Review of Income and Wealth
Series 41, Number 1, March 1995

REAL GDP IN THE SEVEN COLONIES OF AUSTRALASIA: 1861–1991

BY PAUL A. CASHIN

Yale University

Using data on regional money stocks, a variant of Fisher's (1911) quantity theory of money identity, and a technique first suggested by Doblin (1951) and Friedman (1961), this paper presents the first consistently-based estimates of real GDP in each of the seven British colonies of Australasia for the period 1861–1991. Examination of the historical pattern of growth in the regional economies of Australasia has not previously been undertaken, due in particular to the dearth of data on aggregate incomes for the colonies (later states) of Australia. The data calculated here reveal the historical pattern of the domination of New South Wales, Victoria and New Zealand in real Australasian GDP, and the shrinkage of the cross-sectional dispersion of real per capita GDP in the seven colonies over this 131-year period.

I. INTRODUCTION

How have per capita and aggregate incomes in the regions of Australia and New Zealand changed since the 1860s? The answer to this question has previously been unknown due to a large gap in the historical record of regional incomes in the two countries. This paper uses data on regional money stocks to reconstruct national income aggregates for the seven colonies of Australia and New Zealand for the period 1861–1991.[1] These historical estimates of aggregate colonial income are the first to be constructed on a consistent basis for all seven colonies over this 131-year period.

For contemporary economists it is indeed fortunate that British regulations stated that all banks of issue in the colonies of Australasia were required to provide returns to the British Treasury on a quarterly basis, following the passage of the Colonial Bank Regulations of 1840 (Butlin, 1953). Such requirements were continued by the colonial governments of Australasia upon the granting to them of independent government in the late 1850s, and in turn by the Commonwealth

Note: I thank Xavier Sala-i-Martin, T. N. Srinivasan, Gustav Ranis, Etsuro Shioji, David Porteous, participants in the Yale Growth Workshop and an anonymous referee for their comments and suggestions. This paper was completed while I was at the Victorian Department of Agriculture, Australia. The views expressed in this paper are those of the author, and are not necessarily shared by the Goverment of Victoria. The financial support of a Doctoral Dissertation Fellowship of the Alfred P. Sloan Foundation, and the Australian Pig Research and Development Corporation, is gratefully acknowledged.

[1]In this paper "colony" and "state" will be used interchangeably to describe the seven former colonies of Australasia, although New Zealand is not a state of Australia. I also use the term "Australia" in its modern sense, although the act of confederation did not occur until 1901. Especially in the 19th century, contemporary commentators used the term "Australasia" to embrace the independently-governed colonies on the continent of Australia and the adjacent islands of Tasmania and New Zealand (see, for example, Coghlan, 1900).

Government of Australia after 1901.[2] The result is a very long time series (in most cases from 1841 to 1991) of consistently-defined data on bank note issue, bank assets (including deposits), bank liabilities, capital, reserves, dividends paid and interest rates.

The bulk of this data has been gathered in four seminal volumes, which cover the period 1788–1970: Butlin's (1953) *Foundations of the Australian Monetary System, 1788–1851*, Butlin, Hall and White's (1971) *Australian Banking and Monetary Statistics, 1817–1945*, White's (1973) *Australian Banking and Monetary Statistics, 1945–1970* and Butlin's (1986) *The Australian Monetary System, 1851–1914*. An equivalent body of work does not, unfortunately, exist for New Zealand, but this has been partially rectified by the recent contribution of Sheppard, Guerin and Lee (1990) *NZ Monetary Aggregates, 1862–1982*.

Both Doblin (1951) and Friedman (1961) advocated the use of data on monetary aggregates as a means to construct national income estimates when other data are too meagre. The advantage of such data is that it generally becomes available in the early stages of an economy's development, as banks (and particularly banks of issue during periods of free-banking) are likely to be among the earliest private institutions subject to public supervision in any given economy. Both the meagreness of alternative data sources on national aggregates and the early availability of monetary and banking data are attributes common to the seven economies of Australasia. This data on colonial monetary aggregates will be used here to provide estimates of the nominal income in each economy, which will then be deflated and divided by each economy's population to give real per capita income estimates for each of the seven economies.

Section II sets out the historical background of the seven colonies of Australasia. Section III comments on the nature of the large gaps in the existing historical record of the aggregate incomes of the regional economies of Australasia, and describes the monetary-based technique for deriving estimates of colonial incomes from colonial monetary data. Section IV presents the results of these calculations for the Australasian colonies. It highlights the often large differences in colonial rates of growth of per capita incomes, and the increasing similarity of real per capita incomes in the seven colonies. The robustness of the colonial GDP estimates in comparison with previous calculations is discussed in section V. Section VI points out the *caveats* associated with use of the monetary-based technique, which primarily concern the extensiveness of the coverage of monetary data, and inter-colonial differences in the willingness to hold money. However, neither problem appears to be significant in the Australasian context. Finally, section VII provides some concluding comments.

II. Historical Background on the Seven Colonies of Australasia

The seven Australasian colonies which Britain established in the 18th and 19th centuries were politically independent of one another, and largely self-governing

[2]After the granting of self-government, responsibility for most Australasian monetary affairs devolved to the individual colonial governments, although Britain continued to be responsible for coinage.

colonies.[3] The older Australasian colonies (NSW and TAS) were initially established to serve as dumping grounds for the surplus of British criminals (given the loss in the 1770s of Britain's American colonies), and as a useful bulwark against French incursion into the South Pacific. Only later did their potential for prosperity become apparent to both the British and those born in the colonies.

In the decades following the cessation of convict transportation in the mid-nineteenth century, the colonies exploited their strong comparative advantage in agriculture and mining as the engines of economic growth. This development was accompanied by an early orientation of economic activity towards specialisation in the urban-based manufacturing and service sectors of the economy; the large-scale importation of both capital and labour (human capital); and heavy investment in physical capital through the provision of rural infrastructure (prior to 1900), urban infrastructure (after 1900), and the transportation network linking the expanding cities with one another, and each colonial capital city with its hinterland.[4]

A growing sense of nationhood and shared cultural, political and commercial links promoted the establishment of a series of Constitutional Conventions in the 1890s (echoing those of the U.S. over a century earlier), which debated the terms and conditions under which the seven former colonies would federate to form one nation. In the end, six of the seven agreed to join. Due to its much closer trade links with Britain than the six other colonies (which in the 1890s generally engaged in a large proportion of their trade with one another), its higher rate of growth of real gross domestic product (GDP) per capita in the decade of the 1890s (see sections IV and V), and a desire to retain its political and financial autonomy, NZ declined to join the other six in creating the Commonwealth of Australia, which was formed on January 1, 1901.[5] The reasoning behind NZ's failure to join the Commonwealth has been debated most concisely in a series of papers by Wood (1968), Chan (1969) and Fairburn (1970). A key reason for NZ's reluctance was that the proposed federation intended to establish a customs union with internal free trade and a common external tariff (with the tariff set at near the level of "protectionist" VIC, rather than "free trade" NSW). Given that the bulk of NZ's trade with the Australian colonies was with NSW, it was argued at the time that they had little to gain and potentially much to lose by having to dismantle their own trade barriers against imports from the other ex-colonies.

The process of economic growth which transformed these colonies from penal and agricultural settlements into economies with the highest real per capita GDP of all nations in the space of 70 years (see Cashin, 1993, 1993b; Maddison, 1977, 1979, 1982), and continues to sustain relative prosperity to the present day, is certainly one worth understanding and examination. Such an examination has not previously

[3]The colonies and their founding dates were: New South Wales (NSW) 1788, Van Diemen's Land [later Tasmania (TAS)] 1804, Western Australia (WA) 1829, South Australia (SA) 1836, New Zealand (NZ) 1841, Victoria (VIC) 1851 and Queensland (QLD) 1859.

[4]It should be noted that NZ was unlike the other colonies, in that it had no dominant city and a number of economically independent provinces, each with their own main settlement and hinterland.

[5]In 1890 NZ shipped only 16.7 percent of the value of its total exports to the other Australasian colonies, and in 1900 this figure was 14 percent. Corresponding figures for the other colonies were: NSW 52.8 (1890) and 38.6 (1900); VIC 35.1 and 32.8; SA 40.2 and 49.3; QLD 71.7 and 57.3; TAS 82.5 and 42; and WA 28.4 and 16.4 (see Fairburn, 1970; Registrar-General's Office, 1921; Cashin 1993b). It is perhaps no coincidence that WA was the last colony to agree to federate.

been undertaken on a collective basis for the seven Australasian colonies, principally due to the non-existence of colonial GDP estimates for the period 1861–1979. A key contribution of this paper is to fill in this large gap in the available data on the economic history of the colonial economies, using monetary-based estimates of nominal GDP at market prices.

III. The Monetary-based Technique for the Estimation of Nominal National Income

To overcome the dearth of data on colonial "national" incomes, use will be made of monetary data and a technique first suggested by Doblin (1951) and Friedman (1961). This technique uses the income form of Fisher's (1911) Quantity Equation:

$$MV = Y = PNy = Py' \tag{1}$$

where M is the quantity of money (however defined), V is the income velocity of the circulation of money, P is the price index implicit in estimating national income at constant prices, N is the number of persons in the population, y' is national income in constant prices, y is per capita national income in constant prices and Y is nominal national income. Given accurate figures for the monetary aggregate of choice (M), the usefulness of the resulting estimates of nominal income ($Y = Py'$) derived from (1) is contingent on an accurate determination of the annual income supported by a unit of money, (V).

This monetary-based technique is used here to derive estimates of "national" income (as measured by GDP) from 1861–1978/79 (for selected years) for each of the six Australian colonies which later became states of the Commonwealth of Australia and for the seventh colony of New Zealand (from 1861–1931/32, for selected years), which became in time an independent nation. It is proposed to use the Australian (all-colony) income velocity of money (V_a) in (1), and multiply this figure by the money stocks of each colony (M_i, where i = NSW, VIC, QLD, WA, SA, TAS, NZ), to derive estimates of the nominal "national" income of each colony, ($\hat{Y}_i$). Fortunately, a long time series of value-added-based estimates of Australia's GDP (Y_a) has been made from 1788 (when the first colony was established) until 1938/39 (see Butlin, 1962; McLean and Pincus, 1982; and Butlin and Sinclair, 1984), with official estimates of Australian GDP being available from 1938/39 (ABS, 1993a).

III.1. *Calculation of Colonial GDP Data*

Monetary and population data were gathered over the period 1861–1990/91 for all seven Australasian economies, more specifically the Australian census years of 1861, 1871, 1881, 1891, 1901, 1911, 1921, 1933 (delayed due to the Great Depression), 1947 (delayed due to the Second World War), 1954, 1961, 1971,

1981, 1986 and 1991.[6] Data on nominal GDP at market prices for the years 1980/81, 1985/86 and 1990/91 for each of the six Australian economies has been taken from official ABS (1993) estimates. Data on nominal GDP at market prices for NZ, for Australian census years during the period 1932/33–1990/91, has been taken from semi-official estimates (NZ Department of Statistics 1957; Easton 1990) and official estimates (OECD, 1993; NZ Department of Statistics, 1990, 1993).[7]

No official estimates of nominal incomes exist before 1979/80 for the six Australian colonies, or prior to 1932/33 for NZ. Neither are there are any other consistently-derived calculations of such estimates for each of the colonies, as most economic historians in Australia and New Zealand have been content to focus their analysis on secular trends at the national level of both countries.

One potential drawback in converting the monetary-based nominal income aggregates into real income aggregates is the dearth of useful measures of movements in the price levels of the seven economies. There is no consistent series for state-based deflators or consumer/wholesale price indices prior to 1948/49 for the capital cities of the Australian states.[8] As a result, the national Australian implicit GDP deflator (taken from Butlin 1962 and Vamplew 1987 for 1861–1984/85, and ABS 1993a for 1985/86–1990/91, all with base 1910/11) is used here to derive real GDP and real per capita GDP from nominal GDP and nominal per capita GDP for the six Australian colonies between 1861–1990/91. However, use of the same deflator for each of the six Australian colonies could induce measurement error in the levels of real per capita GDP if absolute purchasing power parity (PPP) does not hold across these economies, as noted in Barro and Sala-i-Martin (1992). Moreover, the GDP deflator is a value-added deflator, while the CPI is a commodity-price index, and similarity across economies in the latter need not be replicated in the former.

I proceed by calculating V_a for Australia over the period 1861–1990/91, using the Butlin–ABS data on Australian GDP at market prices (Y_a) and Australian

[6]Data collection is limited to census years to aid in ensuring the accuracy of colonial income calculations. For most of the years between 1861–1991, the series from which Australian colonial income estimates are disaggregated is that of Australian GDP, as calculated by Butlin (1962). In making separate estimates of the components of Australian GDP, Butlin relied on census year data (when available), and interpolated many figures for intercensal years. My reliance on census year data thus avoids compounding any potential inaccuracies arising from Butlin's interpolative method of calculating intercensal GDP data. See Boehm (1965) for an analysis of the quality of Butlin's (1962) estimates.

[7]Estimates of NZ's national income for the 1930s are semi-official in nature, and until 1946/47 are for GNP, not GDP (see NZ Department of Statistics 1957). Easton's (1990) nominal GDP estimates for the 1932/33–1945/46 period, which are used here, were extrapolated from the official nominal GNP estimates, and closely approximate those of Lineham (1968). From 1946/47 official estimates of NZ's nominal GDP become available, and are used here. Note also that official Australian and New Zealand national income data are for years ending June and March, respectively.

[8]Earlier state-based price series are available to measure price changes for certain consumer items in capital cities from 1901, but there is no direct line of continuity between these series and the national GDP deflator. Evidence from the state-based consumer price indices (CPI) indicates that time-series variation in the movements of prices in the various states of Australia is small, and so the use of a common price deflator for all states is reasonable.

data on money stocks (M_a: for derivation, see Section III.2 below).[9] Then the colonial monetary aggregates (M_i) are multiplied by V_a to yield estimates of nominal GDP at market prices ($\hat{Y}_i$ in (1)) for each of the i economies.[10] To yield real GDP figures these nominal values are then deflated (for the Australian states) by the implicit Australian GDP deflator. For NZ a volume GDP index (base year 1910/11) is constructed using the NZ$ (New Zealand dollar)-based current price GDP data and an appropriately-linked price index (base year 1910/11), the latter comprising the consumer price index of Thompson and Nesbit-Savage (1994) for 1861–1914, the GDP deflator constructed by Easton (1990) for 1914/15–1954/55, and the official GDP deflator of the NZ Department of Statistics (1990, 1993) for 1954/55–1990/91.[11,12] The NZ volume GDP index is then applied to the A$ (Australian dollar)-based estimate of NZ's 1910/11 GDP to derive NZ's real GDP (in 1910/11 A$) for the period 1861–1991.[13] For all colonies, these real colonial GDP estimates are then divided by their respective census-based population (taken from Vamplew 1987; ABS 1987, 1990, 1993; Bloomfield 1984; NZ Department of Statistics 1991, 1993), to derive real per capita colonial GDP (in 1910/11 A$) at market prices.

III.2. *Calculation of Colonial Monetary Aggregates*

The monetary aggregate used in the calculation of NZ's GDP is M1, and is taken from Reserve Bank of NZ (1990) and Sheppard, Guerin and Lee (1990) for 1862–1989, and Reserve Bank of NZ (1992) for 1989–91.[14] The M1 aggregates

[9]Australasian colonial monetary aggregates follow the conventional definition: $M1$ is currency held by the non-bank public plus current (demand) deposits at trading (commercial) banks; $M2$ is $M1$ plus fixed (time) deposits at trading banks; $M3$ is $M2$ plus deposits at savings banks held by the non-bank public. All monetary aggregates (as used here) are net of interbank and government deposits, and are at December (prior to 1900) and at June (after 1900) values.

[10]Given my use of the monetary-based technique, $\sum_i \hat{Y}_i$ (for $i \neq$ NZ) will be equal to Australian nominal GDP. This is because I am using national estimates of velocity (derived from national estimates of GDP and national money stocks) and regional money stocks to derive regional income figures, as does Hawke (1975) for NZ. This differs from the manner in which Friedman (1961), Leff (1972) and Rankin (1992) use the technique to generate estimates of Y_i, which is to insert into (1) either: *ad hoc* estimates of V_i (Leff for Brazil); estimates of the secular and cyclical components of V_i (Friedman for the U.S.); or econometrically-based estimates of V_i (Rankin for NZ), to generate estimates of $\hat{Y}_i$.

[11]The NZ deflator for the period 1960/61–1976/77 is derived from a current price measure of GDP which includes an inventory valuation adjustment, and is taken from OECD (1993). After 1976/77 the OECD series and the latest version of the official series (NZ Department of Statistics 1993) for current price GDP coincide. Previously there had been a break in the official series at 1977/78, prior to which the official GDP estimates excluded the valuation adjustment.

[12]The values for the Australian and NZ deflators, with a common base year of 1910/11 = 1,000 are: 1861 (Australia 1,185, NZ 1,254); 1871 (998, 1,245); 1881 (1,000, 1,108); 1891 (951, 901); 1901 (911, 866); 1911 (1,000, 1,000); 1921 (1,801, 1,597); 1933 (1,404, 1,198); 1947 (2,411, 1,958); 1954 (4,945, 3,310); 1961 (5,911, 4,164); 1970 (7,603, 5,080); 1976 (14,478, 9,233); 1981 (22,933, 18,604); 1986 (34,098, 31,905); and 1991 (47,124, 49,964). The values for Australia are for December years prior to 1900, and June years thereafter; the values for New Zealand are for December years prior to 1914, and March years thereafter.

[13]As the Australian and New Zealand currencies traded at par in 1910/11, the value of NZ's nominal GDP in that year was the same when measured in either currency.

[14]In the absence of alternative data, $M1$ for 1861 is taken from Bloomfield's series on trading bank deposits (1984, p. 386), with currency holdings for NZ derived using Schedvin's (1973) and Vamplew's (1987) data on Australian per capita holdings. The 1862–1991 monetary data is at December of each year.

are then multiplied by estimates of Australian velocity of M1 to yield NZ's nominal GDP. Note that as stated in section III.1, from 1932/33 semi-official and official nominal GDP estimates are used in calculating NZ's real GDP per capita. The post-1932/33 monetary-based estimates are used only as a gauge of the accuracy of the pre-1932/33 estimates (see section V).

GDP estimates for the Australian colonies are based on calculations of M3. Statistics on currency held by the non-bank public are not available for the Australian colonies in the 19th century, but (national) estimates from 1900/01 onward have been provided by Butlin, Hall and White (1971) and White (1973). Schedvin (1973) and Vamplew (1987) provide figures for total Australian currency held between 1861-1900 by extrapolating back in time, on the basis of population, from the average national holdings in the first few years of the 1900s. To divide up these national estimates of currency held, I assume that per capita holdings of currency are the same for all colonies, and allocate national holdings of currency on the basis of the respective colony shares in the national population.[15]

The commercial and savings bank deposits (net of government and interbank deposits) for each of the Australian colonies are taken from Butlin, Hall and White (1971) and White (1973) for 1861-1969/70, then from the *Yearbook* of the Commonwealth of Australia (various issues) for 1970/71-1990/91. Note that official state GDP estimates are used in calculating each state's real per capita GDP for 1980/81, 1985/86 and 1990/91. The post-1979/80 monetary-based estimates are used only as a gauge of the accuracy of the pre-1979/80 monetary estimates of state per capita GDP (see section V).[16]

IV. Estimates of Colonial Real GDP and Real Per Capita GDP

Estimates of the levels of nominal GDP (in A$ million) for each of the seven colonies between 1861-1990/91 are given in Table 1. As expected, the dominance of NSW and VIC (and NZ after 1947) in Australasian colonial GDP stands out, as does the sustained rapid rise in colony GDP of NZ, SA, QLD and WA, while TAS' GDP growth has been relatively slow. Note that as stated earlier, the sum of my real colonial GDP estimates (for the six Australian colonies) in Table 1 equals Butlin's (1962) estimate of Australian (all-colony) GDP for the period 1861-1938/39, and equals the official ABS (1993a) estimates of Australia's GDP from 1939/40-1978/79. Between 1979/80-1990/91 I use official ABS (1993) estimates of the six Australian state GDPs, which also sum to the official estimate of Australian GDP for those years.

[15]Although this technique is crude, Schedvin (1973) calculates that while currency comprised about 25 percent of Australian (all colony) *M3* in 1861, by 1891 it was only 8.3 percent and by 1939 6.2 percent. The rapid fall in the share of currency (particularly between 1861-1891) is attributed to the rise of branch banking (and hence the replacement of currency by deposits), and the wide acceptance of checks as a form of payment.

[16]See Cashin (1993, 1993a and 1993b) for a detailed description of, sources for, and values of, the relevant data on the seven colonies and for Australia as a whole. Note that monetary data at June 1970 is used to derive the income of the Australian states, rather than the census year of 1971, as the White (1973) data set terminates in 1970 and official estimates of state product do not begin until 1979/80.

TABLE 1

COLONIAL GDP, CURRENT PRICES (A$ MILLION), 1861–1990/91

Year	NSW	VIC	QLD	SA	WA	TAS	NZ1	NZ2
1861	46.5	64.6	3.1	9.2	0.8	9.1	13.2	13.2
1871	51.8	81.7	10.2	14.1	1.1	6.6	33.5	33.5
1881	103.8	111.3	25.6	28.9	2.1	13.6	57.1	57.1
1891	145.9	163.4	41.6	35.9	5.3	16.0	60.6	60.6
1900/01	155.3	139.3	56.4	33.8	20.2	15.1	82.5	82.5
1910/11	272.1	211.3	81.4	62.9	38.3	19.8	148.5	148.5
1920/21	550.5	427.4	165.6	124.9	64.3	38.2	263.0	263.0
1932/33	465.6	417.7	163.5	104.7	65.0	33.8	*205.4*	*235.0*
1946/47	1,171.2	967.3	436.1	262.7	171.7	91.9	*790.6*	*861.0*
1953/54	3,484.6	2,924.3	1,203.5	909.5	555.5	259.2	*1,811.4*	*1,690.0*
1960/61	5,762.4	4,803.1	1,983.4	1,374.7	849.1	404.3	*3,488.9*	*2,855.0*
1969/70	11,862.0	9,609.1	4,152.0	2,691.2	2,231.1	778.6	*5,769.2*	*4,950.0*
1980/81	*49,170.0*	*41,106.0*	*19,806.0*	*10,531.0*	*12,544.0*	*3,463.0*	*21,303.8*	*23,089.0*
1985/86	*82,345.0*	*68,994.0*	*34,683.0*	*19,464.0*	*22,064.0*	*5,442.0*	*36,855.1*	*45,435.0*
1990/91	*132,216.0*	*102,791.0*	*56,745.0*	*28,981.0*	*38,258.0*	*8,093.0*	*58,975.1*	*73,601.0*

Source: See text, particularly section III.

Note: The current-price GDP estimates are given: in A$ million for the Australian states; in A$ million for NZ in the column denoted NZ1; and in NZ$ million for NZ in the column denoted NZ2. The NZ1 data were converted from NZ$ to A$ using PPP exchange rates derived from Summers and Heston (1991) for the period 1953/54–1985/86. These exchange rates were then extrapolated forward (to 1990/91) and backward (to 1932/33) using changes in the implicit price deflator for both countries (see Ahmad, 1992). The figures in italics are taken from official GDP estimates; all other GDP calculations have been made by the author.

The results in Table 1 for the Australian states confirm the observations of Boehm (1971) and Schedvin (1973), among others, that (apart from the gold-induced expansions of QLD and WA) the general bust of the 1891–1900/01 intercensal period increased in magnitude with any given colony's proximity to VIC. However, the Depression-induced reversal in nominal GDP growth in the 1920/21–1932/33 intercensal period appears to have been more uniform across the states, reflecting the relatively small role played by domestic factors during this period.[17]

Table 2 presents data on the levels of real colonial GDP between 1861–1990/91 (in 1910/11 A$ million), and the (mostly decennial) annualised average growth rates are given in Table 3. The picture presented here is similar to that of Table 1, except that the relatively lower level of the NZ GDP deflator for much of the period of analysis raises the real value of its GDP (when expressed in 1910/11 A$), and is particularly noticeable in the years prior to 1969/70. Table 3 reveals the rapid mean growth rates of real GDP in QLD and WA over the 1861–1990/91 period, and the standard deviation of the growth rates generally diminishes with the size of the economy under consideration (apart from the stable, low-growth case of TAS). These results also confirm previous qualitative findings of the 1861–1891 period as being one of common, rapid growth across the colonies, with growth generally stalling (except for NZ and the gold-induced growth spurts of QLD and WA) in the 1891–1900/01 intercensal period (see also McLean 1989). The relatively slow growth of NZ's real GDP in the 1880s in its relatively rapid growth in the 1890s contrasts with the performance of NSW and VIC during these periods, and this inverse relationship was first noted by Dowie (1963). The

[17]The relative uniformity of output falls across the Australian states during this intercensal period could also reflect the influence of domestic factors at the federal level.

TABLE 2

REAL COLONIAL GDP (1910/11 A$ MILLION), 1861–1990/91

Year	NSW	VIC	QLD	SA	WA	TAS	NZ
1861	39.2	54.5	2.6	7.8	0.7	7.6	10.5
1871	51.9	81.9	10.3	14.1	1.1	6.6	26.9
1881	103.8	111.3	25.6	28.9	2.1	13.6	51.6
1891	153.4	171.8	43.8	37.8	5.5	16.9	67.2
1900/01	170.5	152.8	61.9	37.1	22.2	16.6	95.3
1910/11	272.1	211.3	81.4	62.9	38.3	19.8	148.5
1920/21	305.7	237.3	91.9	69.3	35.7	21.2	164.7
1932/33	331.6	297.5	116.5	74.6	46.3	24.0	*196.2*
1946/47	485.8	401.2	180.9	108.9	71.2	38.1	*439.7*
1953/54	704.7	591.4	243.4	183.9	112.3	52.4	*510.6*
1960/61	974.9	812.6	335.5	232.6	143.6	68.4	*685.6*
1969/70	1,560.2	1,263.9	546.1	354.0	293.5	102.4	*974.4*
1980/81	*2,144.1*	*1,792.4*	*863.6*	*459.2*	*547.0*	*151.0*	*1,241.1*
1985/86	*2,415.0*	*2,023.4*	*1,017.2*	*570.8*	*647.1*	*159.6*	*1,424.1*
1990/91	*2,805.7*	*2,181.3*	*1,204.2*	*615.0*	*811.9*	*171.7*	*1,473.1*

Source: See text, particularly section III.

Note: The sum of the Australian colonial GDP estimates for the period 1946/47–1990/91 (columns one to six) will not exactly equal the official ABS (1993) estimates of Australian GDP due to the inclusion in the latter of the GDPs of the Northern Territory and the Australian Capital Territory, and their non-inclusion after 1946/47 in the state monetary aggregates derived from White (1973). Prior to 1946/47 the two Territories' monetary aggregates had been included in those for SA and NSW, respectively. The figures in italics are derived from official GDP estimates; all other calculations are derived from the author's GDP estimates.

relatively good growth performance of the seven colonies between 1900/01–1910/11 contrasts with the slow (but positive) growth in all colonies during the 1920/21–1932/33 intercensal period. After 1932/33 growth was generally very rapid for all the remaining intercensal periods, with a slight slow-down in the late 1980s.

TABLE 3

GROWTH RATES OF REAL COLONIAL GDP, ANNUALISED PERIOD AVERAGES, IN PERCENTAGE TERMS, 1861–1990/91

Intercensal Period	NSW	VIC	QLD	SA	WA	TAS	NZ
1861–1871	2.81	4.06	13.73	5.97	4.21	−1.45	9.36
1871–1881	6.92	3.06	9.15	7.15	6.76	7.21	6.51
1881–1891	3.91	4.35	5.36	2.66	9.78	2.15	2.66
1891–1900/01	1.06	−1.17	3.45	−0.19	13.92	−0.15	3.48
1900/01–1910/11	4.68	3.24	2.75	5.28	5.46	1.75	4.44
1910/11–1920/21	1.16	1.16	1.22	0.98	−0.71	0.70	1.04
1920/21–1932/33	0.68	1.88	1.97	0.60	2.16	1.04	1.46
1932/33–1946/47	2.73	2.14	3.14	2.71	3.08	3.29	5.77
1946/47–1953/54	5.31	5.54	4.24	7.48	6.51	4.55	2.13
1953/54–1960/61	4.64	4.54	4.59	3.35	3.51	3.80	4.21
1960/61–1969/70	5.23	4.91	5.41	4.67	7.94	4.48	3.91
1969/70–1980/81	2.89	3.18	4.17	2.37	5.66	3.53	2.22
1980/81–1985/86	2.38	2.42	3.27	4.35	3.36	1.11	2.75
1985/86–1990/91	3.00	1.50	3.38	1.49	4.54	1.47	0.68
μ	3.38	2.92	4.70	3.49	5.44	2.39	3.61
σ	1.75	1.71	3.09	2.32	3.43	2.16	2.28

Note: The annualised rate of growth of each colony's real GDP is: $[\ln(RGDP_t/RGDP_{t-T})]/T$, where t is the last year of the sub-period, $t-T$ is the first year of the sub-period, T is the time interval in years between t and $t-T$, and ln is the natural logarithm. RGDP is the real GDP (in 1910/11 A$ million) of each colony, taken from Table 2. μ is the average of the sub-period growth rates; σ is the standard deviation of the sub-period growth rates.

Tables 4 and 5 provide data on real per capita colonial GDP between 1861–1990/91 (in 1910/11 A$), and their associated (mostly decennial) annualised average growth rates. As shown in Table 4, it appears that by the turn of the century a good deal of the real per capita income lost in the depression period of the 1890s had been made up, as conjectured by Sinclair (1976). However there was, as he suspected, significant regional variability in the extent of this process, with fast-growing WA, QLD and NZ easily exceeding their 1891 real per capita income levels, while VIC, TAS, SA and to a lesser extent NSW were in 1900/01 still far below their real per capita income levels of a decade earlier. In Table 4 there is also evidence of mean reversion in per capita GDP levels for the seven colonies, as the initially-poor colonies in 1861 (WA and SA) had by 1900/01 largely "caught up" to their initially-rich counterparts (NSW, VIC and NZ). This pattern of convergence has continued into the 20th century, except for the relatively poor performance of TAS.

TABLE 4

REAL COLONIAL PER CAPITA GDP (1910/11 A$), 1861–1990/91

Year	NSW	VIC	QLD	SA	WA	TAS	NZ
1861	111.8	101.3	86.4	61.4	44.4	85.0	106.5
1871	103.1	111.9	85.4	76.2	41.6	65.5	104.9
1881	138.4	129.1	120.0	104.7	69.9	117.5	96.5
1891	136.5	150.7	111.2	119.7	110.8	115.0	100.6
1900/01	125.8	127.3	124.2	103.4	120.6	96.3	116.8
1910/11	165.3	160.6	134.4	153.9	135.9	103.5	140.3
1920/21	145.5	155.0	121.6	140.0	107.3	99.3	129.5
1932/33	127.5	163.4	122.9	128.3	105.5	105.6	127.8
1946/47	162.7	195.3	163.5	168.6	141.7	148.2	246.9
1953/54	205.8	241.1	184.6	230.7	175.6	169.8	246.1
1960/61	248.9	277.3	220.9	239.9	195.0	195.2	283.9
1969/70	345.0	366.9	304.6	305.7	296.0	264.1	347.5
1980/81	418.3	467.7	376.3	357.4	429.5	360.4	390.8
1985/86	439.3	488.7	391.7	414.6	450.1	359.0	430.6
1990/91	478.4	496.3	410.6	427.3	500.1	368.9	428.9

Source: See text, particularly section III.

Data on the unweighted cross-sectional standard deviation of the logarithm of real per capita GDP, that is, the coefficient of variation, was calculated from the figures given in Table 4. The coefficient of variation for the incomes of the seven colonies shrank over the 131-year period from 0.309 in 1861 to 0.104 in 1990/91: indicating that real per capita incomes across the seven colonies became much more similar over this period. This process was also pronounced for the six Australian states, where the coefficient of variation of state real per capita incomes over the same period shrank from 0.313 in 1861 to 0.111 in 1990/91.

Using the methodology and sources given in section III, Figure 1 depicts for Australia and NZ the real (1910/11 A$) per capita GDP data given in Table 4. While the real per capita income of NZ was larger than for Australia in the period from the mid-1930s until the mid-1970s (see also Gruen, 1986), since that time Australian real per capita incomes have been relatively larger, with the margin between them growing, particularly during the 1985/86–1990/91 sub-period.

An essentially similar pattern emerges with respect to growth rates in Table 5 as that found in Table 3, with some minor differences. The 1860s were generally

TABLE 5

GROWTH RATES OF REAL PER CAPITA COLONIAL GDP, ANNUALISED PERIOD AVERAGES, IN PERCENTAGE TERMS, 1861–1990/91

Intercensal Period	NSW	VIC	QLD	SA	WA	TAS	NZ
1861–1871	−0.81	1.00	−0.12	2.16	−0.65	−2.59	−0.15
1871–1881	2.94	1.43	3.40	3.17	5.18	5.84	−0.83
1881–1891	−0.14	1.55	−0.76	1.34	4.62	−0.22	0.41
1891–1900/01	−0.81	−1.69	1.10	−1.46	0.84	−1.77	1.49
1900/01–1910/11	2.73	2.33	0.79	3.97	1.19	0.72	1.83
1910/11–1920/21	−1.27	−0.36	−1.00	−0.94	−2.36	−0.41	−0.80
1920/21–1932/33	−1.10	0.44	0.09	−0.73	−0.15	0.52	−0.11
1932/33–1946/47	1.74	1.27	2.04	1.95	2.11	2.42	4.70
1946/47–1953/54	3.36	3.01	1.74	4.48	3.06	1.94	−0.05
1953/54–1960/61	2.71	2.00	2.56	0.56	1.50	2.00	2.04
1960/61–1969/70	3.63	3.11	3.57	2.69	4.64	3.36	2.25
1969/70–1980/81	1.75	2.21	1.92	1.42	3.38	2.83	1.07
1980/81–1985/86	0.98	0.88	0.80	2.97	0.94	−0.08	1.94
1985/86–1990/91	1.71	0.31	0.94	0.61	2.10	0.55	−0.08
μ	1.24	1.25	1.22	1.59	1.89	1.08	0.98
σ	1.70	1.26	1.36	1.76	2.08	2.10	1.46

Note: The annualised rate of growth of each colony's real GDP per capita is: $[\ln (RGDPP_t/RGDPP_{t-T})]/T$, where t is the last year of the sub-period, $t-T$ is the first year of the sub-period, T is the time interval in years between t and $t-T$, and ln is the natural logarithm. RGDPP is the real per capita GDP (in 1910/11 A$) of each colony, taken from Table 4. μ is the average of the sub-period growth rates; σ is the standard deviation of the sub-period growth rates.

a slow- or negative-growth decade for colonial per capita incomes, given slow growth in real aggregate incomes and extremely large levels of net international immigration. The 1890s were also a bad decade for colonial per capita growth rates (except for NZ, WA and QLD), as were the 1910/11–1920/21 and 1920/21–

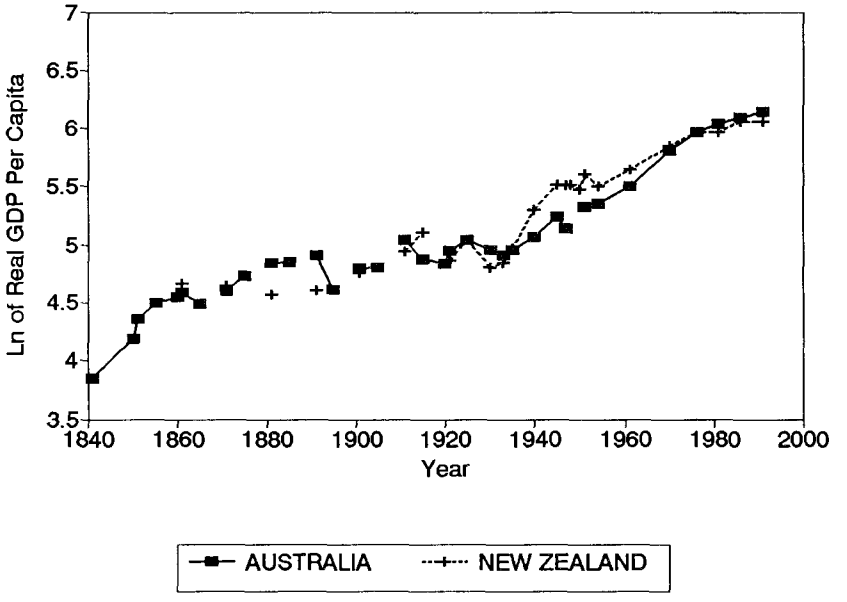

Figure 1. Real GDP per capita (1910/11 A$), 1840–1990/91

1932/33 intercensal periods. Despite another bout of heavy net international immigration in the post-Second World War period, the seven economies enjoyed relatively good rates of growth in real (1910/11 A$) per capita incomes, with a general slowdown of per capita growth rates in the 1980s.

It is important to compare and contrast the high growth rates in real GDP (such as QLD in the 1860s and 1870s, WA in the 1880s, NZ in the 1860s, 1870s and the period 1932/33–1946/47) with relatively low (or even negative) growth rates in real per capita GDP for these same colonies and years, due to the influence of inter-colonial and international flows of labour and capital. The most spectacular example of this is the case of WA in the 1890s, when, chiefly as a result of gold discovery and production, its real GDP grew by 13.92 percent (Table 3), the colony's population grew by 13.08 percent (Vamplew, 1987), and so its real per capita GDP grew by only 0.84 percent (Table 5). These relatively uninhibited factor flows resulted in the standard deviation of the growth of real per capita GDP being generally much less than the standard deviation of the growth of real GDP (see Tables 3 and 5). Several key assumptions are made in using the monetary-based technique to derive these pre-1979/80 state GDP estimates and the pre-1932/33 NZ GDP figures, and these are discussed in section VI below.

V. Robustness of the GDP Estimates

A comparison of my monetary-based estimates of aggregate colonial incomes with offical gross product estimates for the Australian states (available from 1979/80 onwards) reveals that the former are generally very close to the latter, usually within 5–10 percent of the official figures. A similarly small range of discrepancy exists with regard to my estimates of GDP for the Australian states when compared with calculations of aggregate income by earlier researchers.[18] However, previous calculations of colonial aggregate incomes were often made only for individual colonies and for isolated years during the 1861–1990/91 period. Hence, while they are a useful check on the validity of my estimates, they cannot be used here as consistent estimates of colonies GDP.

Haig (1989) presented estimates of per capita GDP for NSW in 1891 and 1900, and his calculations are close to mine for both current-value GDP (1891: Haig A$134.4 m, this paper A$145.9 m; 1900: Haig A$137.2 m, this paper A$148.5 m) and current-value per capita GDP (1891: Haig A$118.0, this paper A$129.7; 1900: Haig A$101.4, this paper A$109.6). Haig's (1989, p. 160) results are even closer to my own when he adjusts Maddison's (1982) per capita GDP figure to account for the revised livestock estimates of McLean and Pincus (1982), and uses the 1985 benchmark for PPP from Summers and Heston (1988) to derive the current-value per capita GDP: (1891: Haig A$132.0, this paper A$129.7; 1900: Haig A$108.2, this paper A$109.6). My estimates also confirm Haig's suspicion that 1891 was an exceptional year for real per capita GDP in NSW, as this figure was exceeded only once previously (in the early 1880s), and was not again

[18]See key contributions by Coghlan (1900, 1902, 1903, 1904), Donovan (1981), Butlin and Sinclair (1984), Harris (1984), Snooks (1973, 1979) and Sinclair (1988). Further details of comparisons between the monetary-based estimates and official and unofficial GDP estimates for the seven colonies can be found in Cashin (1993a).

bettered until sometime during the first decade of this century. Drought, industrial unrest and the fallout from the collapse of VIC output combined to wind back per capita incomes in NSW (and other colonies) in the 1890s.

As noted above, an important test of the robustness of my monetary-based estimates of GDP is their ability to replicate official GDP figures. Using the estimates of NZ GDP of Lineham (1968) for 1918/19–1931/32, Easton (1990) for 1932/33–1945/46 and official figures of NZ GDP for 1946/47–1990/91 from NZ Department of Statistics (1957, 1990, 1993) as a benchmark (denoted as LEO), Figure 2 reveals that my monetary-based estimates are again generally within 5–10 percent of these benchmark LEO figures.[19] This is of some comfort, given that any errors flowing from my use of Australian measures of the income velocity of money in forming the GDP estimates of individual economies are most likely to show up in the NZ estimates.

My methodology for carrying out GDP calculations for NZ differs from that of Rankin (1992), in that I use data on $M1$ as my measure of M_{NZ}, rather than just trading bank deposits. I also follow Hawke (1975) in using V_a as an approximation for V_{NZ}. Despite these differences, my estimates are close to those obtained by Hawke (1975) and Rankin (1992), excepting that for 1921, where both authors appear to overestimate NZ's GDP (which the latter obtained by arbitrary calculation of V_{NZ} between 1913–21 inclusive).

Another important check of my estimates (particularly those for NZ) is the extent to which they are consistent with other data, such as permanent migration (defined to be of at least one year in duration) between NZ and Australia. Table 6 reveals that in periods of higher real per capita GDP for NZ with respect to

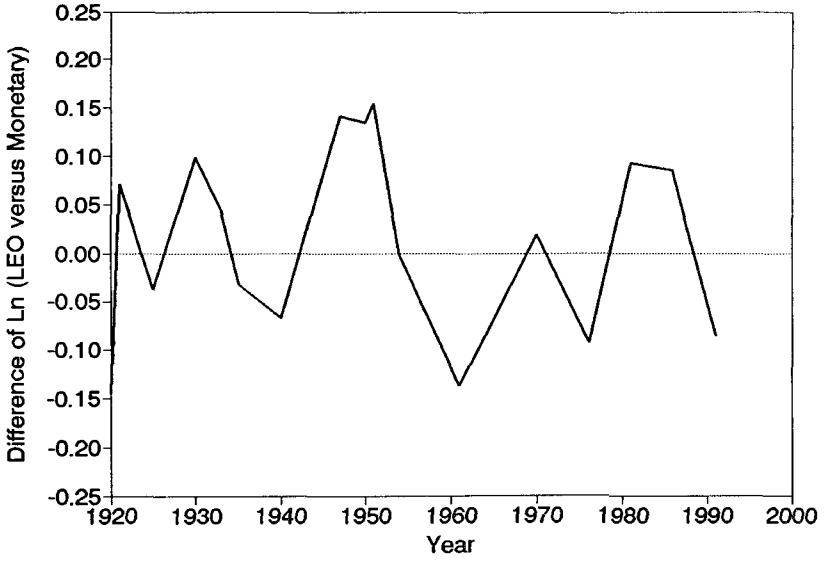

Figure 2. Lineham/Easton/Official (LEO) versus Monetary Estimates of NZ Nominal GDP

[19]A weighted average of the March-based LEO estimates of GDP was calculated to correctly align them with the December-based monetary estimates of GDP.

the Australian colonies (the 1890s through 1910s, mid-1930s through mid-1970s) there is net migration to NZ from Australia.[20] When the opposite holds true (the 1880s, 1920s through mid-1930s, mid-1970s through to the present) there is net migration to Australia from NZ. Of interest is the slight decline in NZ's level of real (1910/11 A$) per capita income between 1985/86–1990/91, the continued growth of Australian state per capita incomes over the same sub-period, and migration data for the 1980s which reveal an annual net migration rate of 6 persons per 1,000 permanently departing from NZ for Australia.

TABLE 6

ANNUAL NET INTERCOLONIAL/INTERSTATE MIGRATION, 1881–1990

Intercensal Period	Annual Net Migration Rate Per Thousand						
	NSW	VIC	QLD	SA	WA	TAS	NZ
1881–1891	3.3	1.2	4.8	−15.8	7.0	−6.6	−3.2
1891–1901	0.6	−7.4	2.4	−6.4	88.6	−0.5	2.4
1901–1911	1.3	−3.8	2.6	−3.5	20.3	−6.8	4.5
1911–1921	2.5	−0.7	0.1	1.4	−9.0	−9.0	−0.4
1921–1933	0.0	0.2	1.7	−1.0	0.2	−7.4	0.2
1933–1947	0.1	0.8	−0.5	−0.7	−2.1	−2.2	−0.1
1947–1954	−1.8	−0.3	3.0	1.6	0.5	0.6	0.05
1954–1961	−1.1	0.1	1.8	0.8	−2.1	−3.0	0.6
1961–1971	−0.9	−1.5	1.6	−1.6	3.8	−3.8	0.07
1971–1981	−2.2	−2.7	7.6	−0.7	2.8	−2.1	−3.2
1981–1990	−3.4	−2.5	9.5	−0.8	4.1	−0.7	−6.0

Source: Rowland (1979); ABS (1987, 1989, 1990); Registrar-General's Office (1921); NZ Department of Statistics (1988, 1991 and earlier years).

Note: Net Migration Rate = [(annual average net migration)/mean population]*1000, where mean population = $(POP_t + POP_T)/2$, and POP_t = population of colony/state at start of period, and POP_T = population of colony/state at end of period. Note that migration data is unavailable for the Australian colonies prior to 1881. Migration data for NZ is net migration to/from Australia, with the latter comprising the six Australian colonies as a whole. Migration data for NSW and SA includes that for the Australian Capital Territory and the Northern Territory prior to 1921.

VI. *CAVEATS* OF THE MONETARY-BASED TECHNIQUE

In using the monetary-based technique it is assumed that the trend income velocity of money ($V_i = Y_i/M_i$, where Y_i is the true colony aggregate income) for each of the seven colonies equals that of Australia as a whole ($V_a = Y_a/M_a$), for which there are both estimates of Australian nominal income (Y_a: Butlin, 1962; McLean and Pincus, 1982; and ABS, 1993a), and Australian monetary aggregates (M_a: Butlin, Hall and White, 1971; White, 1973; Schedvin, 1973 and Vamplew, 1987). This similarity in colonial money demand functions is a reasonable assumption given the geographical, social and political closeness of the economies, and their relatively similar degrees of economic development and urbanisation. Section VI.2 below discusses further the key determinants of colonial money demand.

It should also be noted that each of the seven colonies shared a common, centralised banking system for much of this period (see Simkin, 1951, p. 194; Hawke, 1975, p. 302), although the important role of the Post Office Savings Bank

[20]See Arnold (1986) for further details on the migration of Australians to NZ at the turn of the century.

in NZ and NZ's much more decentralised population could have had significant effects on its demand for money, relative to the other six economies.[21] The highly-centralised Australasian banking sector was and is characterised by the overwhelming dominance of several large commercial banks, which operate in all states (including NZ), and each of which has significant national branch networks. This contrasts with the U.S., where many hundreds of decentralised, locally-based banks operate, more often than not solely within a particular town, state or region.[22]

The monetary technique's chief limitation lies in the potential contamination of the constructed velocity series (V_a) by differences between the economic experiences of particular colonies and that of Australia as a whole. Despite the aforementioned similarities existing between the seven colonies, Australasian GDP is (and has been) largely concentrated in four colonies (NSW, VIC, NZ and QLD) over most of the 1861–1990/91 period (see Table 1). As a consequence, the dominance in the weighting of Y_a and M_a of these colonies could bias the resulting V_a calculated by the monetary technique, which is then used to derive the estimated colonial GDPs, $\hat{Y}_i$. This bias would be particularly pronounced if: (i) the coverage of monetary data and/or the development of each colony's financial sector differed between the colonies, or (ii) if not all colonies were at similar stages of economic development during the period under analysis. The consequences of any such differences for the estimated level of real per capita colonial GDP are examined below.

VI.1. *Differential Coverage of Monetary Data*

While Friedman (1961) noted that monetary data usually has an advantage in becoming available early in an economy's development, he also listed some of its chief defects. The latter may, as a consequence, preclude monetary data from providing satisfactory estimates of an economy's money stock, on which estimates of aggregate income are partly based. The defects involve a lack of data on: holdings of coinage and other currency by the non-bank public; demand and time deposits in commercial banks; and other time and savings deposits. The latter two problems could preclude the use of broader definitions of money, such as *M*2 or *M*3, which are likely to be the more relevant definitions for economies with relatively well-developed financial systems. A further defect is that even if such

[21]Hawke (1975, p. 306) argues that the seven colonies shared the same banking system prior to the 1930s, although the Commonwealth Bank (established in 1912) had exercised some mild influence on the economy as Australia's *de facto* central bank (its central banking responsibilities and powers were formally set out in 1945), and the Reserve Bank of Australia began operations as a completely separate entity in 1960. The Reserve Bank of New Zealand was not established until 1934, although the Bank of New Zealand had been the *de facto* central bank since 1862 (see Quigley, 1992). Three of the six trading (or commercial) banks operating in NZ between 1873–1895 were Australian banks, three of the five between 1895–1912, and four of the six between 1912–1933. Moreover, the Bank of NZ was active in the Australian financial market over the whole of the above period (Hawke, 1975).

[22]Australasian trading (that is, commercial) banks and savings banks operate under a branch banking system where each bank has a head office located in a capital city (usually Melbourne or Sydney), with a large number of branches conducting a full range of banking operations over a broad geographical area.

differentiation of money stocks is available, it may only be so for a relatively small number of large banks, rather than for all banks.

In the context of the Australasian colonies the above defects are likely to present few problems, as banking in Australia and NZ is dominated by a few large banks, and the data on money aggregates derived from Butlin, Hall and White (1971), White (1973) and Sheppard, Guerin and Lee (1990) give a complete coverage of the deposits of all banks for all years. Moreover, Schedvin's (1973) pre-1900/01 currency data includes estimates of holdings of coinage and other currency by the non-bank public, as do the post-1900/01 estimates of Butlin, Hall and White (1971) and White (1973), on which Schedvin's data is based.[23]

VI.2. *Economic Causes of Differences in M_i*

Two stylised facts arising from early work on the income velocity of money (V) by Doblin (1951), Selden (1956), Friedman (1959, 1961), and Cagan (1965) were: that V was inversely related to the level of per capita income (both between economies and over time in any given economy); and that V also declines as an economy becomes more diversified in its structure of production. In the present context use of the monetary technique is likely to induce measurement errors in estimating the true colony GDPs when differences arise between the regions in the determinants (and thus the value) of V_i, given that (as noted in section VI.1) data on regional money stocks (M_i) is robust, due to its complete coverage of colonial financial institutions.

The literature on the income velocity of money ($V = Y/M$) has attributed the above decline in V to increases in M arising from: (i) growing differentiation of production in the economy which interrupts the synchronisation of payments and necessitates larger cash reserves; (ii) as economies develop there is a shrinkage in the share of total production both consumed by the producer and performed as barter trade, inducing a rise in M by this process of monetization (Tobin, 1965); (iii) a change in the habits of wage payments over time from daily to weekly to two-weekly (and longer) payment periods, resulting in a larger M (Fisher, 1911, pp. 79–88); (iv) the development of the commercial banking system of a country both supplies the public with fiat money and allows bank accounts to be used as wealth repositories (hence raising M), whereas in more backward financial systems such assets are held in a less-liquid form (Cameron, 1972); (v) as development occurs there is likely to be a disproportionate growth in the share of purely financial transactions, requiring the holding of increased M (Doblin, 1951); and (vi) a larger population size could also contribute to a reduction in V as it increases the number of decentralised decision-makers who need to hold M to carry out their transactions (Leff, 1972). Conversely, Cagan (1956) found that: (vii) V rises in the presence of rapid inflation as agents transfer their wealth into

[23]From 1817–1910 Australia operated under a free-banking system, after which a prohibitive federal tax on the issuance of such bank notes paved the way for the monopolisation of the power of note issue by the Commonwealth Government. From 1826–1929 (after a brief flirtation in issuing notes in terms of Spanish dollars) the Australian colonies (and later the Commonwealth of Australia) essentially operated under a British sterling-exchange standard [at a fixed (parity) rate of exchange] for the Australian pound, with British units of monetary accounting and British coins in local circulation. See Butlin (1953) for details.

non-money forms to escape real wealth losses; and Selden (1956) argued that: (viii) an increase in nominal interest rates raises the opportunity cost of holding M, thus tending to raise V.

In the Australasian context, it should be noted that in the 1860s convicts comprised a disproportionately large share of the population of both WA and TAS. Thus, the holding of M by the government (as a major employer in the colony) for wage payments, and the need for convicts to hold M for transactions purposes, were both reduced.[24] In addition, the gold discoveries and exploitation of the 1850s and 1860s occurred mainly in NSW, VIC and NZ, those of the 1890s mainly in WA and QLD, and both rapidly and disproportionately increased M in these colonies relative to all others.

Of the above influences leading to differing V_i, (iii) seems unlikely in the context of the Australasian colonies, due to the similarity across colonies in the social influences on payment periods. Similarly, both Cagan's inflation argument and inter-colonial differences in Selden's key interest rate variable are highly unlikely here, given the similarity of the experiences of the colonies in both changes in their respective price levels (see section III.1) and the level of their nominal interest rates.[25]

Note also that the monetary technique relies on the presumption that all or most economic activities (transactions) are paid for by "money," however defined, rather than by the barter exchange of goods and services, or the consumption of home-produced goods. While this may not have been strictly true in the early years of the survey period (1861–1991), it is certainly so in most of these years. To the extent that this is not correct, then colonial GDP estimates calculated here (that is, monetized GDP) will underestimate the true colony GDPs. Further, if the income elasticity of money demand (η) diverges from one [$\eta = 1$ is assumed in equation (1)], then a one percent change in nominal aggregate income for colony i, Y_i, will lead to greater than one percent change in the colony stock of

[24]The last of the convict colonies were TAS (last convict ship landed in 1853) and WA (1868). In 1871 the population of WA was 25,353, of whom some 9,000 were convicts and their families (Hughes, 1986). As late as 1850, some 51.5 percent of the male workforce in NSW and TAS were convicts and ex-convicts (Butlin, 1985). While the gold rushes of the 1850s and 1860s would have greatly reduced the share of convicts in NSW, no such drastic dilution would have occurred in TAS or WA. Note that NZ, VIC and SA received no convict shipments at any time during their history, and hence the migration component of their population increases was wholly due to free immigrants. WA was also convict-free from its initial settlement in 1827 until 1850, when the first shipment arrived. The first settlement in QLD was established as a penal station in 1824, and was subsequently closed down in 1842.

[25]Evidence from Butlin, Hall and White (1971, p. 96), Boehm (1971, p. 211), Butlin (1953) and Butlin (1986, pp. 317–32) indicates that up until the early 1870s, sustained differences in bank deposit and lending rates between the colonies sometimes occurred, despite attempts at collusion among banks in setting rates. However, with the introduction of telegraphic transfer technology in 1872, better communications made rapid interest rate arbitrage a possibility, and so the separate colonial rates converged at about this time. Accordingly, it is argued that the use of a *single*, continent-wide interest rate implied in the V_a measure is justified over most of the 1861–1991 period. Moreover, a key feature of Australasia's centralised banking system is that interest rates are set at a national level, so there is no regional variation in rates as there continues to be in the U.S. A potential *caveat* to using variations in nominal interest rates across economies to explain changes in V is that $M3$ includes time deposits, which bear an interest rate presumably highly correlated with market rates of interest. The proper variable would then be the differential across colonies of this market rate from the rate on time deposits. There appear to be no *a priori* reasons why this differential would not also have been equalised across colonies due to arbitrage.

money, M_i (for money as a superior good: $\eta > 1$). Hence, the true colony velocity, V_i, will be less than the Australian average velocity, V_a (which is calculated under the assumption that $\eta = 1$), and consequently the monetary-based technique will overestimate colonial nominal incomes ($\hat{Y}_i > Y_i$). The opposite occurs for $\eta < 1$.

The time-series evidence for V_a indicates that, in common with other countries with relatively advanced financial systems, V_a (based on $M3$, although similar results are found for $M1$) at first fell from 3.38 in 1861 to a low-point of 1.01 in 1947, thereafter rising to reach 2.53 in 1981 and 1.87 in 1991. The evidence for the 1861–1947 period thus appears consistent with $\eta > 1$, and the evidence for 1947–91 with $\eta < 1$.

Of the above rationales for differing V_i, those of (i), (ii), (iv)–(vi) and the specific Australasian influences seem more promising candidates for the inducement of measurement errors in $\hat{Y}_i$ as a result of using V_a (rather than the true V_i) for each of the i colonies. To the extent that certain colonies (TAS, SA and WA seem the most likely): possessed relatively "less-advanced" economic structures (for example, were more agricultural-based); or were relatively backward in terms of their structures of financial intermediation; or carried out relatively less purely financial transactions; or were simply relatively "small" in GDP terms; or had a relatively large share of their workforce as convicts; or mined a small share of Australia's gold, then it would be expected that the ratio of an individual colony's income to its money stock would be greater than the velocity for Australia as a whole (that is, $Y_i/M_i = V_i > V_a = Y_a/M_a$). Hence the monetary-based technique, in attributing V_a rather than V_i to such (low M_i) colonies would induce an underestimate of the true regional velocity for these relatively backward regions, and thus the calculated nominal colony aggregate incomes ($\hat{Y}_i$) would underestimate the true (Y_i) nominal colony aggregate incomes ($M_iV_i = Y_i > \hat{Y}_i = M_iV_a$).[26]

VII. Conclusion

Using the income variant of Fisher's (1911) money identity, the first consistent set of long-run data on real per capita GDP has been calculated for the seven Australasian colonies of Britain. The data reveal the path of economic growth by which, in the space of 70 years, these economies rose from mendicant penal and agricultural colonies to among the world's richest economies (as measured by real per capita incomes). The Australasian colonies were excellent candidates for the use of money stocks to estimate national income, given the long time series of high-quality, consistently-defined monetary data available.

In constructing the colonial GDP estimates two key assumptions have been made: that the income velocity of money for each of the colonies is the same and equal to the national (Australian) income velocity of money; and that the deflator

[26]As an indication of the differing degrees of monetization in the colonies, data on the number of persons per trading (commercial) bank branch in each Australian colony was taken from Butlin (1986). It reveals that while in 1861 WA and TAS have numbers clearly larger than the other four Australian colonies, by 1881 TAS appears to be the sole remaining outlier. So from the early 1880s it appears that the spread of branch banking across the six Australian colonies ensured that approximately the same quantity of per capita banking services was available in most of the colonies. Consequently, the likelihood of differences across colonies in their respective income velocities of money appears to have been relatively low after 1881.

used across all colonies (except for NZ) is the national (Australian) implicit GDP deflator. It was stated that the strong similarities exhibited by the colonies argued in favour of the plausibility of both of these assumptions. A number of *caveats* were presented regarding the former assumption, which if incorrect could induce measurement error in the calculation of aggregate colonial incomes.

Notwithstanding these difficulties and the potential superiority of colonial GDP estimates constructed from product or factor reward data, the estimates presented here have the advantage of exploiting fully the available monetary data, and are calculated on a consistent basis across all seven colonies for the 131-year period between 1861–1991. These colonial GDP estimates provide for the first time information on the economic development of the colonies, revealing the historical pattern of the dominance of NSW, VIC and NZ in Australasian real GDP. They also provide evidence of convergence in the levels of real per capita incomes across the seven colonies, as the decline in the dispersion of real per capita incomes between 1861–1991 indicates that incomes in the colonies have become more similar over this period.

References

Ahmad, S., Improving Inter-Spatial and Inter-Temporal Comparability of National Accounts, Conference on Data Base and Development Analysis, Yale University, May, 1992.

Arnold, R. The Dynamics and Quality of Trans-Tasman Migration, 1885–1910, *Australian Economic History Review*, 26, 1–20, 1986.

Australian Bureau of Statistics, *Australian Demographic Trends 1986*, Cat. #3102.0, Canberra, 1987.

———, *Projections of the Populations of Australia, States and Territories 1987 to 2031*, Cat. #3222.0, Commonwealth Government Printer, Canberra, 1989.

———, *Projections of the Populations of Australia, States and Territories 1989 to 2031*, Cat. #3222.0, Commonwealth Government Printer, Canberra, 1990.

———, *Australian National Accounts: State Accounts 1991–1992*, Cat. #5220.0, Canberra, 1993.

———, *Australian National Accounts: National Income, Expenditure and Product, 1991–1992*, Cat. #5204.0, Canberra, 1993a.

Barro, R. J. and Sala-i-Martin, X., Convergence, *Journal of Political Economy*, 100, 223–251, 1992.

Bloomfield, G. T., *New Zealand: A Handbook of Historical Statistics*, G. K. Hall and Coy., Boston MA, 1984.

Boehm, E. A., Measuring Australian Economic Growth, 1861–1938/39, *Economic Record*, 41, 207–239, 1965.

———, *Prosperity and Depression in Australia, 1887–1897*, Oxford University Press, Melbourne, 1971.

Butlin, N. G., *Australian Domestic Product, Investment and Foreign Borrowing, 1861–1938/39*, Cambridge University Press, Cambridge, U.K., 1962.

———, White Human Capital in Australia: 1788–1850, Working Paper in Economic History #32, Australian National University, Canberra, 1985.

Butlin, N. G. and Sinclair, W. A., Australian Gross Domestic Product 1788–1860: Estimates, Sources and Methods, ANU Source Papers in Economic History #2, Canberra, 1984.

Butlin, S. J., *Foundations of the Australian Monetary System, 1788–1851*, Melbourne University Press, Melbourne, 1953.

———, *The Australian Monetary System 1851 to 1914*, Ambassador Press, Sydney, 1986.

Butlin, S. J., Hall, A. R., and White, R. C., *Australian Banking and Monetary Statistics 1817–1945*, Reserve Bank of Australia Occasional Paper #4A, Sydney, 1971.

Cagan, P., The Monetary Dynamics of Hyperinflation, in Friedman, M. (ed.), *Studies in the Quantity Theory of Money*, University of Chicago Press, Chicago, pp. 25–120, 1956.

———, *Determinants of Changes in the Stock of Money, 1875–1900*, NBER, Columbia University Press, New York, 1965.

Cameron, R., *Banking and Economic Development*, Oxford University Press, London, 1972.

Cashin, P. A., Essays on Economic Growth: The Effect of Government on Growth, and an Analysis of Growth in, and Convergence Across, the Seven Colonies of Australasia, unpublished Ph.D. dissertation, Department of Economics, Yale University, New Haven, 1993.

———, Using Data on Money Stocks to Estimate Real Colonial GDP in the Seven Colonies of Australasia: 1861–1991, Discussion Paper #687, Economic Growth Center, Yale University, New Haven, 1993a.
———, Economic Growth and Convergence Across the Seven Colonies of Australasia: 1861–1991, Discussion Paper #688, Economic Growth Center, Yale University, New Haven, 1993b.
Chan, A., New Zealand, the Australian Commonwealth and 'Plain Nonsense', *The New Zealand of History*, 3, 190–195, 1969.
Coghlan, T. A., *A Statistical Account of the Seven Colonies of Australasia*, 8th edition, Government Printer, Sydney, 1900.
———, *A Statistical Account of the Seven Colonies of Australasia*, 9th edition, Government Printer, Sydney, 1902.
———, *A Statistical Account of Australia and New Zealand 1902–03*, 10th edition, Government Printer, Sydney, 1903.
———, *A Statistical Account of Australia and New Zealand 1903–04*, 11th edition, Government Printer, Sydney, 1904.
Doblin, E. M., The Ratio of Income to Money Supply: An International Survey, *Review of Economics and Statistics*, 33, 201–213, 1951.
Donovan, J. B., Social Accounting Measures of Regional Growth, in Mathews, R. L. (ed.), *Regional Disparities and Economic Development*, Centre for Research on Federal Financial Relations, Canberra, pp. 221–254, 1981.
Dowie, J. A., Inverse Relations of the Australian and New Zealand Economies, 1871–1900, *Australian Economic Papers*, 2, 151–179, 1963.
Easton, B., A GDP Deflator Series for New Zealand, 1913/14–1976/77, Massey Economic Papers B9004, Massey University, 1990.
Fairburn, M., New Zealand and Australasian Federation, 1883–1901: Another View, *The New Zealand Journal of History*, 4, 138–159, 1970.
Fisher, I., *The Purchasing Power of Money*, Macmillan, New York, 1911.
Friedman, M., The Demand for Money: Some Theoretical and Empirical Results, *Journal of Political Economy*, 67, 327–351, 1959.
———, Monetary Data and National Income Estimates, *Economic Development and Cultural Change*, 9, 267–286, 1961.
Gruen, F. H., How Bad is Australia's Economic Performance and Why?, *Economic Record*, 62, 180–193, 1986.
Haig, B., International Comparisons of Australian GDP in the 19th Century, *Review of Income and Wealth*, 35, 151–162, 1989.
Harris, C. P., *Regional Economic Development in Queensland*, Centre for Research on Federal Financial Relations, Canberra, 1984.
Hawke, G. R., Income Estimation from Monetary Data: Further Explorations, *Review of Income and Wealth*, 21, 301–308, 1975.
Hughes, R., *The Fatal Shore*, Vintage Books, New York, 1986.
Leff, N. H., A Technique for Estimating Income Trends from Currency Data and an Application to Nineteenth Century Brazil, *Review of Income and Wealth*, 18, 355–368, 1972.
Lineham, B. T., New Zealand's Gross Domestic Product 1918–38, *New Zealand Economic Papers*, 2, 15–26, 1968.
Maddison, A., Phases of Capitalist Development, *Banco Nazionale Del Lavoro Quarterly Review*, 121, 103–138, 1977.
———, Per Capita Output in the Long Run, *Kyklos*, 32, 412–429, 1979.
———, *Phases of Capitalist Development*, Oxford University Press, London, 1982.
McLean, I. W., Growth in a Small Open Economy: An Historical View, in Chapman, B. (ed.), *Australian Economic Growth: Essays in Honour of Fred H. Gruen*, Centre for Economic Policy Research, Canberra, pp. 7–33, 1989.
McLean, I. W. and Pincus, J. J., Living Standards in Australia 1890–1940: Evidence and Conjectures, Working Paper #6, Working Papers in Economic History, Australian National University, Canberra, 1982.
New Zealand Department of Statistics, *Official Year-Book*, 62nd edition, Government Printer, Wellington, 1957.
———, *Demographic Trends 1988*, Government Printer, Wellington, 1988.
———, *Official 1990 Yearbook*, 94th edition, Government Printer, Wellington, 1990.
———, *Demographic Trends*, Government Printer, Wellington, 1991.
———, *Official 1993 Yearbook*, 96th edition, Government Printer, Wellington, 1993.
Organisation for Economic Cooperation and Development, *National Accounts*, Main Aggregates, Volume 1, 1960–91, Paris, 1993.

Quigley, N. C., Monetary Policy and the New Zealand System: An Historical Perspective, Discussion Paper G92/1, Reserve Bank of New Zealand, Wellington, 1992.
Rankin, K., New Zealand's Gross National Product: 1859–1939, *Review of Income and Wealth*, 38, 49–69, 1992.
Registrar-General's Office, *Statistics of the Dominion of New Zealand, 1920*, Volume III, Government Printer, Wellington, 1921.
Reserve Bank of New Zealand, Annual Estimates of M1 and M3: 1862–1982, *Reserve Bank Bulletin* 53, 407–411, 1990.
———, *Reserve Bank Bulletin*, December Quarter, Government Printer, Wellington, 1992.
Rowland, D. T., *Internal Migration in Australia*, Catalogue #3409.0, Australian Bureau of Statistics, Canberra, 1979.
Schedvin, C. B., A Century of Money in Australia, *Economic Record*, 49, 588–605, 1973.
Selden, R. T., Monetary Velocity in the United States, in Friedman, M. (ed.), *Studies in the Quantity Theory of Money*, University of Chicago Press, Chicago, 179–257, 1956.
Sheppard, D. K., Guerin, K., and Lee, S., *N.Z. Monetary Aggregates and the Total Assets of Leading Groups of Financial Institutions, 1862–1982*, Money and Finance Group, Victoria University of Wellington, Discussion Paper #11, 1990.
Simkin, C. G. F., *The Instability of a Dependent Economy: Economic Fluctuations in New Zealand, 1840–1914*, Oxford University Press, London, 1951.
Sinclair, W. A., *The Process of Economic Development in Australia*, Cheshire Publishing, Melbourne, 1976.
———, Gross Domestic Product, in Vamplew, W. (ed.), *South Australian Historical Statistics*, Historical Statistics Monograph #3, Printing Unit, University of NSW, Sydney, 25–36, 1988.
Snooks, G. D., Depression and Recovery in Western Australia, 1928–29 to 1938–39: A Deviation from the Norm, *Economic Record*, 49, 420–439, 1973.
———, The Arithmetic of Regional Growth: Western Australia 1912/13 to 1957/58, *Australian Economic History Review*, 19, 63–74, 1979.
Summers, R. and Heston, A., A New Set of International Comparisons of Real Product and Prices: Estimates for 130 Countries, *Review of Income and Wealth*, 34, 1–26, 1988.
———, The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–88, *Quarterly Journal of Economics*, 106, 327–368, 1991.
Thompson, B. J. and Nesbit-Savage, R., New Zealand Consumers' Price Index, 1847–1991, Working Papers in Economics, University of Waikato, Waikato, 1994.
Tobin, J., The Monetary Interpretation of History, *American Economic Review*, 55, 464–485, 1965.
Vamplew, W. (ed.), *Australians: Historical Statistics*, Fairfax, Syme and Weldon Associates, Broadway NSW, 1987.
White, R. C., *Australian Banking and Monetary Statistics 1945–1970*, Reserve Bank of Australia, Occasional Paper #4B, Sydney, 1973.
Wood, F. L. W., Why Did New Zealand Not Join the Australian Commonwealth in 1900–1901?, *The New Zealand Journal of History*, 2, 115–129, 1968.