

# Privatisation and economic growth: the shorthand of a long process<sup>\*</sup>

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## Abstract:

The macroeconomic impact of privatisation on growth in Australia is investigated in a growth accounting framework. Separate measures of public and private capital are computed in order to estimate their impacts together with labour on GDP growth for the period 1960-2003. Previous empirical aggregate studies are relatively few. A simple growth rates version is found preferred by stationarity and other tests. Growth of labour input appears to have a strongly positive effect on the growth of GDP. In contrast, growth of public capital has no statistically significant effect on GDP growth, nor on private capital productivity. The data are consistent with the hypothesis that the coefficients of the growth equation are the same before and during privatisation.

Keywords: macroeconomic, growth, capital, public, privatisation, time series, data, estimation, test

JEL Classification: C52, C82, E23, H54, L33, O47

## Introduction

Privatisation has been taking place over more than two decades in Australia as it has globally.<sup>1</sup> The macroeconomic consequences of privatisation remain surprisingly underexamined relative to partial or microeconomic aspects. This paper addresses the macroeconomic impact of privatisation on growth in the Australian economy. By contrast with a large body of work largely motivated by that of Aschauer<sup>2</sup>, it is not assumed here that the impact of privatisation arises specifically in relation to the role of infrastructure in the economy. The paper seeks to examine the consequences of privatisation of public assets of any kind, in aggregate. No a priori assumption is made about the sources of contribution to growth arising from the change in the pattern of ownership of capital. Rather those sources are a matter for investigation. In order to do this separate aggregate measures of public and private capital are computed from available data and a simple growth accounting framework is used in order to estimate the impacts of these separate capital stocks and labour on aggregate output growth.

In the case of Australia the rate of privatisations was accelerated with the implementation of the raft of policy measures known as 'microeconomic reform' through the 1990s. The express purpose of 'microeconomic reform' was to expose to competition those parts of the economy which had been shielded from it, thereby realizing what are assumed to be hitherto unexploited efficiencies. The intention in this paper is to distinguish the effects of privatisation from other measures associated with microeconomic reform and from

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<sup>1</sup> This is meant in the broad sense in that instances of reversal have occurred eg some public transport in the state of Victoria, as well as extensive regulatory amendment.

<sup>2</sup> A key paper is David Aschauer 1989 Is public expenditure productive? *Journal of Monetary Economics* V23, pp177-200.

other factors in growth.<sup>3</sup> Because public asset sales have predominantly been made to multinational companies, privatisation has also played a major and direct role in the integration of Australia's capital into the international economy. Addressing the globalisation aspect of privatisation however is beyond the scope of this paper.

This paper identifies what is meant by privatisation, considers other approaches to assessing its outcome, sets out the growth accounting approach taken here and the data used for estimation. The results are then interpreted and directions for further investigation are indicated.

### ***The problem***

The measurement of the overall impact of privatisation on the Australian economy is clearly a tall order, as the range of estimates implied in previous work on factors in Australian economic growth shows. Discerning the impact of privatisation, a process which is still relatively recent and small in the scheme of things, is the more difficult as fuller effects are realized only in the longer term.

The intention is also to distinguish the effects of privatisation and investigate the significance of the type of ownership for the productivity of assets as a separate issue from that of the 'microeconomic reform' program in Australia. The latter includes the deregulation of the financial and labour markets and trade, as well as the development of a 'pro competitive' regulatory framework. These measures have been implemented amid all the other noise which accompanies economic growth as well as strongly external contributions to growth such as technological advance, increments to human capital etc.

Indeed the effects of privatisation on growth are expected to be highly indirect as well as direct, impacting on the allocation and productivities of other inputs to growth. Further endogeneities arise if input productivities are in turn driven by output growth. Moreover the issue of whether growth is a predominantly chaotic process of some sort remains contentious. Due to these difficulties in detecting the effects on the economy of privatisation, the investigation is exploratory in character. First what is meant here by privatisation needs to be set out.

### ***Privatisation***

Privatisation is usually taken to mean the sale or transfer of the assets of state owned entities into private ownership (and control). In practice institutionally what constitutes privatisation is not straightforward.<sup>4</sup> However macroeconomic purposes have the advantage of allowing the use of a somewhat broader definition. Here privatisation is treated as a catch all which includes any measures that directly act to reduce the level of public assets in the economy, whether it be by sale or transfer to private sector, or by reducing public investment. The intention is to capture these through the aggregate

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<sup>3</sup> The recent data for Australia reflect some effective reversals of policy, for instance in the case of some public transport.

<sup>4</sup> See Domberger and Piggott 1986 in Bishop et al 1994

measures of capital stocks used here. Indeed a virtue of a macroeconomic study is that it can broadly capture the net impact of the range of privatisation processes.

This is convenient because the means by which privatisation takes place are many and varied as shown by the privatisation events included in the list of reforms given by the (Australian) Productivity Commission in 1998.<sup>5</sup> Apparently no comprehensive update of the list of reforms has been undertaken by government agency since then. The privatisation process can be viewed as occurring along a rough continuum in terms of the degree to which ownership and control of assets and operations therefrom are ceded to the private sector over what period. Control is referred to because in the end full privatisation implies the absorption by the private entity of risk of operational or commercial failure in the long term. That governments rarely allow such failure to occur, in the industrial economies at least, is borne out by the Australian experience.

In terms of a continuum, at one end is the wholesale sale or transfer of existing public assets or enterprises to private firms, 'ideally' leaving the activities to be carried out in conditions which are the same as those that govern existing private commercial activities. This is of course problematic for natural monopolies, network capital and public goods (including arts) production assets. At the other end is the introduction of cosmetically 'pro competitive' arrangements which result effectively in the outsourcing of public services from one government agency to other government agencies, with or without government funding reductions which impact on capital expenditures. In these cases the asset mix between public and private is only affected insofar as the change to the institutional arrangements for and costs of providing the service in turn affect levels of public investment in that or another activity.

Ordering intermediate scenarios along the continuum is 'rough' however. Intermediate scenarios include that where divestment of public assets is contingent upon a comprehensive level of regulation of activity and subsidy arrangements, requirements for service delivery, control over pricing and the dispersal of profits and investment plans. Leasing or franchising over some finite period can be substituted for outright divestment. Regulation, leasing or franchising can also apply to new privately provided (infrastructural projects) which previously would have been provided by the public sector. Entities may be kept in part public ownership as is the case for some public utilities, often with funding arrangements attached in order to deliver what are termed 'Universal Service Obligations' (USOs) and 'Community Service Obligations' (CSOs). Entities may be split with a view to exposing the bits which are seen as contestable to competition either for ownership, franchise or outsourcing of operations. This latter can result in the rearrangement of public production at the end of the privatisation continuum referred to above.

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<sup>5</sup> Industry [now Productivity] Commission 1998 *Microeconomic Reforms in Australia A Compendium from the 1970s to 1997*; pp80-82 note there are apparently omissions, prison privatisation in Vic. See J Quiggin 1998 in Productivity Commission / Australian National University Workshop Proceedings [PC/ANU]

However if the continuum is extended to consider measures which alter the asset mix in the longer term, finally there is the privatisation by opening to competition or by stealth. Examples of this are the withdrawal of public funding from child care centres, an enormous increase in government funding of private schools over government schools, fee charging in tertiary education institutions accompanied by the withdrawal of government funding, and a massive shift in government support toward private health including most recently the withdrawal of universal free health care. The direct effect of such measures would be to move the asset mixes and control in those areas towards the private sector. Any secondary effects occurring through changes to human capital stock or the rate of technological change are part of the impact of privatisation we are seeking to measure.

It needs to be added that corporatisation alone of state entities cannot be considered as privatisation, although insofar as public activity is opened to competition from private provision or outsourced, it will shift the asset base towards private activity, and potentially affect the size of the asset base overall.

### ***Privatisation and microeconomic reform in Australia***

The paper seeks to distinguish privatisation from ‘microeconomic reform’ generally. The latter term refers to a raft of trade, financial and other regulatory ‘reforms’ which have been implemented in Australia from the mid 1980s with the express object of promoting competitive outcomes. Changing the state / private division of activity is only one aspect of that policy approach. Privatisation was a separate policy process which came to be identified with microeconomic reform as the latter gained policy momentum. Other aspects of microeconomic reform such as tariff removal might be considered to be institutionally neutral and are not the object of investigation in this paper.

However there are some features of microeconomic reform which are awakened with privatisation and these should be captured in differences between public and private productivities. Some reforms are apparently ownership neutral but impact differently on public and private activity. A major example is industrial relations / labour market reform. In Australia this impacts differently on public and private sectors and is likely to be captured in measures of productivity differences between public and private sectors. Another case where microeconomic reform may affect public and private productivity differently is that where public monopolies have been broken up vertically and / or horizontally with some privatised or contracted out and other parts remaining in public ownership, and with various regulation introduced to private competition. In this case differences between public and private productivity would also reflect changes to market structure.

### ***Evaluations of privatisation***

Macroeconomic empirical evaluations of privatisation are limited including in reference to Australia.<sup>6</sup>

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<sup>6</sup> See Stephen King discussion of Freebairn pp49-72 in op cit PC/ANU 1998; Welfens 1992 pp124-6; Blomquist and Christiansen 1999 pp31-34

Studies which refer to evaluating public vs private performance at various levels of disaggregation<sup>7</sup> have been done for other countries and less so for Australia.<sup>8</sup> There is an increasing number of country studies focussing on the contribution of (public) infrastructure usually to private capital productivity, mostly motivated by Aschauer's work.<sup>9</sup> These tend to find a large positive contribution of public infrastructure to the economy.

But there remains a relative lack of empirical evaluation of privatisation as such particularly at the macro level. A number of cross country comparative growth studies refer to the role of state activity. Dowrick 1996<sup>10</sup> finds the contribution of government consumption in growth across countries to be non monotonic with size of government, and to be negative only after an estimated critical share of government consumption of 10-18 per cent of GDP. Australia's share is within this range, leaving the question of the impact of government consumption on Australia's growth open.

The macroeconomic studies for Australia which have provided estimates of the full impact of microeconomic reform do not imply great gains from privatisation. Quiggin's 1998 tabulation<sup>11</sup> of estimates of the benefit of microeconomic reform gives a range from 0.1 per cent to 2.8 per cent addition to GDP growth per annum. Included in those are point estimates obtained from ex ante general equilibrium modelling.<sup>12</sup> Benchmarking was another approach used, in which the benefits of microeconomic reform were computed by comparing Australian industry performance with some measure of 'world best practice'<sup>13</sup>. Quiggin calculated that changes in productivities attributable to microeconomic reform on an industry by industry basis were likely to add around one per cent to GDP, less if unemployment resulted.<sup>14</sup> Subsequent work related to sources of growth in the Australian economy does not implicitly challenge these estimates.<sup>15</sup>

Work which seeks specifically to quantify the impact of privatisation on productivity for the Australian economy overall remains limited.<sup>16</sup> The scarcity of macro evaluation of

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<sup>7</sup> Erlich et al 1994 pp1006-1038; Morrison and Schwartz 1996 pp1095-1111; Kocherlakota and Yi 1996 pp126-134; Shirley 1997 pp849-864; Lau and Sin 1997 pp125-137; Temple 1998 esp at pp42-43

<sup>8</sup> Dawkins and Rogers 1998 pp195-231 in op cit PC/ANU 1998

<sup>9</sup> Aschauer 1989

<sup>10</sup> Dowrick Steve 1996 in Durlauf et al eds

<sup>11</sup> p95 J Quiggin op cit in PC/ANU 1998

<sup>12</sup> One off improvements to productivity were imputed to various microeconomic reforms case by case, by the Productivity Commission (then Industry Commission) in 1995 and some earlier estimates, cited Quiggin in PC/ANU 1998 p93 and discussion of limitations p117

<sup>13</sup> Eg in a frontier production function approach the percentage gap that microeconomic reform would close is estimated, highly dependent on benchmark chosen.

<sup>14</sup> Quiggin 1997 pp256-272; Dowrick 1998 op cit PC/ANU 1998 p121-143

<sup>15</sup> Parham 2002 p13, Parham 2004, de Brouwer 2003, Dungey and Pitchford 2003 p99, Chou 2003 p411, McLean 2004 p342

<sup>16</sup> Recently Satya Paul has found that public capital contributes to industry level efficiency based on cost functions. Satya Paul 2003 Effects of public infrastructure on cost structure and productivity in the private sector pp 446-461 Economic Record, Dec V79, 247

privatisation reflects the difficulties of getting relevant data at this scale of aggregation.<sup>17</sup> It also reflects the issues of cross country comparability, of relatively short experience (for Australia at least), and the inherent limitations of methodologies available for this purpose.

Otto and Voss 1994<sup>18</sup> [OV94] commences a very small literature which directly examines the role of public capital in Australia in terms of its impact on private productivity. Motivated by Aschauer 1989, OV94 hypothesised that the productivity of private capital in terms of private output benefits from public capital, due to a positive externality or public good arising from the latter. OV94 found that services provided by public capital had a positive effect on private capital and total (private) factor productivity in Australia from 1966 to 1990, consistent with the empirical literature for a range of countries based on Aschauer 1989 methodology. However the findings of OV94 were subject to the partial sectoral character of measures of public and private capital, employment and GDP, and also the short length of annual time series utilised. Otto and Voss 1996<sup>19</sup> [OV96] provided improved estimates which reduced the impact of public capital by around half. However the focus remained that of the impact on private capital and private sector output.<sup>20</sup> The approach taken in this paper differs from that of Otto and Voss in that it does not rely on estimating impacts of public capital on private sector activity alone. The approach here allows for flexible sourcing of output, albeit with undermeasurement of its publicly related component.

OV94 embedded some variants of endogenous growth into production function specifications incorporating the two kinds of capital. First a 'restricted increasing returns to scale' (RIRS) model is considered which allows increasing returns to scale over all inputs to private production but in which private capital and private labour together exhibit constant returns to scale (CRS). Increasing returns can arise from two sources: total factor productivity (unattributed technological advance) and public capital. Another specification measures the difference between output and the private capital and labour inputs using the alternative assumption of a fixed distribution of private output between private capital and labour. Assuming that those inputs are paid competitively based marginal factor products, the extent to which output exceeds those shares is due to the contributions of government services and technological progress to the productivities of the private inputs. An alternative case of constant returns to scale across private capital and labour is also considered, in which those inputs are paid their marginal physical product, but total output is not exhausted, leaving an implicit 'rent' to public capital which is paid out as an additional reward to private capital and labour.

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<sup>17</sup> This is particularly so since aggregate capital stock measures are no longer provided in separate public and private series by the Australian Bureau of Statistics.

<sup>18</sup> Otto and Voss 1994 pp121-132; Dowrick 1996 in Durlauf et al eds 1996; Dowrick op cit 1998 PC / ANU 1998

<sup>19</sup> Otto Glenn and Graham M Voss 1996 Public capital and private production in Australia *Southern Economic Journal* V62 pp723-788.

<sup>20</sup> OV96 used improved and extended quarterly data series to account for non stationary series and improve dynamic estimation eg of endogeneity between public and private capital variables.

OV94 makes use of the following models in equation [7] and [8] as numbered in the paper, for estimation<sup>21</sup>

$$y_t - k_t = \delta_1 + \delta_2 (n_t - k_t) + \delta_3 g_t + \delta_4 k_t + \delta_5 cy_t + u_t \quad [7]$$

and 
$$p_t = \pi_1 + \pi_2 g_t + \pi_3 i_t + \pi_4 cy_t + v_t \quad [8]$$

where, in the notation of OV94,  $y_t$  is log output at time  $t$ ,  $k_t$  is log private capital at  $t$ ,  $n_t$  is log labour at  $t$ ,  $g_t$  is log public capital at  $t$ ,  $cy_t$  is a cyclical indicator variable value at  $t$ , and  $i_t \equiv s_n n_t + s_k k_t$ , where  $s_n$  is gross of tax labour share and  $s_k$  is capital share of output respectively.  $p_t$  is a measure of ‘private factor productivity’ at  $t$  arising from the contribution of technological progress and increasing returns arising from  $g_t$ . Various restrictions are tested in equations [7] and [8] above.<sup>22</sup>

The RIRS specification was found to be preferred based on both regressions. The public capital coefficient of 0.38 ie that a one per cent increase in the ratio of public to private capital raised private factor productivity by 0.38 per cent in the RIRS restricted version of equation [7] above was found to be preferred, compared with an alternative estimate of 0.45, because the result did not require imposing restrictions on distribution.

From a Hausman test for the exogeneity of public capital it was concluded that endogeneity was unlikely to be a reason for a positive relationship of public capital with private productivity. However coefficients were not found to be stable in estimations for individual sectors perhaps due to mis specification, in contrast with aggregate estimates.

OV94 argued that the decline found in labour productivity throughout the 1980s for Australia could be explained through the impact of public capital on private productivity as public capital growth declines, or through slower development in human capital. However if there were too much public capital to start with, then the decline in public capital stock would not necessarily reduce services to private capital. The calculated ratio of marginal product of public to private capital suggests that public capital is still too low.<sup>23</sup>

A number of aspects of the findings of OV94 are addressed in this paper. These include the data limitations such as the short sample of 24 annual observations, using total capital for particular sectors as a measure of total private capital<sup>24</sup> (48% of the economy in 1989-90) and the absence of full output and labour measures from the aggregate specification, the use of log levels data, and the finding of a positive externality running from public

<sup>21</sup> OV94 p124, equns [7] and [8] as follows.

<sup>22</sup> In equation [7], ‘rejection of the restriction  $\delta_4 = 0$  is evidence against the RIRS specification’, and ‘rejection of the restriction  $\delta_3 = -\delta_4$  is evidence against the CRS specification’. In equation [8] above, rejection of  $\pi_3 = 0$  is evidence against the RIRS specification’ and ‘rejection of the restriction  $\pi_2 = -\pi_3$  is evidence against the CRS specification. OV94 p124.

<sup>23</sup> OV94 p130

<sup>24</sup> Agriculture, mining, manufacturing, wholesale and retail trade, and recreation and personal services

capital to private capital productivity which is constrained by the model chosen where public capital impacts on the private sector.

### ***Growth accounting framework***

Starting with the conventional growth accounting approach in the spirit of Denison, Baumol et al., with all the provisos that entails, the underlying relation is the usual

$$Y = f(K, L)$$

where Y is aggregate output, K is capital stock and L is labour. Here the flow of services provided by these assets drives growth in the economy. The neoclassical specification would include exogenous technological change as a separate source of growth of output. An endogenous growth specification would formally recognise that increasing returns to factor inputs and relationships amongst them drive growth. In the endogenous growth case the effect of technological change is to improve the quality of physical or human capital. In practice we may not be able to easily discriminate between the two models of growth as has been an issue raised in past work.<sup>25</sup>

This paper estimates the growth accounting relationship with two kinds of capital stock, public and private, allowing unrestricted returns to scale. Levels and growth rates versions of these are estimated, including an attempt to model simple dynamics. Use of stationarity tests is made albeit with caution given the degrees of freedom, and a preferred specification selected on this basis in the first instance, followed by other tests for robustness. The sample is also split into a pre privatisation and privatisation period and tested for the stability of coefficients across the two periods by two methods, separate estimation and the use of dummy variables. The Otto and Voss findings of a positive contribution of public capital to growth and an existing too low level of public capital are also addressed. The presence of increasing returns is investigated, and if they arise in the manner suggested by Otto and Voss 1994 ie through the impact of public capital on private capital productivity. Testing was undertaken for simultaneities also, through 2SLS IV estimations using regression variables as instruments.

It is recognised that with the sample size available the ability to discriminate between neoclassical and endogenous growth explanations is limited.

Distinguishing between public and private capital then

$$Y = f(K_g, K_p, L)$$

where Y is aggregate output,  $K_g$  is publicly owned capital,  $K_p$  is privately owned capital and L is labour input.

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<sup>25</sup> eg the key N G Mankiw, D Romer and D N Weil 1992 A contribution to the empirics of economic growth *Quarterly Journal of Economics* May pp407-437, R J Barro 1999 Notes on growth accounting *Journal of Economic Growth* May, V4 pp119-137, D G Swaine 2000 Is the US economy characterized by endogenous growth?: A time series test of two stochastic growth models Federal Reserve Bank of Boston Oct Working Paper 99-9.



A neoclassical approach would identify technological change by a separate term and scrutinise growth rates or marginal productivities of the two kinds of capital. If neoclassical production function properties are assumed ie with well behaved marginal productivity schedules etc the optimal mix of public and private capital could be determined by testing the capital stock levels at year  $t$  for which  $MPK_{g,t} = MPK_{p,t}$  where  $MPK_{g,t}$  is the marginal product of public capital at year  $t$  and  $MPK_{p,t}$  is the marginal product of private capital at year  $t$ . If the estimated  $MPK_g < MPK_p$  then again assuming the right functional derivative properties the optimal ratios of the two capital stocks can be inferred. This should imply directions and rates for privatisation given a specified time frame. In fact we find the estimates do not yield this kind of information.

Alternatively if an endogenous growth approach in which technological change is not exogenous is accepted, the factor contributions would determine output growth rates in the long run. The ratio of long run growth rates of the factors will indicate the optimal marginal rates of privatisation to be sought over a specified time frame. Privatisation might be expected to raise the productivity of private capital (and indeed of public capital).

Both approaches allow for the possibility that the schedules of marginal productivity of the two sorts of capital are different.

A third approach acknowledges that the two capitals may be different in type and asks whether the implementation of privatisation policy has changed the productivities of public and private capital over time. This is tested by splitting the data into two periods, characterised as pre privatisation 1960-79, and privatisation, 1980-2003. If privatisation is preferred, the productivities of public and or private capital would be expected to be higher in the second period. If an endogenous growth scenario applies, then the impact on the second period could be to raise the productivity of labour and / or the impact technological change on the other factors.

### *Data*

See Appendices A, B and C for Data Description, Data Table and Charts respectively.

Comprehensive aggregate data was obtained for Australian GDP, labour, and public and private capital stocks for the years 1960 to 2003. The frequency is limited to annual by the availability of capital stock data. The chief difficulty lies in obtaining consistent long series in private and public capital stock, particularly as in the 1990s the ABS ceased to publish capital stock series based on a public private split. The ABS said that ‘Given the recent extent of privatisations and the difficulties in dealing with them statistically, the estimates no longer distinguish between public and private enterprises.’<sup>26</sup> Series for public and private capital were therefore required to be constructed for this paper, and this is one its contributions.

The inclusion of general government as well as public enterprise assets in public capital ensures its different character from private capital. The most productive assets as measured are plant and equipment, of which general government has a much lower proportion. If the most commercially profitable assets are most prone to be privatised or privatised first, then privatisation itself changes the relative character of public and private capital stocks over time<sup>27</sup>. While the findings of this paper are bound to reflect this, it remains an issue for investigation elsewhere.

Chart 1 in Appendix B shows the stall in growth in public capital in the 1990s. It would appear that the divestiture process is limited for Australia; moreover the figures for the most recent two or three years would reflect return to the public sector of some assets. The challenge for estimation remains in capturing what is a small effect in aggregate.

### *Estimation of functional form*

In principle a specification search from general to particular is recognised as desirable, but the degrees of freedom have limited the possibility for the application of nested testing of the number of possible restrictions.

The conventional Cobb-Douglas production function is taken as the general form, of unrestricted degree and allowing for unattributed growth, expressed in log linear terms as

$$\ln Y_t = a_0 + a_1 \ln K_{g,t} + a_2 \ln K_{p,t} + a_3 \ln L_t + a_4 T + U_t \quad (1)$$

where

- $\ln Y_t$  is the log of aggregate output in year t,
- $\ln K_{g,t}$  is the log of publicly owned capital in year t,
- $\ln K_{p,t}$  is the log of privately owned capital in year t,
- $\ln L_t$  is the log of labour input in year t and
- $a_4 T$  is a time trend proxy for the rate of technological change.

The growth rates form of this is expressed in log differences

<sup>26</sup> p14 ABS Cat 5204.0 April 1999 *Australian System of National Accounts 1997-98*

<sup>27</sup> Moreover some activities with assets leased to the private sector which have proved commercially nonviable have been returned to public control.

$$\Delta \ln Y_t = a_0 + a_1 \Delta \ln K_{g,t} + a_2 \Delta \ln K_{p,t} + a_3 \Delta \ln L_t + U_t \quad (2)$$

where

$$\begin{aligned} \Delta \ln Y_t &= \ln Y_t - \ln Y_{t-1}, \\ \Delta \ln K_{g,t} &= \ln K_{g,t} - \ln K_{g,t-1}, \\ \Delta \ln K_{p,t} &= \ln K_{p,t} - \ln K_{p,t-1} \text{ and} \\ \Delta \ln L_t &= \ln L_t - \ln L_{t-1} \end{aligned}$$

The CRS restriction is imposed by taking labour as the numeraire in (1), giving the output per unit labour as a function of the public capital - labour ratio and the private capital - labour ratios.

$$\ln(Y_t/L_t) = a_0 + a_1 \ln(K_{g,t}/L_t) + a_2 \ln(K_{p,t}/L_t) + a_4 T + U_t \quad (3)$$

Expressing equation (3) in growth rates, growth in labour productivity is a function of the rates of change in the public capital labour ratio and the private capital labour ratio, and technological change. This is

$$\Delta \ln(Y_t/L_t) = a_0 + a_1 \Delta \ln(K_{g,t}/L_t) + a_2 \Delta \ln(K_{p,t}/L_t) + U_t \quad (4)$$

Equation (4) supports exogenous growth with a time trend coefficient  $a_0$  indicating exogenous technological change.

An alternative endogenous approach is that there are increasing returns to private capital or that these are greater than those to public capital. This is essentially the specification estimated by Otto and Voss. The form is

$$\ln(Y_t/K_{p,t}) = a_0 + a_1 \ln(K_{g,t}/K_{p,t}) + a_2 \ln(L_t/K_{p,t}) + U_t \quad (5)$$

or expressed in growth rates

$$\Delta \ln(Y_t/K_{p,t}) = a_1 \Delta \ln(K_{g,t}/K_{p,t}) + a_2 \Delta \ln(L_t/K_{p,t}) + U_t \quad (6)$$

In order to discover whether the period previous to the privatisation policy period was different, the preferred specification was run for two periods of 1961-1979 and 1980-2003 respectively and the coefficients tested for structural change. The estimations were also run with a dummy split between the two periods.

### ***Hypothesis testing***

The regression variables data were tested for stationarity by ADF tests. Tests were also conducted for the presence of a unit root in the regression residuals. The results must be treated cautiously owing to the difficulty of detecting random processes in what is still a short sample of forty-three at most; the stationarity tests are not powerful with this size of sample. In particular it is difficult to test for unit roots when test results are close to

the confidence limits for the tests, as is particularly likely where there is evidence of serial correlation.

Insofar as a specification search was possible through tests of restrictions, log likelihood ratio tests, standard errors and Akaike Information Criterion (AIC) were used to test for robustness of specification.

### **Results**

Most of the variables were found to be difference stationary from the ADF tests. Alternatively the variables were I(1) from the residuals tests so that the relationships might be expected to be cointegrating in levels. However in general estimations of levels specifications would be of spurious regressions, which is problematic for considering coefficients on long run growth paths. The static formulation in levels exhibited serial correlation in the disturbances, which would be ideally remedied in a large sample context by use of a general dynamic specification and which is approximately remedied in a small sample context by first differencing. It is noted for what it is worth that the coefficient on the trend variable is not found to be different from zero (and this was the pattern throughout the levels estimations).

Because the levels estimates are likely to be the result of spurious regression the estimations to be considered are expressed in terms of growth rates. The standard Cobb - Douglas specification allowing returns to scale  $\neq 1$  in growth rates is

$$\Delta \ln Y_t = a_0 + a_1 \Delta \ln K_{g,t} + a_2 \Delta \ln K_{p,t} + a_3 \Delta \ln L_t + U_t \quad (2)$$

OLS estimation of this yielded

$$\Delta \ln Y_t = 0.007 - 0.195 \Delta \ln K_{g,t} + 0.449 \Delta \ln K_{p,t} + 0.696 \Delta \ln L_t + e_t$$

$$\begin{aligned} t \text{ ratios: } & (0.815) \quad (1.169) \quad (2.091) \quad (4.203) \\ & (\text{significant at 0.05 level} = > 1.684, \text{ at 0.10 level} = > 1.303) \\ R^2 = & 0.474, \quad DW = 1.99. \quad RSS = 0.008000 \end{aligned}$$

The residuals test found that the null of a unit root in the residuals could be rejected, which suggests that the underlying levels relationship is cointegrating.<sup>28</sup> The variables were difference stationary too, with the possible exception of the growth of public capital.

This suggests that a one percent increase in private capital might contribute an extra 0.45 per cent to output growth, statistically significant at the 5 per cent level of the t test. A one per cent increase in labour adds 0.7 per cent to output growth, significant at the 5 per cent level. However the coefficient on public capital growth is statistically insignificant

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<sup>28</sup> The test is ADF for the null of a unit root in the residuals referred to in Eviews 4 'Unit Root Tests', allowing for some adjustment of critical values, Davidson and MacKinnon 1993 Table 20.2.

(and negative). Given that the equation explains only almost half of growth, it provides an inadequate indication of the contributions of the sorts of capital to growth. The impact of technological progress on growth can be captured only through the direct estimate for Hicks-neutral technological progress which was negligible at 0.007 in the above regression. The results were not notably different in magnitude from those of the poorly specified Cobb-Douglas in levels.

Rather it may be that growth in private capital productivity is a function of the growth rate of public capital relative to private capital as well as growth in labour, as has been argued by others.

Thus

$$\Delta \ln(Y_t/K_{p,t}) = a_0 + a_1 \Delta \ln(K_{g,t}/K_{p,t}) + a_2 \Delta \ln(L_t/K_{p,t}) + U \quad (6)$$

was estimated, and this yielded

$$\Delta \ln(Y_t/K_{p,t}) = 0.005 - 0.179 \Delta \ln(K_{g,t}/K_{p,t}) + 0.710 \Delta \ln(L_t/K_{p,t}) + U$$

$$\begin{array}{l} \text{t ratios} \quad (1.103) \quad (1.197) \quad (4.639) \\ \text{(significant at 0.05 level = } > 1.684, \text{ at 0.10 level = } > 1.303) \\ R^2 = 0.351, \text{ DW} = 1.98. \end{array}$$

The tests of the null of a unit root process in the residuals find the null to be rejected. This specification in effect supports the findings of the unrestricted growth rates specification (2) by confirming that the growth rate of private capital productivity is a function of the growth in the ratio of labour to private capital, with growth in public capital stock having no discernible impact. That is a one per cent increase in growth of labour relative to private capital increases private capital productivity by 0.71 per cent. These are almost identical findings to those calculated from (2). This finding contrasts with that of the Otto and Voss estimates for the virtually identical specification (except theirs was in levels) which found a positive impact of public capital.

One problem is that of the distinctly different growth rates of public capital in the periods pre and post the implementation of privatisation, particularly as privatisation takes hold in the 1990s. The lack of variability in the growth rates of public capital relative to the other variables is also particularly striking, and indicates that public investment has not been motivated in the same manner as the other variables. (See chart of growth rates.) It may be that the growth of public and private capital have had different effects on output growth over the two periods. This was tested first by splitting the sample period into two, 1961-79 and 1980-2003 and estimating (2) for the two periods. The split ought to reflect the onset of the period of privatisation adequately.

This yielded for the period 1961-79

$$\Delta \ln Y_t = 0.169 - 0.270 \Delta \ln K_{g,t} + 0.303 \Delta \ln K_{p,t} + 0.851 \Delta \ln L_t + e_t$$

(2a)

t ratios: (0.399) (0.401) (0.585) (1.733)  
 (significant at 0.05 level = >1.746, at 0.1 level = > 1.337)  
 $R^2 = 0.419$ ,  $DW = 1.810$ .  $RSS = 0.004167$ .

and for the period 1980-2003

$$\Delta \ln Y_t = 0.026 - 0.335 \Delta \ln K_{g,t} + 0.003 \Delta \ln K_{p,t} + 0.754 \Delta \ln L_t + e_t \quad (2b)$$

t ratios: (1.471) (1.617) (0.005) (3.999)  
 (significant at 0.05 level = >1.729, at 0.1 level = > 1.328)  
 $R^2 = 0.520$ ,  $DW = 2.27$ .  $RSS = 0.003518$

An F-test was applied to the residual sum of squares from the three regressions in order to test whether the regressions for the two periods are different. The null that the two regressions are the same is not rejected from the F-test.<sup>29</sup>

The results were similar when (2) was run with 0 – 1 dummy variables for 1961-79 and 1980-2003 respectively. Nor did the inclusion of slope dummies affect the results. There is no good reason to think that the earlier and later periods are different.

Finally the presence of simultaneities which could lead to biased estimates in the single equation specification were investigated by 2SLS estimations with regression variables  $\ln K_{g,t}$ ,  $\ln K_{p,t}$ ,  $\ln L_t$ ,  $\ln \Delta K_{g,t}$ ,  $\ln \Delta K_{p,t}$ ,  $\ln \Delta L_t$ , and lagged values as instruments. Sargan's misspecification statistic which is distributed  $\chi^2$  with  $s - k$  degrees of freedom where  $s$  is the number of instruments and  $k$  is the number of regressors did not support the null hypothesis that the single equation specification is the correct one. However the IV estimates which used levels variables as instruments did not produce vastly different results.

A need to model dynamics carefully is strongly indicated. This was simply attempted by estimating the effect on output of its lagged value (endogenous variable), and current and lagged values of public and private capital and employment. The problem of stationarity in the levels variables notwithstanding, the magnitudes, signs and significance of the lagged values suggested that differences insufficiently capture some of the processes which are at work, beyond first order. Some preliminary recursive estimations suggest that coefficients may vary through the privatisation period particularly changing direction towards the end of the sample period when privatisation is kicking in, and this is a definite direction to be taken for further investigation.

### ***Discussion of results***

The main findings from this exercise are the following.

<sup>29</sup>  $F = ((0.008000 - 0.004167 - 0.003518) / 4) / ((0.004167 + 0.003518) / (19 + 24 - 2 \times 4)) = 0.3587$ .  
 The critical F value, 4, 30 at 0.05 level is 2.69.

The growth rates estimation is the preferred one according to a range of criteria for robustness including rejection of a unit root in the residuals. The coefficient on public capital growth is not found to be statistically significant, while that on private capital growth is 0.45, statistically significant at the 5 per cent level. Most of the explanatory burden of the regression is taken up by labour growth, with an elasticity of 0.70. (Indeed the strong showing for the labour variable was indicated by its coefficient throughout the specifications estimated.) This is not surprising considering that the growth rates of output and employment are similar in pattern and larger in variation than the others.

The impression is that both public and private capital capacities grow slowly while output varies with labour input due to other factors. Adding a suitable cyclical variable might serve to remove common cyclical elements in the variation in labour and output and improve the estimates, but the growth rates movements do not reveal a need for this. This is consistent with the finding of Otto and Voss that a cyclical variable did not affect their estimates, and the risk of errors in variables is avoided.

The findings are robust to tests for differences between what we characterise as the pre privatisation and privatisation periods, and the coefficient values were not very different anyway. The negative coefficient on public capital suggests that a reduction in public capital could raise the level of output, but without permanent effect on the growth rate of output. Moreover the contribution of private capital is not well revealed from estimation of this specification either. Because of the key difficulty of measuring the intangibles or uncharged on both sides, the results ought to favour private sources of productivity. To the extent that this is the case, the support for privatisation is even weaker. Alternatively if the casual and part time components of labour have increased significantly in the series used here which are uncorrected for this, then the labour measure could be biased upward. Overall, given these equivocal results from a widely used approach to evaluating growth, support for privatisation is not particularly to be found.

That said, it is clear that the specification as it stands is unable to capture the contribution of public capital. The mechanisms underlying the growth process in the Australian economy are clearly more complex, and it should be noted that the influence for technological advance is not well captured here either. A more complex growth process is supported by the 2SLS estimations with instrumental variables which show that simultaneous equations bias is likely to be of concern. The sources of this bias call for investigation. It does not appear to result from improvements in private capital productivity feeding through growth in labour or public capital inputs. The dynamics are an obvious candidate for more careful modelling, beyond one year, and recursive estimation is likely to offer answers. This may be supported by enhancing data through the separation of public capital into its general government and public enterprise components and also the sectoral and hourly measurement of labour.

The results differ from those of OV94 in a number of respects, including its finding of a positive impact of public capital growth on output. One possible reason is that longer and more precise and comprehensive data series for public and private capital were obtained for estimation in this paper. These data include the 1990s when privatisation

really gained momentum as shown in the actual downturn in the public capital stock measures. It would appear that privatisation reached some limit as the downturn is not shown to be sustained subsequently. This paper improves on the approach taken in OV94 to measuring private capital. For that measure their paper used the capital of those sectors where private activity predominates. This paper uses directly the data for private and public capital available from ABS. The apparent and mysterious absence of public employment and output (albeit problematic to measure because of its external component) from the data used for estimation by Otto and Voss must have affected the estimations. This leaves that labour contribution to be captured elsewhere, perhaps in the public capital elasticity.

### ***Conclusion***

This paper has investigated the impact of privatisation on the growth of the Australian economy by taking a growth accounting approach to estimation of the separate contributions of public and private capital. It was found that the impact of public capital growth could not be discerned from a reasonably robust estimation of the simple growth rates specification which was preferred. It is worth noting that the findings of this paper are not inconsistent with the estimates of Quiggin and others of a small impact of microeconomic reform.

While the above approach has elegant appeal for investigating the causes of growth it faces a number of possibly intractable problems. If levels specifications are poorly specified, it is difficult to infer endogenous growth explanations which are contingent on the interaction between level of a particular factor and the productivity of other factors or output growth. That consideration needs addressing, as some cross country studies such as that of Dowrick referred to above indicate. It remains clear that the public good aspect to government activity, as well as the frequency of non market or uncharged output makes the contribution of government particularly difficult to capture. The dynamics need to be further explored, as also suggested by the divergence of coefficients estimated recursively from static results.

The findings of this paper do not give good reason to believe that the transfer of government provided assets into private hands yield the returns to the economy that that policy has anticipated, although it is understood that the consequences are yet to be called. What is shown is that the implications for growth of privatisation call for very careful investigation, and despite the limitations in the above approach it is far from exhausted. Serious macroeconomic modelling is all the more imperative.

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### ***Appendix B Data series for estimations***

Comprehensive aggregate data was obtained for Australian GDP, labour, and public and private capital stocks for the years 1960 to 2003. The frequency is limited to annual by the availability of capital stock data.

#### *Capital stock*

The difficulty lies in obtaining consistent capital stock series for public and private capital stock for a period that is as long as possible. The ideal approach would be to identify assets which have been privatised eg through government budget papers, and value them directly. However this is a major task and beyond the scope of this paper.

For the purpose here use is made of the aggregate data available. Constant price gross capital stock series for public (general government and public corporations) and private entities are available from the Australian Bureau of Statistics (ABS) for the years from 1966-67 to 1996-97.<sup>30</sup> However subsequently the ABS ceased to publish capital stock series based on this split.<sup>31</sup>

From 1997 the ABS ceased also to provide updated constant price capital stock series. Rather it continues to publish chain volume (2001-02) capital stock series from 1960 onwards for the sectors of general government, financial and non financial corporations and households, as well as total capital stock series.<sup>32</sup> These capital stock series do not further separate the financial and non financial corporations on the basis of ownership, so that both these series include a mix of public and private capital stock<sup>33</sup>. However gross fixed capital formation data continue to be published for general government, public corporations and the private sector.

The use of gross measures should not affect long period impacts. Net measures are not available as consistently as gross over as long a period. Additional fitting assumptions are required, and in aggregate the differences in measure are marginal.<sup>34</sup>

For the years 1966 to 1997 public and private capital stock series were obtained from the shares of public and private in total capital stock in constant prices of 1989-90, which had been compiled on the assumption of additivity. These shares were applied to the total capital stock chain volume 2001-02 measure for the corresponding year in order to obtain

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<sup>30</sup> ABS Cat 5221.0 *Australian National Accounts Capital Stock 1989-90* pp2-3 and *1995-96* pp2-3

<sup>31</sup> p14 ABS Cat 5204.0 April 1999 *Australian System of National Accounts 1997-98*

<sup>32</sup> ABS Cat 5204.0 Australian System of National Accounts Tables 63 Gross Fixed Capital Formation by type of asset and 70 Capital Stock by institutional sector.

<sup>33</sup> A major example of financial corporation transfer is that of the Commonwealth Bank, one of the four main banks in Australia; note that financial corporation capital stock is relatively small.

<sup>34</sup> This could matter if the relative depreciation rates for public and private capital are changing over time due to differences in technological composition and vintage structures. The average age of capital stock in general government has increased more than for any other sector except financial according to ABS data (5204070).

separate series for public and private capital stock in chain volume terms.<sup>35</sup> These rescaled measures for public and private capital stocks also provided benchmarks for the years 1966 and 1997.

For the years 1960-66 and 1997-2003 the data for gross fixed capital formation (GFKF) chain measures were used to obtain public and private capital stock series. This was done by summing GFKF for general government and public corporations for each year to obtain a public GFKF. Subtracting this figure from total GFKF gave a figure for private GFKF for that year. For each year the measures of public and private GFKF were rescaled as the shares of increments to public and private capital stock respectively in the change in the total capital stock chain measure which is available for those years. The computed increments in each capital stock for 1998 were added to the benchmark year 1997 in order to obtain figures for 1998, and so on for each year to 2003, the most recent available. The years before 1966 were similarly obtained, by subtracting from the benchmark figures in 1966.

### *GDP*

GDP is taken from ABS 520603 chain volume series 2002-03.<sup>36</sup>

### *Labour*

Labour series were annual average employment figures from ABS 6202003<sup>37</sup>. The figures are apparently unadjusted for the net effect of the recent significant increase in hours worked per employee and the rise of part time and casual work<sup>38</sup>. No split between public and private employment is readily available, and the extent to which any sectoral differences in factor proportions would impact on the analysis is a consideration. Another issue is the impact of changes in human capital which may be significant in recent years. The view is taken at least that human capital is less separable with respect to the provision of services to public and private activity. There is no reason to make the a priori assumption that the quality of labour differs between the public and private sectors, or that the relative quality varies over time. This is yet another field for investigation.

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<sup>35</sup> This is a potentially strong assumption as chain volume series for sectors are not constructed in a manner that results in additivity across sectors to the total series.

<sup>36</sup> The slight difference in reference year should be of little importance with low inflation that year.

<sup>37</sup> Also reported in the OECD database quarterly data, annual average of quarterly data.

<sup>38</sup> Table 4-10c of *RBA Bulletin*, from ABS Cat 6202. 0 *Labour Force* Table .03 Labour force status by sex.

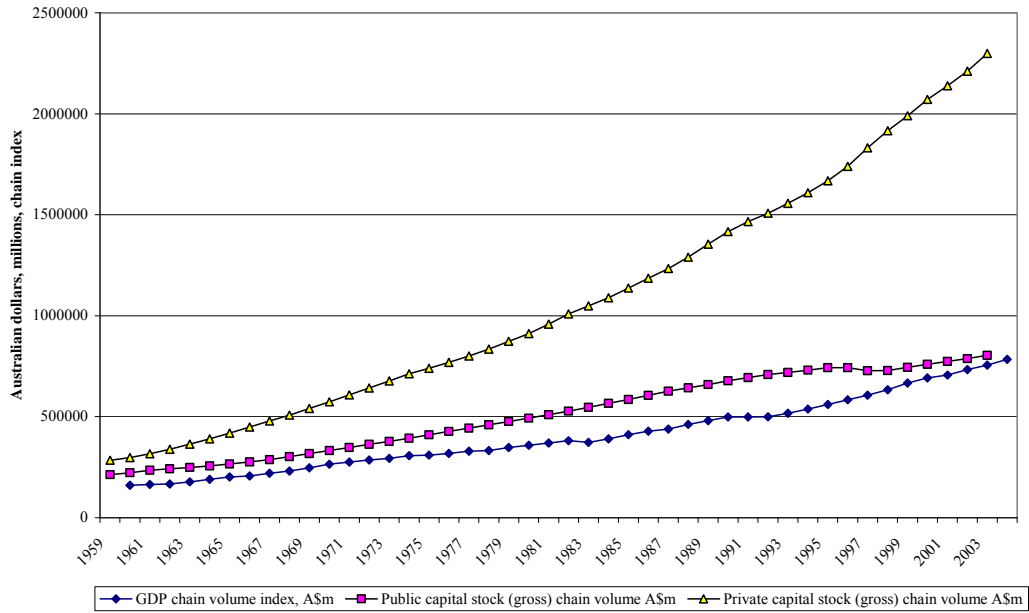
*Appendix B Data series for estimations (cont)*

Year	GDP volume A\$m	chain index, (gross) A\$m	Public capital stock chain volume A\$m	Private capital stock chain volume A\$m	Employment annual average, 1000s
1959	-	213353.42	284223.20	-	
1960	160391.0	222483.43	297373.57	4158.50	
1961	164651.0	234600.83	316091.47	4280.25	
1962	166912.0	241766.14	338815.36	4295.50	
1963	177301.0	248667.77	363847.03	4419.25	
1964	190025.0	256426.74	390756.56	4533.00	
1965	201543.0	265257.43	419081.37	4656.00	
1966	206188.0	275870.60	448584.20	4810.75	
1967	219617.0	286816.59	479251.01	4977.00	
1968	230722.0	301922.56	508293.84	5103.00	
1969	246787.0	316897.25	540403.95	5233.50	
1970	264532.0	332402.00	573782.70	5411.75	
1971	274724.0	346956.99	607969.91	5597.75	
1972	285531.0	362962.83	641980.97	5671.50	
1973	294032.0	377645.83	676432.97	5806.00	
1974	306774.0	392986.25	712491.05	5986.50	
1975	309819.0	410003.30	739777.70	5979.75	
1976	318571.0	426683.33	769251.97	6053.50	
1977	329549.0	442795.55	801102.85	6092.50	
1978	332783.0	459713.70	834362.80	6107.50	
1979	346980.0	476000.26	873286.24	6123.75	
1980	358177.0	492901.46	911814.64	6270.50	
1981	369867.0	509713.94	958625.26	6433.00	
1982	381349.0	527864.47	1009555.23	6510.50	
1983	372373.0	546614.27	1048816.33	6406.25	
1984	390131.0	566465.26	1088606.14	6452.00	
1985	410772.0	584950.58	1136656.12	6658.25	
1986	428423.0	605949.05	1185968.05	6934.50	
1987	438500.0	626518.27	1233638.13	7106.25	
1988	462011.0	643272.26	1289481.84	7306.75	
1989	480616.0	658693.70	1354671.20	7627.50	
1990	498610.0	678031.34	1416255.66	7912.50	
1991	498074.0	693688.53	1466137.47	7853.50	
1992	499358.0	708755.21	1507708.79	7714.75	
1993	517598.0	719396.17	1556877.83	7691.25	
1994	537778.0	730026.53	1608786.47	7842.75	
1995	560446.0	742684.53	1668202.47	8145.00	
1996	583891.0	742655.18	1739272.82	8377.25	
1997	606079.0	727515.57	1831656.43	8443.25	
1998	633353.0	728123.64	1916139.36	8547.50	
1999	666921.0	744094.49	1990331.51	8641.85	
2000	692264.0	759731.33	2071334.67	8867.87	
2001	706109.0	773342.03	2138207.97	8969.68	
2002	733647.0	787716.14	2211276.86	9144.80	
2003	756170.0	803668.09	2299540.91	9354.53	

Sources: Australian Bureau of Statistics and Reserve Bank of Australia Bulletin (see text)

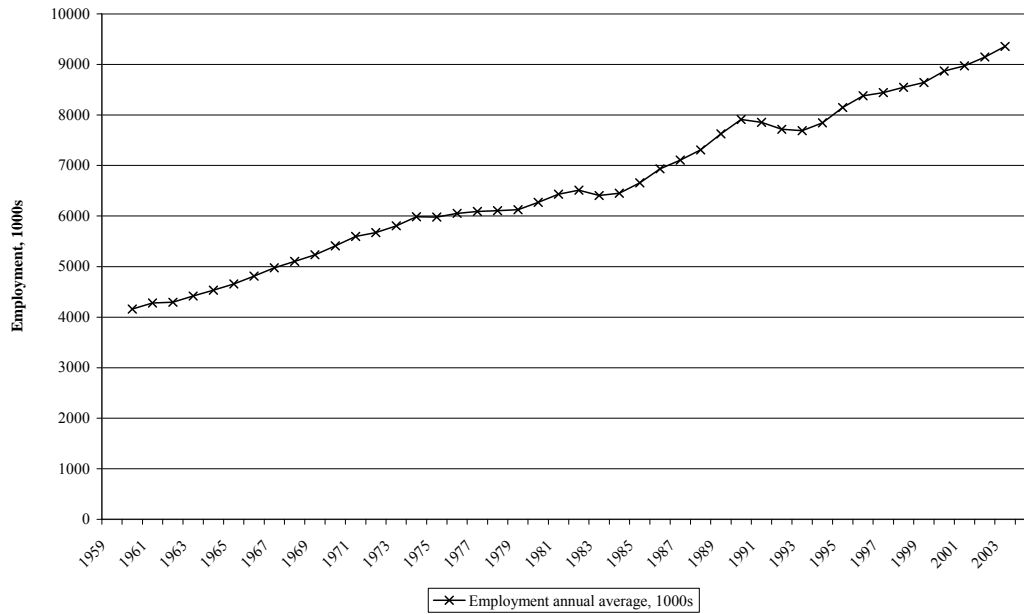
Appendix C Charts

GDP, public capital stock and private capital stock, chain volumes, 1959-2004

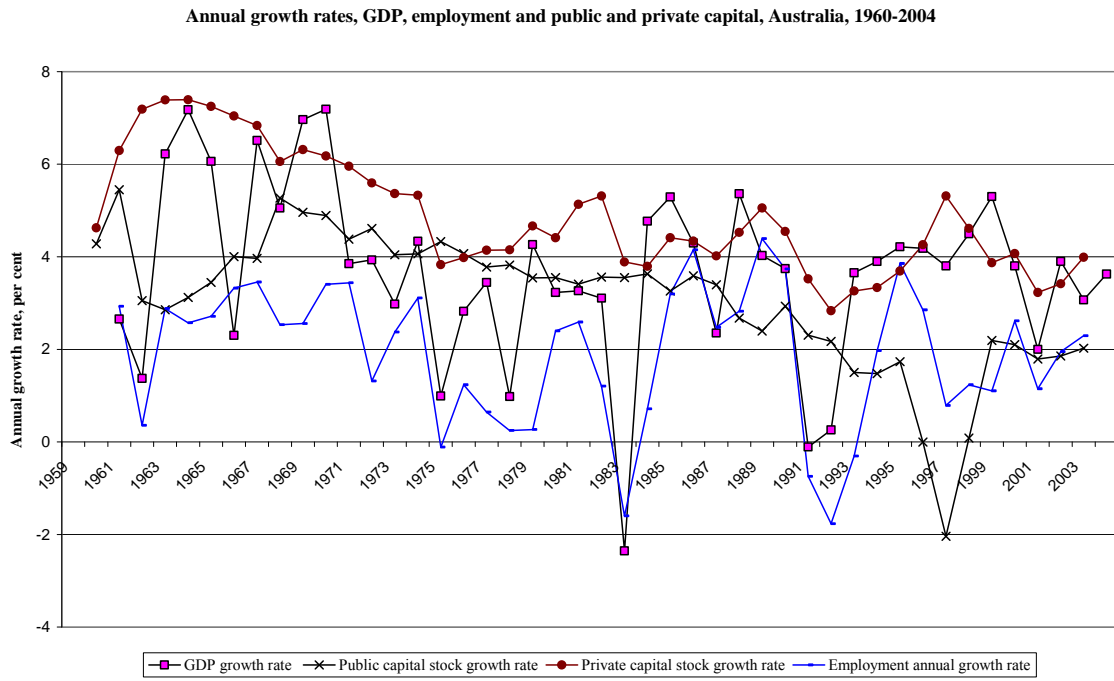


Source: Australian Bureau of Statistics (see text)

Annual average employment, Australia, 1000s, 1959-2004



Source: Australian Bureau of Statistics, Reserve Bank of Australia (see text)



Sources: Derived from Australian Bureau of Statistics and Reserve Bank of Australia (see text)