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Gross Capital Formation and Improved Estimates of Real Gross and Net Capital Stocks to 1990 for the New Zealand Non-Market Production Sector.

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ABSTRACT

This paper presents estimates of real capital formation, and real gross and net capital stocks, for the New Zealand public non-market services sector (NZSNA sectors 22 and 23) the major components of which are in the areas of public health, education, welfare, administration and defense, and road and harbour infrastructure. Gross capital formation and capital stock time series for New Zealand are largely incomplete except for those prepared for the period 1950-90 by Bryan Philpott as a part of the Research Project on Economic Planning. This paper builds upon this work by extending the capital formation series of Philpott (1992-b) backwards through time allowing improvements to be made to the retirement estimates that are one of the components of the post-1949 capital stock series of Philpott (1992-a).

Gross capital formation series are an important pre-requisite of capital stock estimation by the perpetual inventory method. If empirical information on the pattern of asset retirement within the period of investigation is incomplete, or a capital stock valuation within the desired time period of the capital stock estimation is not available, the capital formation series needs to be taken back to the formation time of the longest-surviving element in the capital stock at the commencement of the stock series. This also defines the time period of relevant price indexes, the second requisite of the perpetual inventory model. A non-trivial part of the road infrastructure capital stock is considered to have a near-eternal life, necessitating the estimation of a gross capital formation series at the commencement of European-based settlement. Because of incomplete empirical information on public capital expenditures and on the course of prices of capital assets prior to c. 1914 estimates of real gross capital formation prior to c 1914 can be expected to be more problematic than those after this time. Stock point estimates are compared with other capital valuations utilising different estimation procedures which indicate that the magnitude of error is likely to be small.

Keywords: Capital Stock, Capital Formation, Capital Price Indexes, Non-Market Sector, New Zealand.

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CONTENTS

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INTRODUCTION:

This paper presents estimates of real capital formation, and real gross and net capital stocks, for the New Zealand public non-market sector defined as the following sectors: public education, public health, public administration and defense, and public transport infrastructure excluding those outlays associated with railways and air transport[1]. The main aim was to present estimates of capital stocks from 1950 to 1990 calculated according to the perpetual inventory method which largely determined the terms of reference of the capital formation series. The reliability of estimates for capital formation can be expected to lessen backwards through time depending on the coverage and reporting procedure of the returning authority. Most resources were spent in the preparation of transport infrastructure outlays, which are estimated to be the largest area of capital expenditure in the non-market sector i.e. 65% of the gross non-market capital stock at 1950. The estimates for the administration sector can be considered to be the most uncertain of the four sectors.

Estimates for gross and net capital stocks for the non-market sector have been prepared by Philpott (1992). This paper utilises much the same procedure and source material for gross capital formation for the period 1950-1990 but through the assembly of capital formation series to 1950 it is possible to improve upon the estimates of this paper in two key ways. First, the procedure of estimating a 1950 real gross capital stock starting date for the non-market sector by the conversion of balance-sheet book valuations via the application of a conversion factor based upon the relationship between these parameters in the manufacturing sector (for which there existed an accessible long-run capital formation series beginning in 1910) can be avoided. Second, the age structure of the stock at 1950 and hence the pattern of retirement over the period 1950-90 in Philpott(1992) was assumed to parallel that of the manufacturing sector. Both procedures rest critically upon the respective patterns of investment and inflation in the manufacturing and non-market sectors in the period 1910-1950. Some attention is given to these variables in the appendix below. This paper also can be considered to improve upon Philpott (1992) in the area of asset retirement by using where available direct and/or supplementary information to estimate retirement and by using a sectoral disaggregation of mean asset life assumptions instead of the composite-average approach used in that paper.

The paper is organised as follows. Section 1 introduces the perpetual inventory method and indicates the requisites of the model. Section 2 is concerned with the estimation of capital formation series, section 3 with the preparation of capital price indexes, and section 4 with the estimation of the retirement of the capital assets. Constant-priced gross and net capital stocks for each sector are presented in section 5, section 6 assesses the estimates as derived by the perpetual inventory method in the light of alternative methods, namely either market or net-current value as utilised by the New Zealand Treasury Department or via the valuation of physical survey data. This is followed in the conclusion and the appendix that follows this by a comparison of the results with those of Philpott (1992).

SECTION 1: THE PERPETUAL INVENTORY METHOD OF CAPITAL STOCK ESTIMATION

The method used to estimate stocks of capital is the perpetual inventory method. Gross capital stocks in year t consist of the stock estimated to exist at year t - 1 plus the net capital formation occuring in year t viz

$$GK_t^i = GK_{t-1}^i + GI_t^i - R_t^i \qquad (1)$$

GK_t^i = Gross capital stock of asset i at time t

GI_t^i = Gross investment in i during t

R_t^i = Retirements of i during t

In the absence of information on R the retirement of capital assets is usually approximated via some retirement rate r:

$$R_t^i = r_i Gk_{t-1}^i \qquad (2)$$

r_i =retirement rate for good i

and the method of estimation of GK_t becomes:

$$GK_t^i = GI_t^i + (1-r_i)GK_{t-1}^i \qquad (3)$$

$$GK_t^i = \sum_{m=t-\theta^i}^{t-1} \lambda_{t-m}^i GI_m^i \qquad (4)$$

λ_i^i = proportion of original investment existing in each year after introduction to the stock $j = 1,2,...n$

θ^i = age of the oldest asset of type i in existence

The estimation of depreciated or net capital stocks parallels that of gross stocks, viz

$$NK_t = NK_{t-1} + GI_t - D_t \qquad (5)$$

$$NK_t = \sum_{m=t-\vartheta}^{t-1} \lambda_{t-m} GI_m C_{t-m} \qquad (6)$$

NK_t = Net Capital Stock in time t

D_t = depreciation during t

C_j = proportion of capital invested in j not used up in time period

The perpetual inventory method thus has three basic requirements:

i) historical time series of capital expenditures for the relevant SNA groups. If estimates of the value of the capital stock at starting date are not available, then time series should extend back as far as the assumed average age of the oldest asset.

2) price indices relevant to the components of the capital formation series, adjusted for quality changes and technical improvements.

3) information on asset service lives and their rate of retirement from productive use.

As indicated above, these three requirements of the perpetual inventory method are the concern of the next three sections of the paper[2].

SECTION 2: ESTIMATES OF GROSS CAPITAL FORMATION 1846-1990

There exists very little compiled information on gross capital formation prior to 1950 apart from partial and aggregate information for public capital formation for the period 1871-1900 from Dowie (1965)[3]. From 1950 to 1972 estimates for much of the non-market sector can be found in a 1978 RPEP Internal Paper by Ben Shinawatra; thereafter estimates prepared by the Official Government Statistician are used[4].

Estimates for gross capital formation on buildings in the public health sector begin in 1879 reflecting the implied capital formation date of the oldest surviving part of the stock at 1950 under the asset life assumptions for structures utilised for this sector (see section 3). To 1940 these consist of all outlays out of the public works fund on health institutions plus Hospital Board outlays on additions and new buildings from 1887 when this is first recorded[5]. Estimates for non-transport equipment are begun in 1930 and for transport equipment from 1936. After 1940 expenditure on public buildings from the public works fund was not given by sector. Total capital expenditure by the Hospital Boards for the period 1945-50, and on mental hospitals for the period 1941-50 was available. The series on additions and new works undertaken by hospital boards was continued to 1945; estimates for 1941-45 do not include outlays from the public works fund except for mental hospitals, nor do they include payments under the War Expenses account, for which only partial information was available. For 1950 to 1971 Shinawatra (1978) was utilised; her hospital board outlays were not given by asset type, and in order to disaggregate her series annual consents for furniture and equipment taken from Hospital Statistics were deducted[6]. Gross capital formation by six capital asset types for the period 1972-1989 comes from the government statistician.

Gross capital formation in public education structures begins in 1903, there being available an inventory of the bulk of the education building stock for 1902. For the period 1903-1907 building expenditure for each branch of education was taken from their annual reports. From 1908 capital expenditure in all areas of public education was compiled in Education department reports. From 1950 to 1971 disaggregation into asset type[7] was undertaken by reference to Shinawatra (1978), with gross capital formation for the period 1972-1989 by six asset types being provided by the Government Statistician. Land purchase was deducted from estimates in the period 1950-71 but not for the period before this as there existed an offsetting error source for part of this period[8].

Capital formation estimates for administration and defense are of more reliable for central government than for local government, and structures more reliable than plant and equipment. Estimates for both sectors begin in 1903. The former consists of annual expenditure on public buildings out of the public works fund other than that best allocated to another sector. As this will not incorporate all capital expenditure in this sector outlays are inflated by a factor derived from the average difference between these and more reliable point estimates at 1900 and 1950[9]. For the period 1950-71 Shinawatra's estimates by three asset types is used, while for 1972-89 Philpott (1990) details capital formation by six asset types.[10] Plant and equipment estimates from 1933-1950 are based on Brownlie (1956).

Estimates for local government administration structures capital formation are based upon the expenditure of the dominant authority, boroughs, recorded in the

Municipal Handbook and the Local Authorities Handbook. Construction out of loan monies was recorded according to functional classification but that from other sources was not. For the borough administration sector a series for the latter was calculated by weighting annual outlays by the percentage that administration outlays out of loan monies were in total loan-funded capital works for each year. This series was disaggregated into construction and buildings or plant and equipment according to the weighting utilised by Shinawatra (1978). To derive a total local government administration capital series for each broad asset this series was weighted according to the extent to which borough capital assets book valuations made up the total book value of local administration capital assets at 1950[11]. Gross capital formation for the period 1950-71 is taken from Shinawatra and for the period 1972-89 from the government statistician.

Roading capital formation is taken back to the first recorded expenditure (1846)[12], with estimates being more reliable from 1915-1917 then before this time. Estimates to 1852 come from Statistics of New Zealand for the Crown Colony Period, and will contain an unknown element of port infrastructure. From 1862 outlays by both provincial and central government can be found in Statistics, but for the period 1853-61 quantitative evidence is incomplete and difficult to access. There exists full coverage of provincial revenue, and a complete series of expenditure by category is available for the province of Wellington. First approximations were derived by assuming that the average allocation for public works in Wellington for this period held in the aggregate[13], with the proportion of transport infrastructure in total public works for the period 1846-1852 (67%) used for a second approximation. All estimates to 1862 were assumed to represent capital expenditure i.e. maintenance in this period was assumed to be negligible and/or expended from another source.

Dowie (1965) has prepared estimates of central government roading from Public Works Department annual returns, and aggregate local authority capital outlays out of Statistics for the period 1871-1900. The same primary sources are used to continue estimates to 1928. From 1862 to c 1915 the major uncertainty with estimates is the allocation of infrastructure expenditure into capital and current expenditures according to SNA standards. Uncertainty is less in the case of outlays directly from the public works funds, as to 1900 there exists information which allows non-capital expenditures to be deducted while this information and partial information to 1915 allows similar deductions to be made for central government expenditure to 1927[14].

Local authority gross capital formation estimates are more problematic, as the component of current expenditure in the investment outlays is unlikely to be trivial[15] and there is little evidence on the proportion of roading outlays in aggregate expenditure at this time. Information on the reported distinction between capital and current outlays is available for those authorities that undertook roading construction as part of their activities for the period 1915-1928, while all apart from two[16] explicitly or implicitly gave information on their (aggregate) roading outlays from c.1900-1928. The average proportion of capital expenditures and of roading expenditures in total outlays that held for each authority over these periods was used to estimate capital expenditure on the roading network for the period 1862-1915. The critical assumptions centre around the stability of the various works vote[17] and the magnitude of the expected differential in the rate of growth in outlays for maintenance of vintage assets and

on new capital investment. With respect to the former checks could be undertaken for the most important authority undertaking roading construction, counties, which indicated that the road weight utilised was less than that which was estimated to have been the case in the mid-1880's[18]. The trend for the other important class of authority, boroughs, indicated a declining proportion of road works in total loan works from 1900-1906 but thereafter the absolute and relative trend is upward apart from the aberration of the first world war. The trend for greatly increased roading outlays by this authority after 1919 implies an overstatement in pre-1900 borough estimates, but to what extent this might offset the perceived understatement of the county road estimates in unclear. The capital expenditure in total works series for the period 1915-1828 showed greater stability than did the roading component for all authorities with the exception of the (minor) Town Districts, although a curtailment of capital expenditure over the war period was evident for all authorities. No indication of directional trend was apparent in any case, but *prima facie* it is expected that starting as they did from a point of absolute minimum, maintenance expenditures would progressively become a larger proportion of total outlays through time. It would appear that the estimation procedure is more likely to impart a downward bias to the capital formation estimates of the various local authorities to 1915, but one implication of subsequent road stock estimates is that the magnitude of error is not great[19].

From 1928 to 1954 the Department of Transport prepared estimates of roading construction expenditures separate from maintenance expenditures and sinking fund charges in its annual report in AJHR. Central government roading capital formation from 1954 to 1971 consists of the annual reports of the National Roads Board and expenditure on roads by the Ministry of Works, both in AJHR, with local authority capital formation coming from the Local Authority Handbook (1955-59) and the Local Authorities Statistics from 1960. From 1963 local authority roading capital expenditures are given separately from maintenance expenditures. Estimates to 1963 are derived as for the period before 1915-1928 combining the proportion of road expenditure in total works with the capital component of total works. For 1972-1990 the government statistician's aggregate roading gross capital formation is used. For the post-1949 period a deduction for land purchase is made[20], NRB returns for much of the period explicitly stating land purchase expenditures while that of Local Authorities for 1963-1971 could be found in an unpublished Ministry of Works report. The average component of land purchase in total works for this period was used to adjust authorities in the period 1950-1962[21].

Harbour works infrastructure is first recorded separately from other public works in Statistics in 1862, outlays undertaken by harbour boards first being recorded in 1876[22]. As with road infrastructure no attempt is made to disaggregate plant and equipment from structures. From 1900 expenditure out of loan works is also given, which was considered to represent all capital expenditure[23], and from 1917 to 1972 capital expenditure is recorded separately from maintenance. Thereafter functional classifications along NZSNA lines were adopted in local authority reporting procedures[24]. Expenditure on harbour works out of the public works fund to 1950 is also available[25].

Current-price series of non-market gross capital formation for each sector for their relevant periods can be found in table 1 and table 2 in Appendix 2.

SECTION 3: ASSET PRICE INDEXES

Error is likely to be greater in a real investment series the further back in time not only through the source and estimation procedure of the current-price investment series but through the unavailability of relevant price indexes, with there being little in the way of capital asset price indexes available for New Zealand prior to 1910. A number of price indexes are spliced in order to convert the current-price capital formation into constant prices. For the period 1972-89 when except for transport infrastructure gross investment was recorded according to six asset types each series could be deflated by relevant indexes taken from Philpott (1992). From 1979-89 these could be supplemented by Department of Statistics indexes of educational buildings, hospitals and rest homes, and transport ways. For the period 1962-72 Montrivat (1981) has prepared indexes for building, construction, and plant and equipment[26]. For the period 1910-1950 all sectors utilise Francis' (1964) building and construction, and plant and equipment, price indexes.

An index for the health series from 1879-1910 is prepared which is used for the other three non-transport sectors for 1902-1910. The index is made up of a labour and materials index in equal proportion. For the former Dowie (1965) can be used to 1900, with his source and method used to 1910. The latter are taken from Fraser's (1920) brick series (1891-1913), while for the period 1879-1891 the import price trend of two brick types taken from Statistics is used[27].

The price index for road works for the period 1870-1913 merged prices of timber and the minimum wage series of labourers and stonebreakers, the latter used to proxy the movement in the gravel/metal input[28]. The sources for the latter two was Statistics, with the average of the minimum wage prevailing in the four main centres being taken[29]. The timber series linked Dowie's export timber price series (to 1899) with timber prices based upon Fraser (1920), who presented prices of two and four of the important timber bridging inputs for 1891-1919[30]. The materials weighting in the final index was based on information on roading costs at 1863 and according to the first physical inventory survey at 1926[31]. The same sources were used in the construction of a price index for harbour works, which used an equivalent weighting for materials and labour.

The period before 1870 was problematic as the information with which the series to 1913 series was constructed was not available. Interpolation was undertaken between three point estimates of road costs. For the years to 1851 information could be taken directly from one of the roads which was an important receiver of public works funds at this time[32]. This indicated a cost per mile and a labourer wage rate around half that of the second point estimate, a 1863 memorandum on military roading[33]. The final point estimate was taken from Statistics in 1873, the year in which wages by occupational class were first given in this publication, at which point the average minimum wage paid to labourers was about half as much again as the 1863 estimate. Materials were assumed to follow a similar course as the constructed wage index[34].

The price series for road and harbour assets can be found in table 3 in Appendix 2. Productivity trends are only incorporated after 1950[35]. Capital intensification can be expected to be most marked in the early 1920's, the late 1930's and following world war two[36]. The extent to which error is imparted to final real stock

estimates through inadequate adjustment of pre-1950 indexes for embodied technical change not reflected in asset prices depends on the type of index used and the position of the base year reference point in the index. The pre-1950 index is based on costs at 1950, and can be expected to bias real capital formation and hence real capital stocks upwards. While the plant and equipment series will not be as problematic in this capacity as the structures series it can be expected that the former will be more susceptible to a second source of error in the real series, asset compositional shifts from the base year reference point. This source of error will be compounded for both broad asset types by the practice of utilising a number of spliced price indexes referenced to a single base year. Some indication of the implications of these sources of error to the real stock series can be found in section six below.

SECTION 4: RETIREMENT OF CAPITAL ASSETS

This section is concerned with the estimation of retirement of assets from the capital stock. Apart from road infrastructure there exists little information on this; in the absence of empirical mortality information the perpetual inventory method generally proceeds via the application of an appropriate survival or mortality distribution based around an assumed average asset life (constant replacement theory), the former to capture the variation in actual asset life that can be expected even within the most homogenous of asset sets[37]. The estimation of asset mortality and retirement from a capital stock is generally considered the most problematic aspect of the perpetual inventory method, not the least because of an inadequate amount of empirical work in the area[38]. What empirical testing that has been done suggests that changes to the mean asset life is more criticial to stock estimates than the retirement distribution form chosen[39].

This practice assumes that economic or service life is some function of the engineering or physical life of the particular asset. It is doubtful whether this is the key determinant for many capital assets, as under profit-maximisation assumptions vintage capital can be expected to be replaced when the total i.e capital and variable cost of the new machine is less than the variable costs of the old machine, a key determinant being the rate of capital-embodied productivity growth of factor and other inputs[40]. Constant replacement theory also has important implications for the application of capital stock measures, and in particular it becomes conceptually impossible to use a capital input as measured by this method in the estimation of marginal rates of factor substitution and substitution elasticities, and for estimates of rates of technical change, when the size and direction of the error of capital replacement estimates are correlated with key explanatory variables. Capital productivity estimates based upon constant replacement perpetual inventory models will systematically give the wrong sign: capital-saving innovation will paradoxically result in an increase in the stock as measured since the capital replaced by new capital formation in which the technology is embodied will not be adequately accounted for.

It is possible that the assumption of constant replacement is acceptable for the non-market sector and where estimates are to be used merely as a guide as to trends in the size of the capital stock. Even where physical considerations are a critical determinant of retirement it is doubtful whether the mean asset lives used in many perpetual inventory models closely approximate physical lives even with a mortality or survivor distribution. Many structures could remain operational given an adequate level of maintenance for over one hundred years depending upon their construction material; few perpetual inventory models use mean asset lives in excess of 75 years. The main reason for this understatement appears to be that the mean asset lives are applied to cover the asset *in toto* i.e. to cover all composite parts. This practice becomes conceptually difficult when an asset is dominated by a composite part that has a near-infinite lifetime given appropriate maintenance for example as is the case for the road asset[41].

The importance of the non-renewable element of the road asset is considered by few estimators, but this is probably owing more to the fact that stock estimates are generally done at a highly aggregate level[42]. Estimators who have looked specifically at this issue in the context of road infrastructure, while conceding it as a likely source of error[43], have considered themselves bound by the lack of

information available. Such information, although by no means complete, is available for an important part of the NZ road network, and stock estimates of this paper are prepared by retiring specific components of the road network while assuming a lifetime of the non-renewable component of the stock greater than the earliest recorded capital formation[44]. The following components of the road network are subject to retirement within the time frame of the paper:

i) pavement
ii) obsolete sections of road
iii) bridging

The primary source for this information was AJHR. Estimates of i) replacement pavement were considered to be subsumed under maintenance expenditures[45] and although part of gross capital formation irrelevant to final gross and net stock estimates. Estimates for the period 1950-90 were undertaken to conform with SNA definitions of gross capital formation. For the period 1955-75 these were based around resealing expenditures carried out by the National Roads Boards in the period 1955-69, supplemented by NRB reports on sealing projections from 1959 and 1969 for roads administered by it and Local Authorities. In some cases resealing expenditures was undertaken in conjunction with other improvements, with the length of reseal known but the expenditure subsumed under another category. The value of the reseal only was estimated by applying to the length of improvement-based reseal an average per mile cost of reseal for that year[46], this information also being used in the valuation of reseal length estimates for other authorities in the period 1955-75 and in the valuation of all authorities for the periods outside this in conjunction with a construction index. For the period to 1955 and for the period 1975-90 the retirement method of the perpetual inventory model in conjunction with physical survey data on the length of road by surface medium for the period 1925-1952 was used to calculate the length of road by surface medium due for retirement in these periods[47].

Estimates for ii) were prepared by using information on the annual length of deviation constructed on state and main dustless and gravel highways for the period 1955-67. Under the assumption that much of this was constructed to remove excess curvature the length of obsolete road was estimated by applying the formula for the perimeter of an arc[48] and valued according to 1930 cost estimates of third class dustless and gravel roading inflated to current prices by the construction index. This type of work was assumed to be only carried out with the establishment of the National Roads Boards on the better class of roading and similar work carried out by other authorities was considered negligible. For the period after 1967 deviation construction was assumed to show a stable relationship with aggregate construction expenditure and the average proportion of deviation expenditure in total construction[49] was applied to NRB total construction to estimate the value of redundant roading.

There was good information on the extent of iii) Bridge renewals of bridges 25 feet or longer from 1954 to 1974. NRB annual reports to 1968 specify the value of replacement and expansionary capital outlays on state highway bridging[50] and physical survey information related to these outlays. NRB surveys at 1959 and 1969 provided further information on state highways and detail projected replacement outlays on other classes of roading. Using this in conjunction with physical surveys of the bridging stock both before 1955 and between 1969-79[51] and

the known retirement for the 1954-69 period it was possible to calculate the length of timber bridging needing replacement that remains unretired after 1975. Allowance was also made for retirement of non-wood structures by assuming a constant rate of formation of such structures from the turn of the century to the time of the first physical survey. Valuation of retired bridging lengths was obtained by adjusting average (main highway) bridging costs in the period 1954-60 by the construction index. Allowance was also made for the fact that bridge replacement in the period generally involved an element of improve-ment, by estimating the average 'timber-equivalence' of the replacement bridging on state highways and on local authority controlled road[52] for the period 1954-60 and assuming the improvement/replacement ratios held for the rest of the period.

The retirements so calculated are presented in table 4, Appendix 2. The retirement of all other capital assets is undertaken under constant replacement assumptions and is also shown in table 4. Table 5 in Appendix 2 details roading capital stock series derived utilising the preferred estimated retirement series and stock estimates derived under constant replacement conditions utilising mean asset lives of 50, 75, 90 and 100 years respectively with delayed linear mortality functions of ±20%. The implicit differential rate of growth between the retirement method of this thesis and that utilising each of the above mean asset lives is shown on page two of this table, with the final four columns showing the extent to which level estimates under constant replacement conditions differ from the level estimates derived under the preferred estimated retirement conditions. Estimates derived under constant replacement conditions generally manifested faster rates of growth over the period than did the series generated under the preferred retirement conditions, this reflecting the more even pace of expansionary capital formation assumed under constant replacement. In respect of level estimates preferred stock estimates shows the greatest compatibility between stock estimates obtained under retirement utilising a mean asset life of 90 years. The retirement method of this paper exhibits the pattern of an asset dominated by expansionary capital formation in its formative stages followed by increased rates of replacement capital formation necessitated by upgrade and improvement of the stock commensurate with technological improvement in the rest of the road transport sector.

Based upon the mean asset lives used in other perpetual inventory models (used for harbour works, health, administration assets)[53], information from primary sources (education, health), and via comparative stock simulation exercises (administration) the following mean asset lives were utilised:

1) Harbour Works: 75 years
2) Health: buildings, 60 years; transport equipment, 12 years; all other equipment, 16 years;
3) Administration: structures 40 years; plant and equipment 15 years
4) Education: buildings, 50 years; furniture and equipment, 12 years

These mean asset lives were utilised with a delayed linear mortality function of ±20% of mean asset life except for certain education assets, where information from building stock inventory implied a Winfrey left-skewed distribution[54]. As with the road network some parts of the education stock were not retired, while certain larger education assets were retired at their known or estimated point of departure from the stock[55].

SECTION 5: REAL NET AND GROSS CAPITAL STOCKS

Table 6 in Appendix 2 details the estimates of real gross and net structures capital stock for the non-market sector. The generation of gross capital formation estimates from the time of the initial formation implies that road stock estimates can be estimated contempor-aneous with the capital formation series. This procedure is also adopted for harbour infrastructure, although the stock series will err insofar as there was a non-trivial and unknown existent capital stock prior to 1860, the beginning of the capital formation series. Net stock estimates are derived using depreciation based upon the above mean asset lives and under straight-line conditions. A depreciated roading stock was approximated using the mean asset life of the stock estimate series which generated the most compatible level estimates with the preferred series[56].

Estimates of gross and net plant and equipment stocks for the non-market non-transport sector are shown in table 7 of Appendix 2. Depreciation of plant and equipment is undertaken under declining-balance conditions based upon the above mean asset lives.

SECTION 6: CHECKS ON THE ESTIMATES

It is possible to undertake point estimate checks for three of the sectors under investigation. Book valuations of all Central Government administration and foreign relations fixed assets can be found in AJHR, with personal correspondence from the NZ Treasury Department used to disaggregate assets into broad asset type viz structures or plant and equipment. A valuation at 1991 of public education capital assets is taken from the 1992 AJHR. Stock estimates of the roading stock are compared to valuations of physical surveys of the road network.

The 1990 book valuation of central government administration and external relations assets exclusive of land value is some $6.55 billion. Structures are valued at net-current value, the price ' an asset might reasonably be expected to be sold...less anticipated disposal costs.' Plant and Equipment depreciation is based upon mean asset lives ranging from 3-15 years for non-military conditions and 5-25 years for military equipment, Using the broad asset weighting implied by personal correspondence on the fixed asset valuation at 1991 this implies a depreciated stock value of $2.35 billion for structures and $4.20 billion for plant and equipment[57]. The latter consists of $2.02 billion of specialised military equipment, and $0.5 billion and $0.8 billion respectively for the National Library and National Archives collection. The last two are unlikely to be picked up within the capital formation series, implying a depreciated plant and equipment stock of $2.88 billion, or a total depreciated stock for this sector of $5.22 billion. The depreciated constant price stock estimates for structures and plant and equipment for central government administration at 1990 from tables 6 and 7 imply current valuations of $3.98 billion and $1.14 billion respectively, or a total depreciated stock of $5.12 billion.

Good correspondence between the two sets of estimates for aggregated capital stocks needs to be qualified by the divergence in disaggregated fixed asset valuations, with the structures estimates of this paper some 70% higher than the NZ Treasury estimates and the plant and equipment estimates around 150% lower than the NZ Treasury estimates. The most obvious reason for both these results is misallocation in the post-1949 series. Given the mean asset lives expected for plant and equipment in this sector this source of error by itself implies fault with the government statistician series, but the method of Shinawatra is more likely to result in misallocation[58]. For her series to influence the net stock estimate at 1990 there must also exist downward bias in the mean asset life used, with the most likely error source being a higher than expected retention rate in the dominant component of plant and equipment, specialised military equipment. Discussion with defense personnel indicated that 15 years might be a reasonable average for army equipment, the service with the smallest capital expenditure of the three in the period 1950-1971, but inadequate for navy and airforce, 25 years being a better average for the latter while the second is dominated by assets with a hull life between 20 and 30 years. Utilising an aggregate equipment mean asset life of 25 years and reallocating all structures GCF in the period 1964-1971 to plant and equipment implies an upward revision of the 1989 net stock estimate of 42%, but the simulated estimate is still only 58% of the Treasury estimate. In order to retain total asset compatibility the scaling up of the plant and equipment mean asset life would necessitate either a downward revision of the structures mean asset life or upward revision of the pre-1950

structures gross capital formation series. As regards the first a survey of average lives used for similar sectoral categories in other perpetual inventory models indicates that a mean asset life of 40 years is around the minimum average age to use. As regards the second simulations undertaken indicated that the necessary upwards revision to the structures gross capital formation series for compatibility in structures stock estimates would require application of a prohibitively large inflation factor[59], as most of the pre-1950 capital has been depreciated fully by 1990. The most likely explanation for divergence in the structures estimates at 1989 then appears to be the possibility of divergent valuation techniques, the key issue being the market valuation of many of the product specific assets of the non-market sector. Critical to the ability of a current market valuation to approximate a depreciated balance sheet valuation is the state of the market at valuation, with the depressed state of the New Zealand economy at the time of the Treasury valuation suggestive of a conservative Treasury market valuation. Perhaps more critical is the extent to which the discount rate used is normal in the sense of approximating a long-run equilibrium rate, but here it is unclear of the direction of bias[60].

An understatement in the valuation of building assets is also evident in a similar comparison between a net current value of education building assets and that generated by the perpetual inventory. Public education capital assets at June 1991 are valued at $4.19 billion for buildings and $0.016 billion for equipment. To this needs to be added tertiary education assets, the net assets at the end of 1990 of which were valued at $1.9 billion (likely to be land-inclusive), and the net assets of school boards of trustees, valued at January 1991 at $0.5 billion, or a total valuation for reported education assets of $6.6 billion[61]. The total net education capital stock at 1989 of tables 6 and 7 implies a current valuation of around $8.1 billion. It is possible that there are omissions from the valuations recorded in the Financial Statements, but the comments made above for central government administration assets apply equally here.

Gross roading stock estimates can be compared to valuations of physical inventory information at 1929 and 1953 in conjunction with valuations by the Public works engineer on the capital cost of the roading system for the years 1914 and 1927. These are useful positions to undertake point comparisons, as gross capital formation estimates are considered most uncertain prior to c 1914, more reliable after 1928 and most reliable from 1954.

Physical inventory valuations are undertaken using survey information on the length by surface and grade of the roading system and of the bridging stock (over 25 feet) by construction type, valued according to construction costs of roading from a 1930 Department of Transport Survey and for bridging from information in a 1931 Main Highways Board return, botht aken from AJHR. The main information deficiency was the classification of the roading network, as although complete information of the roading system by surface and whether in an urban or rural locale was available, 72% of rural roading at 1929 and 33% at 1954 was not classified. The unclassified network at 1929 was classified as follows: all rural unsurfaced roading was allocated to class 5 roading, all dustless roading was assumed to have been classified and allocated to either 1st or 2nd class roading, and the residual unclassified metalled rural roading was allocated to 2nd, 3rd and 4th classes on the basis of their weights in the classified rural network. A similar procedure for the rural network was used at 1954 although a greater breakdown

by surface type implied less uncertainty in the allocation method. The urban network at both benchmarks was classified according to its surface construction i.e. at 1929 the dustless network was allocated equally into 1st and 2nd classes, the metalled network into 3rd and 4th classes, the unsurfaced network was considered to be 5th class only; at 1954 all concrete roading was assumed 1st class, bitumen roading was assumed to be either 2nd or 3rd class, metalled roading was either 3rd or 4th class, unsurfaced 4th class only.

A 1930 survey of transport infrastructure by the Department of Transport provides cost information on six types of roading of three classes: 5th, 3rd and 1st class granular surface (£735, £1299, £2198 per mile respectively for a depth of 3.5", 6", and 10" respectively); 5th class sealed (£2511 per mile), 3rd class dustless penetration (£4692 per mile) and 1st class bituminous concrete (£12,473 per mile). These were used as a guide to the construction cost of classes 2 and 4 viz 2nd and 4th class granular as half way between that of 5th and 3rd classes and 3rd and 1st classes respectively. 2nd class penetration was assumed to be of the same value as 3rd class, more for 1st class penetration[62]. Unsurfaced 5th class roading was valued by deducting an arbitrary £50 per mile for the granular surface.

Bridging survey details (for bridging over 25 feet) by type of construction begin in 1926. These are valued according to an average construction cost per foot derived from information on the cost of bridges constructed around 1930 in conjunction with their physical dimensions. No such bridges were constructed of wood: the valuation of these bridges was based on information from the 1931 Main Highways return which indicated a value of half the construction costs of concrete structures[63]. The valuation of the bridging stock at 1954 was undertaken by inflating the construction cost per foot for each type of construction by a building and construction index.

The resulting estimates and the basic information from which these were derived in shown in table 8 in Appendix 2. The estimates of table 8 imply a constant-price gross road stock estimate at 1929 and 1953 of £67.8 million (1929 £) and £349.9 million (1953 £) respectively. This can be compared with the stock estimates of table 6 which imply a gross stock estimate at 1929 of £73.0 million (1929 £) and £390.5 million (1953 £), respectively 7.7% and 11.6% greater than the physical inventory valuations. Given the assumptions used in the valuation of the physical inventory it is not possible to take the cause for the differential much further than noting that once the valuation of omissions from the physical inventory is taken into account i.e. bridges under 25 feet, culverts, tunnels etc., insufficient retirement in the estimation procedure of this thesis looms as the most likely candidate (particular given the increase in the differential between 1929 and 1953) in combination with the overstatement of stock estimates implied by the use of price indexes based at 1950 with insufficient allowance for productivity increase up to this date.

The Public works engineer's estimates appear to be based upon cumulative current-price capital formation[64] and are useful only insofar as providing some check on the total gross capital formation series to each benchmark. The capital-cost estimates of the Public Works Engineer at 1914 and 1927 of £28 million and £49 million respectively compare favourably with the cumulative capital formation estimates of table 1 of £26 million and £47 million respectively.

CONCLUSION

The estimates of table 6 and 7 in Appendix 2 imply a gross structures and plant and equipment capital stocks at March 1990 for the non-market sector as defined of $67.6 billion (1990$) and 3.75 billion (1990 $) respectively, and a net structures and plant and equipment capital stocks at March 1990 of $38.4 billion (1990 $) and $2.7 billion (1990 $) respectively. These estimates can be compared to Philpott's (1992) estimates at the same date and in the same base year valuation of $52.9 billion and $4.0 billion respectively for gross structures, and plant and equipment, and $38.1 billion and $2.0 billion respectively for net structures, and plant and equipment. As expected most of the difference between the two series becomes progressively less important as the capital surviving at 1950 is retired and as retirement based on a common gross formation series becomes progressively more important: comparisons of Philpott's (1992) starting value estimates for each sector with those of this paper indicate that the former is generally about half that of the latter (for the education, health and transport infrastructure) and about one-fifth in the case of the administration sector[65].

This can be further seen by reference to table 9 in Appendix 2 which details Philpott's constant price gross structures series and the total gross structures stock series and non-transport structures stock series from table 7. The gross structures and plant and equipment capital stocks estimates at the end of 1950 of this paper are estimated to be $14.9 billion (1983$) and $0.62 billion (1983 $) respectively, while that of Philpott (1992) are $6.2 billion (1983$) and $0.28 billion (1983$) respectively. The final three columns of this table detail the annual growth stock rates implied by Philpott's estimates (GR 3), by those of this paper (GR 1) and gross stocks of the non-transport sectors only (GR 2), indicating a greater volatility in pre-1950 capital formation in the manufacturing sector. It can also be seen that estimation of the roading stock as outlined above has implied greater stability to the growth rate of the aggregate capital stock, presumably the result of the balancing out of a gross capital formation series with a retirement series more volatile than would have been the case under complete constant replacement.

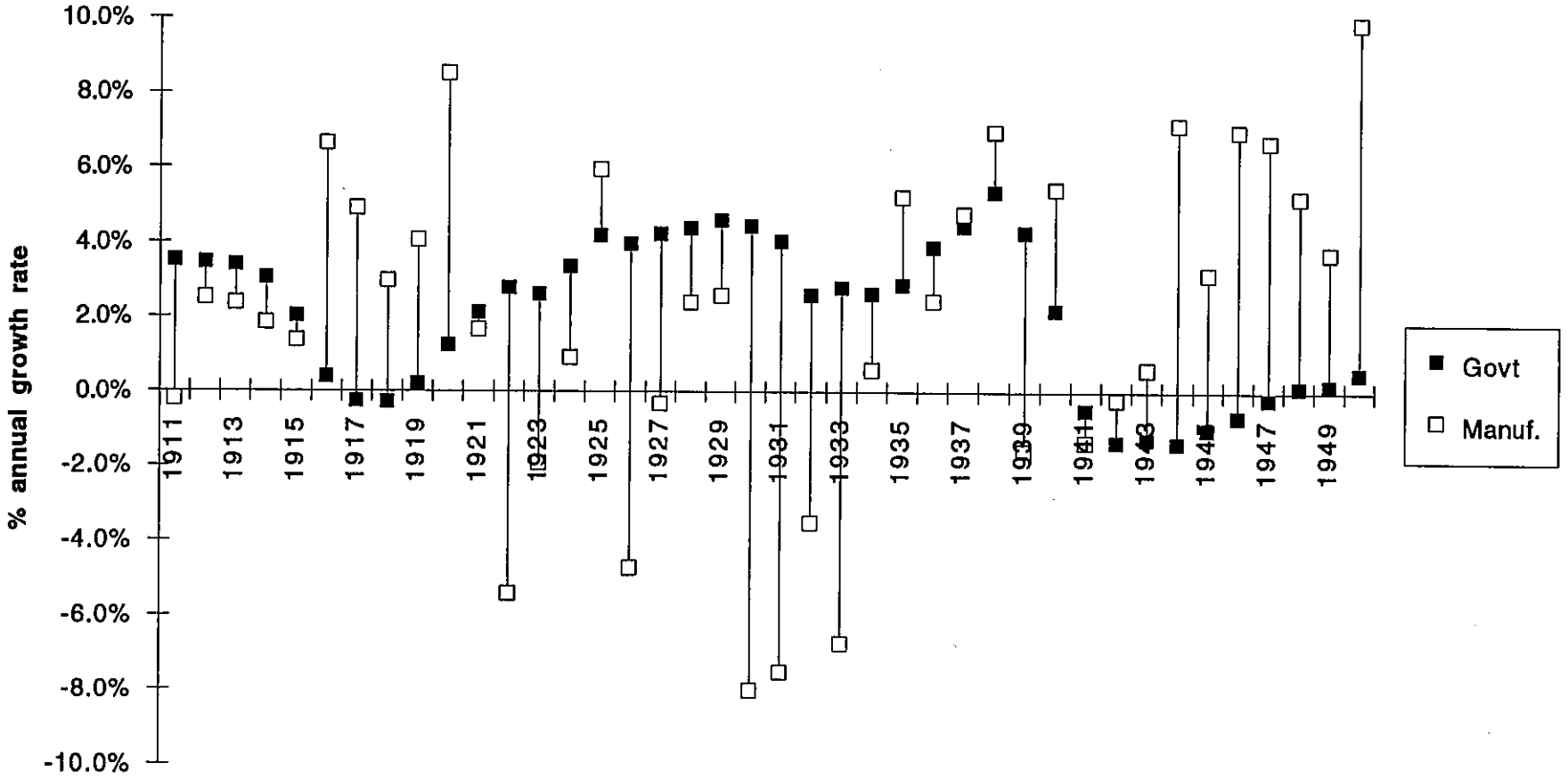
That the use of Campbell's (1977) conversion factors derived from a market setting to a non-market setting are likely to be problematic is indicated by the implicit real gross stock value to net stock value ratio at 1950. The estimates of table 6 indicate a ratio for structures of 1.66, whereas that implied in Philpott (1992) was 1.35[66]. A greater divergence between the replacement to market value ratios in the non-market sector compared with the manufacturing series implies either a slower rate of pre-1950 capital formation for the non-market stock than in Campbell's simulated stock, slower capital consumption, or a faster rate of inflation[67]. The pattern of investment in each sector in the period 1910-1950 described in appendix chart 1 is suggestive of divergence in all three.

APPENDIX 1: COMPARISON OF THE DEPRECIATED CAPITAL STOCKS IN THE MANUFACTURING AND NON-MARKET SECTORS, 1910-1950.

As noted in the conclusion above there are speculated to be two key determinants of divergence between implicit replacement : market valuation ratios derived from the manufacturing capital stocks information and that from the non-market sector. These are differential rates of growth in the capital stocks of each series and/or differential rates of inflation. Chart 1 in Appendix 1 describes the divergence in annual net stock growth rates for the manufacturing sector over the period 1910-1950 taken from Francis and that for net non-market transport stocks for the same period, this subgroup (representing two-thirds of the non-market stocks at 1950) being the only sectors for which net capital stocks could be estimated (from table 6) without requiring further information. The divergence is suggestive of a much faster rate of growth in the manufacturing capital stocks, with the manufacturing series in the 1940's decade growing almost 50% faster than that estimated for the non-market transport sectors, over two-thirds of this differential occuring in the quinquennium to 1950. Given the paucity of information in Francis (1968) it was not possible to easily investigate to what extent this was the result of a faster rate of capital formation or through a faster rate of capital consumption which is also evident from appendix chart 1. It is possible to simulate a net stock estimate at 1950 for non-market transport based on the growth rates of the manufacturing sector, and a real stock value under the assumption of a negligible divergence in growth rates between a real and a net stock series[68]. The implicit replacement : market valuation at 1950 under these conditions was 1.34, the same as that implied in Philpott (1992). A simulation undertaken by inflating the gross stock growth rate series by the differential between the growth rate in the gross and net capital stocks series (25%) for the non-market transport sector in the period 1910-1950 resulted in an implied replacement : market valuation at 1950 of 1.57; an implicit replacement : market valuation ratio of 1.66 could be obtained by setting the growth rate of the gross stock an average 33% higher than the growth rate of the net stock. Such a growth rate differential between gross and net stocks in the aggregate non-market sector in the period 1910-1950 would exist if there was a faster rate of capital formation in the non-transport non-market sector than in the non-market transport sector and/or slower capital consumption. The gross capital formation series for the non-transport sector did on average grow at a faster rate than the transport sector but the growth differential was not great (average 8.3% compared with 7.8%, similar standard deviations), while capital consumption was obviously at a much faster rate in the non-transport sector. This leaves as explanations for the residual divergence in the replacement : market valuation ratios greater inflation in the non-market sector compared to the manufacturing sector or estimation error.

The greater volatility in the pre-1950 manufacturing capital stocks suggested by the greater volatility in the Philpott (1992) series can also be seen in appendix chart 1. Mean growth rates for the two stocks were similar (2.1% and 1.9% respectively for the non-market transport sector and the manufacturing sector) but the standard deviation of the latter was 4.4% compared to 2%.

% Annual Capital Stock Growth Rates: Manufacturing vs Non-market Transport Structures Stock, 1911-1950



APPENDIX 2: TABLES

1) Table 1: Non-Market Structures Gross Capital Formation 1846-1989
2) Table 2: Non-Market Plant and Equipment Gross Capital Formation 1930-1989
3) Table 3: Non-Market Capital Price Indexes 1846-1989
4) Table 4: Asset Retirement from the Non-Market Capital Stock 1903-1989
5) Table 5: Road Capital Stock Estimates 1950-1989, under different Mean Asset Life Assumptions, (MAL = 50, 75, 90 or 100 Years versus Actual Estimated Retirement)
6) Table 6: Non-Market Gross and Net Structures Capital Stocks 1846-1989
7) Table 7: Non-Market Gross and Net Plant and Equipment Capital Stocks 1950-1990
8) Table 8: Valuation of Physical Survey Information: Road Infrastructure at 1929 and 1954
9) Table 9: Non-Market Gross Structures Capital Stocks Comparison 1950-1990: Total Stocks, Non-Transport Stocks, and Philpott (1992) Total Stocks

Table 1

YEAR	ROAD ($)	HARBOUR ($)	YEAR	ROAD ($)	HARBOUR ($)	YEAR	ROAD ($)	HARBOUR ($)
1846	950		**1894**	489,644	144,000	**1942**	709,120	691,558
1847	44,618		**1895**	462,960	168,000	**1943**	1,138,373	726,154
1848	48,292		**1896**	491,812	132,000	**1944**	1,710,950	438,356
1849	31,066		**1897**	938,236	128,000	**1945**	2,474,030	710,812
1850	7,380		**1898**	921,100	170,000	**1946**	3,776,380	647,198
1851	24,120		**1899**	933,408	126,000	**1947**	6,176,920	695,266
1852	29,092		**1900**	1,142,614	297,994	**1948**	8,051,390	778,966
1853	70,010		**1901**	1,366,616	349,232	**1949**	9,230,496	1,175,926
1854	151,266		**1902**	1,233,784	338,224	**1950**	8,475,400	1,325,860
1855	100,236		**1903**	1,473,368	209,470	**1951**	11,833,732	3,487,584
1856	120,210		**1904**	1,175,042	276,370	**1952**	14,725,340	3,142,110
1857	195,372		**1905**	1,354,396	386,944	**1953**	15,884,470	2,205,622
1858	226,460		**1906**	1,460,792	299,380	**1954**	23,952,499	2,554,696
1859	253,032		**1907**	1,572,418	449,436	**1955**	33,825,827	3,556,258
1860	219,844	21,984	**1908**	1,930,481	554,608	**1956**	37,598,078	4,543,076
1861	360,142	36,014	**1909**	1,587,228	809,584	**1957**	37,020,384	5,318,888
1862	572,274	51,606	**1910**	1,681,127	790,082	**1958**	37,972,842	6,831,164
1863	833,020	119,304	**1911**	1,971,491	655,072	**1959**	42,462,555	7,784,548
1864	1,327,480	126,750	**1912**	2,005,385	770,348	**1960**	42,413,772	7,702,570
1865	562,938	61,112	**1913**	2,181,536	655,652	**1961**	47,615,224	8,062,316
1866	648,836	43,380	**1914**	2,339,057	607,376	**1962**	46,390,773	12,454,042
1867	511,717	71,598	**1915**	2,164,956	487,294	**1963**	52,084,225	11,946,172
1868	480,080	28,818	**1916**	1,402,331	257,106	**1964**	54,790,149	10,214,330
1869	343,147	900	**1917**	1,044,689	417,536	**1965**	61,583,330	12,291,066
1870	326,015	44,238	**1918**	1,202,466	328,150	**1966**	58,879,131	10,845,310
1871	338,400	38,000	**1919**	1,871,953	411,066	**1967**	53,952,377	13,700,223
1872	473,400	64,000	**1920**	2,981,783	810,264	**1968**	60,652,683	14,042,976
1873	754,200	162,000	**1921**	3,233,188	1,237,116	**1969**	65,837,585	11,010,943
1874	1,095,520	220,000	**1922**	3,536,248	1,489,894	**1970**	70,117,102	15,384,657
1875	987,900	282,000	**1923**	3,734,980	1,288,268	**1971**	73,150,205	16,316,810
1876	609,948	316,000	**1924**	4,477,536	1,580,774	**1972**	66,111,000	11,786,000
1877	644,064	256,000	**1925**	5,558,873	1,464,512	**1973**	78,268,000	12,708,000
1878	994,352	326,000	**1926**	5,256,448	1,531,004	**1974**	64,227,881	19,732,000
1879	992,112	272,000	**1927**	5,474,696	1,539,946	**1975**	64,596,000	35,141,000
1880	966,644	286,000	**1928**	6,297,326	1,132,400	**1976**	70,596,000	43,158,000
1881	673,260	326,000	**1929**	7,036,102	1,044,158	**1977**	62,814,000	40,144,000
1882	767,108	272,000	**1930**	7,144,504	895,302	**1978**	65,412,000	34,371,500
1883	824,308	338,000	**1931**	6,737,290	487,172	**1979**	71,269,000	28,599,000
1884	756,260	342,000	**1932**	5,215,922	251,074	**1980**	68,642,000	20,963,000
1885	774,404	282,000	**1933**	5,176,150	335,038	**1981**	71,560,000	24,450,000
1886	726,244	394,000	**1934**	4,987,266	495,394	**1982**	86,003,000	37,325,000
1887	641,204	420,000	**1935**	5,263,182	771,860	**1983**	87,789,000	42,732,000
1888	442,752	284,000	**1936**	8,009,718	932,476	**1984**	122,948,000	43,121,000
1889	452,780	212,000	**1937**	10,306,956	1,100,306	**1985**	135,912,000	55,009,000
1890	404,484	234,000	**1938**	13,331,882	1,335,576	**1986**	127,611,000	39,172,000
1891	472,612	212,000	**1939**	13,010,926	1,067,948	**1987**	133,337,000	40,650,000
1892	495,860	192,000	**1940**	9,283,837	858,052	**1988**	135,591,000	84,041,240
1893	621,620	184,000	**1941**	2,990,711	586,912	**1989**	177,681,000	52,717,273

Source: see text

Table 1

YEAR	HEALTH ($)	YEAR	HEALTH ($)	EDUCATION ($)	CENTRAL ADMIN. ($)	LOCAL ADMIN. ($)
1879	10,496	**1903**	88,132	197,694	290,525	669,583
1880	4,438	**1904**	98,052	147,624	150,298	857,657
1881	280	**1905**	115,174	185,496	187,120	733,720
1882	128	**1906**	80,904	310,076	274,879	1,134,856
1883	512	**1907**	125,136	200,000	269,955	1,004,963
1884	7,584	**1908**	140,700	204,000	425,682	1,184,626
1885	14,612	**1909**	166,508	200,000	422,049	1,305,438
1886	36,230	**1910**	119,344	190,000	534,734	1,263,472
1887	66,026	**1911**	207,863	180,000	613,852	1,822,391
1888	41,248	**1912**	268,443	210,000	672,670	1,038,242
1889	39,064	**1913**	264,424	243,908	504,806	720,470
1890	23,206	**1914**	282,243	245,880	531,753	613,493
1891	38,564	**1915**	268,414	195,944	355,578	780,604
1892	46,520	**1916**	236,388	140,734	275,816	755,044
1893	47,132	**1917**	266,904	126,164	331,859	609,998
1894	50,870	**1918**	291,794	231,312	265,918	469,682
1895	59,268	**1919**	350,774	391,000	617,796	556,297
1896	56,924	**1920**	307,994	918,586	628,366	1,078,362
1897	50,940	**1921**	437,916	1,131,760	792,239	1,538,982
1898	52,584	**1922**	290,726	723,952	708,606	1,796,642
1899	64,766	**1923**	456,690	591,362	459,638	1,796,297
1900	66,200	**1924**	985,942	924,424	423,942	2,088,093
1901	73,182	**1925**	1,254,344	1,129,892	484,979	2,608,586
1902	57,606	**1926**	813,840	1,101,908	688,460	2,253,471
		1927	622,056	738,268	450,071	2,191,414
		1928	523,798	750,846	273,409	1,055,056
		1929	592,268	857,528	546,435	1,605,853
		1930	705,756	983,948	783,099	1,887,801
		1931	306,334	518,296	424,560	1,537,092
		1932	223,718	105,246	25,775	1,639,135
		1933	213,466	102,870	66,224	1,485,171
		1934	342,192	102,578	394,658	1,939,703
		1935	451,848	242,848	838,871	1,872,259
		1936	699,004	537,768	667,363	2,136,612
		1937	765,926	1,092,868	1,577,855	3,050,088
		1938	993,848	1,320,960	3,456,090	3,349,973
		1939	1,077,841	1,686,128	1,968,935	3,018,108
		1940	1,331,527	1,082,272	2,024,067	1,808,736
		1941	1,468,180	932,000	2,128,861	1,597,004
		1942	1,352,498	414,000	1,961,122	1,431,366
		1943	2,062,784	472,000	2,991,037	939,433
		1944	2,514,056	954,000	3,645,381	1,408,027
		1945	2,610,950	2,376,000	3,785,878	1,317,778
		1946	2,361,502	1,984,000	3,424,178	1,481,076
		1947	3,439,530	3,249,008	4,987,319	1,679,828
		1948	2,868,174	4,519,072	4,158,852	2,008,674
		1949	2,648,884	6,501,908	3,840,882	2,738,547
		1950	2,547,000	4,840,868	3,733,350	4,435,000
		1951	2,973,000	5,626,649	5,554,212	5,616,000
		1952	4,160,000	9,732,805	6,222,942	8,055,000
		1953	5,797,000	11,731,727	7,193,814	10,003,000
		1954	5,732,000	10,552,112	4,956,514	11,670,000
		1955	6,515,000	11,979,483	7,028,018	14,771,000
		1956	7,764,000	13,901,532	9,457,808	17,592,000
		1957	9,152,000	14,251,807	8,852,098	18,598,000
		1958	8,927,000	13,672,767	7,581,614	20,747,000

Table 1

YEAR	HEALTH STRUCTURES (000'$)	EDUCATION STRUCTURES (000'$)	CENTRAL ADMIN. STRUCTURES (000'$)	LOCAL ADMIN. STRUCTURES (000'$)
1959	10500	14035	7214	24729
1960	11370	16803	9788	23118
1961	10892	17443	13529	24632
1962	11472	16054	11277	23957
1963	12508	19742	15984	26424
1964	13793	23973	20340	25609
1965	13950	25609	17405	31391
1966	12387	28774	19324	33428
1967	14548	27823	16722	32243
1968	17484	28188	16513	29979
1969	19003	33458	23512	34731
1970	19492	41805	29453	35879
1971	20206	47103	29882	43320

YEAR	HEALTH RB*. (000'$)	HEALTH NRB#. (000'$)	HEALTH CONSTR@. (000'$)	HEALTH LI°. (000'$)	C. ADMIN RB*. (000'$)	C. ADMIN NRB#. (000'$)	C. ADMIN CONSTR@. (000'$)	C. ADMIN LI°. (000'$)
1972	76	22310	462	462	5331	33352	6761	538
1973		22751	500	200	7361	46846		
1974	2918	23173	544	25		60450	3846	
1975	2093	29063	1116	35	3599	88675	3475	
1976	1873	45310	1685	60	6966	36387	1891	
1977	1527	55748	1319	853	4823	44736		
1978	1069	56015	754	14	3278	57472	7781	567
1979	818	69083	688	23	6605	44479	8573	
1980	2807	71996	1299	589	15853	54863	8708	411
1981	9975	59705	1802	476	6216	78929	9111	524
1982	6688	50936	3507	386	8717	89008	15212	613
1983	9072	44097	3913	371	8103	86149	7511	1597
1984	9311	41135	1079	318		99043	6118	1680
1985	5716	47576	382	395	4464	173300	22876	2585
1986	4950	44022	1949	71	9065	206994	1122	
1987	5508	60276	465	12	5986	45297	47410	
1988	6976	73140	5307	115	10315	108730	39411	
1989	3780	117039	70	217	4553	95777	15928	

	EDUCATn. RB*. (000'$)	EDUCATn. NRB#. (000'$)	EDUCATn. CONSTR@. (000'$)	EDUCATn. LI°. (000'$)	L ADMIN RB*. (000'$)	L ADMIN NRB#. (000'$)	L ADMIN CONSTR@. (000'$)	L ADMIN LI°. (000'$)
1972	2593	47338	18			8000	17862	8000
1973	1639	58403	14			5000	102	8000
1974	3642	59377	15		1000	11000	7635	8000
1975	308	83262	16		1000	11000	14797	10000
1976	161	114303				9000		9000
1977	2650	104516	2700	250	1000	11000	3927	13000
1978	3653	106513	3248	419	1000	18000	24433	18000
1979	577	103438			1000	26000	31871	20000
1980	340	93141				35000	47568	24000
1981	3809	102135	3146		1000	33000	61931	28000
1982	5595	108895	4313	1		32000	48640	29000
1983	4825	108716	6013	32	1000	30000	75042	31000
1984	5473	121381	6224	2		33000	38510	35000
1985	2820	117678	806	22	1000	41000	31015	33000
1986	2985	138730	5318	185		40000	77828	26000
1987	4506	183563	4216	86		21000	87922	30000
1988	5709	220231	2851	80		31000	166840	45000
1989	2667	256855	3157	112		1989		26000

* = residential building; # = non-residential building; @ = construction;
° = land improvement

Table 2

YEAR	HEALTH ($)	EDUCATION ($)	CENTRAL ADMIN. ($)	LOCAL ADMIN. ($)
1930	104,582			
1931	57,468			
1932	39,990	6,947		
1933	31,890	6,789	404,000	481,514
1934	52,420	6,769	480,000	628,880
1935	94,624	16,027	632,000	607,014
1936	138,076	35,490	864,000	692,721
1937	169,022	72,133	1,196,000	988,883
1938	255,768	87,188	1,720,000	1,086,111
1939	215,808	111,277	1,774,800	978,515
1940	360,687	71,433	1,632,000	586,419
1941	476,640	61,516	1,224,000	517,772
1942	481,342	27,326	918,000	464,070
1943	686,742	31,153	612,000	304,578
1944	668,636	62,962	1,020,000	456,503
1945	548,250	156,826	1,428,000	427,243
1946	611,248	130,943	1,700,000	480,187
1947	702,378	214,424	2,380,000	544,625
1948	798,444	298,257	2,900,000	651,242
1949	708,396	429,137	2,900,000	887,877
1950	705,000	318,250	2,184,000	623,000
1951	723,000	233,700	5,484,000	753,000
1952	666,000	532,000	8,895,000	963,000
1953	816,000	697,300	10,158,000	1,085,000
1954	877,000	785,650	5,867,000	1,184,000
1955	1,210,000	1,258,750	5,434,000	1,633,000
1956	1,137,000	1,086,800	7,289,000	1,654,000
1957	1,703,000	1,104,850	3,319,000	4,415,000
1958	1,349,000	1,066,850	11,979,000	4,008,000
1959	1,303,000	907,511	13,815,000	3,033,000
1960	1,219,000	1,308,792	12,207,000	4,590,000
1961	1,538,400	1,396,000	6,537,000	4,351,000
1962	2,787,200	1,571,000	3,939,000	5,230,000
1963	2,206,000	1,824,000	7,962,000	5,512,000
1964	2,706,000	1,879,000	17,989,000	10,136,000
1965	4,147,000	2,389,000	20,638,000	6,259,000
1966	3,428,000	2,895,000	23,527,000	6,712,000
1967	3,677,600	6,564,000	12,665,000	6,752,000
1968	6,349,700	4,818,000	5,953,000	7,720,000
1969	5,476,300	1,413,000	3,293,000	8,593,000
1970	5,675,000	3,797,000	16,618,000	10,403,000
1971	6,111,000	3,238,000	18,715,000	11,348,000

YEAR	HEALTH TRANSPORT ($)	EDUCATION TRANSPORT ($)	CENTRAL ADMIN. TRANSPORT ($)	LOCAL ADMIN. TRANSPORT ($)
1972	1,330,000	385,000	2,285,000	8,000,000
1973	507,000	483,000	2,010,000	5,000,000
1974	368,000	433,000	7,199,000	8,000,000
1975	1,103,000	486,000	7,411,000	10,000,000
1976	1,713,000	816,000	3,471,000	8,000,000
1977	740,000	766,000	10,494,000	10,000,000
1978	3,071,000	1,405,000	12,524,000	10,000,000
1979	3,094,000	1,799,000	6,107,000	12,000,000
1980	1,478,000	1,123,000	13,399,000	16,000,000
1981	2,067,000	1,446,000	13,487,000	17,000,000
1982	2,649,000	1,061,000	21,290,000	19,000,000
1983	3,421,000	2,164,000	30,415,000	24,000,000
1984	6,944,000	4,280,000	19,776,000	29,000,000
1985	5,513,000	2,149,000	40,338,000	30,000,000
1986	9,571,000	5,327,000	27,102,000	25,000,000
1987	8,668,000	3,849,000	44,483,000	38,000,000
1988	6,350,000	1,617,000	37,033,000	33,000,000
1989	5,396,000	361,000	30,243,000	185,164,000

	HEALTH NON-TRANSP. ($)	EDUCATION NON-TRANSP. ($)	CENTRAL ADMIN NON-TRANSP. ($)	LOCAL ADMIN. NON-TRANSP. ($)
1972	4,134,000	7,294,000	11,572,000	8,000,000
1973	7,319,000	9,478,000	6,203,000	5,000,000
1974	6,806,000	9,028,000	12,166,000	8,000,000
1975	8,401,000	9,428,000	17,171,000	13,000,000
1976	9,879,000	13,774,000	20,347,000	14,000,000
1977	14,372,000	17,647,000	16,981,000	11,000,000
1978	14,442,000	19,019,000	18,539,000	12,000,000
1979	12,484,000	23,608,000	29,908,000	13,000,000
1980	19,023,000	24,157,000	35,820,000	23,000,000
1981	26,714,000	25,319,000	33,967,000	27,000,000
1982	26,289,000	31,446,000	37,265,000	29,000,000
1983	24,341,000	31,321,000	46,338,000	25,000,000
1984	24,883,000	34,557,000	72,560,000	34,000,000
1985	24,016,000	48,834,000	147,150,000	43,000,000
1986	34,777,000	83,159,000	114,064,000	45,000,000
1987	47,972,000	64,217,000	157,811,000	40,000,000
1988	56,859,000	88,298,000	160,843,000	43,000,000
1989	58,439,000	85,641,000	47,920,000	40,000,000

Source: see text

Year	Roading Price Index (1950 = 100)	Year	Roading Price Index (1950 = 100)	HEA Price Index (1950 = 100)	Year	Structures Price index (1950 = 100)	Equipment Price index (1950 = 100)	Year	Structures Price index (1983 = 100)	Equipment Price index (1983 = 100)	Construction Price index (1983 = 100)
1846	78	**1879**	236	300	**1911**	266		**1950**	7.5	9.9	
1847	78	**1880**	222	320	**1912**	273		**1951**	8.4	11.5	
1848	78	**1881**	228	277	**1913**	273		**1952**	8.9	12.3	
1849	78	**1882**	237	268	**1914**	295		**1953**	9.3	12.5	
1850	78	**1883**	229	250	**1915**	330		**1954**	9.7	13.3	
1851	78	**1884**	226	322	**1916**	369		**1955**	10.1	13.5	
1852	85	**1885**	213	254	**1917**	473		**1956**	10.4	13.8	
1853	91	**1886**	203	266	**1918**	504		**1957**	10.7	14.4	
1854	98	**1887**	201	287	**1919**	543		**1958**	10.9	14.6	
1855	104	**1888**	198	261	**1920**	575		**1959**	10.8	14.9	
1856	111	**1889**	204	243	**1921**	512		**1960**	11.0	15.3	
1857	117	**1890**	207	253	**1922**	479		**1961**	11.3	15.8	
1858	124	**1891**	206	246	**1923**	483		**1962**	11.3	15.8	9.6
1859	130	**1892**	203	247	**1924**	485		**1963**	11.3	16.2	9.6
1860	137	**1893**	203	252	**1925**	466		**1964**	12.0	16.7	10.2
1861	143	**1894**	206	239	**1926**	450		**1965**	12.6	17.1	10.8
1862	150	**1895**	187	237	**1927**	426		**1966**	13.0	17.3	11.1
1863	156	**1896**	199	246	**1928**	422		**1967**	13.3	18.4	11.4
1864	162	**1897**	206	238	**1929**	426		**1968**	14.2	20.0	12.2
1865	168	**1898**	211	244	**1930**	416	420	**1969**	15.5	20.6	13.2
1866	174	**1899**	217	252	**1931**	383	395	**1970**	17.6	22.7	15.0
1867	179	**1900**	218	253	**1932**	373	366	**1971**	20.0	25.0	17.1
1868	185	**1901**	196	245	**1933**	350	419				
1869	191	**1902**	224	258	**1934**	351	415				
1870	197	**1903**	228	257	**1935**	356	412				
1871	203	**1904**	248	257	**1936**	409	424				
1872	223	**1905**	228	265	**1937**	451	481				
1873	234	**1906**	237	281	**1938**	479	489				
1874	215	**1907**	249	276	**1939**	518	473				
1875	223	**1908**	257	270	**1940**	562	540				
1876	230	**1909**	246	272	**1941**	593	642				
1877	220	**1910**	263	272	**1942**	623	694				
1878	235				**1943**	643	744				
					1944	689	772				
Source: see text					**1945**	707	776				
					1946	720	803				
					1947	767	855				
					1948	804	932				
					1949	895	934				

Table 3

Table 3

Year	Residential building (1983 = 100)	Non-residential building (1983 = 100)	Other construction (1983 = 100)	Land Improvement (1983 = 100)	Transport Equipment (1983 = 100)	Plant & Equipment (1983 = 100)	Transport Ways (1983 = 100)	Hospitals (1983 = 100)	Educational Buildings (1983 = 100)
1971	20.9	19.3	20.0	20.9	20.3	25.0			
1972	22.2	21.1	21.2	21.9	22.2	26.8			
1973	24.2	23.7	23.3	25.6	23.8	28.3			
1974	28.0	27.2	27.3	30.0	27.2	32.0			
1975	33.3	31.6	33.3	32.9	35.6	39.4			
1976	39.1	37.1	39.2	38.3	44.2	47.3			
1977	44.7	43.8	44.7	44.9	49.1	53.3			
1978	50.4	50.6	49.5	48.8	54.8	60.7			
1979	58.6	58.0	59.0	59.2	63.7	68.1	58.3	61.4	60.6
1980	71.2	70.8	74.2	75.5	72.7	81.1	67.6	71.7	70.3
1981	84.8	84.9	88.0	89.9	82.6	91.4	82.0	87.4	85.9
1982	94.3	96.9	97.3	97.9	92.4	97.4	96.0	97.8	96.0
1983	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1984	108.7	105.9	106.3	107.2	113.5	108.8	107.2	107.4	107.0
1985	124.7	119.0	118.9	122.4	134.8	116.7	119.8	121.3	120.5
1986	151.8	134.1	134.1	136.9	148.2	116.2	137.5	135.7	133.9
1987	170.5	144.1	148.3	152.4	156.5	111.1	153.4	146.0	144.1
1988	171.5	151.7	153.9	154.7	126.7	121.6	161.8	151.7	149.7
1989	1736.8	157.9	173.2	175.2	132.2	111.4	168.1	157.5	155.3

Year	Education structures (1983 $)	Road structures (1983 $)
1903	1,039,114	
1904	1,140,163	
1905	1,241,213	
1906	1,342,263	
1907	1,443,312	
1908	1,486,098	
1909	1,558,637	
1910	1,631,176	
1911	1,703,702	
1912	1,776,241	
1913	1,844,373	
1914	1,882,765	
1915	1,920,838	
1916	1,959,658	
1917	2,102,145	
1918	1,988,649	
1919	2,183,310	
1920	1,972,718	
1921	1,964,385	
1922	1,955,531	
1923	1,922,707	
1924	1,890,217	
1925	1,860,464	1,402,124
1926	1,827,039	2,314,145
1927	1,795,390	505,317
1928	1,733,935	333,964
1929	1,671,893	400,257
1930	1,608,581	390,524
1931	1,546,859	1,114,617
1932	1,484,870	1,838,723
1933	1,432,028	677,163
1934	1,378,906	2,678,933
1935	1,325,076	920,604
1936	1,272,208	808,833
1937	1,219,019	1,186,785
1938	1,160,435	1,202,258
1939	1,101,864	2,377,825
1940	1,043,280	466,214
1941	984,710	1,361,191
1942	1,107,144	1,905,650
1943	866,487	722,362
1944	806,848	253,631
1945	1,109,246	881,631
1946	687,570	529,105
1947	627,931	34,868,867
1948	566,903	2,484,334
1949	686,894	4,028,583

Year	Road structures (1983 $)	Harbour structures (1983 $)	Health structures (1983 $)	Education structures (1983 $)	C. Admin structures (1983 $)	L. Admin structures (1983 $)	Health Plant/Equip. (1983 $)	Education Plant/Equip. (1983$)	C. Admin Plant/Equip. (1983 $)	L. Admin Plant/Equip. (1983 $)
1950	20,928,224	3,894,301	1,991,484	888,318	17,095,871	42,297,743	2,281,719	587,600	19,700,027	18,475,184
1951	20,417,493	4,131,623	2,162,438	1,193,590	17,169,610	41,135,639	2,958,098	862,495	24,399,765	17,753,186
1952	21,114,298	4,350,504	2,366,590	1,390,685	17,621,347	40,080,424	3,568,514	1,191,394	27,543,193	16,630,874
1953	20,748,746	4,488,063	2,607,856	1,708,722	18,353,167	40,397,023	4,477,810	1,372,832	28,172,852	15,007,257
1954	30,907,648	4,628,900	2,767,626	2,256,041	18,799,137	40,275,407	5,278,092	1,471,635	26,970,632	12,232,365
1955	36,444,795	4,816,431	3,018,806	2,583,101	18,826,876	40,525,620	5,851,150	1,399,488	24,166,110	9,485,770
1956	42,034,220	4,956,439	3,306,622	2,929,954	18,346,812	40,752,081	6,851,212	1,211,736	20,464,486	6,926,309
1957	45,084,115	5,078,574	3,614,148	3,267,101	18,026,042	41,710,838	7,450,078	1,059,315	17,239,342	6,103,842
1958	49,830,222	5,258,860	3,790,630	3,612,283	17,607,796	41,914,636	7,869,745	1,071,009	15,713,106	5,817,606
1959	53,455,318	5,390,718	4,097,896	3,929,537	16,561,477	40,480,724	7,973,804	1,163,189	17,187,546	5,868,737
1960	60,964,342	5,684,214	4,555,644	4,296,142	15,050,075	39,397,215	8,018,619	1,459,401	20,201,467	6,779,174
1961	54,494,209	6,035,597	5,003,926	4,735,578	14,579,446	40,340,640	8,093,019	2,009,785	24,041,821	6,832,256
1962	55,925,000	6,345,238	5,483,808	5,140,440	14,648,483	42,393,029	7,700,730	2,735,277	25,493,732	6,996,481
1963	63,768,398	6,488,156	5,848,096	5,470,002	14,674,153	43,764,413	7,374,305	3,117,232	30,342,924	7,294,245
1964	59,045,109	6,650,102	6,099,208	5,681,790	14,109,127	45,721,540	7,182,285	3,082,652	38,830,294	7,668,582
1965	54,824,402	6,893,422	6,308,878	5,830,036	13,682,001	48,185,125	6,950,815	3,497,435	47,688,239	7,975,356
1966	49,357,364	7,017,652	6,512,336	6,085,068	14,179,110	52,013,068	6,765,125	3,956,403	49,799,439	8,391,429
1967	48,410,762	7,302,740	6,732,424	6,485,296	15,192,997	55,538,882	6,518,668	4,316,714	51,282,212	9,340,192
1968	50,694,375	7,602,198	6,901,472	7,372,620	15,641,186	58,326,247	6,817,958	11,680,785	56,408,584	13,358,842
1969	46,345,144	8,180,482	7,258,224	8,601,480	17,267,789	61,458,293	7,004,278	13,560,917	52,302,193	16,629,306
1970	46,290,184	8,670,740	7,475,562	9,440,656	22,044,948	64,159,132	7,927,517	14,554,913	53,924,005	18,575,257
1971	47,159,343	9,024,936	7,858,098	10,120,626	24,418,889	65,915,085	8,565,032	14,725,672	55,833,025	22,091,548
1972	45,914,960	9,476,986	8,843,254	11,180,720	26,689,994	65,004,418	8,934,527	15,608,023	61,778,281	24,665,161
1973	39,227,927	9,779,780	10,171,856	12,526,826	28,813,642	62,586,020	9,163,416	15,445,146	61,965,208	28,184,454
1974	35,777,976	9,987,905	11,053,786	13,888,776	30,160,231	60,322,555	9,292,373	16,134,372	57,317,131	28,745,282
1975	38,302,645	10,076,472	11,674,284	14,424,044	33,159,657	57,255,902	10,859,269	17,329,935	61,667,054	34,285,708
1976	32,541,733	9,865,340	12,151,542	15,092,900	37,028,372	56,876,527	11,157,752	18,644,703	65,945,491	36,993,480
1977	33,634,568	9,665,238	12,241,842	15,821,306	40,420,634	55,289,101	12,318,396	21,271,398	70,607,480	38,459,762
1978	35,531,344	9,522,320	13,024,768	16,522,600	42,813,214	53,219,371	14,902,812	23,998,034	79,975,798	39,986,041
1979	32,109,187	9,476,940	13,216,316	16,870,320	47,310,245	51,704,108	16,877,430	26,998,538	84,552,148	40,902,497
1980	34,866,603	9,546,948	13,260,390	16,597,561	51,561,090	50,123,526	18,585,805	27,969,192	85,357,918	42,183,980
1981	34,291,242	9,847,760	13,259,924	16,342,332	54,979,228	49,134,420	20,937,137	25,089,310	79,830,800	39,706,244
1982	32,659,562	10,320,759	13,549,336	16,092,536	57,158,284	48,231,269	24,296,451	24,126,623	74,078,881	41,171,188
1983	32,932,291	10,704,243	13,819,158	16,071,644	59,342,697	48,044,313	26,188,570	21,628,369	66,440,538	44,655,155
1984	32,895,240	11,266,580	14,222,226	16,326,498	62,370,937	49,372,878	26,491,248	20,825,832	52,392,372	44,428,495
1985	32,853,466	11,764,610	14,628,702	17,088,718	64,277,318	50,441,100	26,379,302	20,746,493	45,757,318	46,328,495
1986	30,996,747	12,371,638	15,249,806	18,056,339	61,461,708	52,135,698	28,133,620	21,659,098	50,882,423	49,105,502
1987	29,405,996	13,033,990	15,954,042	19,415,360	62,624,220	56,380,422	25,490,222	24,709,633	58,616,660	49,219,407
1988	27,224,074	13,442,067	16,914,154	20,202,511	65,324,481	64,302,684	25,308,034	27,062,765	54,808,015	48,220,678
1989	26,234,858	13,855,209	17,975,394	20,869,423	67,509,903	72,933,529	25,323,180	30,661,670	50,922,656	44,311,066

Source: see text

Table 4

Table 5

Year (end)	Road Stock thesis retirement (1983 $)	Road Stock 50 MAL* (1983 $)	Road Stock 75 MAL* (1983 $)	Road Stock 90 MAL* (1983 $)	Road Stock 100 MAL* (1983 $)
1949	8,182,026,898	6,196,176,834	7,348,678,810	7,786,725,255	8,073,139,557
1950	8,274,279,060	6,277,290,529	7,439,408,592	7,996,888,988	8,194,825,557
1951	8,395,225,689	6,384,875,700	7,558,371,734	8,123,366,526	8,327,621,453
1952	8,540,202,888	6,515,553,651	7,702,370,928	8,273,757,299	8,484,789,656
1953	8,689,857,287	6,648,898,800	7,851,190,077	8,427,902,459	8,645,731,835
1954	8,905,882,618	6,856,925,003	8,077,834,330	8,657,976,002	8,882,353,573
1955	9,202,822,015	7,150,042,569	8,391,124,710	8,973,940,158	9,204,685,938
1956	9,523,378,117	7,471,922,753	8,733,903,549	9,318,603,966	9,555,780,800
1957	9,824,621,995	7,778,321,588	9,060,042,463	9,646,406,453	9,890,125,071
1958	10,122,149,886	8,086,408,094	9,386,818,783	9,974,594,396	10,224,793,771
1959	10,461,302,903	8,440,030,638	9,758,286,795	10,347,497,948	10,604,004,171
1960	10,785,585,589	8,786,313,389	10,121,593,676	10,712,690,132	10,975,120,544
1961	11,154,262,587	9,170,741,727	10,521,642,106	11,115,537,772	11,383,659,573
1962	11,508,850,512	9,541,886,362	10,908,280,451	11,505,651,799	11,778,996,973
1963	11,905,976,511	9,962,991,832	11,344,577,071	11,945,900,317	12,224,115,824
1964	12,304,746,757	10,379,513,975	11,777,874,172	12,382,818,819	12,665,596,449
1965	12,738,851,412	10,825,155,774	12,241,948,627	12,850,593,918	13,137,585,198
1966	13,141,465,514	11,231,990,348	12,668,287,301	13,281,309,696	13,572,022,398
1967	13,497,462,422	11,589,083,665	13,046,305,649	13,664,362,510	13,958,445,171
1968	13,872,592,997	11,965,119,528	13,445,012,963	14,068,673,184	14,366,029,402
1969	14,252,106,418	12,337,831,346	13,843,262,399	14,472,640,891	14,773,343,445
1970	14,603,799,978	12,679,066,372	14,213,190,898	14,848,635,826	15,152,471,705
1971	14,922,897,254	12,985,186,620	14,550,408,723	15,193,095,546	15,499,541,275
1972	15,188,414,968	13,234,264,719	14,831,894,026	15,483,279,008	15,791,436,905
1973	15,484,426,386	13,504,873,236	15,136,209,569	15,796,596,728	16,106,757,497
1974	15,684,167,711	13,673,662,687	15,339,787,921	16,009,866,790	16,322,219,375
1975	15,839,997,226	13,798,320,447	15,501,327,805	16,181,078,673	16,496,040,842
1976	15,987,370,673	13,903,496,605	15,648,599,911	16,337,675,748	16,655,414,598
1977	16,094,282,736	13,962,408,454	15,756,722,046	16,454,134,150	16,774,939,221
1978	16,190,846,212	14,004,378,547	15,856,357,942	16,561,306,342	16,885,590,996
1979	16,280,941,794	14,029,226,725	15,945,829,858	16,657,725,016	16,985,958,991
1980	16,347,672,181	14,029,684,740	16,013,975,777	16,732,539,396	17,065,111,854
1981	16,400,631,349	14,016,222,809	16,066,879,611	16,792,407,788	17,129,173,025
1982	16,457,589,624	14,007,211,606	16,121,051,986	16,854,402,595	17,195,321,683
1983	16,512,446,333	13,998,360,803	16,172,355,181	16,914,014,427	17,259,452,799
1984	16,594,212,629	14,018,639,227	16,249,004,071	16,999,630,854	17,351,034,919
1985	16,674,778,013	14,040,486,860	16,322,309,319	17,083,066,730	17,440,941,830
1986	16,736,603,448	14,043,891,489	16,372,964,870	17,145,221,106	17,509,848,877
1987	16,794,092,868	14,042,968,947	16,415,846,905	17,201,020,320	17,572,249,635
1988	16,850,645,165	14,040,564,411	16,453,260,328	17,253,810,085	17,630,712,000
1989	16,930,130,502	14,062,172,807	16,509,901,133	17,328,691,115	17,710,340,787

* = Mean Asset Life
Source: see text

Table 5

G.R. diff# method 1-2	G.R. diff# method 1-3	G.R. diff# method 1-4	G.R. diff# method 1-5	Stock 2 as % of 1	Stock 3 as % of 1	Stock 4 as % of 1	Stock 5 as % of 1
0.3%	0.1%	0.1%	0.2%	75.7%	89.8%	95.2%	98.7%
0.3%	0.2%	0.1%	0.2%	75.9%	89.9%	96.6%	99.0%
0.3%	0.2%	0.1%	0.1%	76.1%	90.0%	96.8%	99.2%
0.6%	0.4%	0.2%	0.3%	76.3%	90.2%	96.9%	99.4%
0.9%	0.5%	0.3%	0.3%	76.5%	90.3%	97.0%	99.5%
1.0%	0.6%	0.4%	0.3%	77.0%	90.7%	97.2%	99.7%
0.9%	0.6%	0.4%	0.3%	77.7%	91.2%	97.5%	100.0%
0.9%	0.6%	0.4%	0.4%	78.5%	91.7%	97.8%	100.3%
1.0%	0.6%	0.4%	0.4%	79.2%	92.2%	98.2%	100.7%
1.0%	0.6%	0.4%	0.4%	79.9%	92.7%	98.5%	101.0%
1.0%	0.5%	0.3%	0.3%	80.7%	93.3%	98.9%	101.4%
0.9%	0.5%	0.3%	0.3%	81.5%	93.8%	99.3%	101.8%
1.0%	0.5%	0.4%	0.3%	82.2%	94.3%	99.7%	102.1%
0.8%	0.5%	0.3%	0.3%	82.9%	94.8%	100.0%	102.3%
0.8%	0.4%	0.2%	0.2%	83.7%	95.3%	100.3%	102.7%
0.6%	0.3%	0.2%	0.1%	84.4%	95.7%	100.6%	102.9%
0.5%	0.3%	0.2%	0.1%	85.0%	96.1%	100.9%	103.1%
0.5%	0.3%	0.2%	0.1%	85.5%	96.4%	101.1%	103.3%
0.4%	0.2%	0.1%	0.1%	85.9%	96.7%	101.2%	103.4%
0.3%	0.2%	0.1%	0.1%	86.3%	96.9%	101.4%	103.6%
0.2%	0.2%	0.1%	0.1%	86.6%	97.1%	101.5%	103.7%
0.1%	0.2%	0.1%	0.1%	86.8%	97.3%	101.7%	103.8%
0.1%	0.1%	0.1%	0.0%	87.0%	97.5%	101.8%	103.9%
0.0%	0.1%	0.1%	0.0%	87.1%	97.7%	101.9%	104.0%
-0.1%	0.1%	0.1%	0.1%	87.2%	97.8%	102.0%	104.0%
-0.2%	0.0%	0.0%	0.0%	87.2%	97.8%	102.1%	104.1%
-0.2%	0.0%	0.0%	0.0%	87.1%	97.9%	102.2%	104.1%
-0.3%	0.0%	0.1%	0.1%	87.0%	97.9%	102.2%	104.2%
-0.4%	0.0%	0.0%	0.0%	86.8%	97.9%	102.2%	104.2%
-0.4%	0.0%	0.0%	0.1%	86.5%	97.9%	102.3%	104.3%
-0.4%	0.0%	0.0%	0.1%	86.2%	97.9%	102.3%	104.3%
-0.4%	0.0%	0.0%	0.0%	85.8%	98.0%	102.4%	104.4%
-0.4%	0.0%	0.0%	0.0%	85.5%	98.0%	102.4%	104.4%
-0.4%	0.0%	0.0%	0.0%	85.1%	98.0%	102.4%	104.5%
-0.3%	0.0%	0.0%	0.0%	84.8%	97.9%	102.4%	104.5%
-0.3%	-0.1%	0.0%	0.0%	84.5%	97.9%	102.4%	104.6%
-0.4%	-0.1%	0.0%	0.0%	84.2%	97.9%	102.4%	104.6%
-0.4%	-0.1%	0.0%	0.0%	83.9%	97.8%	102.4%	104.6%
-0.3%	-0.1%	0.0%	0.0%	83.6%	97.7%	102.4%	104.6%
AVERAGE							
0.2%	0.2%	0.2%	0.1%	83.2%	95.4%	100.4%	102.7%
STD. DEV.							
0.5%	0.2%	0.1%	0.1%	3.9%	3.0%	2.2%	1.9%

= Growth Rate Difference

Table 6

YEAR (end)	Road Gross Stock (1950 £)	Harbour Gross Stock (1950 £)	Road Net Stock (1950 £)	Harbour Net Stock (1950 £)
1846	6,090		6,090	
1847	292,103		292,035	
1848	601,667		598,353	
1849	800,808		790,809	
1850	848,115		829,218	
1851	1,002,731		974,410	
1852	1,174,873		1,135,411	
1853	1,559,543		1,507,027	
1854	2,335,266		2,265,422	
1855	2,817,170		2,721,379	
1856	3,361,107		3,234,014	
1857	4,196,030		4,031,591	
1858	5,112,872		4,901,810	
1859	6,086,072		5,818,200	
1860	6,891,361	77,111	6,555,866	77,111
1861	8,150,599	198,114	7,738,533	197,086
1862	10,064,559	362,835	9,561,931	359,165
1863	12,734,496	743,638	12,120,040	735,130
1864	16,835,455	1,132,139	16,079,505	1,113,716
1865	18,513,863	1,313,071	17,570,852	1,279,553
1866	20,383,169	1,437,299	19,234,448	1,386,273
1867	21,809,357	1,627,502	20,434,156	1,557,312
1868	23,105,121	1,698,937	21,487,594	1,607,047
1869	24,002,942	1,701,298	22,128,691	1,586,756
1870	24,830,602	1,812,608	22,689,652	1,675,382
1871	25,664,922	1,902,517	23,248,176	1,741,123
1872	26,728,480	2,042,949	24,026,468	1,856,188
1873	28,338,988	2,368,788	25,339,993	2,154,788
1874	30,885,882	2,827,570	27,572,009	2,581,986
1875	33,104,198	3,429,762	29,447,149	3,146,477
1876	34,433,030	4,107,137	30,408,157	3,778,122
1877	35,895,555	4,601,579	31,488,093	4,217,802
1878	38,009,358	5,290,429	33,203,057	4,845,298
1879	42,326,384	5,824,997	34,902,999	5,309,327
1880	43,828,660	6,426,422	36,651,850	5,833,085
1881	45,456,162	7,051,768	37,683,833	6,372,745
1882	47,253,447	7,588,661	38,824,350	6,815,614
1883	47,235,447	8,265,886	40,116,567	7,391,657
1884	48,928,380	8,966,786	41,266,462	7,982,345
1885	50,742,312	9,613,180	42,536,745	8,509,182
1886	52,527,516	10,562,256	43,758,146	9,330,082
1887	54,123,350	11,552,360	44,770,341	10,179,356
1888	55,239,201	12,245,238	45,284,821	10,718,203
1889	56,348,309	12,742,449	45,780,160	11,052,144
1890	57,327,092	13,289,594	46,132,851	11,429,390
1891	58,474,843	13,822,743	46,643,634	11,785,344
1892	59,695,352	14,314,463	47,214,423	12,092,761
1893	61,223,377	14,786,129	48,079,166	12,373,567
1894	62,414,472	15,154,320	48,590,001	12,544,610
1895	63,655,010	15,605,768	49,137,042	12,794,000
1896	64,890,070	15,945,145	49,664,827	12,925,300
1897	67,164,514	16,263,904	51,218,270	13,031,457
1898	69,342,516	16,687,970	52,650,000	13,238,671
1899	71,495,090	16,984,899	54,032,102	13,313,094
1900	74,119,592	17,681,348	55,862,214	13,783,078
1901	77,610,710	18,503,255	58,529,781	14,369,234
1902	80,363,205	19,255,490	60,419,935	14,874,759
1903	83,598,382	19,717,756	62,762,187	15,080,285
1904	85,966,628	20,295,668	64,201,562	15,395,294
1905	87,175,557	21,143,389	66,220,318	15,972,406
1906	90,252,604	21,783,740	68,309,137	16,330,848
1907	93,414,674	22,704,379	70,448,788	16,961,034
1908	97,164,653	23,790,428	73,141,216	17,744,357
1909	100,391,083	25,428,114	75,268,427	19,064,837
1910	103,587,710	26,930,438	77,329,986	20,228,119
1911	107,299,885	28,163,890	79,871,575	21,102,498
1912	110,968,506	29,573,151	82,328,364	22,136,240
1913	114,959,376	30,772,589	85,066,638	22,941,369
1914	118,919,361	31,800,865	87,729,685	23,559,343
1915	122,496,512	32,538,495	89,665,900	23,872,961
1916	124,095,812	32,886,716	90,187,849	23,787,335
1917	125,200,606	33,328,276	89,894,190	23,790,405
1918	126,393,800	33,653,895	89,676,654	23,671,647
1919	128,118,321	34,032,586	89,977,188	23,601,619

YEAR	Education Gross Building Stock (1950 £)
1902	7,500,980
1903	7,807,601
1904	8,009,289
1905	8,266,874
1906	8,718,386
1907	8,973,244
1908	9,239,190
1909	9,489,539
1910	9,728,671
1911	9,938,267
1912	10,189,426
1913	10,497,513
1914	10,772,795
1915	10,925,561
1916	10,969,422
1917	10,945,428
1918	11,026,038
1919	11,222,749

Source: Table 1, 3, 4

YEAR	Road Gross Stock (1950 £)	Harbour Gross Stock (1950 £)	Road Net Stock (1950 £)	Harbour Net Stock (1950 £)	Educat. Gross Building Stock (1950 £)
1920	130,710,593	34,737,005	91,126,312	23,852,270	11,873,615
1921	133,870,115	35,940,443	92,813,884	24,598,038	12,832,487
1922	137,559,284	37,494,765	94,995,996	25,673,080	13,441,308
1923	141,424,441	38,809,749	97,313,104	26,506,244	13,909,301
1924	146,045,644	40,319,869	100,343,313	27,619,959	14,721,839
1925	151,900,998	41,762,747	104,661,324	28,650,619	15,794,016
1926	157,574,940	43,334,277	108,799,990	29,793,225	16,882,954
1927	163,960,304	45,003,137	113,449,658	31,016,793	17,614,683
1928	171,391,643	46,203,688	119,061,101	31,750,344	18,373,879
1929	179,616,798	47,288,405	125,388,476	32,350,261	19,254,778
1930	188,178,769	48,220,943	131,960,214	32,785,376	20,317,511
1931	196,881,098	48,709,220	138,631,075	32,764,872	20,877,563
1932	203,734,196	48,893,996	143,409,309	32,437,077	20,907,429
1933	211,083,469	49,210,381	148,519,061	32,247,265	20,947,259
1934	217,986,498	49,738,110	153,250,246	32,277,704	20,990,108
1935	225,305,157	50,623,561	158,186,463	32,599,418	21,231,752
1936	235,028,617	51,343,944	165,430,935	32,647,478	21,793,378
1937	246,372,181	52,327,378	173,935,316	32,994,277	22,914,298
1938	260,190,556	53,460,727	184,771,443	33,285,991	24,205,483
1939	272,568,046	54,213,495	194,217,481	33,198,821	25,750,086
1940	280,790,192	54,678,798	199,381,778	33,234,955	26,634,535
1941	283,208,818	54,854,751	198,611,574	32,864,761	27,346,281
1942	283,635,180	55,073,132	195,847,780	32,485,636	27,595,607
1943	284,466,999	55,279,079	193,185,807	32,233,092	27,898,044
1944	285,689,410	55,214,606	190,486,984	31,796,935	28,529,812
1945	287,372,431	55,313,047	188,593,055	31,432,111	30,126,485
1946	289,954,542	55,326,650	187,501,063	31,031,755	31,452,379
1947	291,370,944	55,311,269	187,506,829	30,581,301	33,523,799
1948	296,189,477	55,303,647	188,381,529	29,973,996	36,290,305
1949	301,044,058	55,452,148	189,316,326	29,408,678	39,870,905

YEAR	Road Gross Stock (1983 $)	Harbour Gross Stock (1983 $)	Health Gross Building Stock (1983 $)	Education Gross Building Stock (1983 $)
1950	8,132,529,338	1,555,101,148	953,686,162	1,100,552,074
1951	8,253,475,967	1,592,631,720	987,038,770	1,166,573,648
1952	8,398,453,166	1,623,722,011	1,024,442,985	1,274,962,172
1953	8,548,107,565	1,642,895,104	1,079,217,366	1,399,107,390
1954	8,764,132,896	1,664,603,276	1,130,284,791	1,505,636,006
1955	9,061,072,293	1,694,836,992	1,185,130,013	1,621,121,570
1956	9,381,628,395	1,733,693,308	1,247,999,507	1,752,255,944
1957	9,682,872,273	1,778,373,261	1,322,069,794	1,882,315,381
1958	9,980,400,164	1,835,602,752	1,387,187,588	2,003,775,288
1959	10,319,553,181	1,902,187,883	1,471,111,513	2,129,617,562
1960	10,643,835,867	1,966,466,610	1,561,982,546	2,277,940,433
1961	11,012,512,865	2,032,083,306	1,647,842,466	2,428,225,740
1962	11,367,100,790	2,135,944,147	1,733,862,845	2,565,147,926
1963	11,764,226,789	2,235,167,918	1,819,980,854	2,734,374,854
1964	12,162,997,035	2,313,866,683	1,917,660,644	2,929,008,672
1965	12,597,101,690	2,404,555,827	2,006,766,376	3,126,497,580
1966	12,999,715,792	2,480,789,585	2,079,442,330	3,341,286,123
1967	13,355,712,700	2,576,178,803	2,161,405,829	3,543,349,432
1968	13,730,843,275	2,667,168,279	2,258,940,240	3,733,879,419
1969	14,110,356,696	2,730,210,099	2,338,818,694	3,941,695,310
1970	14,462,050,256	2,808,862,469	2,418,785,681	4,169,537,861
1971	14,781,147,532	2,881,534,359	2,512,097,241	4,395,257,296
1972	15,046,665,246	2,927,578,323	2,613,061,668	4,619,374,040
1973	15,342,676,664	2,972,229,749	2,703,335,689	4,864,080,491
1974	15,542,417,989	3,034,597,755	2,790,042,322	5,081,333,135
1975	15,698,247,504	3,130,131,510	2,875,461,166	5,318,112,428
1976	15,845,620,951	3,230,255,112	2,988,003,516	5,594,733,098
1977	15,952,533,014	3,310,412,269	3,108,774,626	5,825,296,878
1978	16,049,096,490	3,370,300,717	3,212,577,802	6,038,651,818
1979	16,139,192,072	3,409,252,393	3,318,933,551	6,197,917,116
1980	16,205,922,459	3,427,957,472	3,409,030,325	6,307,304,756
1981	16,258,881,627	3,445,893,803	3,477,540,855	6,414,928,333
1982	16,315,839,902	3,473,933,784	3,527,215,569	6,520,936,517
1983	16,370,696,611	3,505,961,541	3,570,849,411	6,624,450,873
1984	16,452,462,907	3,535,260,342	3,605,397,646	6,732,555,005
1985	16,533,028,291	3,569,760,661	3,636,243,292	6,816,539,036
1986	16,594,853,726	3,586,600,059	3,659,018,840	6,906,905,928
1987	16,652,343,146	3,600,976,723	3,687,745,176	7,016,420,882
1988	16,708,895,443	3,642,142,350	3,726,411,269	7,144,265,559
1989	16,788,380,780	3,661,091,915	3,783,797,418	7,307,794,495

Table 6

Table 6

YEAR	C. Admin Gross Building Stock (1983 $)	L. Admin Gross Building Stock (1983 $)	Road Net Stock (1983 $)	Harbour Net Stock (1983 $)	Health Net Building Stock (1983 $)	Education Net Building Stock (1983 $)	C. Admin Net Building Stock (1983 $)	L. Admin Net Building Stock (1983 $)
1950	1,272,836,221	1,886,672,285	5,079,923,002	781,918,792	712,753,531	651,359,071	803,209,229	943,822,493
1951	1,322,016,458	1,912,624,603	5,130,755,452	802,326,395	731,867,363	701,870,430	837,199,604	963,477,499
1952	1,374,585,528	1,963,398,924	5,205,118,250	816,198,319	754,679,901	793,958,932	874,142,362	1,007,509,715
1953	1,433,405,130	2,030,310,654	5,282,515,214	817,994,134	794,482,873	900,425,862	917,133,093	1,066,990,800
1954	1,465,704,075	2,110,344,525	5,435,340,961	822,395,687	829,823,869	987,889,293	932,735,474	1,137,668,369
1955	1,516,144,689	2,215,400,502	5,673,091,201	835,349,517	868,343,894	1,082,927,007	965,829,976	1,231,302,948
1956	1,589,007,582	2,344,303,075	5,936,841,380	856,812,791	914,267,193	1,192,125,923	1,019,493,838	1,346,158,791
1957	1,653,793,466	2,476,577,680	6,180,855,175	883,860,357	970,647,261	1,298,485,993	1,062,728,719	1,461,785,806
1958	1,705,538,792	2,624,447,071	6,422,474,230	923,165,491	1,017,004,072	1,394,502,928	1,090,668,466	1,589,291,831
1959	1,755,677,052	2,812,610,423	6,705,868,497	971,366,109	1,081,373,670	1,493,268,328	1,114,396,912	1,751,224,011
1960	1,829,532,032	2,983,195,496	6,977,805,576	1,016,843,736	1,151,738,127	1,612,851,417	1,159,042,608	1,889,119,956
1961	1,935,188,988	3,161,767,049	7,283,631,923	1,063,308,060	1,216,007,202	1,732,426,080	1,233,161,213	2,031,321,246
1962	2,020,330,915	3,331,370,016	7,572,345,674	1,147,708,779	1,279,468,829	1,836,592,151	1,284,344,042	2,162,136,146
1963	2,147,099,514	3,521,432,134	7,907,195,259	1,226,498,513	1,341,916,892	1,971,158,168	1,375,177,286	2,310,731,238
1964	2,302,947,295	3,689,694,197	8,234,322,682	1,283,762,433	1,414,721,249	2,128,602,106	1,491,305,722	2,434,877,007
1965	2,427,448,960	3,890,731,907	8,588,232,772	1,352,299,128	1,477,516,311	2,285,838,373	1,571,703,690	2,590,349,147
1966	2,561,605,882	4,095,320,831	8,900,411,024	1,405,398,408	1,522,591,540	2,457,396,450	1,659,146,103	2,748,834,531
1967	2,671,755,000	4,281,463,912	9,160,397,911	1,477,018,074	1,575,918,612	2,613,193,639	1,720,396,757	2,887,655,998
1968	2,772,046,812	4,433,611,557	9,437,742,672	1,543,343,335	1,643,608,304	2,755,030,326	1,769,456,772	2,990,941,400
1969	2,906,862,161	4,596,804,483	9,711,016,942	1,581,152,631	1,692,373,828	2,912,251,059	1,851,984,422	3,103,975,109
1970	3,051,992,051	4,736,294,079	9,952,314,424	1,634,244,220	1,740,128,766	3,086,893,812	1,946,229,099	3,191,646,093
1971	3,177,189,697	4,887,278,409	10,158,114,045	1,680,705,980	1,800,254,296	3,256,299,268	2,019,363,882	3,288,989,924
1972	3,335,260,196	4,981,790,097	10,305,466,011	1,700,023,428	1,867,505,639	3,421,381,315	2,124,271,309	3,324,864,264
1973	3,538,627,256	4,975,324,514	10,473,647,256	1,717,624,364	1,923,783,311	3,604,648,293	2,272,002,964	3,254,819,629
1974	3,724,412,677	5,016,336,544	10,538,916,928	1,752,575,268	1,975,916,419	3,757,734,505	2,397,758,169	3,230,001,629
1975	3,968,566,645	5,069,667,284	10,560,679,625	1,819,921,481	2,025,965,266	3,927,215,286	2,579,857,461	3,213,744,205
1976	4,042,024,176	5,058,224,572	10,566,606,610	1,890,486,283	2,102,177,239	4,133,151,403	2,588,981,171	3,131,321,270
1977	4,112,492,046	5,067,658,790	10,531,695,758	1,939,710,705	2,184,772,334	4,288,981,858	2,596,288,799	3,068,791,936
1978	4,193,504,095	5,138,499,038	10,487,245,038	1,967,593,744	2,249,090,987	4,424,257,648	2,614,927,740	3,066,236,249
1979	4,232,697,834	5,220,352,358	10,431,767,681	1,973,733,770	2,314,335,315	4,502,062,236	2,595,553,467	3,072,406,774
1980	4,276,995,254	5,313,851,471	10,354,653,848	1,959,257,290	2,361,515,495	4,526,940,904	2,584,637,802	3,087,245,224
1981	4,319,366,026	5,405,547,559	10,262,355,039	1,944,238,059	2,385,505,351	4,548,055,457	2,574,017,303	3,096,773,439
1982	4,363,242,686	5,469,998,305	10,171,794,809	1,939,653,055	2,389,776,157	4,565,730,265	2,565,844,127	3,075,529,695
1983	4,399,778,989	5,558,995,580	10,078,772,180	1,939,255,680	2,387,356,978	4,579,191,012	2,551,038,328	3,076,594,251
1984	4,430,464,496	5,609,819,798	10,012,100,103	1,936,508,675	2,375,410,989	4,596,537,497	2,532,564,800	3,037,875,670
1985	4,517,729,650	5,648,541,596	9,943,264,787	1,939,503,537	2,359,648,730	4,589,068,993	2,572,014,195	2,986,299,039
1986	4,617,385,765	5,703,660,065	9,852,940,730	1,925,362,627	2,336,206,081	4,588,180,141	2,619,034,688	2,951,205,683
1987	4,589,342,125	5,740,955,840	9,756,025,061	1,909,471,095	2,318,998,152	4,605,941,576	2,537,074,805	2,900,538,489
1988	4,601,369,821	5,834,443,929	9,655,699,794	1,920,912,974	2,312,039,400	4,640,922,656	2,499,189,917	2,912,374,162
1989	4,596,293,023	5,917,804,271	9,577,033,837	1,910,250,958	2,329,968,823	4,688,635,132	2,446,175,521	2,919,600,529

YEAR	Health Gross Equipment Stock (1983 $)	Education Gross Equipment Stock (1983 $)	C. Admin Gross Equipment Stock (1983 $)	L. Admin Gross Equipment Stock (1983 $)	Health Net Equipment Stock (1983 $)	Education Net Equipment Stock (1983 $)	C. Admin Net Equipment Stock (1983 $)	L. Admin Net Equipment Stock (1983 $)
1950	101,876,786	29,055,681	339,541,745	146,238,153	51,478,254	17,222,018	169,131,583	62,131,827
1951	105,205,645	30,225,360	362,828,937	134,310,795	51,290,431	17,104,315	195,849,613	61,139,206
1952	107,051,765	33,359,170	407,602,817	124,386,877	50,303,759	19,301,062	244,086,638	61,771,699
1953	109,101,955	37,564,738	460,693,965	116,436,003	50,614,459	22,489,338	295,544,622	63,419,324
1954	110,417,848	42,000,245	477,836,115	110,331,002	51,016,624	25,631,675	303,790,169	65,390,029
1955	113,529,661	49,924,832	493,921,857	110,194,933	53,826,604	31,825,271	307,668,884	70,639,820
1956	114,917,579	56,588,458	526,276,211	112,694,670	55,642,172	35,827,972	324,189,720	75,431,333
1957	119,293,890	63,201,712	532,085,480	136,428,083	60,922,602	39,146,484	309,326,096	98,460,132
1958	120,663,871	69,437,895	598,420,319	157,776,296	63,068,777	41,700,262	355,604,148	115,522,965
1959	121,435,034	74,365,383	673,950,894	172,314,395	64,569,749	42,724,840	406,964,822	123,456,284
1960	121,383,735	81,460,177	733,533,741	196,445,658	65,249,614	46,092,092	439,094,292	140,103,292
1961	123,027,425	88,285,835	750,865,338	217,204,459	67,750,739	49,333,306	428,993,694	152,295,572
1962	132,967,201	95,493,596	750,301,985	243,473,468	77,954,902	53,310,017	403,987,017	168,609,202
1963	139,210,180	103,635,624	769,107,210	270,501,679	82,960,731	58,132,965	406,639,669	183,896,233
1964	148,231,488	111,804,469	837,995,478	323,902,045	90,039,926	62,386,968	467,946,104	224,037,260
1965	165,532,135	122,277,794	910,997,298	352,835,802	104,401,231	68,883,758	535,024,818	235,172,605
1966	178,582,039	135,055,495	997,192,079	383,658,134	112,636,716	77,403,264	609,485,606	247,253,059
1967	192,050,327	166,412,694	1,014,741,388	411,962,357	120,119,790	103,845,084	607,801,675	255,814,294
1968	216,980,869	178,821,909	988,097,804	441,222,165	138,521,809	115,427,755	567,965,497	265,306,358
1969	236,560,572	172,120,215	951,781,048	469,576,915	149,538,968	108,395,648	520,396,562	276,841,053
1970	253,633,055	174,292,175	971,064,092	498,775,803	157,691,344	112,192,532	537,194,681	291,176,616
1971	269,512,023	172,518,503	990,091,067	525,592,546	164,365,990	111,827,113	554,197,020	303,415,423
1972	280,965,555	185,563,465	980,018,010	563,202,490	166,282,643	127,345,965	546,513,343	328,612,394
1973	299,455,850	205,316,198	947,074,003	573,873,018	175,222,895	147,586,082	517,885,623	326,470,826
1974	312,582,227	218,747,451	950,272,497	595,688,564	177,959,016	159,777,165	524,670,952	339,713,753
1975	325,844,785	226,579,953	950,996,306	625,318,917	182,186,348	166,149,017	533,694,248	360,082,097
1976	339,194,433	238,780,916	935,405,995	637,544,837	186,353,380	177,497,505	530,922,319	366,340,809
1977	355,228,757	252,055,484	916,346,357	639,950,982	193,902,345	191,253,978	530,867,031	365,147,930
1978	369,177,675	261,704,897	887,545,188	637,735,042	201,155,149	202,522,770	531,056,046	361,354,779
1979	375,175,428	272,014,729	855,878,503	634,459,720	201,697,416	216,190,629	533,300,200	358,991,187
1980	381,868,292	275,216,930	831,209,857	641,646,003	204,714,680	222,179,197	543,792,991	368,803,252
1981	392,420,214	279,410,990	803,298,095	647,602,066	213,819,913	225,697,225	545,793,701	378,335,829
1982	397,834,235	288,659,110	789,337,283	657,177,136	220,368,600	233,073,058	557,524,544	388,358,295
1983	399,407,665	300,515,741	799,649,745	665,005,948	224,433,151	239,884,138	586,431,018	397,419,230
1984	402,169,175	315,385,681	832,125,021	678,255,205	229,749,746	248,581,094	620,854,673	414,793,529
1985	401,093,214	338,326,420	947,025,800	696,380,266	230,930,980	264,537,920	727,205,103	435,214,858
1986	411,124,827	392,817,064	1,017,628,747	710,292,735	245,214,383	311,063,884	781,324,922	451,386,554
1987	436,615,703	429,372,958	1,141,094,896	731,394,254	270,796,717	337,136,749	890,357,620	476,179,195
1988	463,288,754	476,253,449	1,249,013,854	744,674,847	294,505,730	372,819,386	967,510,208	490,835,648
1989	489,115,414	514,503,638	1,260,721,807	741,325,964	314,706,199	399,433,168	935,685,444	486,912,937

Source: Table 2, 3, 4

Table 7

Table 8

ROAD INVENTORY 1929

	Rural	Urban	Total
Unsurfaced	15132	361	15493
Granular	28815	2808	31623
Dustless	852	875	1727

COUNTIES						
Class	1	2	3	4	5	Unclassified
Mileage	390	1274	3530	4582	2544	32479

RURAL						
Class	1	2	3	4	5	
Mileage	390	3084	11398	14795	15132	

RURAL						
Class	1 Penetration	2 Penetration	2 Granular	3 Granular	4 Granular	5 Unsurfaced
Mileage	390	462	2622	11398	14795	15132
Cost per mile	£5000	£4692	£2109	£1299	£1017	£685
Value	1,950,000	2,167,704	5,529,798	14,806,002	15,046,515	10,365,420

URBAN						
Class	1 Concrete	1 Penetration	2 Penetration	3 Granular	4 Granular	5 Unsurfaced
Mileage	243	244	488	1404	1404	361
Cost per mile	£12473	£5000	£4692	£1299	£1018	£685
Value	3,043,412	1,215,000	2,052,750	1,823,796	1,427,868	247,285

TOTAL RURAL	**49,865,439**
TOTAL URBAN	**9,810,111**

BRIDGE INVENTORY 1929

	Number	Length	Cost per foot	Value (£)
Iron/Steel	232	32,330	£32	1,034,560
Concrete	671	57,739	£27	1,558,953
Hardwood	2285	245,867	£14	3,442,138
Native	2097	168,120	£12	2,017,440
Other	38	5,447	£12	65,364
TOTAL	5390	509,503		**8,118,455**

GRAND TOTAL	**67,794,005**

ROAD INVENTORY 1954

	County	Borough Town	District Road	District
Unsurfaced	6736	166	87	15
Granular	37929	1294	215	59
Bitumen	5861	2555	108	2
Concrete	175	253	7	-

RURAL					
Class	1	2	3	4	Unclassified
Mileage	310	18556	16099	1073	13797

NZ WIDE				
Class	1 Concrete	1 Bitumen	2 Bitumen	2 Granular
Mileage	435	135	7058	12830
Cost per mile	£36430	£14603	£13704	£6160
Value	15,847,050	1,971,405	96,722,832	79,032,800

Class	3 Bitumen	3 Granular	4 Granular	4 Unsurfaced
Mileage	1331	16854	9754	6123
Cost per mile	£13704	£3794	£2970	£2824
Value	18,240,024	63,944,076	28,969,380	2,730,808

TOTAL ROAD	**307,458,375**

BRIDGE INVENTORY 1954

	Number	Length	Cost per foot	Value (£)
Concrete	1767	178,789	£79	14,124,331
Steel/concrete	346	40,838	£85	3,471,230
Stl./concr./timb	551	57,249	£85	4,866,165
Steel/Timber	990	92,926	£52	4,832,152
Hardwood	2543	243,411	£40	9,736,440
Native	2571	155,634	£35	5447190
TOTAL	8,768	768,847		**42,477,508**

GRAND TOTAL	**349,935,883**

Source: See text

Table 9

YEAR	Total Gross Structures (1983 $)	Non-transport Gross Structures (1983 $)	Philpott 1992 Gross Structures (1983 $)	Growth Rate 1	Growth Rate 2	Growth Rate 3
1949	14,748,600,000	5,068,600,000	5,963,000,000			
1950	14,901,377,228	5,213,746,742	6,233,800,000	1.0%	2.9%	4.5%
1951	15,234,361,166	5,388,253,479	6,488,800,000	2.2%	3.3%	4.1%
1952	15,659,564,786	5,637,389,609	6,797,000,000	2.8%	4.6%	4.7%
1953	16,133,043,209	5,942,040,539	6,926,800,000	3.0%	5.4%	1.9%
1954	16,640,705,570	6,211,969,397	7,686,300,000	3.1%	4.5%	11.0%
1955	17,293,706,059	6,537,796,774	8,199,100,000	3.9%	5.2%	6.7%
1956	18,048,887,812	6,933,566,109	9,158,500,000	4.4%	6.1%	11.7%
1957	18,796,001,856	7,334,756,322	9,607,000,000	4.1%	5.8%	4.9%
1958	19,536,951,655	7,720,948,740	10,304,200,000	3.9%	5.3%	7.3%
1959	20,390,757,613	8,169,016,549	11,009,700,000	4.4%	5.8%	6.8%
1960	21,262,952,984	8,652,650,506	11,848,900,000	4.3%	5.9%	7.6%
1961	22,217,620,415	9,173,024,244	12,663,600,000	4.5%	6.0%	6.9%
1962	23,153,756,639	9,650,711,702	13,517,200,000	4.2%	5.2%	6.7%
1963	24,222,282,064	10,222,887,357	14,379,500,000	4.6%	5.9%	6.4%
1964	25,316,174,526	10,839,310,808	15,410,400,000	4.5%	6.0%	7.2%
1965	26,453,102,339	11,451,444,823	16,448,600,000	4.5%	5.6%	6.7%
1966	27,558,160,544	12,077,655,166	17,582,300,000	4.2%	5.5%	6.9%
1967	28,589,865,676	12,657,974,173	18,711,900,000	3.7%	4.8%	6.4%
1968	29,596,489,582	13,198,478,028	19,760,500,000	3.5%	4.3%	5.6%
1969	30,624,747,444	13,784,180,649	20,706,000,000	3.5%	4.4%	4.8%
1970	31,647,522,397	14,376,609,673	21,778,200,000	3.3%	4.3%	5.2%
1971	32,634,504,533	14,971,822,642	22,798,800,000	3.1%	4.1%	4.7%
1972	33,523,729,570	15,549,486,001	23,727,800,000	2.7%	3.9%	4.1%
1973	34,396,274,363	16,081,367,950	24,718,300,000	2.6%	3.4%	4.2%
1974	35,189,140,422	16,612,124,678	25,558,200,000	2.3%	3.3%	3.4%
1975	36,060,186,537	17,231,807,523	26,427,900,000	2.5%	3.7%	3.4%
1976	36,758,861,424	17,682,985,361	27,404,200,000	1.9%	2.6%	3.7%
1977	37,377,167,623	18,114,222,340	28,172,500,000	1.7%	2.4%	2.8%
1978	38,002,629,959	18,583,232,753	28,859,700,000	1.7%	2.6%	2.4%
1979	38,518,345,324	18,969,900,859	29,547,300,000	1.4%	2.1%	2.4%
1980	38,941,061,738	19,307,181,807	30,137,200,000	1.1%	1.8%	2.0%
1981	39,322,158,205	19,617,382,774	30,632,700,000	1.0%	1.6%	1.6%
1982	39,671,166,762	19,881,393,076	31,054,800,000	0.9%	1.3%	1.4%
1983	40,030,733,004	20,154,074,852	31,431,800,000	0.9%	1.4%	1.2%
1984	40,365,960,194	20,378,236,944	31,795,400,000	0.8%	1.1%	1.2%
1985	40,721,842,526	20,619,053,575	32,123,100,000	0.9%	1.2%	1.0%
1986	41,068,424,384	20,886,970,598	32,446,100,000	0.9%	1.3%	1.0%
1987	41,287,783,892	21,034,464,022	32,724,800,000	0.5%	0.7%	0.9%
1988	41,657,528,370	21,306,490,577	32,843,600,000	0.9%	1.3%	0.4%
1989	42,055,161,901	21,605,689,206	32,943,600,000	1.0%	1.4%	0.3%
			Mean =	2.7%	3.7%	4.4%
			Std. deviation =	1.4%	1.8%	2.8%

Source: Table 7, Philpott (1992)

REFERENCES

Appendices to the Journals of the House of Representatives

D Baumol, Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis *AER 57 3 (1967)*

Morris Beck, The Expanding Public Sector: Some Contrary Evidence *National Tax Journal 29 1 1976*

Morris Beck, Public Sector Growth: A Real Perspective *Public Finance 36 3 1979*

Derek Blades, Service Lives of Fixed Assets. *OECD Working Paper no 4 (1983)*

A D Brownlie, Capital Formation in New Zealand 1946-1956 *Unpublished M. Com. Thesis University of Auckland (1958)*

Colin Campbell, A Simulation of Survival Functions, Retirement Rates and Stock Valuation in a Stock of Capital *RPEP Internal Paper no 31 (1977)*

J A Dowie, Capital Formation in New Zealand: Estimates, 1871-1900 *Unpublished Ph. D Thesis ANU (1965)*

Martin Feldstein and David Foot, The Other Half of Gross Investment: Replacement and Modernization Expenditures, *Review of Economics and Statistics 55 (1971) p 49-58*

T W Francis, Capital Formation in New Zealand Manufacturing Industries 1910-1964 *AERU Technical Paper no 6 (1986)*

Malcolm Fraser, Prices: An Inquiry into the Course of Prices In New Zealand 1891-1919 *Wellington (1920)*

Gazette of the Province of Wellington *(1875)*

Peter Heller, Diverging Trends in the Shares of Nominal and Real Government Expenditure in GDP: Implications For Policy *National Tax Journal 34 1 (1981)*

Local Authority Handbook *(1926-1961)*

Local Authority Statistics *(1963-1974)*

J W MacIlraith, The Course of Prices in New Zealand, (*Wellington, 1911)*

Aree Montrivat , Price Indices for Investment Goods 1962/63-1980/81 *RPEP Internal Paper no 96A (1981)*

Tim Mulcare, The Measurement and Implications for Economic Growth of Government Capital Stock in a Small Open Economy: New Zealand 1950-90,*Unpublished Thesis, Victoria University of Wellington (1993)*

Municipal Handbook of New Zealand *(1912-1920)*

New Zealand Official Yearbook *(1925-)*

S Peacock and J Wiseman, Approaches to the Analysis of Public Expenditure Growth *Public Finance Quarterly 7 1/1979*

Bryan Philpott, Provisional Estimates of Real Capital Stock in New Zealand Government Non Market Sector 1950-90 *RPEP Internal Paper no 240 (1992-a)*

Bryan Philpott, New Zealand Real Gross Capital Formation in 22 SNA Sectors 1950-89 *RPEP Occasional Paper no 104 (1992-b)*

A R Prest, Some Aspects of Road Finance in the U.K.*The Manchester School of Econmics and Social Studies 38 (1963)*

G C Scott, Indexes of Costs of Investment Goods 1949/50-1963/64 *AERU no 26 (1966)*

Ben Shinawatra, Sectoral Allocation of Government Capital Formation 1950-76 *RPEP Internal Paper 50 (1978)*

Statistics of the Colony of New Zealand *(1863-1907)*
Statistics of the Dominion of New Zealand *(1908-1920)*

R Walters and R Dippelsman, Estimates of Depreciation and Capital Stock Australia *Australian Bureau of Statistics Occasional Paper no 1985/3*

Micheal Ward, The Measurement of Capital *OECD Paris (1976)*

M K Watson and B R Patterson, The Growth and Subordination of the Maori Economy in the Wellington Region of New Zealand, 1840-52 *Pacific Viewpoint 26 3 (1985)*

Robley Winfrey, Economic Analysis for Highways *Pennsylvannia (1969)*

ENDNOTES

[1] In the New Zealand context a distinction can be made between air and rail transport on the one hand and road and harbour transport on the other, with the two first groups for most of the period under investigation consisting of a public monopoly on both the construction and ownership pf the transport infrastructure and on the right to use. Similarity between harbour and road infrastructure in the context of a non-market setting exists insofar as a network installed and maintained through public finance is administered by public authorities with a monopoly (for most of the period) on the construction, maintenance and administration of the network but not upon the operations of those organisations generating the transport services utilising the network. While the user charges for road and harbour works were generally administratively-set grey areas exist such as port stevedore and wharfage operations.

[2] Sections 2,3 4 and 6 are a precis of work undertaken in T G Mulcare, The Measurement and Implications for Economic Growth of Government Capital Stock in a Small Open Economy: New Zealand 1950-1990, *Unpublished Thesis, Victoria University of Wellington.* This is available on interloan from the University Library, although minor queries might be addressed to the author.

[3] J A Dowie, Studies in New Zealand Investment 1871-1900, unpublished Ph. D Thesis, ANU Canberra (1965).

[4] Ben Shinawatra, Sectoral Allocation of Government Real Gross Investment, RPEP Internal Paper no 50 (1978). Estimates from Official Government Statistician were via personal correpsondence.

[5] Such outlays between 1887 and the first expenditure on hospitals out of the public works fund (1877) can be expected to be trivial. Additions to mental hospitals was not recorded. It is unclear whether outlays include land purchase.

[6] Consents were only recorded for purchases greater than £250 (1951-60) and £500 (1960-1971)

[7] The series from 1903 to 1949 is structures only. In order to estimate retirement and depreciation of the plant and equipment stock in the period 1950-90 estimates of furniture and equipment for the period 1932-1950 were undertaken by weighting the gross capital formation series by the average proportion that furniture and equipment were in total capital formation for the period 1950-60.

[8] Information for the period 1959-65 indicated that land purchase averaged about 5% of total capital expenditure in this period. This was used as a deduction for 1950-59 and 1966-71 when land purchase information could not be found. From 1904 Education boards were able to use part of their maintenance vote for small additions and alterations. Evidence to a 1912 Select Committee suggests that this practice was resorted to by many boards (AJHR (1912) II E-12 p 382-383, p631, p 635) while information for the period 1932-37 indicates that 8% of total capital expenditure was from the Consolidated fund. Source: AJHR (1933-37) E-2

[9] The first taken from Dowie (1965), the second from Shinawatra (1978). The inflation factor was the average of the difference in each point estimate (45%).

[10] Education and health capital formation has to be deducted from both sources

[11] Boroughs represented 80% of the (book-value) of administration structures and 50% of administration plant and equipment, or 75% of the total capital stock of local authority administration. Source: Local Authorities Handbook (1951) p 201. A differential pattern of capital formation between boroughs and the rest of the administration sector to 1950 is assumed negligible.

[12] Public works expenditures are first recorded in 1840 but the distinction between outlays on transport infrastructure and other public works was not made until 1846

[13] On an annual basis the relationship between the Wellington public works expenditures and total revenue was unstable, nor was there any stable relationship between works expenditure and the more volatile territorial revenue. It might be expected that a key determinant would be loan funding, but this was not incorporated into revenue accounts while expenditure and revenue over the 1853-1861 period in Wellington were practically equivalent.

[14] Non-capital outlays to 1900 represented 12.5% of total net expenditure on roads and bridges to this date. Source: AJHR (1901) D-1 p 79. This form of return was discontinued the following year: partial information after 1900 suggests that similar deductions might be made for the post-1900 data i.e in 1913 and 1914 about 10% of the total outlays on roads etc from the fund was on 'maintenance and improvements', and 6-7% for the years 1907 and 1908. The deduction used for outlays out of the public works fund for the period 1900-1927 was 10%.

[15] According to the first annual report of the Main Highways Board in 1928 while the usual situation was for the Public Works Department to open up and form new roads which were then handed over to local authorities for "care and control" there were districts where 'a great deal of development work had been done by the local authorities'. Source: AJHR (1926) D-1 p 110.

[16] Counties, estimated to provide the largest disbursement of local authority roading funds to the mid-1920's, and Town Districts, which provided the least.

[17] Both in terms of changing agendas through time and in respect of the method of payment of lumpy capital assets i.e in 1919 75% of borough public works expenditures out of loan-monies was for a one-off payment for tramways expenditure, representing an increase of a factor of over 600 times on the previous year's expenditure in this area when it was less than 1% of total loan expenditure. Source: Local Authorities Handbook (1928) p 56

[18] A report on all expenditures for county roading construction for the period 1882-1888 indicated that 95% of the counties aggregate expenditure as measured by Dowie (1965) was on roading, while the earliest available expenditures by agenda for all counties (1926-31) indicated a quinquennial average of 85% of total works expenditure on roads, or 90% if plant and machinery (unspecified) was subsumed under roading expenditure.

[19] Or is offset by other error sources i.e current-price/constant-price conversion error. See section 6 below.

[20] It is unclear where the Department of Transport estimates might have allocated this if at all. The likely inclusion of land purchase in estimates to at least 1928 will impart an upward bias to gross capital formation estimates, but information to 1900 suggests insignificance for this component of error i.e the total net expenditure out of the Public Works fund to this date on native land purchases and surveys was was £18,733,while payments to local authorities for land purchases was £1262. It is likely that much land purchase was taken from other (past) votes, with subsequent payment for transfer not being subsumed under construction expenditure. It can be expected that for all sources of roading outlays the greatest source of error will be the differential between capital expenditures incorporated within maintenance votes and maintenance incorporated within capital outlays.

[21] No adjustment was made to the ad hoc roading authorities, the Lyttleton Tunnel Authority and the Auckland Harbour Bridge Authority.

[22] For the two years 1860 and 1861 harbour capital formation was estimated by deducting 10% from the roading estimates for these years, this being the weight of harbour expenditure in total works outlays in the period 1863-1870.

[23] The functional classification used by Harbour Boards prior to 1917 is somewhat ambiguous. The 1915 edition of the Municipal Handbook classifies expenditure as 'works and maintenance' or 'expenditure out of loan', with the 1917 edition listing these expenditures out of loan for 1912-1914 as 'works and maintenance out of loan', other expenditures being classified as works and maintenance out of revenue'. 2 sets of estimates were prepared for the period 1900-1916, one utilising the average capital-in-total-works ratio estimated for the period 1917-1928, the other utilising expenditures out of loan funds. The latter was greater than the former for the period 1900-1916 by 0.3%, implying statistical indifference in choice of estimation method.

[24] The Local Authority Statistics were discontinued after 1987. The estimates for 1988 and 1989 were derived by weighting total local authority capital formation in these years by the average proportion that harbour boards were in total local authority outlays in the 3 years to 1988.

[25] By 1950 harbour works out of the public works fund were a trivial proportion of total harbour works, representing about 3% of total harbour works in 1945-49.

[26] The first is used for the health and education structures series, the construction index for transport infrastructure, and a combined building and construction index is used for each administration structure series based on the implicit weights of each broad asset taken from the 1972-89 series.

[27] Consistency of returns was available only for 'Bath' and 'Fire' bricks. The volatility of the implicit import series explains much of the divergence in trend between the transport structures and non-transport structures series to 1891.

[28] Dustless surfacing represented only 1.5% of the physical stock of roading at 1925. Source: Local Authority Statistics (1926) p 170.

[29] No information was given on stonebreakers' wages for two periods, 1871-73 and 1879-1882, and so the general labourers index only was used.

[30] According to the earliest reliable bridge survey 83-85% of the bridging at 1925 was of wooden construction, and of this the length of bridging constructed from native timber and from Australian Hardwood was about equal - 41% and 44% respectively. It is likely that construction using other materials (iron and steel and stone or concrete) accelerated in the twentieth century. Source: NZOYB (1926) section XIV. "Bridging quality" heart rimu and totara prices were given from 1891 and that of two important Australian Hardwoods Jarrah and Ironbark was given for 1909 - 1919. In this reduced period the first of the hardwoods was priced similarly to Totara and showed a similar pattern of

price movement until 1915, when the price of the imported timber rose sharply. Ironbark prices rose more steeply than the other three to 1912, thereafter to plateau until towards the end of the war. The two native timbers were given equal weight in the final timber index (1925) .

[31] A 1863 Memorandum on military roads inferred that 22% of the cost per mile of roading was for materials. Source: AJHR (1863) A-8a p 6. The cost of tools was about 2% of total expenditure in one quarter on the Wairarapa Rd. Source NZ Gazette (Province of New Munster) vol 2 p 124. The valuation of physical inventory data indicated that 12% of the road stock was bridging. The equivalent weighting for timber and gravel adopted indicates that the labour content of bridging is probably underestimated.

[32] The Porirua road, constructed between 1846-1849 at a cost of £20,410, or 33% of road disbursements. Much of the residual would have been expended on the Wairarapa road (total expenditure £35,000) for which there were likely to have been greater geographic cost variations. The former also utilised a greater amount of Maori labour. Source: Watson and Patterson, *(1985)* p 527

[33] *Op cit* p 6

[34] McIlraith has prepared indexes for up to 39 commodities in this period. His materials index (none of which were relevant here) implied a rising pattern to 1869, although it is significant that the incidence of two large annual rises appears to be mainly through the introduction of additional commodities into the index.

[35] Montravit's index was based upon Scott (1966) who adjusted his building and construction index by an index implied by annual aggregate employment and volume of production. Francis (1968) claims that his index is based upon Scott, but no explicit mention is made up of a productivity adjustment in the description of his series. Source: *op cit* p 27.

[36] Equiping of the Public Works Department was vigorous under Coates (1920-25), and Semple (1936-1939), the latter after considerable labour substitution in the period 1929-1935. In his 1922 Public Works Statement Coates claims a 30% reduction in the cost of earthworks as a result of the application of 'modern mechanical construction plant'. Source: AJHR (1922) D-1 p ii. In his first statement Semple lambasted the state of equipment in the Department, claiming that its was 'practically depleted of effective and up-to-date plant', some branches of the Department having 'steadily dispos(ed) of plant and machinery', with 'many thousands of pounds (to be) spent to 'scrap inadequate appliances such as wheelbarrows and hand-carts...to modernize the public works'. Source: AJHR (1936) D-1a p i. Provision was even made to purchase equipment out of the Consolidated fund, with the outlays from this source for 'modern plant' in 1936 greater than the total Consolidated fund maintenance vote for the previous year by 30%. Source AJHR (1936) D-1 p iii.

[37] This implies a smoothed final stock series contrary to the lumpiness of some capital formation.

[38] According to Ward (1976) 'in most countries no recent, comprehensive and empirically based set of estimates has been compiled, which may not be surprising as Walters and Dippelsman (1985) note that asset life information is not required for other purposes in National Accounts.

[39] As the latter is the average of an average. Ward (1976) suggests that capital stock estimates undertaken using, amongst others, survival distributions at each end of the survival spectrum rarely gives variations in annual stock estimates greater than 10% and 'in most cases the differences were very small' *ibid* p 35.

[40] Empirical testing has also indicated that constant-replacement in a market setting is an unreasonable assumption i.e Feldstein and Foot (1971) indicated that as a determinant of replacement capital formation in the short term asset age was statistically insignificant, with the key determinants in this study being availability of (internal funds), the level of capital utilisation and the timing of competing expansionary capital formation. Source: Feldstein and Foot (1971) p 49-57.

[41] This might be used to support the notion that maintenance and a part of new capital formation are in respect of capacity stocks one and the same thing, not to be divorced in stock estimates, certainly not to be assumed as given. Alterations and modifications that often go hand-in-hand with 'routine maintenance' are rarely reported separately in accounts and will further increase the uncertainty surrounding the use of mean asset lives in stock estimation.

[42] i.e A review of the asset lives used in perpetual inventory models in Blades (1983) simply distinguishes between 'engineering construction' and 'combined engineering construction and buildings', with a wide range of mean asset lives for the former, from 31 years (USA) to 80 years (Sweden). Source Blades (1983) p 14. Road asset lives used in more specific studies range from 43 years (for weighted road construction (75 years) and alterations and additions (35 years)) to 100 years, with 75 the most commonly used mean asset life. Source: Mulcare (1993) p 194-195.

[43] For example Prest (1963) considers inappropriate asset lives used in Redfern (1955) to be the most likely explanation for the discrepancy of a factor of nine in the roading stock between this work and a UK Road Research Technical paper. Source: Prest (1963) p 240.

[44] A recent valuation of NZ government assets undertaken by the NZ Treasury also did not depreciate foundation work but only the pavement component (average life assumed = 25 years) and bridging (average life assumed = 90 years). Source: Financial Statements of the Government of New Zealand (1992) p 42.

[45] As per National Roads Board outlays.

[46] As both the length and expenditure on reseal-only roading was given.

[47] Under an assumed pavement life of 20 years with a delayed-linear distribution about this of ±20%, this mean asset life being taken from Winfrey (1969)'s upper bound estimate of the length of life of intermediate-type bituminous surface in conjunction with information from the 1959 Department of Transport report, which considered that an implied mean asset life of 25 years was too long for main highway roading. Source AJHR (1959) D-5A p22.

[48] The angle of curvature assumed was 2.67r, halfway between an arc with radius sine 45' and that defined by a semicircle, r π.

[49] 3% of total construction.

[50] Information was available on main highways to 1960, this class of roading being subsumed under state highways or passed to local authorities after this time.

[51] i.e. and using the perpetual inventory method to estimate retirements under a mean asset life of 75 years taken from the upper bound estimate of Winfrey, and using a delayed linear distribution about this of ±20%. 1979 was the last time in which physical surveys of the bridging stock were recorded.

[52] The comparison of 1930 and 1960 average bridging costs on the two types of road indicated that replacement bridging on state highways after 1954 represented about 70% improvement while for local authority bridging replacement implied 50% improvement, 50% replacement.

[53] A general review of asset lives and functional forms used in various perpetual inventory models can be found in Blades (1983) p 3-23. For asset lives more specific to the government sector consult Mulcare (1992) Unpublished M.A. Thesis (1993-a).

[54] Assumed to be an L-3 type curve being the most neutral choice of the range. The information in the Education Board inventory also implied the mean asset life used, this being 35 years for wooden buildings and 100 years for stone buildings, giving a weighted average from the proportion of each type of construction of 50 years. Source: AJHR 1903 I-13. This was a similar mean asset life to other studies. See Mulcare (1992) p 118-119.

[55] All parts of Public High Schools and District High Schools made of stone or brick built before 1903 were assumed retained for posterity reasons, as were all University buildings not subject to resite. Other University buildings built before 1903 were retired at the date of establishment of resite using information from centenary publications. See Mulcare (1992) p 116-121 for more information.

[56] i.e. 90 years. A net education building stock for the period 1902-1950 is not estimated because of the difficulty arising from the one-off retirement of key parts of the stock.

[57] Source: AJHR (1992) B1 pt 1p 99.

[58] Shinawatra investigated the annual expenditure categories of each department, needing in a few cases to assign an arbitrary equal weighting to categories that contained both capital and current expenditures and/or both broad asset types. As regards the latter the most likely error source is outlays for new structures with associated newly installed plant and equipment subsumed under a new construction outlay.

[59] For instance inflation of the gross capital formation series inflated by a factor 6 times larger than the inflation factor actually utilised implied a depreciated stock value only 8% larger than the original estimate, still around 30% short of the Treasury valuation figure.

[60] It is possible that through reasons of efficiency or because of different agenda setting the market might anticipate a higher rate of return on some government assets than is being derived from these assets, but the public-good and/or merit-good nature of many government services and the resultant incorporation of a risk-premium into the discounted earnings might offset this to an unknown degree.

[61] Source: AJHR (1992) B1 pt 1 p 70; personal correspondence.

[62] viz £5000. Source for costs: AJHR (1930) p 55.

[63] Source: AJHR (1931) D-1 p 163. Physical dimensions of each bridge were found by referring to returns in the years 1928-1932. Reference was made in the 1931 return of a Californian report which indicated that a concrete bridge cost about double that of those constructed from fir and redwood.

The average value for concrete bridging was £27 per foot and £32 per foot for steel and steel/concrete structures. Native timber bridges were assigned a value of £12 per foot and £14 per foot for Australian Hardwoods, being the approximate differential between the two timber types indicated in Fraser (1920).

[64] The capital cost of railways to March 1914 was stated as £35 million which can be compared with Dowie's series to 1900 plus outlays from the Public Works fund to 1914 which totals some £39.8 million. It is known that in the financial year 1928 £3.5 million was transferred from railways to other areas of the Public Works department as payment for 107 miles of line taken over by the Railways from these departments. Dowie's series to 1900 excludes private railway construction and it is possible that government purchase of private railway in 1908-1909, by which time only one private operator remained (Wellington-Manawatu line), is incorporated within public works outlays). Source: Dowie (1965) p 49, 56; AJHR (1908), (1919) D-1 Table 2. AJHR (1929) D-2 p i.

[65] The Administration starting value estimate excluded defense capital, although expenditures on defense were part of the post-1949 capital formation series.

[66] Source: personal correspondence from the author. The two parameters essentially differ on the treatment of capital consumption, whereas the key determinant of error in the ratio of market i.e. net stock valuations to book valuations lies with the price index. The comments from section 3 and 6 indicate that error from the price indexes is more likely to show impart upward bias to the constant-priced stock, implying that the implicit real : market value ratio of this paper is likely if anything to be downward biased.

[67] This 'relative price effect' was described by Peacock and Wiseman (1961), 'explained' by Baumol (1967), and elaborated upon by Beck (1976), Beck (1979) and Heller (1981). Beck (1979) estimates a median price increase in the government consumption sector for 13 OECD countries of 681% in the period 1950-77 compared with a median increase in the GDP deflator of 369%. Source: Beck (1979) p 323. Heller (1981) found the same directional trends in 15 of 24 developing economies for the period 1960-75. Source: Heller (1981) p 67.

[68] The gross non-market transport sector series for 1910-1950 from table 6 showed faster average growth than the net series (2.6% versus 2.1% respectively) but lower variance (sample standard deviations of 1.4% and 2.0% respectively).

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