <u>1900-1913</u>

$$LN(VEL) = \underset{[2.21]}{-7.46} + \underset{[2.08]}{1.32} * LN(PRI) + \underset{[.058]}{.097} * LN(MPC) - \underset{[.478]}{.238} * LN(MPC_{-1})$$

$R^2 = .670$
DW = 1.28
F = 6.76

f): <u>1919-1939</u>

$$LN(VEL) = \underset{[8.52]}{-8.35} + \underset{[14.5]}{1.47} * LN(PRI) - \underset{[2.20]}{.594} * LN(MPC) + \underset{[.592]}{.167} * LN(MPC_{-1})$$

$R^2 = .935$
DW = 0.74
F = 81.5

The relative importance of the current and lagged monetary aggregates varies for each function. But when they were used as substitute rather than complementing regressors - as in equations (a) and (b) - the coefficients were similar whichever monetary series was used.

Serial correlation is present. The effects are shown in Figure 4. In the 1920s the serial correlation is marked, but the size of the deviations are small. There are a few short periods where the predicted Australian GNP deviates by about 10% from the Butlin estimates. This suggests that Australia experienced some events for which dummy variables would enhance the regression R^2; periods such as the early 1860s, 1879-81, mid-1890s, early 1920s. Similar periods for New Zealand must also have occured. A likely candidate would be 1887-1888, when GNP may have been significantly lower than has been shown in Figure 1.

BENCHMARK ESTIMATES

Independent benchmark estimates for New Zealand's gross national product have been derived for the years 1865, 1898/99-1902/03, 1925/26, 1932-33, and 1938/39. The benchmark estimates used in this paper are shown below:

TABLE 2: Estimates of New Zealand's GNP.

year	GNP (£m)
1865	15.8
1898/99	36.8
1900/01	43.3
1902/03	46.2
1925/26	175.7
1932	117.0
(1932/33	113.7)
1933	123.7
1938/39	231.1

The first benchmark is a contemporary estimate of national income by Charles Knight, a senior public servant.[18] JA Dowie, in assessing Knight's estimate of £15.8 million, has found that any errors which may have lead to understatement appear to be balanced by factors which would lead to overstatement. Dowie concluded that Knight's effort was one of great intellectual merit, overcoming a lack of data and an absense of methodological precedent. Knight's national income total has therefore been taken as a valid estimate of New Zealand's GNP for 1865. Dowie noted from Knight's work that New Zealanders' incomes were well above Australians' which in turn were markedly higher than prevailing incomes in any other country. This conclusion has to be tempered, however, by the higher prices in New Zealand and by the fact that average incomes had been boosted by the gold rushes of the early 1860s.

Dowie gives four estimates of New Zealand's turn of the century GNP by the Australian economist and statistician, TA Coghlan: 1898/99, 1900/01, 1901/02 and 1902/03. He suggests that Coghlan's estimates should be raised by 12½% to match Butlin's.[19] The Coghlan estimates, raised accordingly, are taken as a set of benchmarks for the year to March 1899 to the year to March 1903.[20]

Because the introduction of the Reserve Bank in 1934 created a discontinuity in New Zealand's monetary data, it is inappropriate to apply the monetary technique beyond 1933. Estimates of GNP from 1932 are taken from the New Zealand Official Year Book for 1957. This series was scaled up from the aggregate private income data published in the 1940s.[21] They were then adjusted from March years to calendar years so as to make them compatible with the regression estimates. The

first two statistics in this series are taken as benchmarks. Note that the trough of depression was the year to March 1933, with a GNP of only £113.7 million.

AGB Fisher[22] estimated aggregate private income for 1925-26 from census and tax data. His estimate was £137.1 million. Assuming that the Fisher estimate of aggregate private income is comparable with the earliest official estimates for the years 1931/32 to 1935/36, I have scaled his estimate up by the same amount that the first official estimates have been scaled. Because this paper is producing estimates of GNP, and because the 1932 benchmark coincides with the peak of the Great Depression, I have further adjusted Fisher's estimate, in line with the ratio of GNP:GDP in Butlin's Australian data. In the middle of the depression in Australia, GNP was unusually low compared to GDP.

The adjusted Fisher estimate serves as a useful benchmark, which can be checked against Lineham's GDP estimate of £168.8m for 1925/26. Lineham's series is likely to be comparatively accurate for that year because it was a census year, and because it was a year of low unemployment.[23] Lineham's 1938-39 GDP estimate is 95% of the official GNP statistic. Similarly, his 1925-26 estimate is 96% of the 1925 benchmark.

THE NEW ZEALAND DATABASE

Because prices constitute a key regressor used to determine "velocity", it is necessary to have a series of prices which can be used with some confidence as a GNP deflator. A price deflator is also necessary for converting nominal GNP estimates into real GNP and real GNP per capita; series necessary for evaluating economic growth and for comparing New Zealand and Australian income levels.

The deflator used, presented in Table 3 along with money supply and population, is a linked series of four segments. The principal segments are the wholesale price index for locally produced products (1913-1940),[24] and a conflation of four indexes (provided by JW McIlraith and by Brian Easton) for 1861-1910: imports, exports, farm, non-farm.[25]

The link from 1910-1913 is made up by conflating retail and wholesale prices. The 1859-1860 price estimates are derived from the series provided by Easton: imports, all exports, and farm exports. The deflator has been based on 1910/11, to conform with the Australian deflator series given in Table 1.[26] The New Zealand monetary data is the series of trading bank deposits given by Bloomfield.[27] The population data is exclusive of indigenous Maoris.[28]

TABLE 3: NEW ZEALAND Data Series used to Estimate GNP

	population; ex. Maoris	trading bank deposits £m	£ p.c.	prices base; 1910/11
1859	65,503	.541	8.26	1411
1860	75,652	.645	8.53	1533
1861	89,366	.883	9.88	1387
1862	112,417	1.596	14.20	1447
1863	144,930	2.092	14.43	1453
1864	168,103	2.480	14.75	1472
1865	181,383	2.638	14.54	1498
1866	197,361	3.097	15.69	1513
1867	211,391	2.905	13.74	1443
1868	222,643	3.103	13.94	1449
1869	231,934	3.175	13.69	1332
1870	242,825	3.128	12.88	1282
1871	257,693	3.335	12.94	1231
1872	273,273	3.920	14.34	1309
1873	287,753	4.714	16.38	1417
1874	318,903	5.564	17.45	1407
1875	358,858	5.967	16.63	1382
1876	387,466	6.238	16.10	1298
1877	403,847	7.185	17.79	1356
1878	420,569	8.960	21.30	1278
1879	448,124	8.021	17.90	1241
1880	474,297	8.538	18.00	1163
1881	492,887	9.069	18.40	1126
1882	509,309	8.945	17.56	1140
1883	529,292	8.659	16.36	1088
1884	552,591	9.643	17.45	1046
1885	569,765	10.083	17.70	977
1886	582,306	10.579	18.17	950
1887	596,374	11.031	18.50	937
1888	605,371	11.155	18.43	917
1889	611,716	11.528	18.85	987
1890	620,780	12.368	19.92	945
1891	629,783	12.796	20.32	935
1892	642,246	13.587	21.16	929
1893	661,349	14.433	21.82	892
1894	679,197	13.927	20.51	871
1895	692,417	13.544	19.56	843
1896	706,434	14.490	20.51	859
1897	721,609	14.290	19.80	846
1898	736,260	14.143	19.21	839
1899	749,984	14.591	19.46	840
1900	762,392	15.570	20.42	889
1901	777,968	16.034	20.61	838
1902	797,793	17.231	21.60	858
1903	820,217	19.011	23.18	869
1904	845,022	19.074	22.57	862
1905	870,001	20.545	23.61	904
1906	895,594	22.422	25.04	945
1907	919,105	23.517	25.59	1006
1908	945,063	21.821	23.09	987
1909	971,784	21.996	22.63	964
1910	992,803	24.968	25.15	999
1911	1,014,043	26.765	26.39	1001
1912	1,039,017	25.622	24.66	1040
1913	1,068,645	25.733	24.08	1046
1914	1,090,328	27.640	25.35	1128
1915	1,099,394	31.433	28.59	1315
1916	1,101,679	37.757	34.27	1362
1917	1,099,118	42.930	39.06	1484
1918	1,103,023	45.562	41.31	1600
1919	1,142,889	49.489	43.30	1674
1920	1,192,620	59.405	49.81	1874
1921	1,223,901	49.397	40.36	1906
1922	1,251,895	45.913	36.67	1613
1923	1,274,551	49.039	38.48	1618
1924	1,298,635	49.502	38.12	1674
1925	1,325,781	52.207	39.38	1688
1926	1,352,927	50.135	37.06	1619
1927	1,374,439	48.294	35.14	1564
1928	1,390,684	53.799	38.69	1586
1929	1,406,942	57.609	40.95	1585
1930	1,425,084	56.425	39.59	1523
1931	1,444,901	53.645	37.13	1344
1932	1,456,237	52.851	36.29	1263
1933	1,466,930	57.620	39.28	1249
1934	1,476,988			1284
1935	1,484,666			1383
1936	1,492,344			1419
1937	1,504,826			1522
1938	1,519,606			1555
1939	1,539,420			1657

REGRESSION ESTIMATES

The Australian regression equations form the essence of The functions used to estimate New Zealand velocities are constructed from the Australian regressions (equations d to f). Equal weighting is given to the current and lagged monetary aggregates. The New Zealand equations are, with variable names and scale factors highlighted:[29]

1: 1859-1897: $VEL = 0.98 * EXP(-6.10 + 1.33 * LN(PRI) + (-.190 + -.491) * AVG(LN(MPC), LN(MPC_{-1}))$

2: 1895-1913: $VEL = 1.18 * EXP(-7.46 + 1.32 * LN(PRI) + (0.097 + -.238) * AVG(LN(MPC), LN(MPC_{-1}))$

3: 1922-1933: $VEL = 1.18 * EXP(-8.35 + 1.47 * LN(PRI) + (-.594 + 0.167) * AVG(LN(MPC), LN(MPC_{-1}))$

The scale factors (eg 1.18 for equation 3) are used to scale the function values to the independent benchmarks. The estimates for 1895 to 1897 are made up of weighted averages of functions 1 and 2. This pattern of linking the two equations was chosen so as to make the estimates fit the Coghlan benchmarks. These years constituted a key turning point in the political economy of New Zealand. The "Long Depression" (which began in either 1867, 1875 or 1879) had just come to an end. Coinciding with the Liberal Government's land and labour reform legislation in the last years of the depression, the opening up of the North Island dairy lands gave people with access to capital the confidence to raise investment spending. The result was to raise the velocity of money without compromising price stability. It is therefore appropriate that velocity estimates from 1895 should be higher than they would have been under equation 1.

The regressions showed that there was a significant change in the relationship between GNP and the monetary data as a result of World War I. Velocity for the war years has been estimated 1914-1918 arbitrarily, with the aim of producing GNP estimates which are consistent with other information about economic activity. The war period is something of an enigma in New Zealand's economic history. New Zealand and Australia both seem to have had a depression that was disguised by inflation and the fact that both countries' labour surpluses were in Europe. The number of factories and factory workers in New Zealand fell[30] (unlike World War II) and the volume of farm production was static. JB Condliffe claimed that "during the war and the years immediately following, production fell off considerably in New Zealand".[31] He describes the period around 1920 as a "post-war boom", and it is clear that a strong multiplier effect, which was not in operation in 1918, was boosting New Zealand's GNP in 1919 and 1920.

There was no war-time labour shortage despite the big fall in labour supply. The Labour Department Report[32] for 1917-18 states that "despite anticipations to the contrary, there were more men available during harvest time than were required". An increase in female employment from 1917 appears to be related to falling real disposable household incomes in the face of inflation; that is, an

increase in female labour supply rather than in any specific demand for females to replace males in factories. Labour Department Reports for 1917/18 and 1918/19 indicate that the increase in female and teenage employment at the end of the war coincided with falls in factory overtime.

Equation 3, when applied to 1919-1921, gives an unrealistically high GNP, especially for 1920. I have taken it that the New Zealand economy did not fully settle into its new pattern until 1922. The post-war increase in money supply was much sharper in New Zealand than Australia. It was linked to land speculation as well as restocking and fixed capital investment. For those years, I have scaled down the predicted velocity values to give more plausible estimates. That is somewhat arbitrary, but gives a boom/bust phase for 1918-1922 that is sharper than 1905-1909 and less pronounced than 1876-1879. This conforms with the general impressions of these periods in the historical literature.

The estimates for velocity, GNP, real GNP, GNP per capita and economic growth are detailed in Table 4.

COMPARISONS WITH OTHER ESTIMATES

Figures 1 and 2 show the new estimates of real GNP per capita, compared to previously published estimates of national income or gross product. Other contemporary estimates of national income, discussed by Dowie and Lineham and displayed in Figure 1,[33] are available as additional checks. The 1886 estimate of £30 million by Otago University's Professor Mainwaring Brown fits this paper's GNP estimate almost exactly. Dowie regarded Brown's work as an important contribution, although not of the same significance as Knight's.[34]

MG Mulhall produced estimates for 1888 and 1895 for inter-country comparisons for the London *Dictionary of Statistics* (1892, 1909). He used two formulae which are of some interest,[35] but his own estimates derived from those techniques cannot be taken with any degree of precision because the data used was taken from a variety of different years. For example, for his 1895 estimate, data were taken from various years in the early 1890s.[36] Mulhall's 1895 estimate for Australia of £179 exceeds the Australian GNP (given in Table 1) for 1891-95 by 5%, while his New Zealand estimate of £34.2 for 1895 exceeds the Table 4 New Zealand average for those years by a similar 4½%. Therefore, my GNP estimates for the early 1990s are fully consistent with his 1895 estimate of Australia's gross product. Mulhall's 1888 aggregate of £22.5m appears to be well short of New Zealand's true GNP for that year, although my GNP estimate for that year is probably too high. 1888 was the year of the New Zealand "Exodus"; a period of mass emigration to Australia.

TABLE 4: NEW ZEALAND GNP ESTIMATES

calendar years	velocity of money	GNP £m	real GNP 1910/11 £m	p.c. GNP 1910/11 £	p.c. real Economic Growth
1859	8.20	4.4	3.1	48.0	
1860	9.04	5.8	3.8	50.3	4.7%
1861	7.44	6.6	4.7	53.0	5.5%
1862	6.62	10.6	7.3	64.9	22.5%
1863	5.85	12.2	8.4	58.1	-10.5%
1864	5.88	14.6	9.9	58.9	1.3%
1865	6.00	15.8	10.6	58.2	-1.1%
1866	5.95	18.4	12.2	61.7	6.0%
1867	5.69	16.5	11.5	54.2	-12.1%
1868	5.96	18.5	12.8	57.4	5.7%
1869	5.34	16.9	12.7	54.9	-4.4%
1870	5.21	16.3	12.7	52.4	-4.6%
1871	5.03	16.8	13.6	52.9	1.0%
1872	5.27	20.6	15.8	57.7	9.1%
1873	5.40	25.5	18.0	62.4	8.2%
1874	5.01	27.9	19.8	62.0	-.6%
1875	4.86	29.0	21.0	58.5	-5.8%
1876	4.59	28.7	22.1	57.0	-2.5%
1877	4.76	34.2	25.2	62.4	9.6%
1878	4.00	35.8	28.0	66.7	6.7%
1879	3.84	30.8	24.8	55.3	-17.0%
1880	3.73	31.8	27.4	57.7	4.2%
1881	3.54	32.1	28.5	57.8	.2%
1882	3.63	32.4	28.4	55.9	-3.4%
1883	3.54	30.7	28.2	53.3	-4.6%
1884	3.37	32.5	31.1	56.3	5.5%
1885	3.00	30.2	30.9	54.3	-3.5%
1886	2.85	30.1	31.7	54.5	.3%
1887	2.76	30.4	32.4	54.4	-.2%
1888	2.66	29.7	32.4	53.5	-1.6%
1889	2.92	33.7	34.1	55.7	4.1%
1890	2.68	33.2	35.1	56.6	1.5%
1891	2.58	33.0	35.3	56.0	-1.0%
1892	2.50	34.0	36.6	57.0	1.8%
1893	2.32	33.4	37.5	56.7	-.7%
1894	2.27	31.6	36.3	53.4	-5.8%
1895	2.34	31.7	37.6	54.2	1.6%
1896	2.48	36.0	41.9	59.3	9.3%
1897	2.51	35.9	42.4	58.8	-.8%
1898	2.59	36.6	43.6	59.3	.8%
1899	2.60	37.9	45.1	60.2	1.5%
1900	2.78	43.3	48.7	63.9	6.2%
1901	2.56	41.0	48.9	62.9	-1.6%
1902	2.62	45.1	52.6	66.0	4.9%
1903	2.63	50.0	57.6	70.2	6.4%
1904	2.59	49.4	57.3	67.9	-3.3%
1905	2.76	56.6	62.6	71.9	6.0%
1906	2.89	64.7	68.5	76.5	6.3%
1907	3.11	73.1	72.7	79.1	3.4%
1908	3.06	66.7	67.6	71.5	-9.5%
1909	3.01	66.1	68.6	70.5	-1.4%
1910	3.12	77.9	78.0	78.5	11.3%
1911	3.08	82.4	82.3	81.1	3.3%
1912	3.24	83.0	79.9	76.9	-5.2%
1913	3.30	84.9	81.2	76.0	-1.2%
1914	3.40	94.0	83.3	76.4	.6%
1915	3.50	110.0	83.7	76.1	-.4%
1916	3.00	113.3	83.1	75.5	-.8%
1917	2.80	120.2	81.0	73.7	-2.3%
1918	2.80	127.6	79.7	72.3	-1.9%
1919	3.00	148.5	88.7	77.6	7.4%
1920	3.10	184.2	98.3	82.4	6.2%
1921	3.54	174.9	91.8	75.0	-9.0%
1922	3.11	143.0	88.7	70.8	-5.6%
1923	3.16	155.0	95.8	75.2	6.1%
1924	3.30	163.2	97.5	75.1	-.1%
1925	3.32	173.5	102.7	77.5	3.2%
1926	3.14	157.5	97.3	71.9	-7.2%
1927	3.06	147.8	94.5	68.7	-4.4%
1928	3.09	166.5	105.0	75.5	9.8%
1929	2.99	172.3	108.7	77.3	2.4%
1930	2.81	158.4	104.0	73.0	-5.6%
1931	2.38	127.9	95.2	65.9	-9.8%
1932	2.22	117.2	92.8	63.7	-3.3%
1933	2.15	123.7	99.0	67.5	6.0%
1934	2.10	133.5	104.0	70.4	4.3%
1935	2.28	150.5	108.8	73.3	4.1%
1936	2.78	183.1	129.0	86.4	18.0%
1937	3.05	207.0	136.0	90.4	4.6%
1938	3.39	226.3	145.6	95.8	6.0%
1939	3.22	244.5	147.6	95.9	.1%

In the 1894 and 1897 Official Year Books, the New Zealand Registrar-General presented national income estimates using both the Brown and Mulhall methods.[37] Averaging his two estimates gives £27.5 million for 1893, and £28.6 million for 1896. With both numbers being about 18% short of this paper's estimates,[38] the Registrar-General's estimates *consistently* understate them.

BT Lineham presents contemporary national income estimates by FB Stephens and Colin Clark.[39] I have included Stephens' estimates in Figure 1. Clark's estimates show a very high level of correlation with Stephens',[40] which are too low for 1925 and 1926. Financial, labour market and trade data indicate that the New Zealand economy was bouyant in 1925 but in a sharp downturn in 1927. Stephens' estimates for 1928 to 1930 are close to mine, although they show a faster slide into depression in 1930. His data are for March years, so his estimate for 1930 will have been considerably affected by the much greater extent of depression in early 1931 than in early 1930. The estimates of this paper cover calendar years.

GNP ESTIMATES CONTRASTED WITH HAWKE AND LINEHAM

This paper's GNP estimates are in agreement with Gary Hawke's 1870-1918 GDP series - displayed in Figure 2 - for the years 1894 to 1905. Outside that range my estimates suggest that Hawke understates New Zealand's income. For the earlier years, this finding is particularly important, as my estimates clearly support the existence of a Long Depression in New Zealand from 1879 to 1895. However Figure 5 shows that the nineteenth century economy was not stagnant.[41] It was only *per capita* income growth that was imperceptible from the 1860s to the 1890s. The Long Depression related to per capita incomes and not the overall size of the economy, which was expanding at over 10% per annum in the 1870s, and at 2-3 percent through the 1880s and 1890s.

With Hawke's estimates, when using the GNP deflator given in Table 3, pre-war real per capita incomes peak in 1904. However my estimates suggest that, despite a slight check in 1904, income growth was rapid up to 1907. Migration data (Figure 7) suggests that New Zealand incomes remained ahead of Australia's until 1908, and were comparable with Australian incomes from 1908 to 1914. JB Condliffe believed that New Zealand incomes were higher before the war than in 1924.[42]

BT Lineham's GDP estimates (Table 5) were based on determining the value-added product for each sector, and on aggregating the sectoral estimates. He used three main methods of data collection:[43] (i) direct use of annual data on profits and wages/salaries where it was available, (ii) annual data on employment and wage rates, and (iii) interpolated census employment data. His empirical assumptions were able to provide a valid indication of the size and structure of the New Zealand economy for the period as a whole, but fell short of representing the important short-run changes in a period of macroeconomic instability.

Lineham's early estimates suggest that activity was at a low level at the end of

World War I, with significant growth not occuring until 1922. This conclusion is not consistent with the more usual view that the economy was very bouyant in 1920 and depressed in 1922. In 1919-20 New Zealand experienced a significant fall in its terms of trade from rising import prices. As export prices initially remained high, this boosted the demand for domestically produced investment goods in what was a major period of restocking. Real money balances rose, despite the import drain. The years 1919-1920 were a period in which private investment expenditure - especially but not only post-war restocking - must have raised GNP. 1921 and 1922, with big falls in export and import prices, saw and end to the boom. Lineham's interpolations between 1916 and 1921 could not give an accurate picture of GDP for 1917-1920. Any attempt to equate actual incomes with published wage rates in a census year as volatile as 1921 - with falling employment and downward wage pressure - could only yield GDP estimates with a high margin of error.

Lineham's estimates show 1925 as a year of nil growth, and the 1926-27 period as one of recovery, in contrast to the business cycle pattern suggested by other indicators. In the 1930s, however, Lineham's estimates show a broad agreement with the GNP estimates presented here, at least with respect to the direction of economic growth and in the timing of turning points. While Lineham shows the decline in GDP from the 1920s' peak to be of a similar magnitude to my data, his mid-depression low was at a level 15% higher than the 1932/33 GNP benchmark.

During the depression a greater proportion than usual of the employed workforce were women and teenagers, so average earnings were well below published male wages.[44] And there was no lack of anecdotes about awards being ignored. Compulsory arbitration had been abandoned in 1931. In some years, realised labour incomes would fall far short of those suggested by wage rates. Unemployment and underemployment during the depression were more severe than most sources indicate.[45] In the 1920s, and especially during the depression, short-time and irregular work was commonplace. The censuses were taken at peak-employment times of the year, so their employment data cannot be taken as valid across the whole year. In 1925/26 and 1935, the years for which the censuses give incomes, the annual income for most males in the 20-29 age cohort was less than the annualised minimum weekly award wage rate. The important point is that neither the number of people employed at a particular point in time nor award wage rates provide a consistent guide to actual labour incomes. And labour incomes cannot be relied on to exhibit a consistent relationship with non-labour incomes in any particular year of an unsettled period.

Published wage rates were those operative on March 31, and not annual averages. Employment numbers varied for different sectors and different years as to whether they were annual averages or March 31 data. Income estimates based on census interpolations were centred on early April. Thus, for some sectors, Lineham's estimates are for the year centred on March 31 rather than for the year ending on March 31.

Lineham's interpolations between the 1926 and 1936 censuses have assumed away much of the uncertainty of the period. Activity in the very small factories not

covered by the Factory Statistics fluctuated more than in the larger factories.[46] Employment-related earnings must have been more depressed than Lineham's estimates reflect, although earnings (in kind as well as in money) through handicrafts and the informal economy may have partly compensated for reduced earnings from mainstream jobs. Lineham's employment interpolations based on comparing different sectors with tram drivers will have been valid for much of the 1930s. But for the 1920s, tramways were a "sheltered industry" which was excempt from much of the buffeting experienced by rural based activities which depended each year on the volatile state of farmers' bank accounts.

TABLE 5: ALTERNATIVE GNP SERIES; 1918-1939

	Lineham March year	robust March year [1]	£m	Table 4 calendar year	robust calendar year [2]
1918	90.9	107.7		127.6	119.2
1919	114.5	126.1		148.5	138.2
1920	127.4	144.8		184.2	163.0
1921	143.5	165.1		174.9	160.8
1922	140.4	156.5		143.0	147.5
1923	148.2	150.7		155.0	157.6
1924	155.8	159.9		163.2	167.3
1925	168.3	170.7		173.5	174.8
1926	168.8	172.9		157.5	166.7
1927	168.8	165.4		147.8	163.5
1928	175.2	167.1		166.5	177.4
1929	183.7	179.6		172.3	180.0
1930	178.0	177.2		158.4	164.4
1931	155.7	156.7		127.9	136.9
1932	132.4	131.6		117.2	125.3
1933	126.2	125.2		123.7	129.9
1934	132.9	132.3		133.5	139.6
1935	143.2	143.5		150.5	157.1
1936	163.8	164.8		183.1	189.9
1937	200.9	199.2		207.0	212.9
1938	213.9	217.6		226.3	226.6
1939	218.9	229.8		244.5	242.5

[1] Lineham GDP estimates scaled to official GNP, averaged with Table 4 estimates adjusted to years ending March 31

[2] Lineham GDP estimates scaled to official GNP and adjusted to March years, averaged with Table 4 estimates

(Note that parts of the Lineham series average are effectively for September years, as they utilise April census data. Therefore, the raw Lineham estimates have been given one-third weight in the adjustment. The averages are geometric averages.)

Published wage rates were those operative on March 31, and not annual averages. Employment numbers varied for different sectors and different years as to whether they were annual averages or March 31 data. Income estimates based on census interpolations were centred on early April. Thus, for some sectors, Lineham's estimates are for the year centred on March 31 rather than for the year to the end of March.

Figure 5 shows that economic growth rates were very high for most of the 1930s, averaging as much as 8% from 1933 to 1938. Lineham[47] noted that "the massive public works program would probably have set the economy off on an exponential rather than a linear growth path". This exponential growth path is also the result of the increased numbers of additional workers, women and teenagers who sought work during the depression and who contributed to a rapid increase in household incomes during the recovery years. By 1936/37, the multiplier effect was reinforced by their earnings.

Lineham's estimates have serious empirical weaknesses, despite a more direct methodology. In my approach, interpolations between benchmarks were at least based on known data. Nevertheless, historians seeking a robust series of GNP for New Zealand in the interwar years may prefer an average of this paper's series and Lineham's, as is given in Table 5.

HISTORICAL OUTLINE

A plausible GNP series should be consistent with other macroeconomic data. Figure 6 shows changes in the real value of New Zealand's export receipts and import payments for the years of the estimates.[48] The import series in particular clearly indicates the pattern of fluctuations, while the export series shows why many of the fluctuations occured. The pattern is broadly consistent with the economic growth estimates shown in Figure 5.

The New Zealand GNP estimates are fully comparable with Butlin's Australian data. Figure 7 shows that New Zealand experienced an inflow of trans-Tasman migrants in years in which New Zealand incomes were higher (1893, 1900s, 1929-30, 1938), and an outflow in years of comparatively low GNP (1880s, 1926-28, 1933-35).[49] For most other years, per capita incomes in the two countries were similar. Hence the reduced level of contact between Australia and New Zealand after about 1910 can be explained by the general similarity of living standards and comparative advantage.

The peaks of per capita income in the 1860s coincide with the gold discoveries in Otago (1861), Westland (1865) and Coromandel (1868). The New Zealand economy was also growing strongly because of the high demand in Britain for wool. Expansion in the 1870s was boosted by a programme of Government sponsored public works and immigration (the "Vogel boom") financed by borrowing in London.

In the 1880s, in the absence of an export staple with powerful linkages into the domestic economy, and with many producers burdened by indebtedness in the face

Fig.5

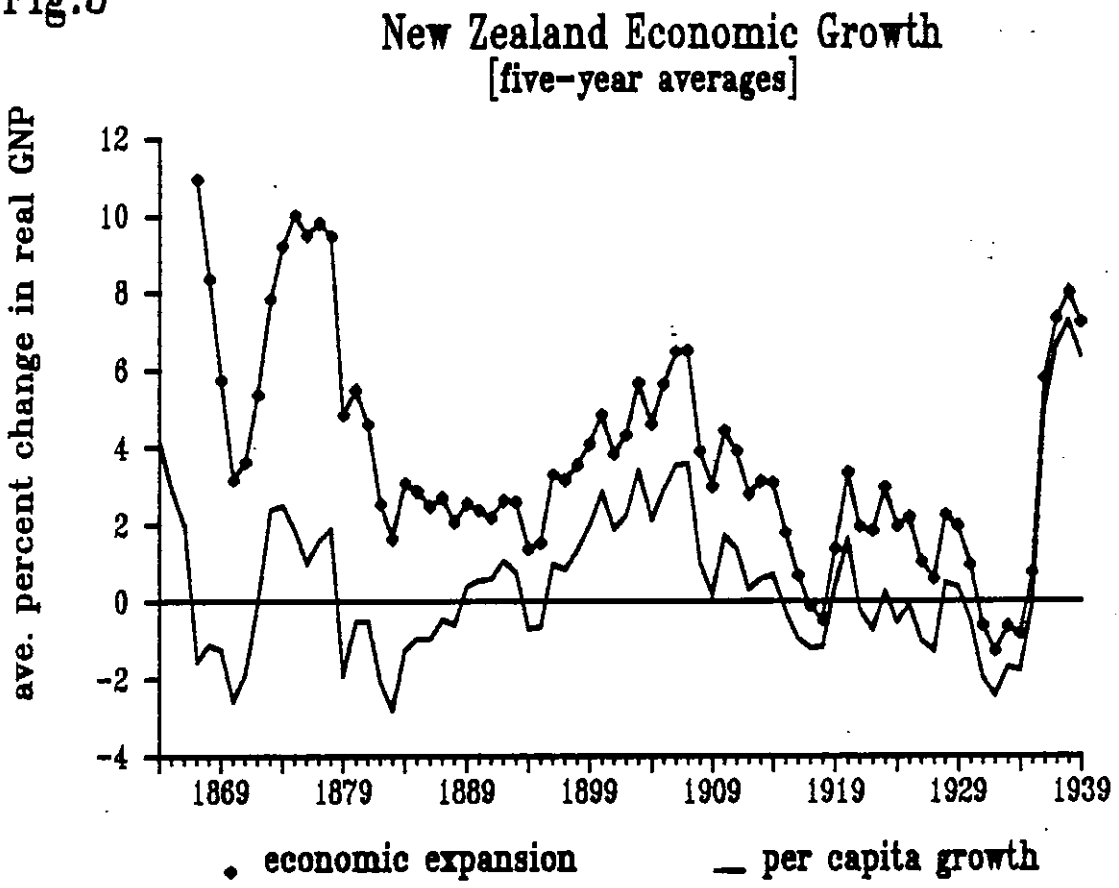
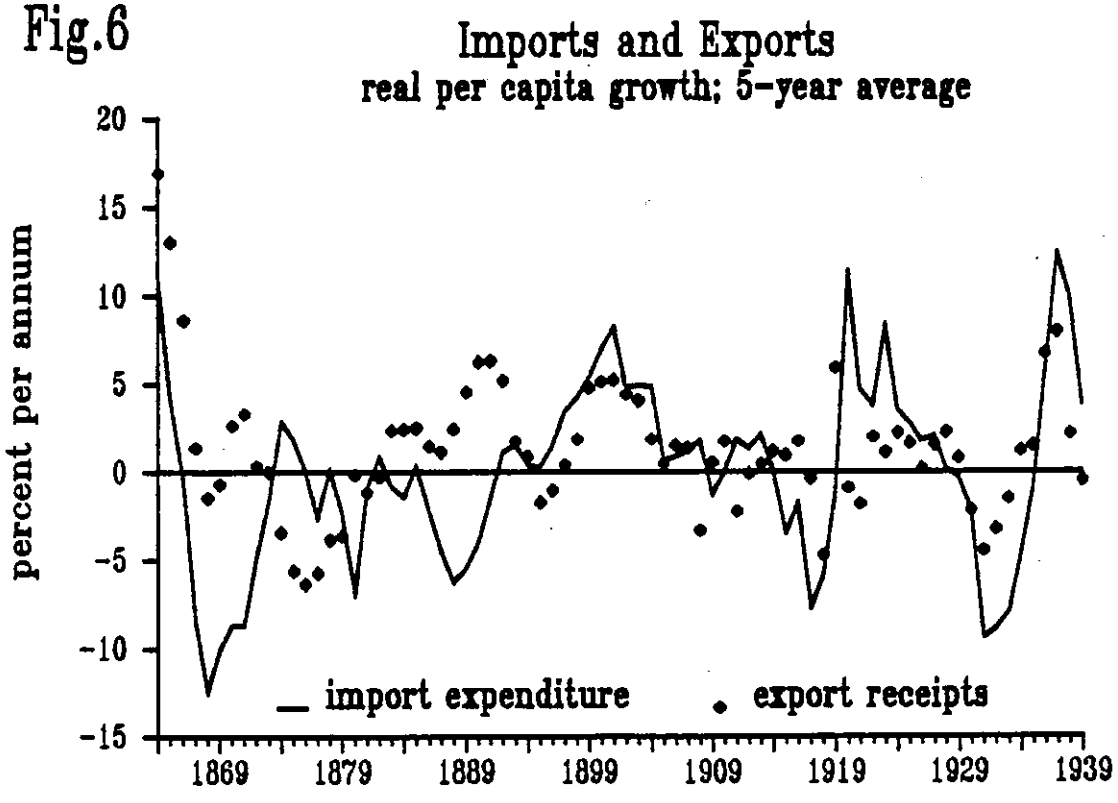


Fig.6



additional source: GT Bloomfield 1984, pp.267-269

of falling product and land prices, New Zealand tentatively moved towards a manufacturing-based economy[50] based in part on the availability of cheap female and teenage labour.[51] Australia was also industrialising in the 1880s, but there investment confidence had not been sapped by falling prices and there was sufficient land for an expansion of wool-growing to be able to support Australians' demand for imports. Wages were high in Australia, and many New Zealanders migrated there.

The Australian depression of the 1890s was a shorter but deeper equivalent of New Zealand's Long Depression, bringing average Australian incomes down to prevailing New Zealand levels. The slump in Australian demand for New Zealand manufactures caused the New Zealand economy to turn down once again in 1894. From the mid-1890s the New Zealand economy expanded at a greater rate than Australia's because the new export staple - frozen meat and dairy produce - facilitated the opening of a new geographical frontier. The North Island was deforested to make way for dairy farms. The growth of refrigerated shipping also boosted the Australian economy, but did not have the same proportionate impact there as in New Zealand.

Australia's growth in the twentieth century was predicated on manufacturing, with industrialisation increasingly complemented by mining rather than farming as an export staple. In the years prior to World War I, as the growth in farm export prices slowed down, industrialisation enabled Australian incomes to catch up with New Zealand's.

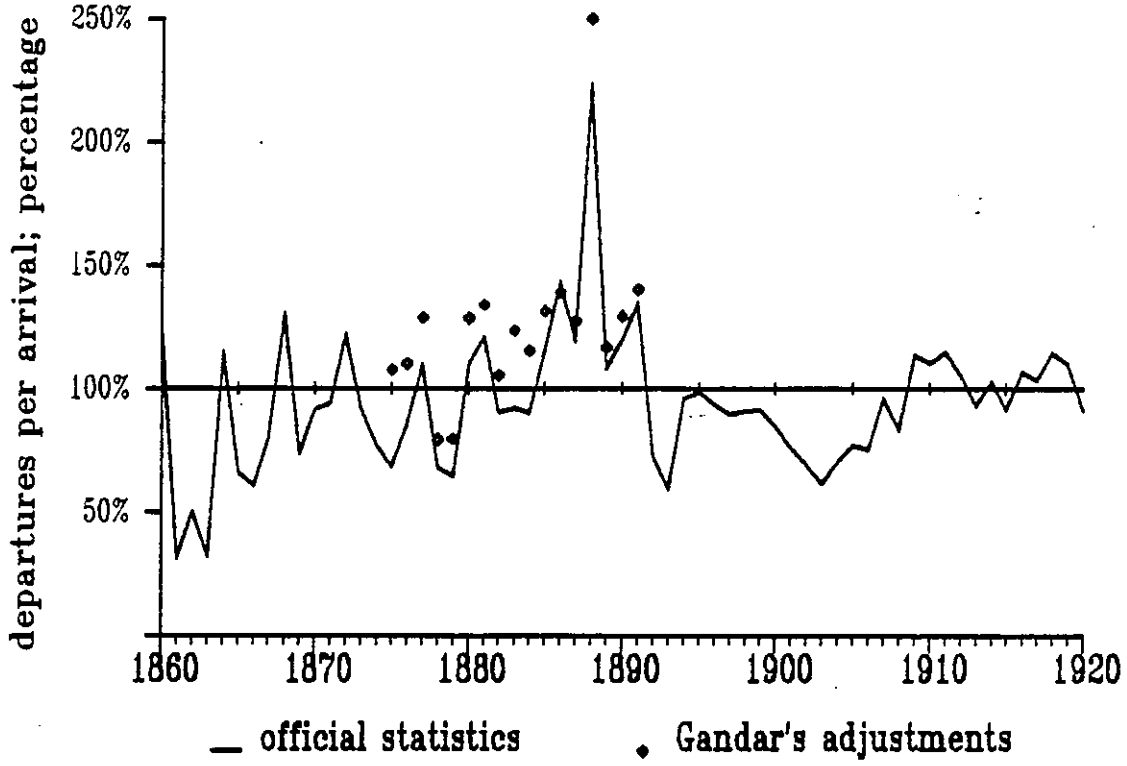
In New Zealand the post- World War I boom was driven largely by an unrealistic optimism about the future demand for farm exports. In contrast, Australia's recovery was delayed, but was rooted more in the firmer foundations of its domestic economy. New Zealand's real GNP per capita was lower in 1925 than in 1920, despite both being years of near full employment. There had been a fall in the supply of labour in the years between the two censuses.[52] New Zealand living standards were higher in 1925, reflecting a growing household preference for leisure over income.

New Zealand suffered a severe recession in 1926-1927, largely as a result of the price effects on a narrow range of export products brought about by the 1926 general strike in Great Britain. In 1928, New Zealand's economy recovered following a revival in export prices. The effects of the world depression were not apparent until the summer of 1930/31.

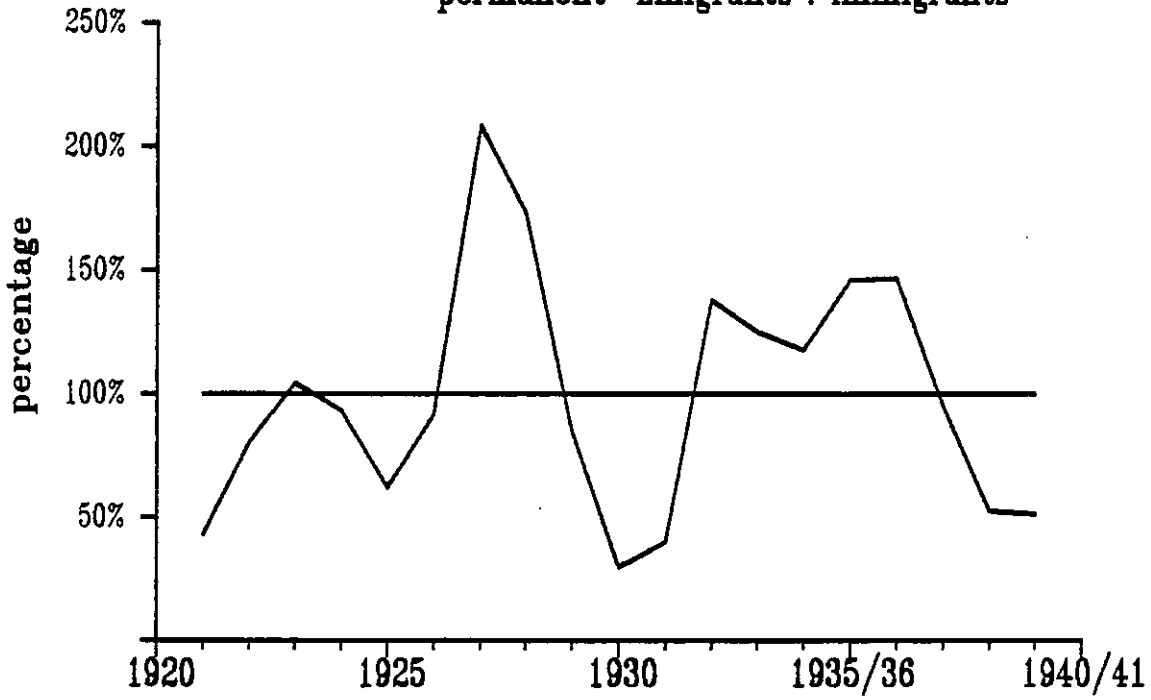
The especially rapid recovery in New Zealand in the late 1930s can be attributed to the expansionary public works, social welfare and wages policies of the incoming Labour Government. Investment confidence grew with the domestic market. In New Zealand, unlike Australia,[53] negative wage overhang was eliminated as real wage increases were granted and compulsory arbitration restored. New Zealand had a particularly favourable supply of London reserves built up from balance of payments surpluses in the depression years. Thus, the big increase in imports resulting from the increased expenditure of the late 1930s did not bring about a check to growth until 1938.

Fig.7 Trans-Tasman Migration;
net Emigration

a) 1860-1920



b) Inter-War
"permanent" Emigrants : Immigrants



sources: a) Statistics of New Zealand; JM Gandar, AEHR 1979
b) New Zealand Statistics of External Migration
New Zealand Statistics of Population and Buildings

A general feature of the New Zealand aggregates from the 1890s which is not apparent in the Australian data is the existence of 3-5 year trade cycle. From 1907 to 1929, the fluctuations were very sharp oscillations around a nil-growth trend. These short period cycles were the main source of the uncertainty and "instability" that pervaded New Zealand's economic consciousness.[54] They were the price New Zealand paid for its narrowly structured economic development, based on pastoral exports to a single market.[55] It is those fluctuations which explain the emergence of a somewhat nationalistic approach to economic management in the years following the Second World War.[56]

CONCLUSION

This paper has presented a set of GNP estimates for New Zealand that can be linked to official estimates beginning in 1938/39. They are based primarily on the work of contemporary economic statisticians. Through an apparently strong statistical relationship in the Australian data between the price level, the quantity of money per person, and the velocity of circulation of money, it has been possible to produce a gross product series that stands up to historical scutiny. No functional link between monetary aggregates and GNP is postulated in this paper; only the logical relationship inherent in the Quantity Identity.

It is possible to produce improved estimates of New Zealand's GNP by following the same procedures that Butlin's team in Australia used. Indeed, the statistical and archival record has yet to be mined in New Zealand to the extent it has in other developed countries. The GNP estimates therefore remain a stop-gap; a source which future estimates can be checked against. Their virtue is that they give a better indication of New Zealand's national income in the nineteenth century than any single alternative source, and that they present a macroeconomic picture of New Zealand's first century which gives credence to the considerable anxiety felt by New Zealanders about their country's economic destiny.

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1990

APPENDIXES:

A. THE RELATIONSHIP OF VELOCITY AND MONEY TO PRICES

As a by-product of the regressions conducted for this exercise, I performed another set of regressions on the full data set (1861-1939, excl. 1914-18), this time checking the orthodox monetarist hypothesis that there is a direct (but lagged) relationship between money supply and prices. The data yielded the following equations (with t-values in brackets):

A1: $LN(PRI) = \underset{[63.9]}{7.22} - \underset{[2.7]}{.0995} * LN(MPC_{-1}) + \underset{[16.2]}{0.604} * IW$

$R^2 = .888$
$F = 281$

A2: $LN(PRI) = \underset{[215.5]}{6.65} + \underset{[9.0]}{0.252} * LN(VEL_{-1}) + \underset{[33.9]}{0.548} * IW$

$R^2 = .942$
$F = 578$

A3: $LN(PRI) = \underset{[45.5]}{5.40} + \underset{[10.7]}{0.314} * LN(MPC_{-1}) + \underset{[17.0]}{0.529} * LN(VEL_{-1}) + \underset{[13.6]}{0.32} * IW$

$R^2 = .979$
$F = 1040$

Similar relationships were found when the monetary data covered the same period as the price data.

Equation A1 suggests that, in a simple linear regression, if there is a causative relationship from the money supply (narrowly defined) to prices, then it is negative. However there is a strong relationship between prices and velocity (equation A2). (This result could be reversed, perhaps, by using a broader definition of money.) This is consistent with the theoretical discussion at the beginning with this paper (and regression equations (a) to (f) for which velocity was the dependent variable) which suggested that velocity should be negatively related to money balances. A significant direct relationship from money to prices does become apparent, however, when velocity is accounted for as a separate regressor (A3).

B. THE ECONOMIC SIGNIFICANCE OF THE REGRESSION VARIABLES

While the concept of monetary velocity provides the means to link monetary and income/product variables, this paper uses variables contained within the quantity identity to estimate velocity. Thus it is possible to remove velocity entirely from the equation, leaving a society's gross product as a function of the money stock, the price level and the population.

From regressions (a) to (f) we have

B1: $\log V = a + b.\log P - c.\log(M/N)$ $\quad b > 1; \quad 0 < c < 1;$

B2: $V = A.P^{b}.(M/N)^{c}$

where $V \equiv$ velocity
$\log A \equiv$ [illegible] a
$P \equiv$ prices
$M \equiv$ money stock
$N \equiv$ population

From the Quantity Identity we have

B3: $Y = M.V$

B4: $Q/N = M.V.P^{-1}.N^{-1}$

where $Y \equiv$ gross product
$Q \equiv$ real gross product

Taking the two together:

B5: $Q/N = A.P^{b-1}.(M/N)^{1-c}$

B6: $Q/N = A.P^{b-c}.(M/P.N)^{1-c}$

where $M/P.N \equiv$ real money balances per capita

B7: $Q = A.P^{b-1}.M^{1-c}.N^{c}$

Looked at in this way, equation B7 shows that real gross product is positively related to population, money balances and prices. An increase of 1% in any of those three variables will, in itself, be associated with an increase of less than 1% in gross product. Equation B6 suggests that rising real money balances are linked with economic growth only when prices are rising.

It is not possible to claim a simple causal link from prices, money or population to real incomes because of the interdependence of the variables. For example, a sharp rise in prices may induce a significant fall in real money balances. Rather, the above is a historical generalisation with respect to the Australian economy, and *ipso facto*, the New Zealand economy. Economic growth has been caused by market situations which also brought about rising prices and in which growth in the money supply was accomodated.

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NOTES

1. NG Butlin, *Australian Domestic Product, Investment and Foreign Borrowing; 1861-1938/39*; Cambridge UP, 1962.

2. GR Hawke, "Income Estimation from Monetary Data: Further Explorations"; *Review of Income and Wealth*, 1975, pp.301-307

3. BT Lineham, "New Zealand's Gross Domestic Product, 1918/38"; *New Zealand Economic Papers*, 1968; pp.15-26

4. *New Zealand Official Yearbook* 1954, p.653

5. Calculated by dividing NG Butlin's GDP or GNP estimates by monetary data provided by SJ Butlin, AR Hall & RW White:
   "Australian Banking and Monetary Statistics 1817-1945",
   Reserve Bank of Australia Occasional Paper no.4A, 1971; pp.140-156

6. GR Hawke, *The Making of New Zealand*; Cambridge UP, 1985; pp.76-77.
   JA Dowie, "A Century-Old Estimate of the National Income of New Zealand"; *Business Archives and History* (now *Australian Economic History Review*), August 1966.

7. JA Dowie, "Inverse Relations of the Australian and New Zealand Economies, 1871-1900"; *Australian Economic Papers*, December 1963, pp.151-179.
   GM von Tunzelmann, "Inverse Relations of the Australian and New Zealand Reversed", *Australian Economic Papers*, vol. 6, no. 8, 1967

8. Hawke 1985, p.79; Hawke 1975, p.306 (*op.cit.*)

9. Paul Bairoch in Bairoch and Maurice Lévy-Leboyer (eds.), 1981, *Disparities in Economic Development Since the Industrial Revolution*, p.10. Bairoch gives only gives a reference to an unpublished paper, but it is apparent from an earlier paper, ("Estimations du Revenu National dan les Sociétés Occidentales Pré-Industrielles et au Dix-Neuvième Siècle: Propositions d'Approches Indirectes", *Revue Economique* 1977, p.185) that his 1860 New Zealand datum is derived from Hawke's series.
   Bradford de Long, "Productivity Growth, Convergence and Welfare: Comment", *American Economic Review*, December 1988, p.1152.

10. "Productivity, Growth, Convergence and Welfare", *American Economic Review*, December 1986, 76, pp.1072-85.

11. Hawke (1985, p.79) acknowledged a possible problem by noting that he had, in effect, assumed that velocity decreases were less marked in New Zealand than in many other countries during the 19th century.

12. GR Davison, *The Rise and Fall of Marvellous Melbourne*; Melbourne UP, 1978. CP Kindelberger, in *The Financial History of Western Europe* (p.365), says that "while the overall money supply is unchanged, within the total there is a shift from what Keynes ... called the 'transactions circulation' to the 'financial circulation'" which is the same as "a decline in income velocity".

13. NG Butlin (1962), p.468.

14. *ibid.*, pp.33-34

15. *op.cit.*, pp.142-157

16. Rodney Maddock & IW McLean, *The Australian Economy in the Long Run*; Cambridge UP, 1987; pp.353-354

17. *Official Yearbook of the Commonwealth of Australia*, no.3, 1910, pp.118-119

18. "Final Report of the Civil Service Commissioners", *Appendix to the Journals of the House of Representitives (AJHR)*; cited Dowie, *op.cit.*, 1966, p.119.

19. Butlin's GNP estimates are lower than his estimates of GDP at market prices. However, the scaled up GNP estimate for 1902 (Table 1) is equal to the unscaled GDP estimates for 1901/02 and 1902/03. Therefore the 12.5% scale factor still holds.

20. The 1901/02 benchmark has been dropped from figure 1, as it was not possible to fit a function to all four of Coghlan's estimates.

21. *NZOYB* 1957, pp.716-717; note also *NZOYB* 1990 p.679, and the aggregate private income series: eg *NZOYB* 1940, p.782; *NZOYB* 1942, p.647.

22. AGB Fisher, "Distribution of Income in New Zealand", *The Economic Record*, November, 1930; pp.221-234.

23. He is likely to have overstated GDP for 1935/36, because in years of high unemployment there was always a comparable amount of underemployment. Lineham used census employment data rather than personal income data.

24. NZ Yearbook, 1941 page 710. Note other price indexes in my thesis: Keith Rankin, *Labour Supply in New Zealand and Australia, 1919-1939*; unpublished thesis, Victoria University of Wellington, 1990; (p.40) and how the chosen inter-war series is near to an average of these.

25. JW McIlraith, *The Course of Prices in New Zealand*, Wellington 1911; Brian Easton & N Wilson, "An Investigation of the Database of New Zealand's Terms of Trade", the First Draft of a Report Prepared by the New Zealand Institute of Economic Research for the Department of Trade and Industry, *Working Paper no. 84/10*, Appendix 2

26. The implicit assumption has been made that there was purchasing power parity between Australia and New Zealand in those years. This assumption is supported by the overall consistency of the two countries' price series in the early part of the 20th century. Higher prices in New Zealand in the third quarter of the nineteenth century reflect the high costs of imported supplies, combined with the ability of New Zealanders to pay those prices. Higher prices in Australia in the 1880s reflect the depression in New Zealand, and higher prices in Australia in the 1920s and 1930s reflect higher levels of tariff protection.

27. GT Bloomfield, *A Handbook of New Zealand Statistics*, 1984; pp.386-387.

28. Population data is taken from the Statistical Summaries of the *New Zealand Official Year Book* (1901, 1919, 1924), and the *New Zealand Statistics of Population and Buildings* for 1922/23-1939/40.
Maoris, before the Land Wars of the 1860s and after World War II, played a significant role in the New Zealand market economy and made up a significant share of the New Zealand population. Little research has been done on the Maori economy between the 1860s and the 1940s (Paul Dalzeil, *Economists' Analyses of Maori Economic Experience, 1959-1989*; presentation to the NZ Association of Economists' Conference, Auckland, August 21, 1990), but it is known as the period in which the Maori were least integrated into the pakeha (people of European origin) economy and in which the proportion of Maoris in the population was lowest.

29. For example, the coefficients of function 1 are exactly the same as those for regression equation (d). But the coefficients for MPC and MPC_{-1} are added together to give a single coefficient, which is applied to the average of those two variables. The number "0.98" is the scale factor used to fit the equation to the 1865 New Zealand benchmark. "EXP" in the function to convert from natural logarithms. Recomputed Durban-Watson statistics are 1.32, 1.19, 1.14 respectively; thus serial correlation is not as severe for the reconstructed interwar function as it was in equation (f).

30. *AJHR* H-11, 1919

31. JB Condliffe, *The Accountants Journal* of New Zealand, 1924-25, p.231.

32. *AJHR* 1918, H-11, p.1.

33. Lineham *op.cit.*, p.25; Dowie 1966 *op.cit.* p.127

34. Dowie (1966) *op.cit.*; pp.130-131.

35. detailed by Dowie (1966) *op.cit.*, p.126, n15.

36. Dowie *op.cit.*; p.126, n15

37. *ibid.*, p.127; NZOYB 1894, p.139; NZOYB 1897, pp.283-284

38. As the registrar-general's 1896 estimate is based on data from the census in April 1896, I have adjusted my estimates to the year ended September, by taking weighted averages of that year and the previous year. His estimates are 18% short of my estimates for the year to September 1893 and the year to September 1896. This slight adjustment is significant because real per capita incomes recovered by 10% in 1896.

39. Colin Clark, *The Conditions of Economic Progress* (2nd edn.), London 1951; FB Stephens, "National Income of New Zealand", *Economic Record* Dec. 1936; cited Lineham, pp.25-26.

40. Lineham, *op.cit* p.25

41. Significant structural change was also taking place. Manufacturing exports grew markedly from 1888, remaining high for nearly 20 years with the exception of the years of depression in Australia, the mid-1990s. (see Bloomfield, p.272; IW Horsfield, *The Struggle for Economic Viability*, Victoria University of Wellington MA thesis, 1960.)

42. JB Condliffe, *op.cit.*

43. Lineham, *op.cit.* p.17.

44. Rankin 1990, *op.cit.*, chapter 6

45. Especially J Macrae and K Sinclair, "Unemployment in New Zealand during the Depression of the Late 1920s and Early 1930s"; *Australian Economic History Review*, March 1975, pp.35-44.
see Rankin (1990), chapter 4, for full critique of Macrae and Sinclair

46. comparing AJHR H-11 factory employment data with the employment data in the official *Statistics of Factory Production*

47. Lineham, *op.cit.* p.18.

48. The nominal values have been deflated by the GNP deflator; thus the graph does not represent export and import volumes.

49. *Statistics of New Zealand 1920*, pp.25-26
Statistics of New Zealand 1871, Table 3
Statistics of Population, External Migration and Buildings (inter-war)
The 1875-1920 data have been adjusted in line with JM Gandar, *Australian Economic History Review* 1979/2, pp.167-168. The discrepancy has been assumed to relate almost entirely to Trans-Tasman migration. (I allowed for 100 unrecorded migrants not from Australia.) For the inter-war years, no country of origin is given for returning New Zealanders. Likewise Australian residents leaving New Zealand could not be counted, although most temporary visitors departing for Australia would have been returning Australians. The apparent lack of a trans-Tasman migration surplus in the late 1930s is the result of more New Zealanders, especially females, being able to travel overseas and their return not being counted. Focusing only on those who *said* they were permanent migrants shows a significant trans-Tasman inflow in 1938.

50. Sir Robert Stout,
cited in JD Salmond *New Zealand Labour's Pioneering Days*, Forward 1950

51. IW Horsfield, *op.cit.*

52. Rankin, *op.cit.* chapters 3,6.

53. *ibid.*, pp.152-153

54. Hawke (1985); *op.cit.* p.100

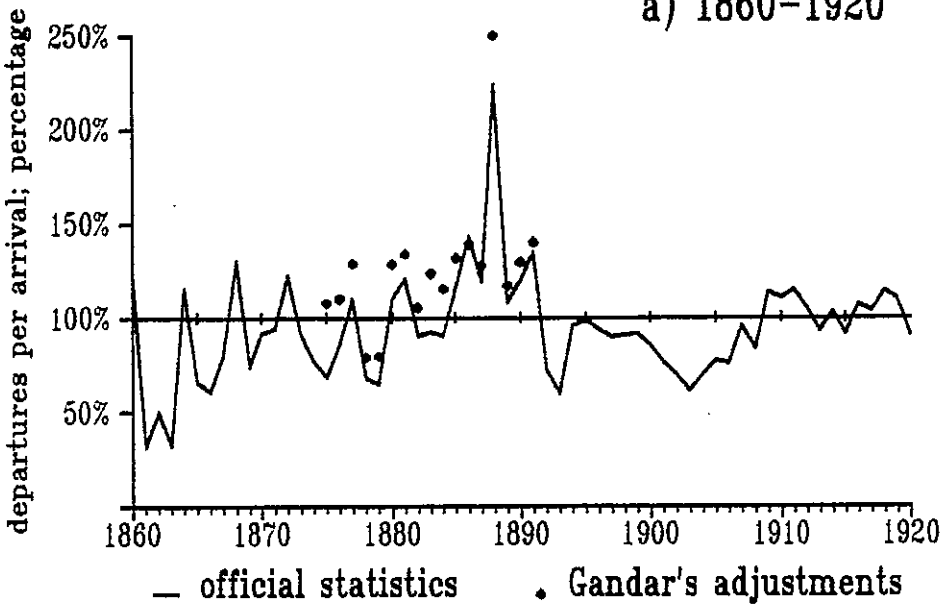
55. Note CGF Simkin, *The Instability of a Dependent Economy: Economic Fluctuations in New Zealand, 1840-1914*, Oxford, 1951

56. Hawke 1985, *op.cit.*, "insulationism"

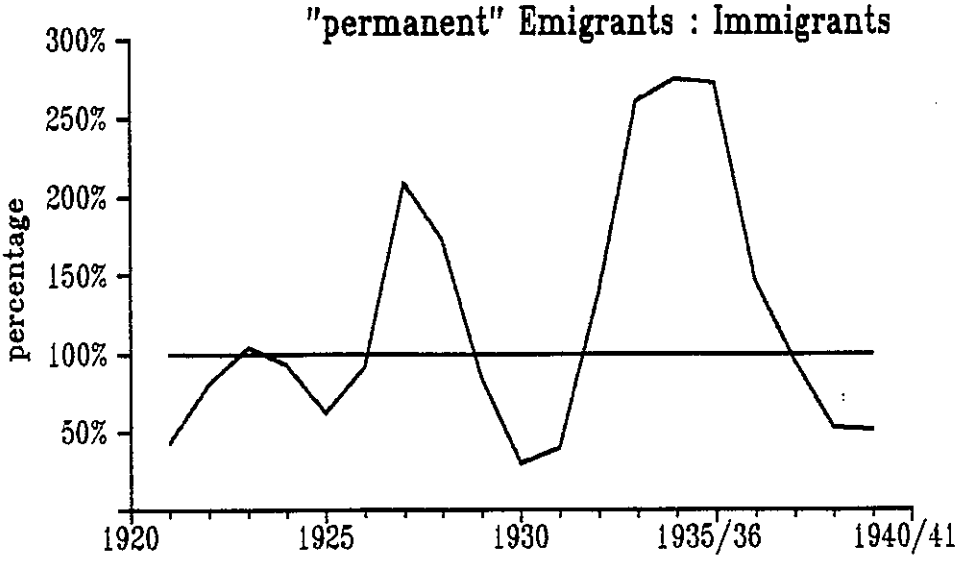
ERRATUM

Fig.7 Trans-Tasman Migration;
net Emigration

a) 1860-1920



b) Inter-War
"permanent" Emigrants : Immigrants



sources: a) Statistics of New Zealand; JM Gandar, AEHR 1979
b) New Zealand Statistics of External Migration
New Zealand Statistics of Population and Buildings