CAPITAL CONSTRAINTS AND EMPLOYMENT

Jerome Fahrer
John Simon

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ABSTRACT

This paper considers whether capital is a significant constraint on employment in Australia. We calculate the level of capital-constrained employment for ten sectors of the Australian economy. The calculations suggest that the manufacturing; mining; transport, storage and communication and recreation, personal and other services sectors have sufficient capital installed to increase employment. In another sector, wholesale and retail trade, the potential for increases in employment through increased capital utilisation may be constrained by surplus labour (as of June 1993). While some sectors, e.g. community services, are capital constrained at the moment, we find that the investment requirements to increase employment in these sectors are not onerous. We also project investment requirements in each of the sectors for employment growth over the next five years. These projections suggest that a jump in investment followed by relatively modest growth is required to sustain growth in employment.

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1. INTRODUCTION

Australian investment is currently at historically low levels. In seasonally adjusted terms, real expenditure on plant and equipment was approximately 25 per cent lower in the December quarter of 1993 than four years earlier, falling from 7.5 per cent of GDP to 5.6 per cent.[1] On some estimates, the capital stock has been falling over this period, i.e. gross investment has been less than depreciation.[2] There has been considerable concern expressed about these low levels of investment. Access Economics (1992, p. 15) has claimed that "current investment levels are at crisis levels." One reason for concern is that this low level of investment may restrict output growth, and thus employment, during the recovery from the recent recession.[3]

This paper attempts to place concerns about these issues on a more rigorous foundation than is present in most current discussions. To do this we calculate the level of output that could be produced, on a sectoral basis, operating the current capital stock at full capacity. We then calculate the employment that this full capital utilisation level of output could create. This allows an understanding of whether capital shortages are likely to restrict the growth of employment as the recovery proceeds. We also calculate hypothetical projections for each sector of the investment required to sustain employment growth over a five year horizon.

The results of our analysis suggest that, in the manufacturing; mining; transport, storage and communications and recreation, personal and other services sectors there is sufficient capital installed to accommodate substantial increases in employment and output. Similarly in the wholesale and retail trade sector capital is currently under-utilised. However, in this sector the amount of labour currently

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1 Source: Australian National Accounts (ABS Cat. 5206.0, Table 59)

2 Access Economics Monitor, January 1993.

3 These concerns were also raised in the context of European unemployment through the 1980s; see Bean (1989).

employed is greater than necessary, given the degree of capacity utilisation; this means that the potential for employment growth as the capital stock is more fully employed may be limited. In other sectors of the economy further capital accumulation may be needed before substantial increases in employment are realised. However, these other sectors include labour intensive service sectors where capital is not the primary constraint on output or employment. Furthermore, we find that the investment requirements for renewed employment growth are relatively modest, at least after an initial jump to recover the ground lost over the past three years.

The remainder of this paper is organised as follows. Section 2 describes the techniques used to calculate capacity output, capacity employment and the investment projections. The results of these methods are presented in Section 3 along with some discussion of interesting features of the sectoral results. Finally, Section 4 concludes and summarises the paper.

2. TECHNIQUES AND DATA

This section describes the methods used to estimate full-capacity employment and the investment projections; it also describes the data used. Full-capacity employment is the labour that could be employed if the current capital stock was operated at full capacity. A two stage procedure is used to generate these estimates. The first stage estimates the capital-constrained output level. The second stage estimates the employment associated with this capacity constrained level of output, i.e. full-capacity employment. The projections of investment required for differing levels of employment growth are then made based upon assumptions about future capital to labour ratios.

2.1 Capacity Output

Methods of calculating capacity output are commonly *ad hoc*; for example, connecting peak levels of output together with a linear trend. The estimates of capacity output in this paper are based upon a method described in Berg (1984). Berg's method improves on others by explicitly basing capacity estimates on a 'putty-clay' production technology. With putty-clay technology the productive technique is freely chosen before installation but fixed after installation. Thus, although they can be altered before installation, the capital/labour/output ratios are fixed after installation.[4] This embodies the idea that once a machine is installed its output and the number of people required to use it cannot be altered. In this paper we allow for some post-installation, or 'disembodied', technical change. This possibility can capture physical depreciation as well as possible changes in the production technique. This description of technology is not specific to any particular production function but can be applied to any general function.

The exact production function used is not specified in this method. Instead, it is assumed that the capacity output to capital ratio follows a linear trend. This assumption can capture the effect of changing relative prices and technology upon the choice of capital intensity and, hence, capital productivity. This also requires an assumption that relative factor prices, or more specifically, future expectations of relative factor prices, change smoothly over the estimation period to be consistent with the trend in the capacity output to capital ratio. The capacity output, per hour, in year *t*, per unit of capital installed in year *t*, is thus assumed to be:

$$a(t,t) = a_0 + a_1(t - t_0) + a_2(t - t) \tag{1}$$

where a_0 is the capacity output per unit of capital installed in a base year t_0, a_1 is the change in this capacity output ratio between years and a_2 captures any change in capacity output after installation.

The capacity output per hour in any given year is the sum of all active capital investments times the capacity output to capital ratios for those investments. The choice of what to include in the active capital stock will affect the estimates. There are many different assumptions that can be made about retirements of capital; we decided to keep the assumptions as simple as possible.[5] To this end we assume that all capital in a particular industry has a fixed life after which all investments are no longer productive, i.e. all retirements occur at the same age. The maximum life of

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[4] The choice will be based on current and expected values of relative factor prices.

[5] The assumptions can be characterised by the shape of the retirement schedules, that is, a graph of capital retired against its age. The Australian Bureau of Statistics (ABS) assumes a bell shaped retirement function; thus most retirements occur close to a specific mean life while some capital lives for a relatively short or relatively long time. Other possible assumptions are that a fixed proportion of the investment is retired each year after some minimum age or that all retirements happen at the same age.

capital used is based upon lives used by the ABS in its calculation of the capital stock. In most cases a life slightly shorter than that published in ABS Occasional Paper 1985/3 is used due to the gradual shortening of capital lives that has been occurring. The exact lives used for each sector are included in Table 1 which is presented in Section 3. We also assume that capital becomes productive the year after expenditure is incurred on it; this allows time for installation and integration into the output process. Thus the active capital stock includes all investments between the previous year and the maximum life of investment.

Multiplying the capacity output per hour by the maximum hours of operation of machines yields an estimate of capacity output. However, due to the lack of data on the maximum operation period of machines, we assume that the maximum operation period of machines is proportional to the normal hours of work in a given industry. We use average hours of work per person per week as an indicator of normal hours of work in an industry, scaling this up by a factor c to estimate the maximum operating period.

The capacity output in year t, Y_t, can then be written as:

$$Y_t = hours \cdot \sum_{life\,of\ capital} \left(\frac{capacity\ output}{capital \cdot hours} \right) \cdot capital \tag{2}$$

and in terms of more standard notation this can be written:

$$Y_t = c \cdot H_t \cdot \sum_{t=t-l}^{t-1} a(t,t) \cdot J_t \tag{3}$$

where c is the ratio between maximum operation period of the capital and normal hours of work, H_t are the normal hours of work in year t, l is the life of the capital and J_t is gross investment in capital in year t.

The estimation procedure involves choosing values for the a_i coefficients in equation (1) to minimise an objective function subject to certain constraints. The objective used is to minimise the sum of differences between actual output and capacity output.[6] This fits the tightest capacity frontier to the data that is consistent with the underlying investment and hours data. The constraints used are that capacity output is always above actual output and that $a(t,t)$ is always positive, that is, investment cannot create negative output. This can be expressed as a linear programming problem:

$$\begin{aligned}&\underset{a_0,a_1,a_2}{Min}\ \sum_t \left\{ c \cdot H_t \cdot \sum_{t=t-l}^{t-1} \left[a_0 + a_1(t - t_0) + a_2(t - t) \right] J_t - X_t \right\} \\ &s.t. \quad a(t,t) \geq 0, \forall t,t \\ &\qquad\quad Y_t \geq X_t, \forall t\end{aligned} \tag{4}$$

where X_t is actual output in year t. The estimation procedure is such that full output will occur in at least one year over the estimation period. This means that the estimates should be regarded as economic capacity rather than a strict engineering definition of capacity. They reflect the best efficiency that has been achieved over the estimation period. Thus, if the capital stock was never fully utilised during the estimation period, it is possible for greater capacity to exist than is estimated.

The assumption of putty-clay technology means that changes in relative prices have a limited effect on capacity output. As factor proportions are fixed after installation a change in relative factor prices should only affect the proportions embodied in current investment, not on the already installed capital stock. It is important to note though that changed relative factor prices would only lead to sub-optimal factor proportions if factor prices changed in an unexpected way. This is because future expectations should be included in previous investment decisions. The possibility of changes in relative factor prices affecting capacity output after installation is encompassed, in part, by the $c \cdot a_2$ parameter. However, this is subject to the assumption mentioned earlier, that relative factor prices change smoothly over the estimation period.

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[6] It is also possible to consider other objectives such as minimising the sum of squared differences or log differences. These objectives will minimise the average divergence and proportional divergence respectively. A discussion of the effect of this is included with the results.

2.2 Full Capacity Employment

In estimating capacity employment there are two factors to be considered: actual employment can include some degree of surplus labour given current capital utilisation and some assumption needs to be made about the labour requirement on unused capital when it is fully utilised.

Two common methods have been used to estimate the quantity of surplus labour. One method is based on estimating production functions. The other assumes that labour productivity follows a well-defined trend; departures from this trend are then attributed to under-utilisation of labour.[7] The second approach is used here due to the difficulty encountered in fitting production functions across all sectors of the economy. We assume that productivity follows a quadratic time trend.[8] To estimate the productivity frontier a quadratic trend is fitted through each industry's productivity series and then shifted up by the amount of the largest positive difference.[9] The frontier generated indicates the best productivity that could have been achieved in the absence of any surplus labour. Using this measure the hours of work related to actual production can be calculated by dividing output by this frontier productivity measure. This can be converted to employment by making some assumption about what proportion of the surplus labour is full-time or part-time. For convenience we assume that surplus labour contains the same proportion of full-time and part-time labour as our estimated 'productive' employment.

The next step involves calculating the number of workers required to operate the installed capital at full capacity. The capacity output estimation procedure above allows us to estimate what proportion of the capital stock is in operation at any time. The estimation procedure generates capacity output to capital ratios for each vintage in each year. Assuming that recent investments are operated before older

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7 This general approach was developed and popularised by Taylor (1976/1979). His basic method was to connect peaks in the productivity series to obtain the potential productivity series. These peak-to-peak methods suffer from endpoint problems and so a modified method in this general spirit is used.

8 That is, a function of the form $a + bt + \gamma t^2$. Productivity is defined to be output divided by total hours worked.

9 As this frontier touches at one point we need to assume that there is no surplus labour in at least one period in the estimation range.

investments the capacity outputs from each vintage in a year, starting from the most recent, are added until they equal actual output for that year.[10] This identifies which vintages were probably used for production in that year. The total investment in these vintages is then summed and divided by the total stock to estimate a capital utilisation rate.[11] Full-capacity employment is then calculated by assuming that the capital to labour ratio on the idle units will be the same as on the units already in use in each particular year.[12]

The 'productive' employment calculated in the first stage is multiplied by the capital utilisation figure to estimate full-capacity employment. We emphasise that as this estimate does not include any surplus labour it is possible for this number to be less than actual employment, particularly in periods when surplus labour is estimated to be high. To the extent that this surplus labour is retained full capacity employment could be higher than the figure we indicate. Results from this method indicate that there is generally a higher labour requirement to increase output as older, less productive, machines are being used.

2.3 Investment Projections

The methods used allow us to determine the required rate of investment to sustain a given rate of employment growth. In projecting the required rate of investment a number of steps are followed.[13] First, we assume that the sectoral shares of employment continue to follow their current trends.[14] Next, projections of total employment in the future, based upon selected growth rates, are used to calculate employment in each sector based on the projected shares.

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[10] A fraction of the investment for the oldest year employed is used to ensure that the capacity output sum is exactly the same as actual output rather than slightly above or below it.

[11] This will not necessarily be the same as the capacity utilisation rate since the capacity output to capital ratio changes over time and the life of investment.

[12] This does not fix the capital to labour ratio between years; in fact the capital to labour ratio generally follows an upward trend over the estimation period.

[13] These projections are not forecasts of what we think will occur to investment in each year. They are projections, based on hypothetical scenarios, conditional on our assumptions and the structure of the model.

[14] For example, manufacturing's share of employment is falling while service sectors have rising shares.

A capital to labour ratio is then calculated and we assume this also follows its trend. The capital stock is calculated by adding together the gross investment over the assumed life of capital in each sector. This is done as, even though depreciation is occurring, the labour required to operate a machine should not alter after installation. The machine may be less productive and break down more often but this affects the output to capital ratio not the capital to labour ratio. The labour supply used is the full employment value calculated earlier. The required capital stock is then calculated using the projections of the capital to labour ratio and employment.[15] The investment required to reach this stock level can then be calculated.

For the purposes of this paper three different growth rates of employment are considered. A baseline of 2.2 per cent growth per annum is used with high and low levels of 3.1 per cent and 1.4 per cent growth also considered. The high rate is chosen to correspond with the growth rate following the early 1980s recession and the other rates are arbitrarily chosen.

It is important to note that these projections are likely to be an overstatement of actual requirements for a number of reasons. An increase in the incidence of continuous operation of capital, concomitant with enterprise bargaining over working conditions, is likely to reduce the capital to output ratio and the capital to labour ratio. As this possibility is not included in the projections a lower level of capital would sustain a given level of employment. Also the recent recession may have reduced the relative cost of labour to capital, leading to a reduction in the desired capital intensity of production. This would also reduce the capital required to sustain a given level of employment; however, this effect would primarily apply to the newest investment due to the putty-clay production technology discussed above. In line with this the projections should be interpreted as an upper bound on investment requirements rather than as exact projections.

[15] Actual employment was used to forecast shares of employment so, due to the slightly different numbers involved, employment growth in each sector is added onto the full employment bases rather than actual employment.

2.4 Data Sources

The techniques described above require data on output, investment, average hours worked and employment by industry. The estimation is applied to each of ten ASIC industry sectors and all estimations use data in 1989/90 constant prices.[16] Investment data across all of these sectors are only available on an annual basis so the data used are limited to this frequency.[17] Data on employment by industry are available from August 1966 so the estimation begins with the 1966/67 financial year.[18] The average hours data used are for employed persons; they are a weighted average of full-time and part-time workers. Investment data are available earlier than this and are used to construct a full stock of capital for the first estimation period.

The investment data used are gross fixed capital expenditure on plant and equipment for both public and private sectors from the Australian National Accounts. Plant and equipment data are used as this form of capital investment is most likely to include productive capital. Investment in non-dwelling construction would not generally be expected to directly raise the capacity output of a sector. While this form of investment may be necessary for output to be produced, a larger factory is unlikely to increase production in the same way that a larger metal press will.[19] Similarly, investment in roads and bridges may make it possible for output to be delivered to customers but will not increase the actual output potential (e.g. non-

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[16] The sectors examined are: Agriculture, Forestry, Fishing and Hunting; Mining; Manufacturing; Electricity, Gas and Water; Construction; Wholesale and Retail Trade; Transport, Storage and Communication; Finance, Property and Business Services; Community Services; Recreation, Personal and Other Services. The only major ASIC sector excluded is Public Administration and Defence as there are no investment data available for this sector.

[17] Quarterly investment data are available from Private New Capital Expenditure, Australia (ABS Cat. 5626.0), however, this only reports investment for a few industry subdivisions and is thus unsuitable for this project.

[18] The particular employment series used are total persons (full-time and part-time) from ABS Cat. No. 6203.0.

[19] Estimates were made using non-dwelling construction investment as well as plant and equipment investment. However, these estimates were not significantly different from the estimates using plant and equipment data only. Furthermore, non-dwelling construction investment generally follows the same pattern as plant and equipment investment or is relatively flat over time. As such it does not offer much additional information for fitting capacity output frontiers.

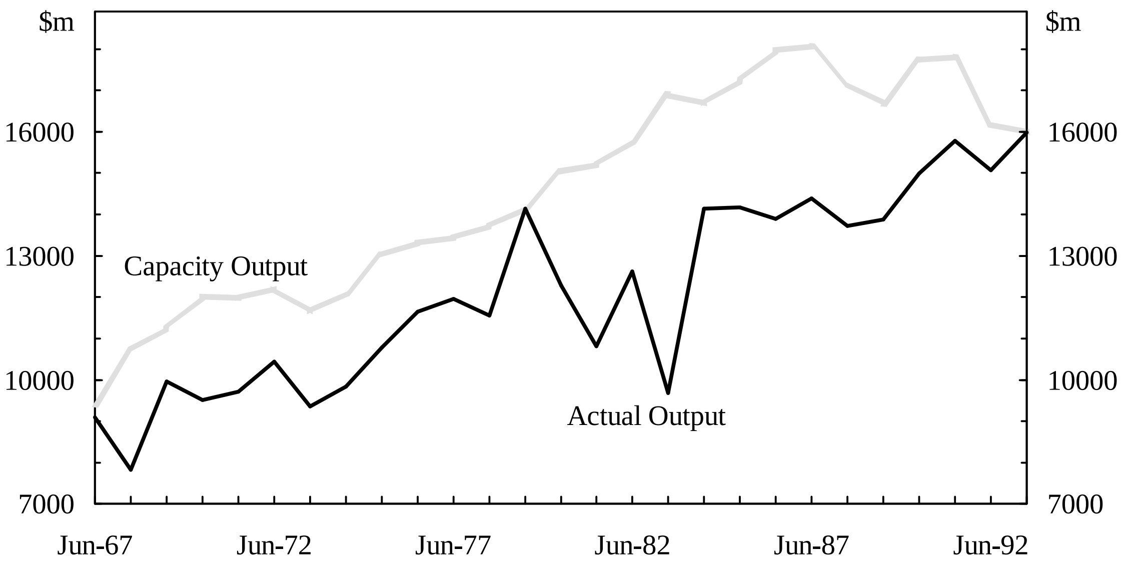
dwelling construction could be likened to the valve on a tap, opening it may increase the flow but not the actual supply). As physical depreciation can be encompassed in the estimation procedure, gross investment data are used rather than attempting to account for depreciation before estimation. Installation costs, which do not directly create productive capital, are included in the gross investment estimates. There is no reasonable way of accounting for these costs as estimates do not exist.[20] Nonetheless, if costs are proportional to the value of capital installed or small relative to the total investment, this should not affect the results.

3. RESULTS

3.1 Capacity Output

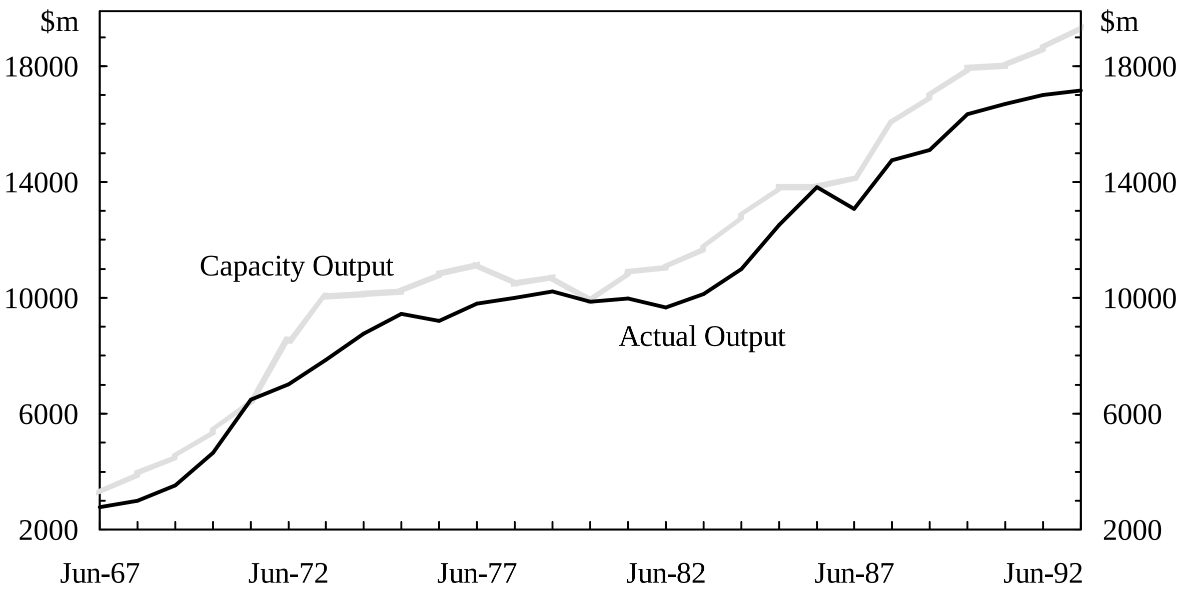
The results from stage one of the estimation procedure are presented below. Graphs 1 through 10 show the estimated capacity output frontiers for each industry division considered. It should be noted that the selection of peak levels of output is determined by the estimation procedure; they are not chosen subjectively as in other methods that connect peaks. The output data are all in constant 1989/90 dollars.

Graph 1: Real Agriculture, Forestry, Fishing and Hunting Output

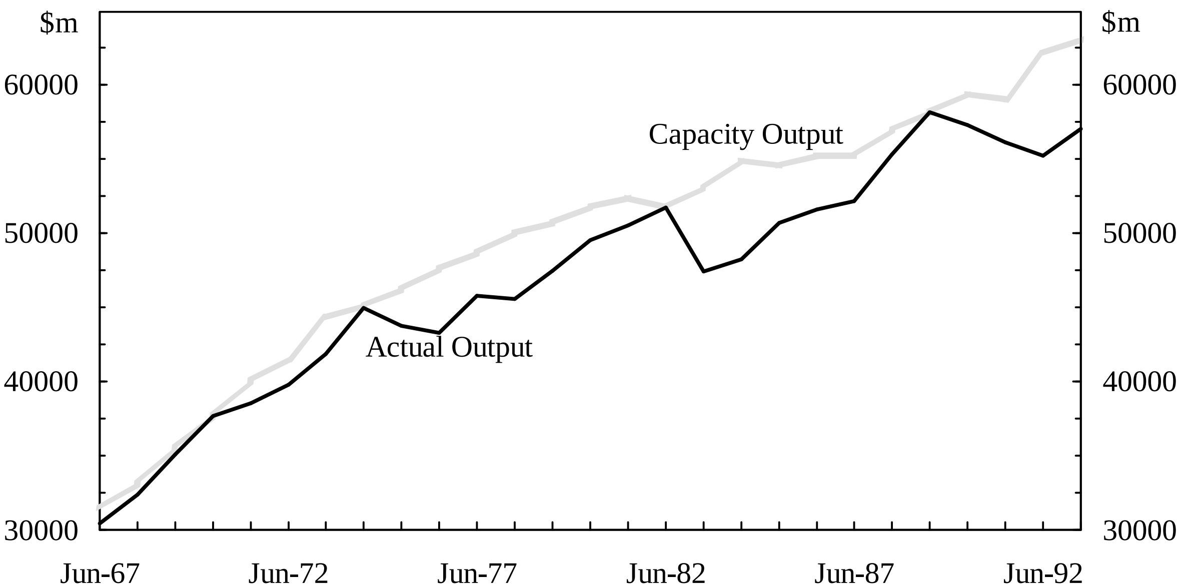


[20] The ABS publishes capital consumption; however, this is a measure of depreciation of the total capital stock rather than a measure of installation costs.

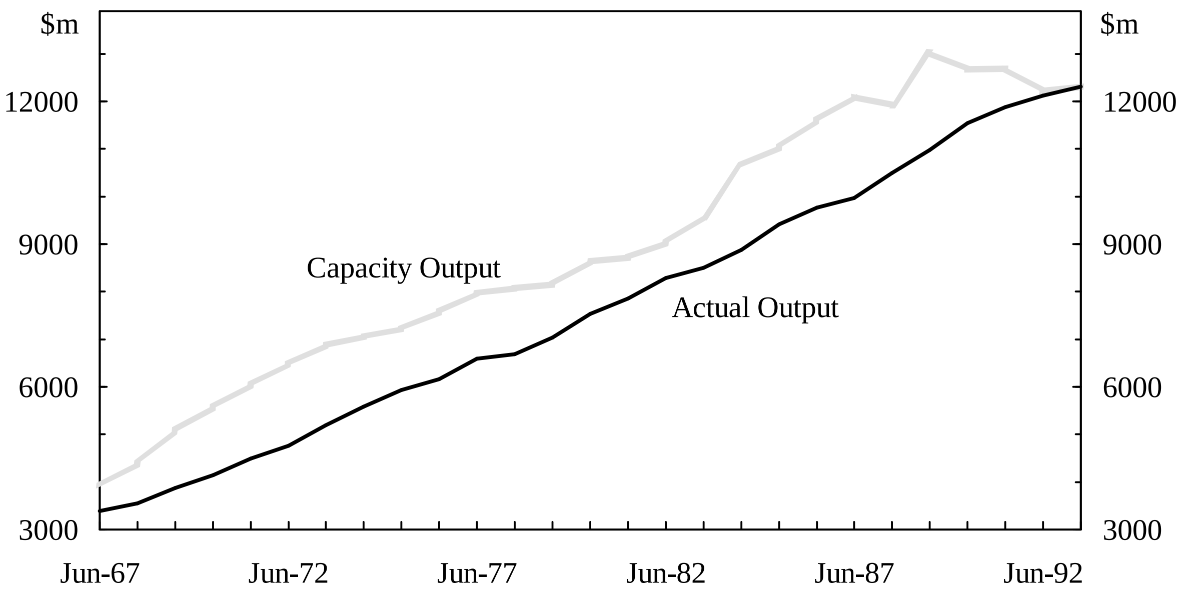
Graph 2: Real Mining Output



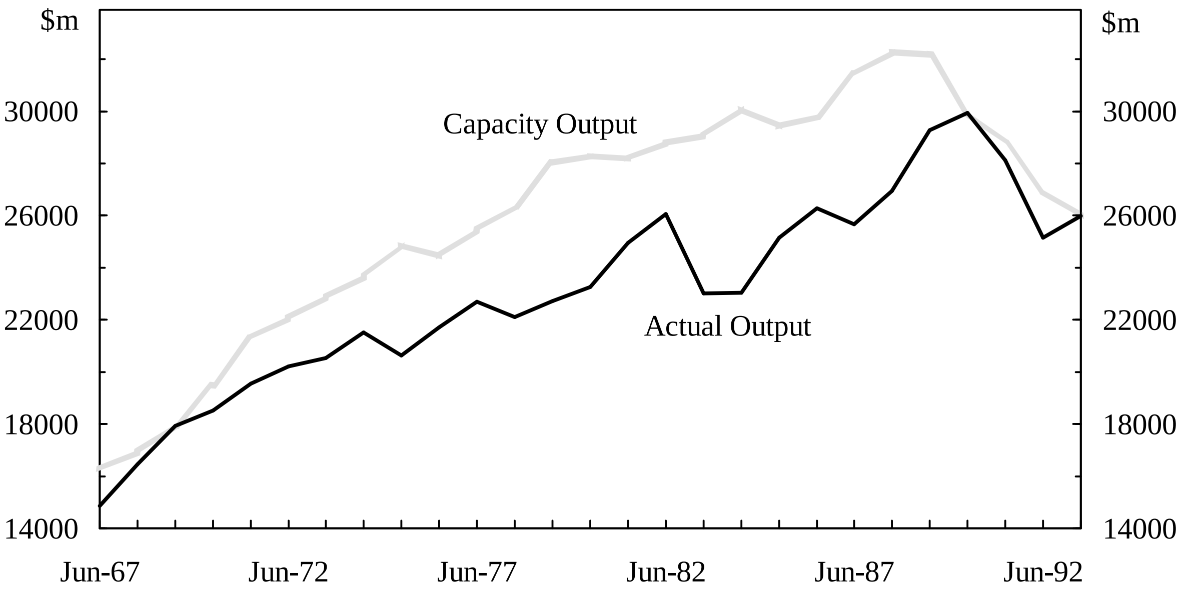
Graph 3: Real Manufacturing Output



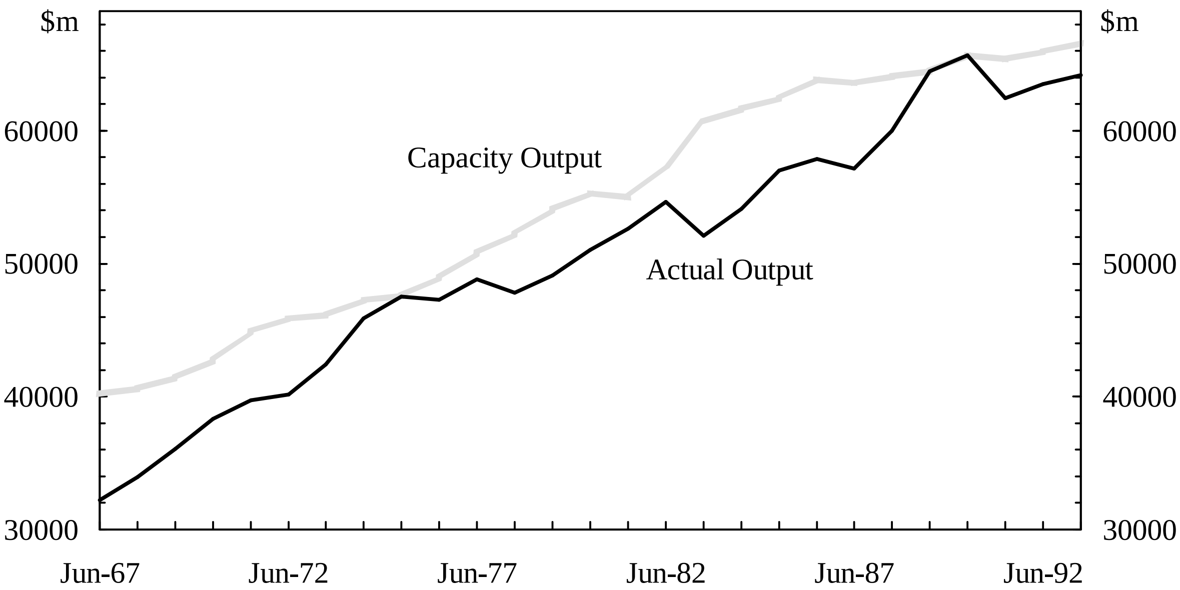
Graph 4: Real Electricity, Gas and Water Output



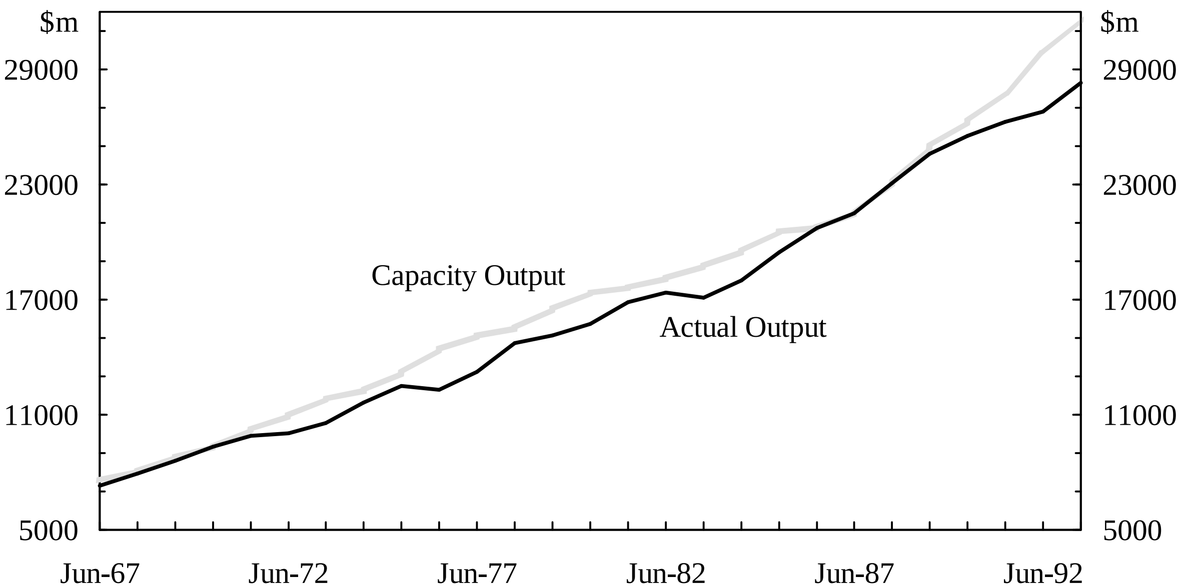
Graph 5: Real Construction Output



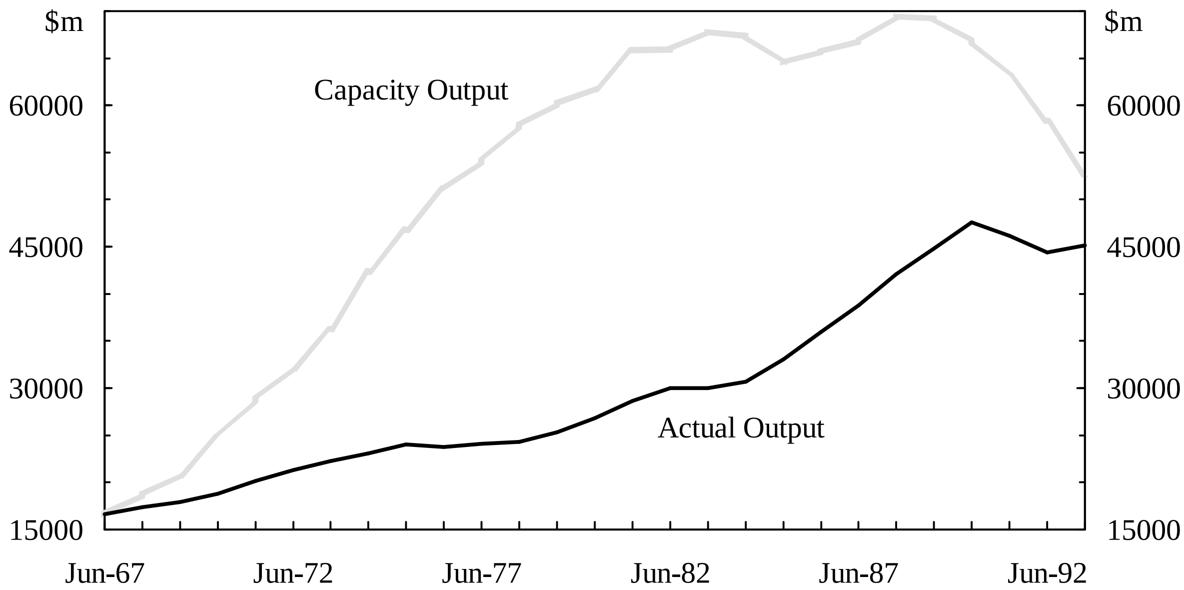
Graph 6: Real Wholesale and Retail Trade Output



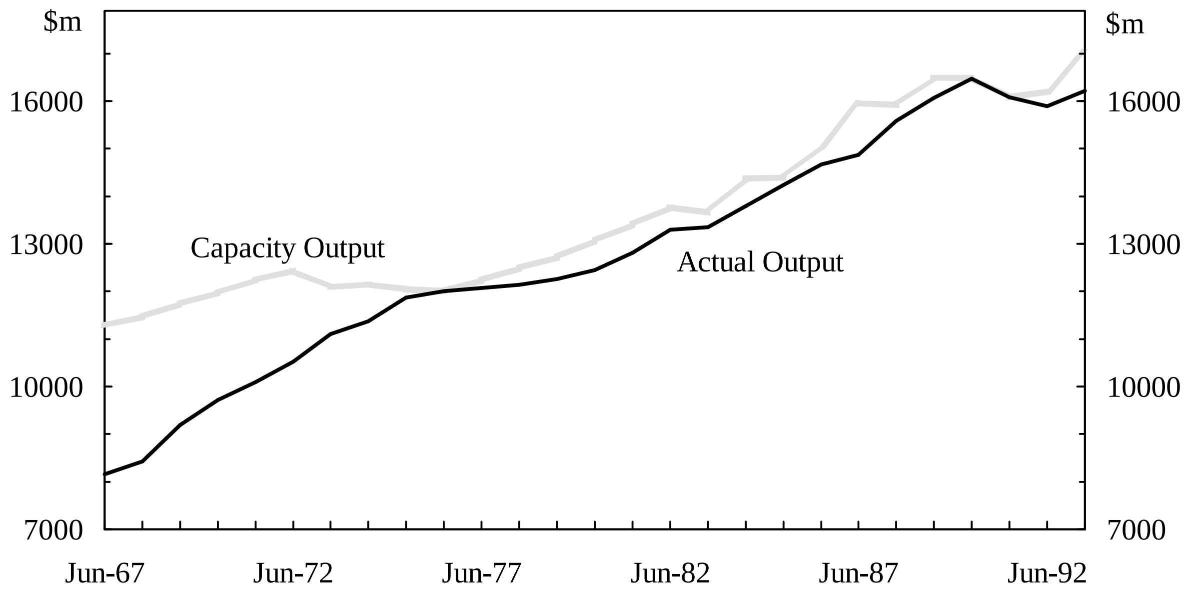
Graph 7: Real Transport, Storage and Communication Output



Graph 8: Real Finance, Property and Business Services Output



Graph 9: Real Recreation, Personal and Other Services Output



Graph 10: Real Community Services Output

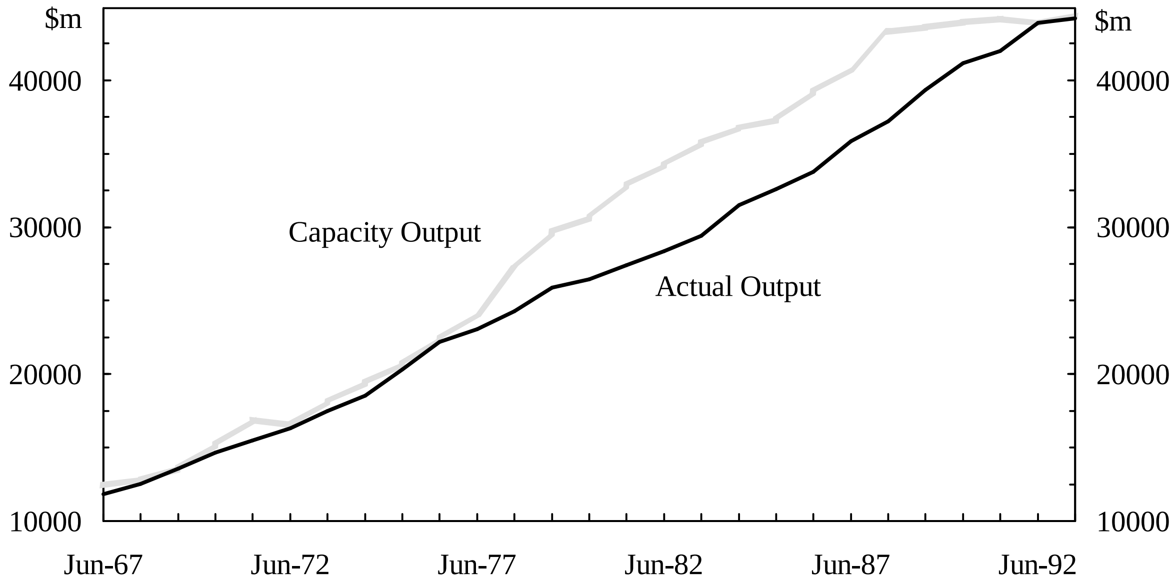


Table 1 presents the asset lives used in the calculation of the output frontiers. These lives were chosen as a general rule to be three years shorter than that used by the ABS. This is approximately the shortening that is suggested by the ABS of 5-10 per cent each decade.[21] The results generated were quite robust to variations in the asset life chosen; the results remained similar for lives of around two years either side of the ages presented. The results were also checked for sensitivity to the investment data used as these are the data that are most likely to be subject to errors. Once again the frontiers generated were very robust to relatively large variations in the investment data used.[22]

Table 2 shows the coefficients estimated in the calculation of the capacity output frontiers. Due to the presence of the constant c in the estimations these coefficients are not comparable across sectors. In general, a negative coefficient on $c \cdot a_1$ indicates that capital has become less productive over the estimation period.

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21 Asset life in the finance services sector was shortened somewhat more than this due to the impact we assumed that computers have had on asset lives.

22 To check the results the investment data was changed by a random amount in each period with a standard deviation of 5 per cent. The frontiers generated from a large number of repetitions of this process were then graphed to identify 'error bounds'. In all cases the general shape of the frontiers remained the same, although the levels moved around somewhat. Importantly, the peaks selected as being full capacity remained the same for all trials.

Table 1: Investment Life Used

Sector	Mean asset life for 60s	Life used (years)
Agriculture, forestry, fishing and hunting	13	11
Mining	16	13
Manufacturing	19	16
Electricity, gas and water	22	18
Construction	13	11
Wholesale and retail trade	16	13
Transport, storage and communication	14	11
Finance, property and business services	13	9
Recreation, personal and other services	15	12
Community services	15	12

Table 2: Capacity Output to Capital Coefficients

Sector	$c \cdot a_0$	$c \cdot a_1$	$c \cdot a_2$
Agriculture, forestry, fishing and hunting	17.1	0.12	-1.56
Mining	36.2	-0.08	-2.28
Manufacturing	24.5	-0.13	-0.02
Electricity, gas and water	0	0.45	0
Construction	156.2	-2.14	-2.67
Wholesale and retail trade	90.8	-1.37	0.70
Transport, storage and communication	3.7	0.04	1.31
Finance, property and business services	358.5	-7.31	0
Recreation, personal and other services	143.5	-1.85	-4.37
Community services	506.2	-10.33	39.43

This could reflect a trend to greater capital intensity in production and, thus, a reduction in the marginal product of capital. A positive coefficient suggests capital productivity has increased and could indicate that improvements in technology have been made. A negative coefficient on $c \cdot a_2$ indicates a fall in the capacity output of a particular vintage over its life and, as such, is indicative of depreciation.

The main driving force in the estimated frontiers is the investment data. The change in hours worked over the time period chosen is generally a smooth downward trend. This has the effect of pulling capacity output estimates down in later periods of the estimation. The other objective functions mentioned in footnote 6 did not greatly affect the results, as the solution which minimised equation (4) also minimised the other possible objectives.

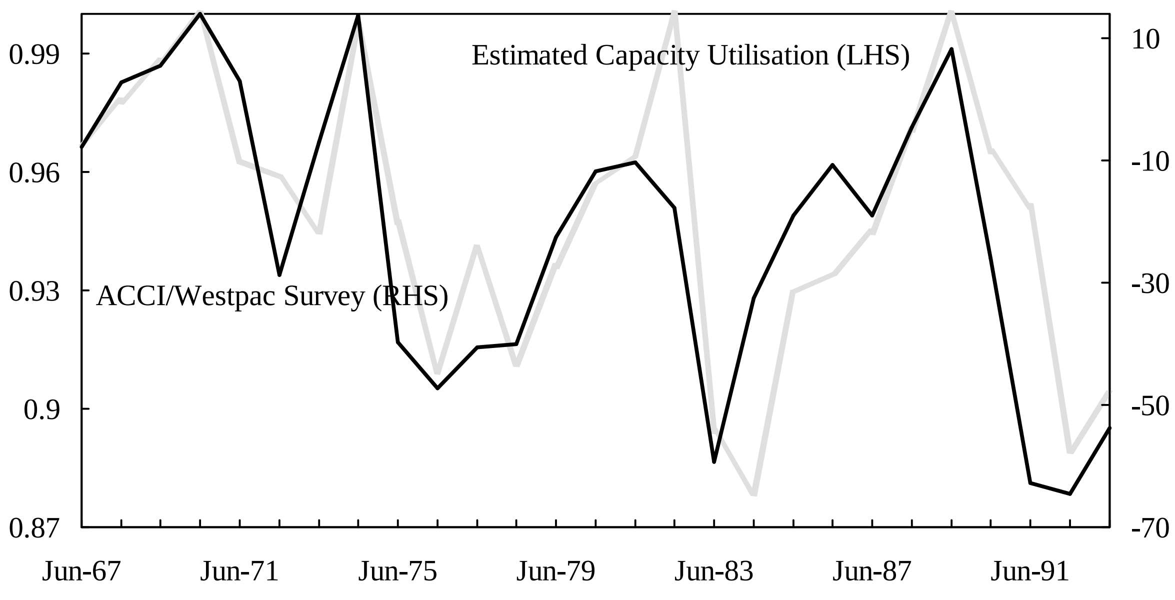
The capacity output results on Graphs 1 through 10 suggest that the economy has excess capacity in a number of sectors. These five sectors are mining; manufacturing; transport, storage and communication; wholesale and retail trade and recreation, personal and other services. Thus, if the demand existed, these sectors could raise output with their existing capital stock. The employment implications of increasing output are considered below in Section 3.2.

Examining the results for individual sectors highlights some interesting features. The only curious result is the bulge in estimated capacity in finance, property and business services shown in Graph 8. One factor that seems to be driving this is the high level of investment through the 1980s. This would normally be expected to increase output; however, output in the finance services sector is computed by assuming constant labour productivity so changes in capital input do not necessarily affect the published output. This is in contrast to the capital-based production technology assumed in the estimation procedure. Due to the lack of correspondence between the investment and output figures the estimation procedure has difficulty fitting a tight frontier. One possible interpretation of these results is that the estimated capacity frontier more closely reflects actual output than the published figures. This is as the estimation method takes account of the effect of capital on output, which could reflect the productivity improvements in this sector from computer technology, whereas the ABS does not. However, this interpretation is limited by the fact that the estimation method is still trying to fit the data to the published output which will bias the results.

In agriculture the high output in 1979 pushes up the capacity frontier, particularly during the 1970s. Thus the low level of estimated capacity utilisation over the 1970s may be illusory. This highlights the fact that one factor not accounted for in the estimation method is the effect of weather on agricultural output. For example, drought was responsible for low output in 1983 rather than low capital utilisation. However, to maintain consistency across sectors, the same method was used for all sectors.

The pattern of growth in capacity output in the mining sector reflects the bursts in investment that have occurred in the mining sector. There are rapid rises in capacity output in the early 1970s and 1980s corresponding to investment in Bass Strait and iron ore mines followed by the resources boom. In between these periods capacity remained fairly level. Interestingly, investment has been remarkably resilient in this sector recently with capacity output estimated to be rising relatively rapidly. This may reflect the longer investment horizon of this sector which would be relatively unaffected by the recent recession.

Graph 11: Comparison of ACCI/Westpac Survey and Estimated Capacity Utilisation



The manufacturing sector is the only one where it is possible to compare the results with another source of data. To confirm the validity of these results we show the ACCI/Westpac survey of capacity utilisation in Graph 11 above; the peaks and troughs in capacity utilisation correspond and the magnitude of fluctuations across time are also similar. Our results identify full capacity peaks in 1982 and 1989 which accords with prior expectations. Furthermore, the results indicate that manufacturing has significant excess capacity at present stemming from previous investment decisions.

The results for the construction sector may reflect some problems with the estimation method. A few more years of data with rising output may flatten the capacity output frontier. This would make the peak in 1982 output closer to full capacity and the current capacity estimate higher. This problem is not likely to occur in other sectors as it is created by the combination of falling output and a significant drop in investment in construction. Naturally, this has implications for the estimates of capacity employment in the construction sector presented later in this paper.

In the service sectors output follows a smooth path. This stems from the labour-based method of calculating output that the ABS uses for these sectors; there are few cyclical peaks or troughs. As a result of this the estimation procedure fits a capacity frontier that is relatively close to the actual output frontier. Thus output is never estimated to be significantly below potential. This should not be a significant problem as capital is unlikely to be the primary constraint on output or employment in these sectors. Apart from the finance sector, as already noted, results for the other sectors seem fairly unexceptional. Thus, of the ten sectors, two have problems that render the results unreliable (agriculture and finance), five have excess capacity at the moment and three are capital constrained. Community services, although estimated to be capacity constrained, is unlikely to have significant problems as it has always been estimated to be close to capacity due to the non-cyclical nature of its output. Also as a service sector it is labour intensive and unlikely to be restricted by a lack of capital.

3.2 Full Capacity Employment

Graphs 12 to 21 below show results from the two stages of estimating capacity employment. The 'productive' employment line is the estimated level of employment once surplus labour has been removed. This is estimated as described in Section 2.2. If an abnormally high productivity result occurs which may not be directly linked to productivity improvements, as happened in 1979 for agriculture, this will displace the fitted productivity frontier further up than it should actually be, and will lead to estimated 'productive' employment being too low. The capacity employment line indicates the level of employment that could be sustained if the active capital stock were operated at full capacity.

As described in detail in Section 2.2, the estimates of 'productive' employment and capacity employment are calculated as follows:

(a) Surplus labour is removed from actual employment to give 'productive' employment,

(b) an estimate of the proportion of the capital stock used to produce actual output is made for each year. The estimate of 'productive' employment is divided by this proportion to obtain an estimate of employment if the capital was fully utilised. Thus capacity employment always exceeds 'productive' employment but can be less than actual employment, particularly in years when the amount of surplus labour is high.

As the employment data include full-time and part-time employment, an underlying assumption is that the proportion of full and part time jobs is the same in new jobs created as in actual employment. Another assumption is that surplus labour is equally spread between full and part-time employees. If we assumed that surplus labour was concentrated among full-time employees this would raise the employment identified as 'productive' employment (as a larger number of 'non-productive' hours would be absorbed by a given number of employees). It is possible to present these results in terms of total hours worked – the shape of the graphs will remain the same, only the scale would change. This would remove any need to make assumptions about the proportion of full and part-time jobs created; however, some assumption about full and part-time work would then be needed to derive any implications for employment.[23] Given this it seems more useful to assume that the proportion of full and part-time employment is the same on the extra jobs.

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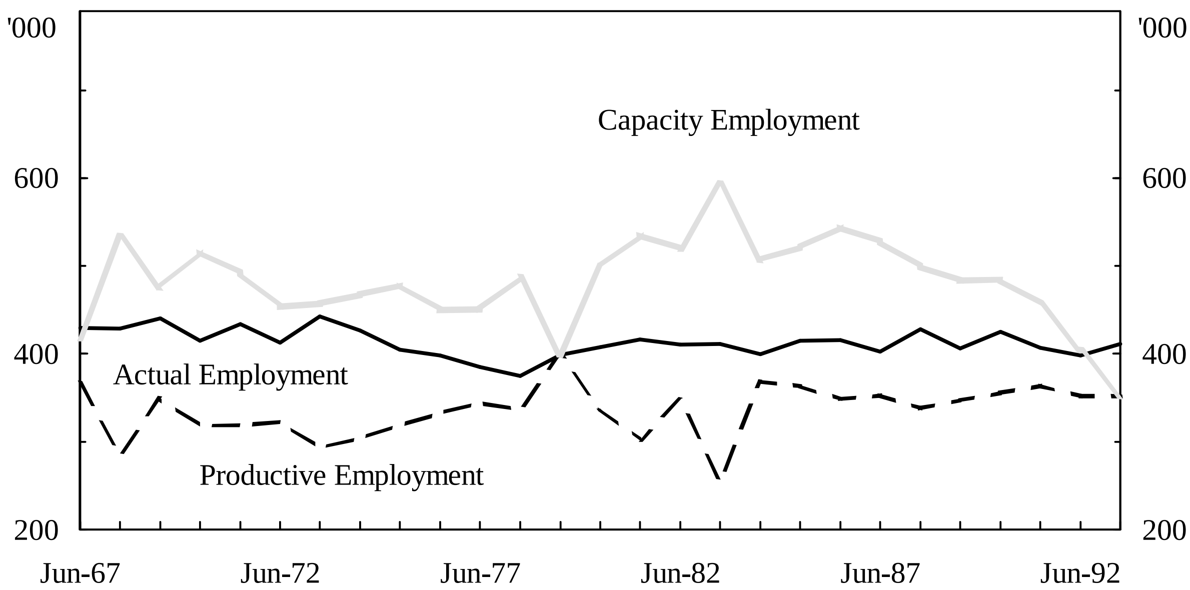
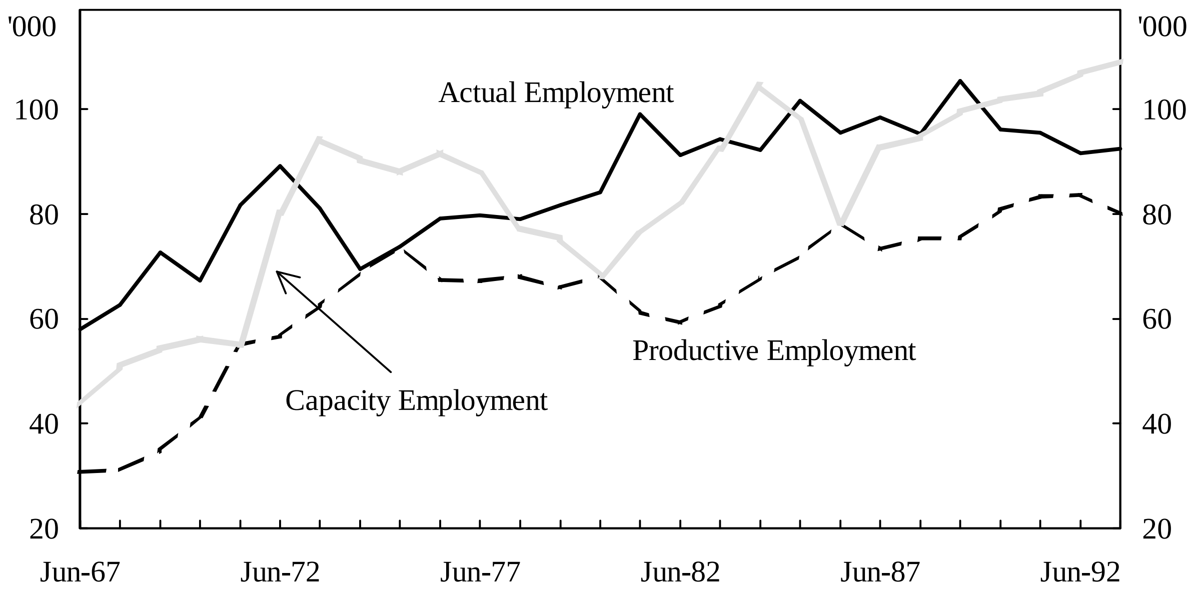
[23] The estimation that 40,000 more hours are worked could involve 1,000 more full time jobs or 2,000 more part time jobs. Some assumption would need to be made about this proportion to identify the exact level.

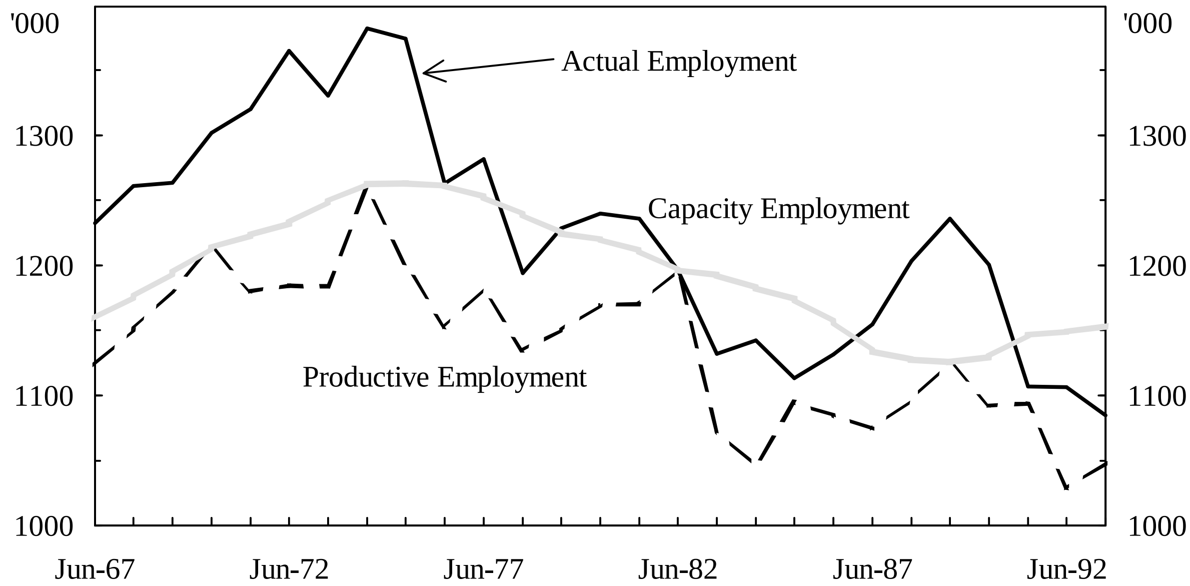
Graph 12: Agriculture, Forestry, Fishing and Hunting



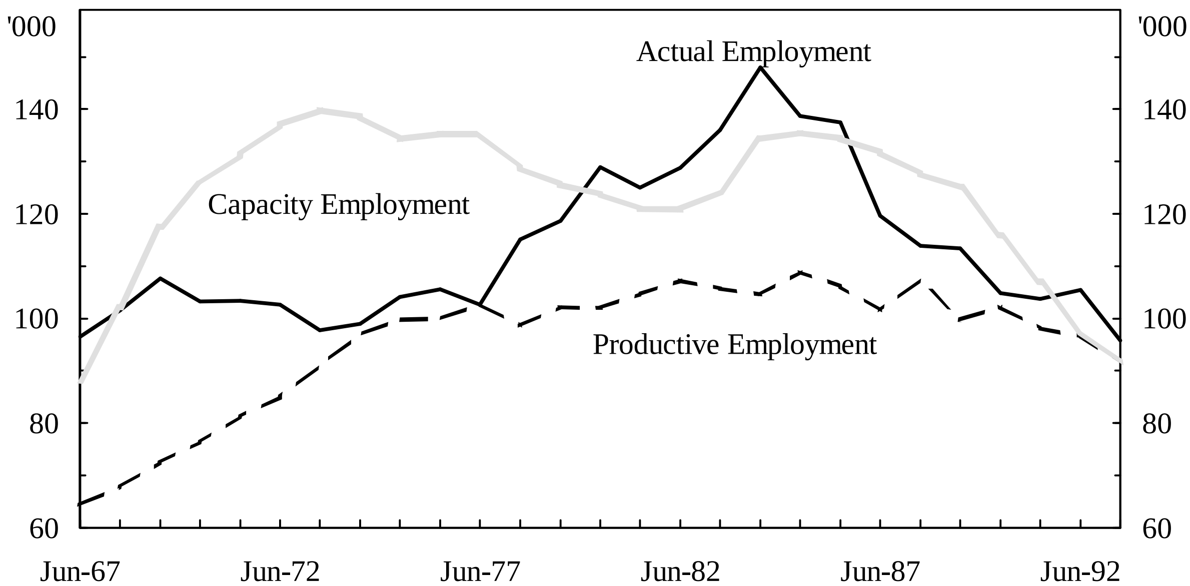
Graph 13: Mining



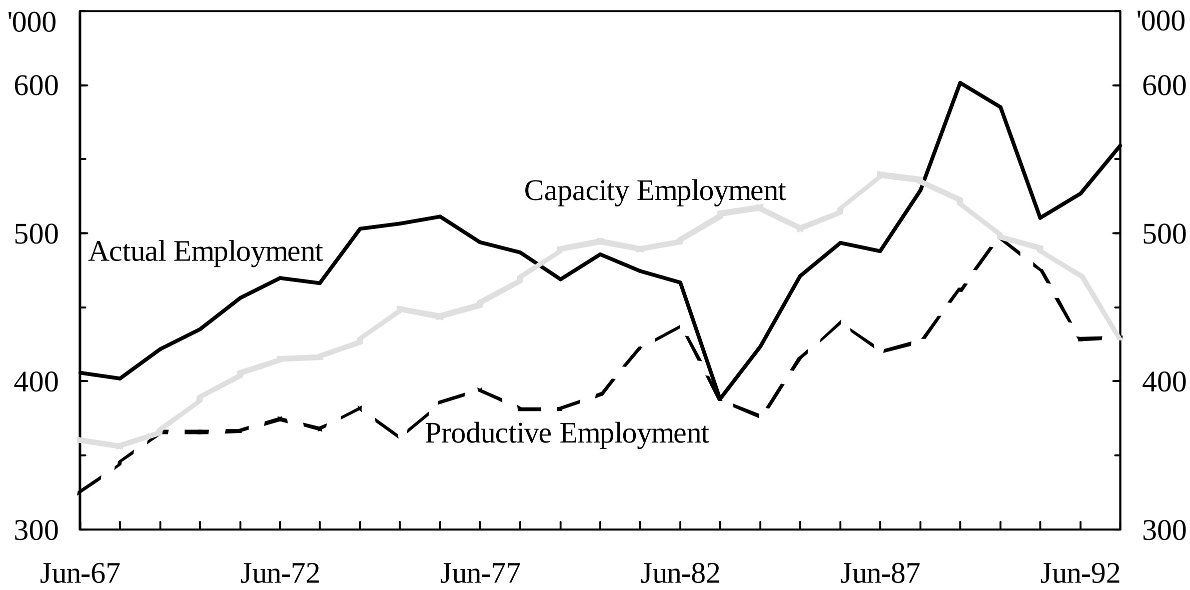
Graph 14: Manufacturing



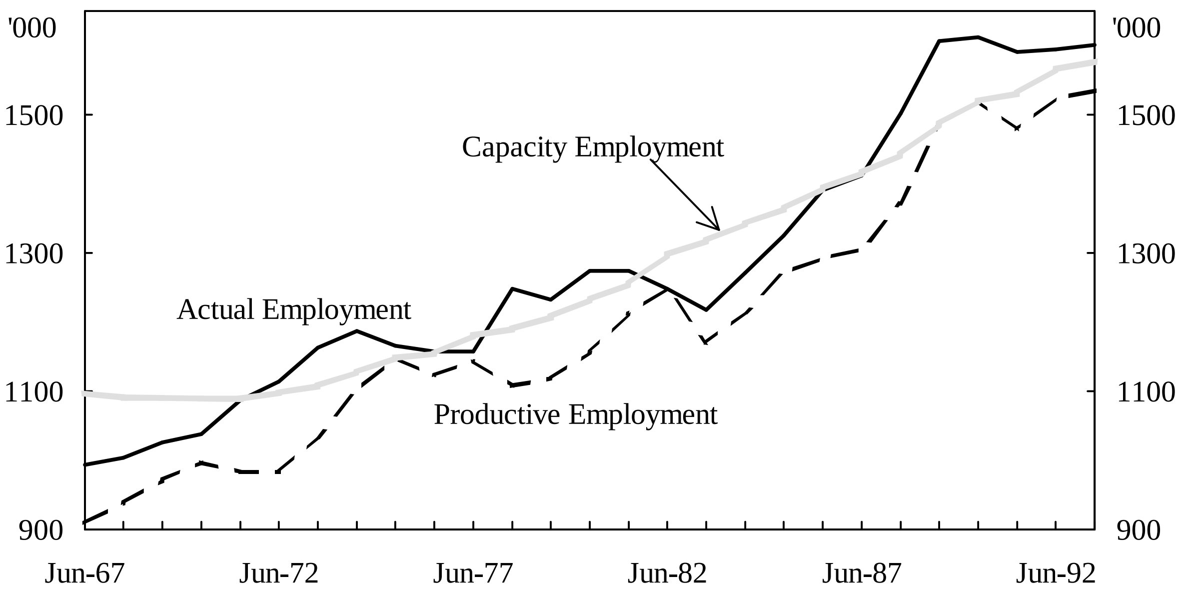
Graph 15: Electricity, Gas and Water



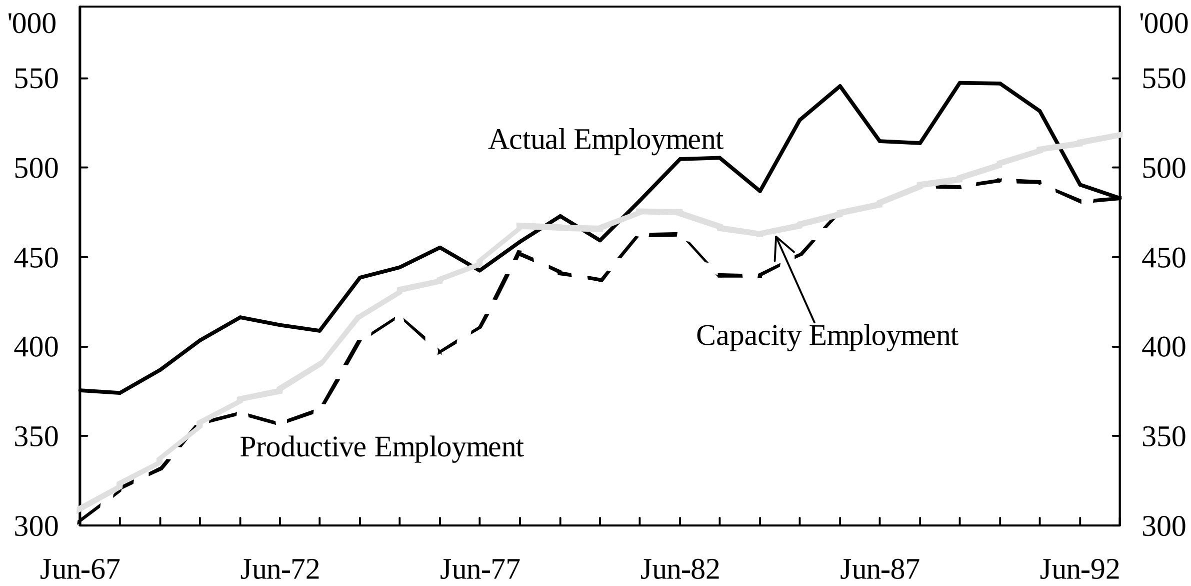
Graph 16: Construction



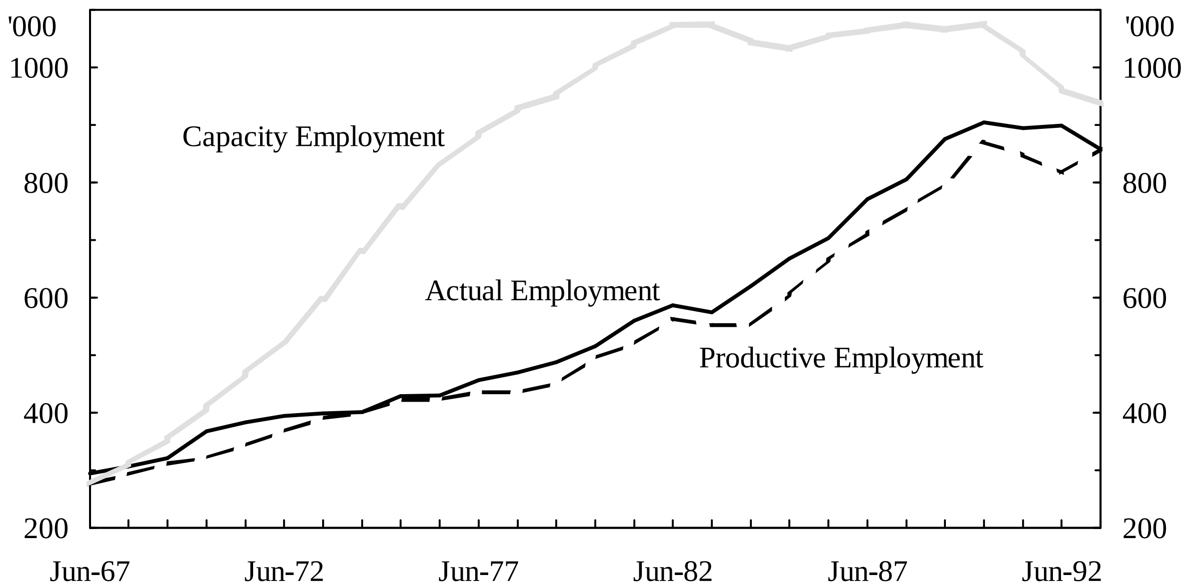
Graph 17: Wholesale and Retail Trade



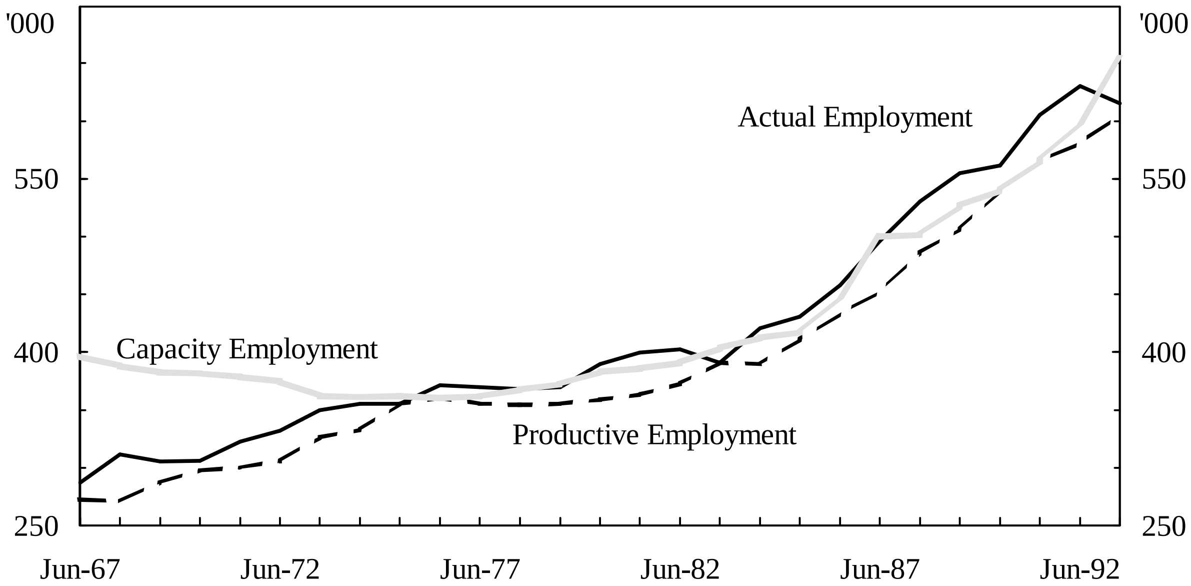
Graph 18: Transport, Storage and Communication



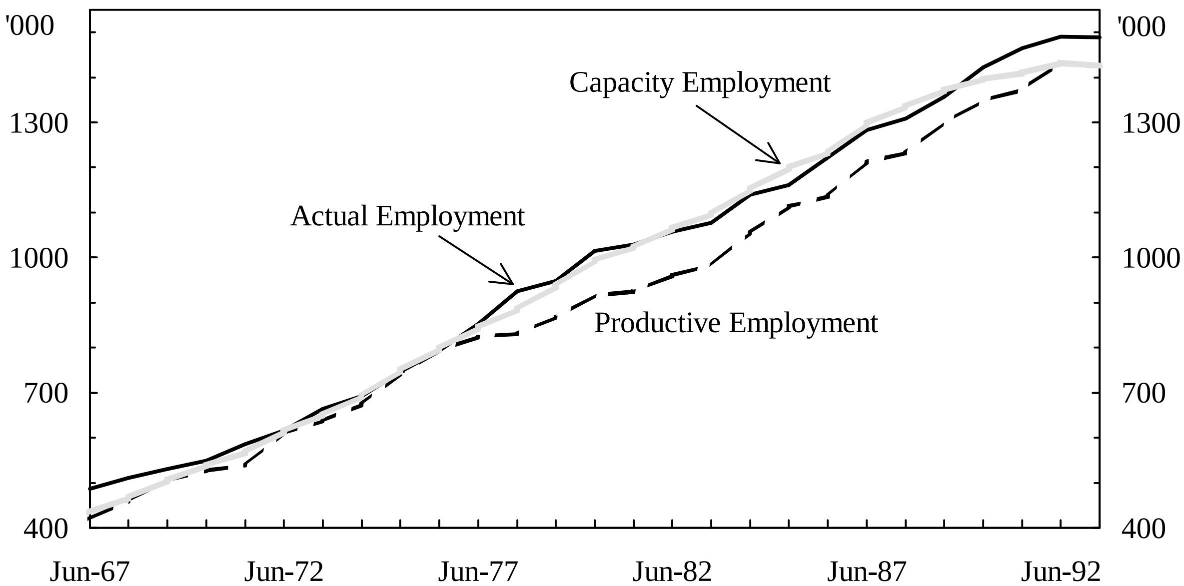
Graph 19: Finance, Property and Business Services



Graph 20: Recreation, Personal and Other Services



Graph 21: Community Services



In aggregate there would seem to be limited scope for new employment as there is underemployment or labour hoarding still occurring in some sectors which offsets the potential for growth in other sectors. Employment possibilities are distributed unevenly between sectors; some sectors could increase employment whereas others are estimated to have surplus labour. More interesting points can be gleaned from a consideration of the individual sectors.

The results for agriculture are affected by the 1979 output observation. This peak affects both the levels of labour hoarding estimated on either side of the peak and the large increase in employment due to low capacity utilisation on either side of the peak. As such it is difficult to make any definite statements about this sector.

The electricity, gas and water sector has reduced much of the surplus labour evident through the 1980s to the point where there is relatively little currently employed. The high level of estimated surplus over this period may be related to high levels of investment over this period. Labour employed in investment activities would be 'non-productive' in that no output could be directly attributed to it. The overall impression is that the industry has reduced employment to a more efficient level than previously where most employees are productively employed, operating the capital close to capacity.[24]

In construction, except for the dip in 1983, there seems to have been a consistently high level of surplus labour. This could be distorted due to the unusually productive 1983 result; however, this is less likely than for the agriculture sector where climatic conditions affect the results substantially. Interestingly, employment in construction has been rising even though output and estimated capacity have fallen. This is in contrast to the trend evidenced in other sectors where job losses have not been reversed.

The estimates of surplus labour in the finance, property and business services sector are relatively small. This is to be expected given that the ABS estimates output in this sector by assuming a constant level of labour productivity. However, as the ABS uses different data and somewhat complicated methods the level of productivity calculated in this paper is not perfectly flat over time and hence there is

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[24] It is, however, possible that some excess capacity still exists in this sector as the estimation merely indicates that this sector is closer to capacity than it has been over the estimation period.

some estimated surplus. The large bump in capacity employment is an artefact of the high capacity output estimated in the first stage. Results for the other sectors seem unremarkable.

3.3 Investment Projections

Projections of investment required to sustain various rates of employment growth are presented below in graphs 22 to 31.[25] The employment growth rates considered are 1.4 per cent, 2.2 per cent and 3.1 per cent. These projections are dependent upon the assumption made about the path of the capital to labour ratio. The assumptions made in this paper, as discussed in Section 2.3, are most likely to be an overstatement of the path this ratio will follow. As such, these projections will probably be higher than actual requirements.

In the graphs below investment data since 1967 are included with the projections to provide some idea of whether the projections are consistent with the historical pattern of investment in each sector. The data used are public and private gross fixed capital expenditure in plant and equipment by sector in constant 1989/90 prices. The different lines indicate the investment paths required for employment growth at the levels indicated in the legends.

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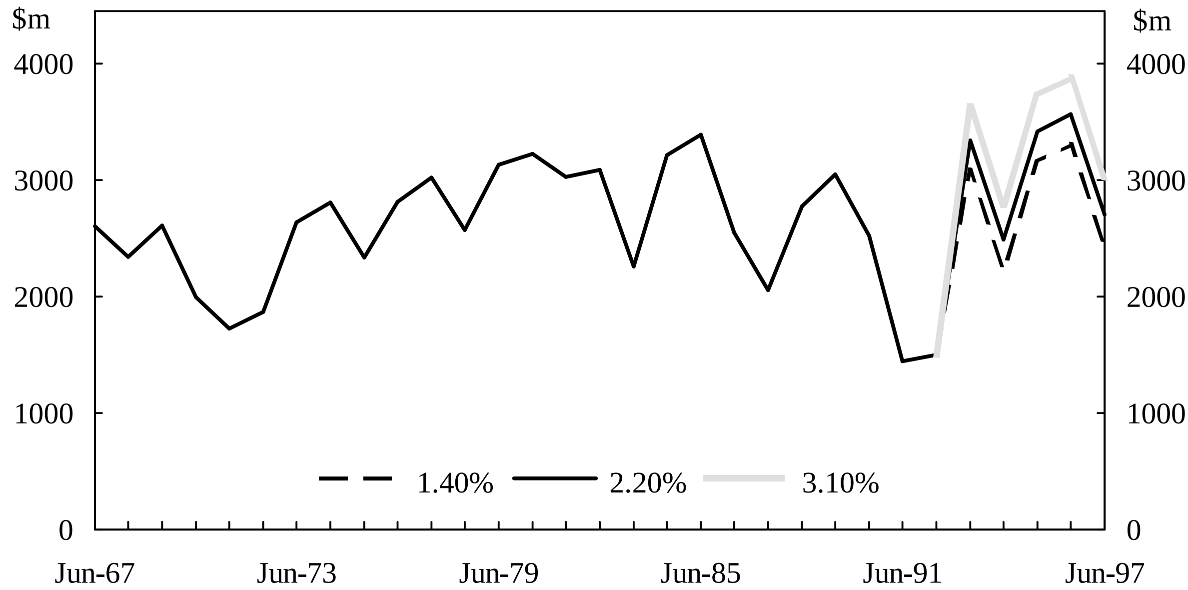
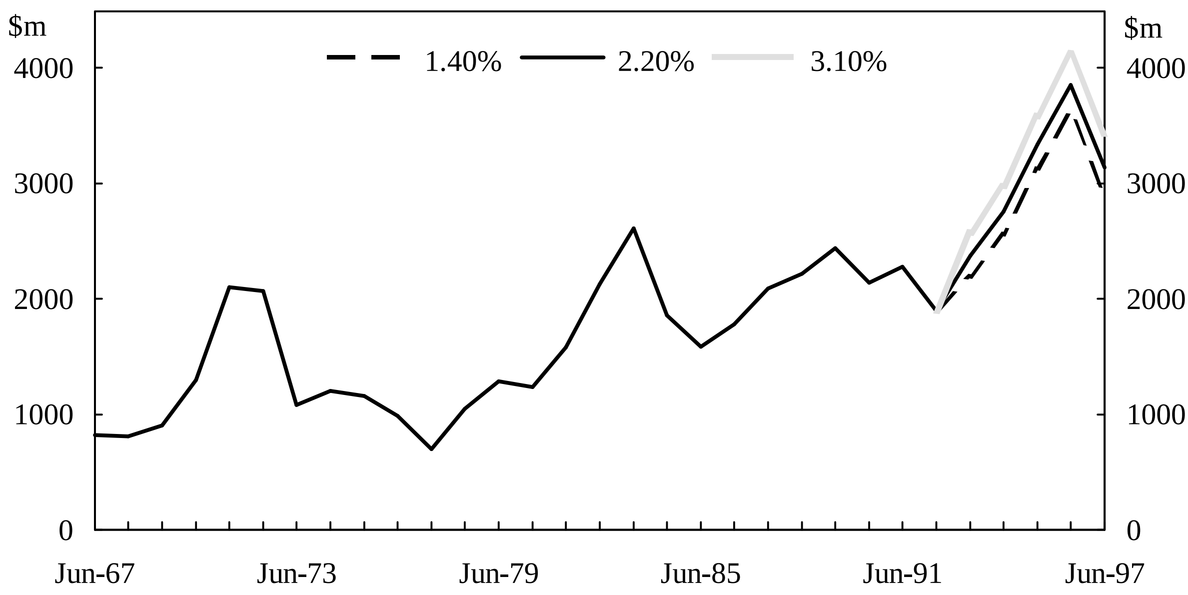
[25] Once again, we stress that these projections are not forecasts. They are model-generated, hypothetical scenarios.

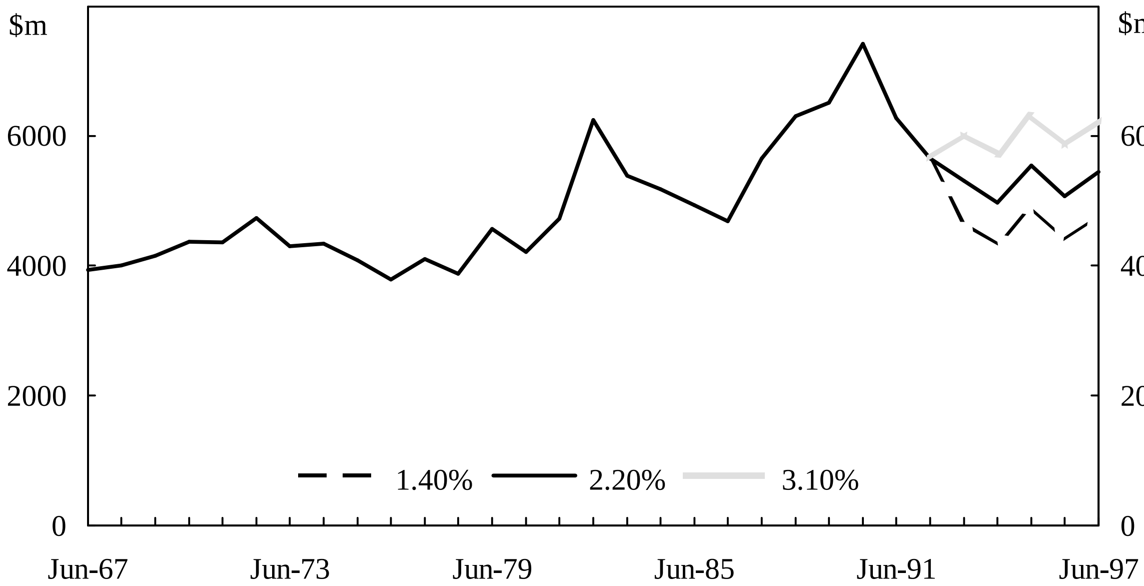
Graph 22: Real Gross Investment in Agriculture, Forestry, Fishing & Hunting



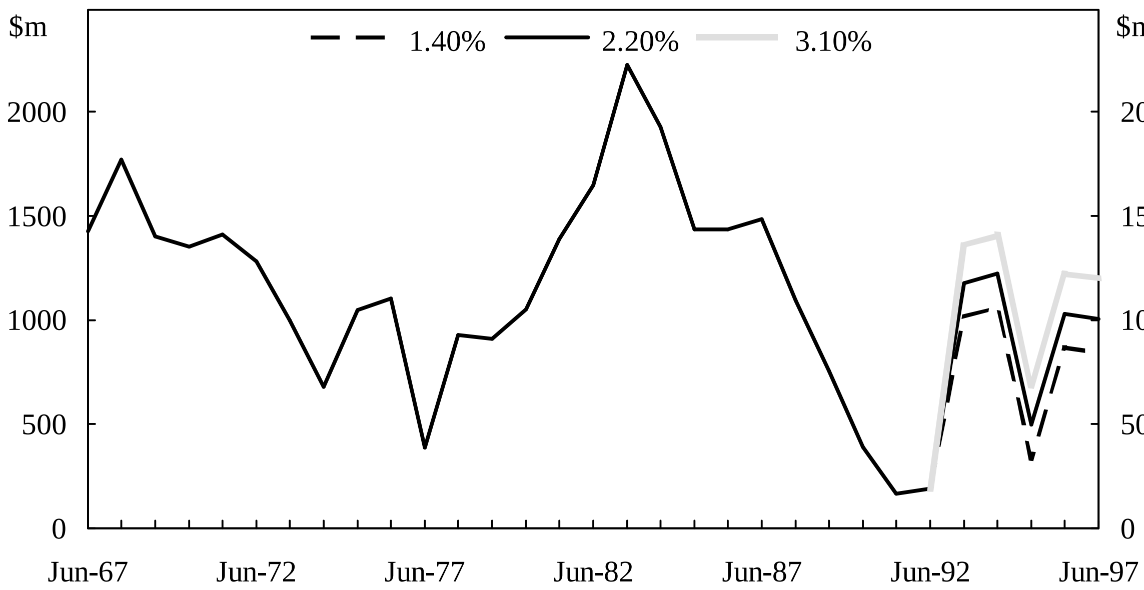
Graph 23: Real Gross Investment in Mining



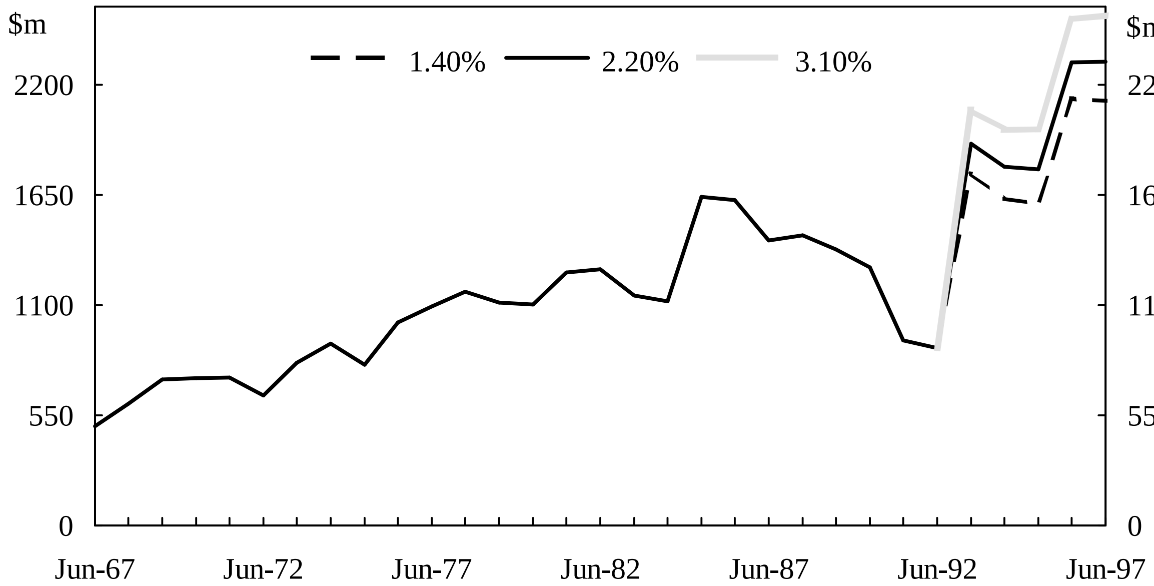
Graph 24: Real Gross Investment in Manufacturing



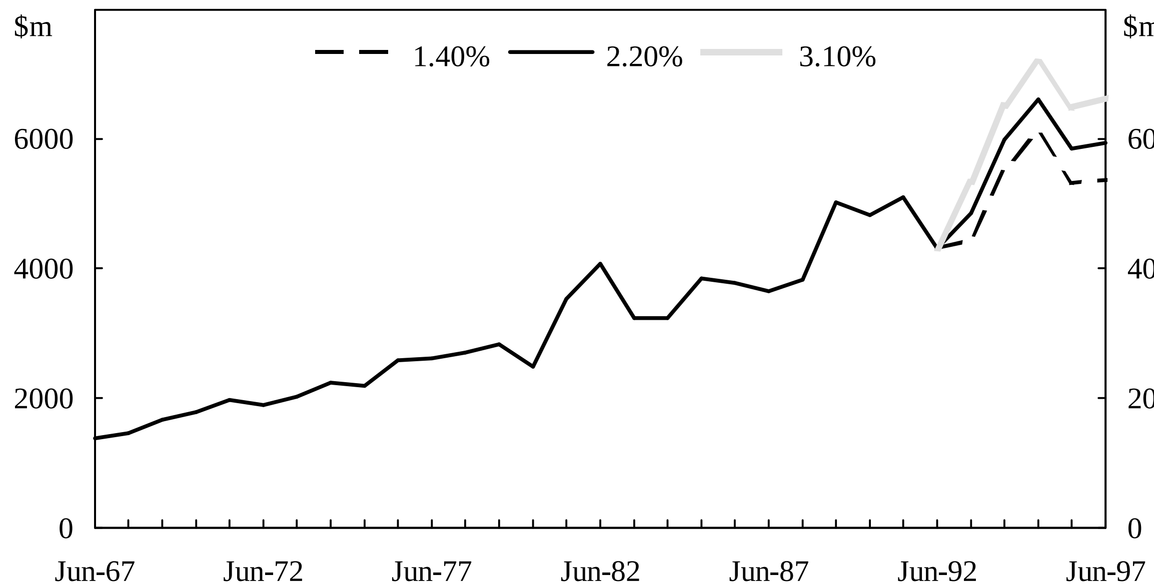
Graph 25: Real Gross Investment in Electricity, Gas and Water



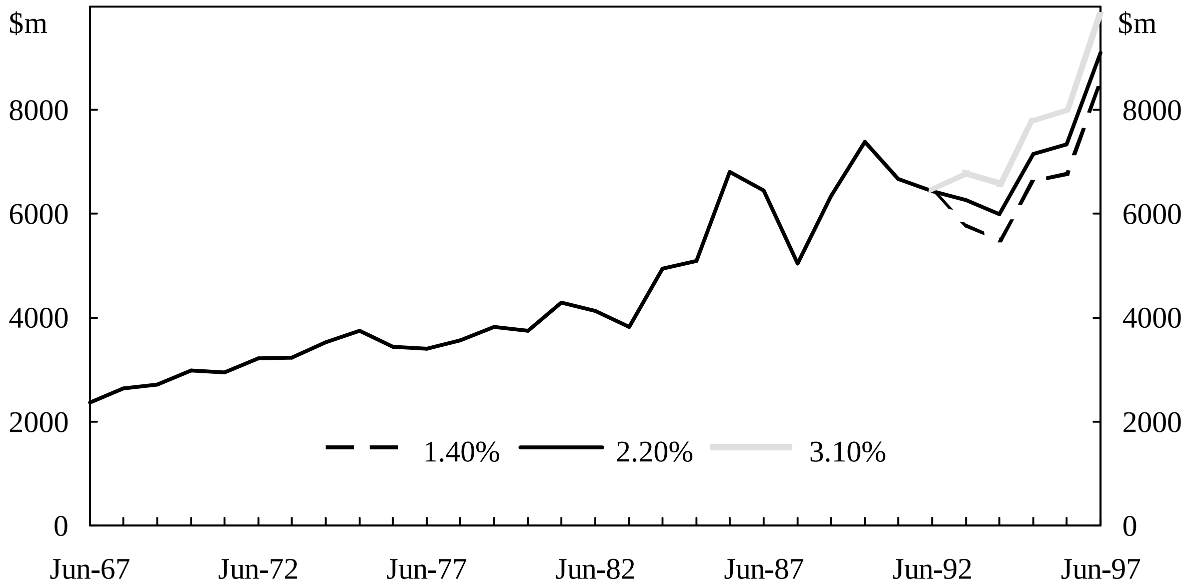
Graph 26: Real Gross Investment in Construction



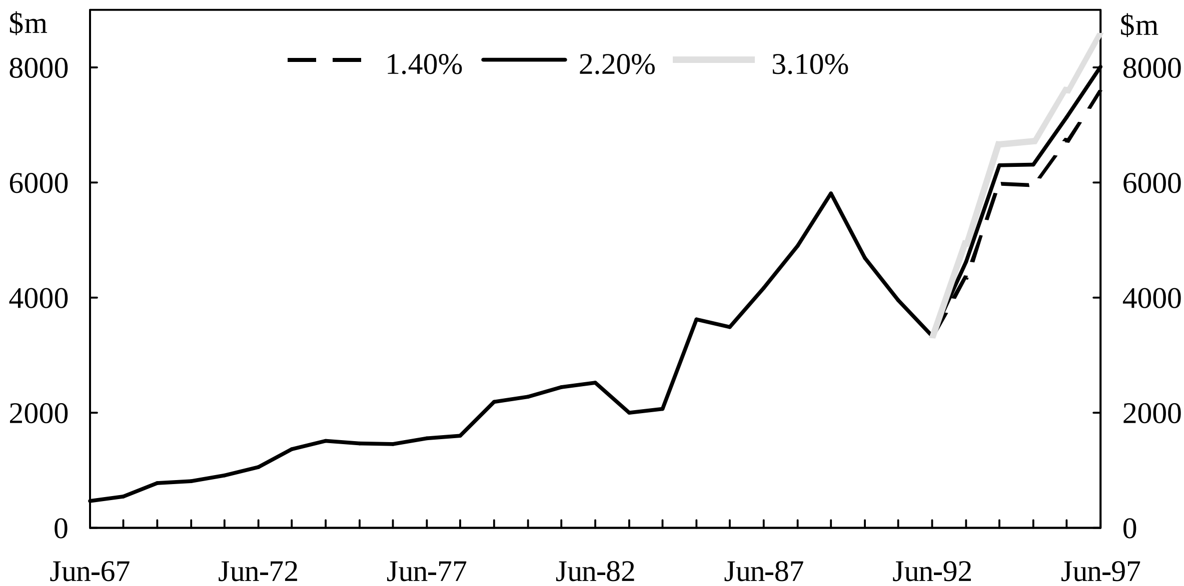
Graph 27: Real Gross Investment in Wholesale and Retail Trade



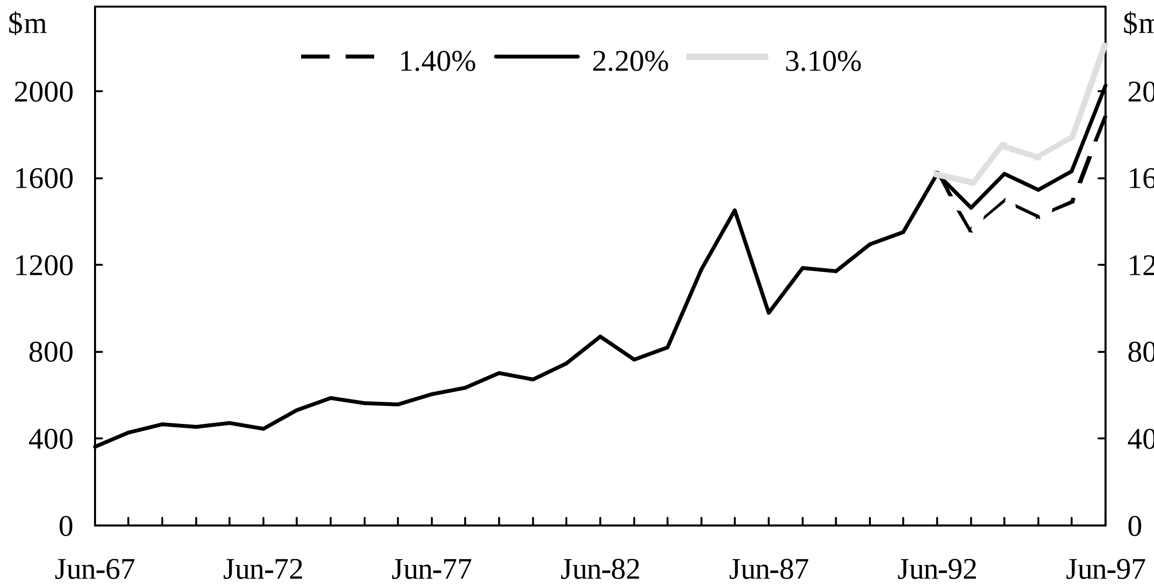
Graph 28: Real Gross Investment in Transport, Storage and Communication



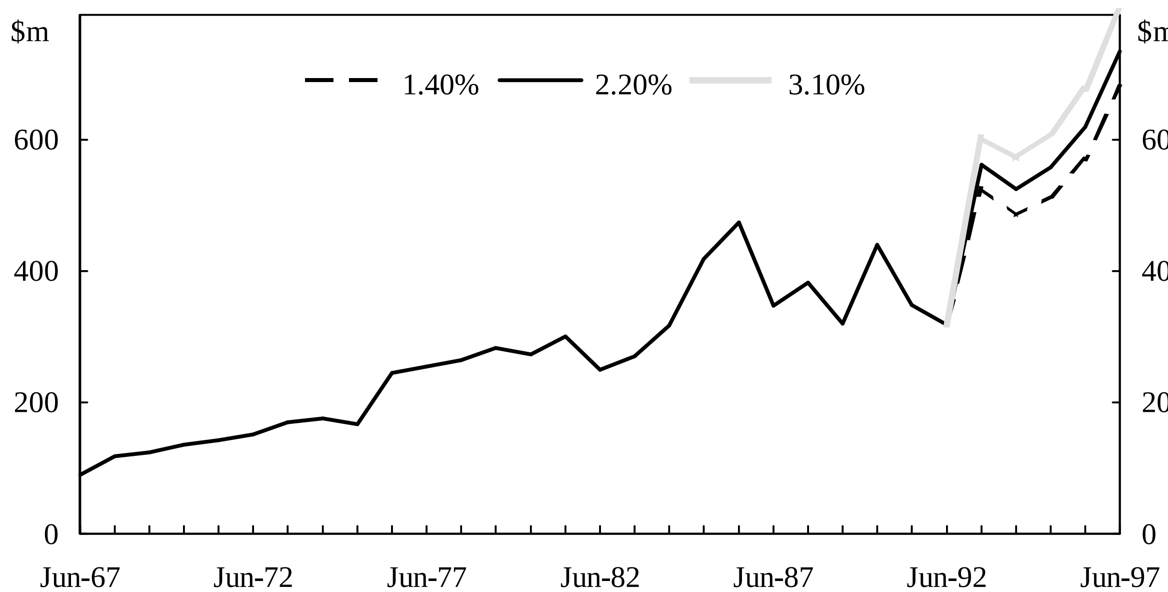
Graph 29: Real Gross Investment in Finance, Property and Business Services



Graph 30: Real Gross Investment in Recreation, Personal and Other Services



Graph 31: Real Gross Investment in Community Services



It appears that the investment rates required to generate employment are not excessive. In most cases an initial jump in investment is projected followed by modest growth; this jump can be substantial. However, these projections assume that employment growth resumes immediately. If employment growth was projected to resume gradually the investment requirement could be spread over more years. Thus, instead of an excessive jump in the first year being necessary, sustained investment over a longer period would suffice. The highest requirement for growth is in finance, property and business services where a return to the boom levels of the 1980s is required. This projection could be affected by the high trend in the capital to labour ratio through that period. Projecting the capital to labour ratio to grow at the rate of the 1980s, as is done in this method, may be an unreasonable assumption which biases the projections upward.

If the results are aggregated across sectors they suggest that an initial jump in investment of 27 per cent is consistent with employment growth of 2.2 per cent. Thereafter, growth rates of around 5 per cent are sufficient to maintain the employment growth. However, the initial jump is distorted by the results for the electricity, gas and water and construction sectors where investment has fallen significantly over the past few years. If these sectors are excluded the initial jump required in investment is 19 per cent. Thus, while the initial jump in investment is substantial the rates following are not abnormal; for example, from 1984 to 1985 private investment grew by 16 per cent.

At a sectoral level it is interesting to note that the requirements in the manufacturing sector do not involve an initial jump. Investment in this sector in the past three years has been relatively high. While it has fallen from a peak in 1989 it seems to be a return to a longer run trend. In comparison, investment in the electricity, gas and water sector has to jump quite a long way, as investment has fallen to practically nothing over the past few years. However, the required level of investment is not unreasonable given the historical pattern of investment in this sector.

4. CONCLUSION

The pattern of capital constraints on employment varies between sectors with some being capital constrained while others have excess capital. However, the results must be qualified due to the technical nature of the calculations and the possibility of errors in the data. A number of sectors, such as finance and business services, have problems that make the results for those sectors problematic. The investment projections are based on the assumption of constant real wages. Were real wages to change relative to the cost of capital, so too would the capital to labour ratios consistent with a given future rate of output growth, and thus the required amount of capital expenditure. As real wages will undoubtedly be changing this restricts the usefulness of the investment projections. Nonetheless, noting that a number of qualifications to this conclusion exist, the investment requirements for employment growth in the near future do not seem excessive after the initial jump.

DATA APPENDIX

The following data sources were used:

- Output by industry in constant 1989/90 prices from *Australian National Accounts: National Income, Expenditure and Product*, ABS Cat. No. 5206.0. Data for period 1967-1974 from *Australian National Accounts: Gross Product by Industry at Current and Constant Prices*, ABS Cat. No. 5211.0 spliced onto first series.

- Total persons employed by industry from *Labour Force Australia*, ABS Cat. No. 6203.0

- Average hours of work for employed persons by industry from *Labour Force Australia*, ABS Cat. No. 6203.0. Data for period 1967-1978 from *Labour Force Australia*, ABS Cat. No. 6204.0

- Public and private gross fixed capital expenditure in constant 1989/90 prices from *Australian National Accounts: Capital Stock*, ABS Cat. No. 5221.0 for period 1945-1993.

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