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The Contribution of Services and Other Sectors to Australian Productivity Growth 1980-2004

A Report Prepared for the Australian Business Foundation

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Executive Summary

There has been a clear acceleration in the growth of labour productivity in Australia in the 1990s. From 1992 to 2004 labour productivity grew at an annual rate of 2.32% compared to 1.59% observed for 1980-1992. This has been accompanied by a substantial increase in living standards, which was also supported by the boom in export prices in the mineral and energy sectors at the beginning of the 21st century. The increase in mineral and energy exports has also helped to finance rapidly growing imports in manufacturers.

Given the significance of labour productivity growth for living standards and trade performance it is important to understand which sectors have been responsible for the change in overall labour productivity growth performance. There have been a number of studies of sectoral patterns of Australian labour productivity growth (Gruen and Stevens, 2000; Cobbold and Kulys, 2003; Ewing et al, 2007) which have provided evidence of the changing importance of the contributions of different sectors to labour productivity growth over time. These have indicated an important contribution from the services sectors to overall performance. These studies remain, however, at a relatively high level of aggregation and do not provide an analysis of which sectors account for productivity growth acceleration in the 1990s.

To complement existing Australian productivity studies we provide an updated and more disaggregated decomposition analysis for 49 sectors of the Australian market economy within the periods 1980-1992 and 1992-2004. We also consider the two sub-periods 1992-1998 and 1998-2004. Most importantly, we directly address the question of which sectors account for the acceleration in productivity growth between periods. In our analysis we make use of a standardised international dataset of industry performance compiled by the Gröningen Growth and Development Centre. This dataset is widely referred to and used in growth and productivity analyses including those related to Australia (Davis and Rahman, 2006).

In disaggregating Australian labour productivity growth we have chosen for reasons of comparability the method adopted in a series of well-known studies of the United States carried out by Robert Solow and others for the McKinsey Global Institute. According to this method the contribution of any given sector to aggregate productivity growth is essentially the contribution of that sector to aggregate output growth minus its contribution to aggregate labour input growth, multiplied by the ratio of opening to closing aggregate employment over the relevant period.

Our analysis of sectoral contributions to productivity growth within the low and high productivity growth periods shows that the most striking difference between the 1980-1992 and 1992-2004

periods is the higher importance of wholesaling and financial intermediation along with agriculture in the high productivity growth period. Mining and quarrying played a much less important role as a contributor to labour productivity in the high growth period 1992-2004 than it did in the low growth period 1980-1992. In both periods a small number of sectors can explain almost all productivity growth although the sectoral productivity growth contributions in the high-growth period are less concentrated than in the low-growth period.

Our analysis of productivity growth acceleration between 1980-1992 and 1992-2004 reveals that nearly all of the post-1992 acceleration can be attributed to the performance of just three services sectors: financial intermediation, wholesale trade and other business activities not elsewhere classified. The remaining sectoral contributions effectively cancel each other out. Mining and quarrying which had played a positive role in labour productivity growth within each of the periods, nonetheless played a negative role in terms of productivity growth acceleration between periods.

When we compare productivity acceleration between 1980-1992 and the two sub periods 1992-1998 and 1998-2004 we find substantial differences in sectoral contributions to productivity growth. For instance, in the case of communications its small overall contribution to the growth acceleration between the low growth period 1980-1992 and high-growth period 1992-2004 as a whole masks the fact that it played a substantial role in generating productivity growth acceleration between the sub-period 1980-1992 and sub-period 1992-1998. Its small role overall is therefore due to a decline in its impact on productivity acceleration between 1980-1992 and the sub-period 1998-2004.

The results of our analysis reveal a similar pattern of contributions to productivity growth acceleration to that observed for the US in the McKinsey Global Institute reports for the periods 1995-2003, with services sectors playing a dominant role in both economies. This is particularly true in relation to wholesaling and financial intermediation. It is notable that retailing has not played a significant part in the Australian context. In relation to the overall sectoral concentration of productivity growth acceleration, the picture is more concentrated in the case of Australia than is the case for the US. In the Australian context in most periods and sub-periods three or four sectors accounted for all or more than all of the total acceleration in productivity growth. A notable feature of the Australian productivity growth performance is the role of the agricultural sector which was, however, excluded from the analysis in the US study. Our results show that agriculture made a significant contribution to the acceleration of labour productivity in the period 1992-2004, with most of this impact being generated after 1998.

Thus our study shows that services sectors have dominated the acceleration of productivity growth in the Australian economy since 1992. It also shows that there are considerable variations in the importance played by different sectors to productivity growth both within and between periods. Our analysis suggests that the forces which have driven productivity growth in services sectors have been central to the overall acceleration of labour productivity growth.

The transformation of productivity in the services sectors is intimately linked to the development and application of information technologies which in turn require the effective development of a wide range of complementary investments in management and other organisational and often intangible assets. One aspect of this is the extent to which lower unemployment is leading to tightening labour markets and a higher weight being placed on raising skill levels in pursuit of further output and productivity growth. Another is the extent to which major broadband infrastructure investments will be required to underpin further ICT based productivity gains.

In relation to the structure of trade and overall labour productivity growth performance, our analysis raises two interrelated questions about the net export potential of the services sectors which have dominated productivity growth acceleration. The first relates to the extent to which further gains in productivity growth in services can be expected in the future at the same pace as in the recent past. The second relates to the extent to which the sectors which have driven Australian productivity growth acceleration are capable of offsetting further deterioration in the current ability of the minerals, fuel and metals sectors to generate significant net surpluses, or any deterioration in the ability of Australian banks to borrow overseas as the capital account counterpart to the current account deficit.

Introduction

The purpose of this report is to provide an analysis of the contribution of individual goods and services sectors to the well-known acceleration of labour productivity growth in Australia between the 1980s and 1990s. More specifically we compare the low productivity growth period 1980-1992 with the high productivity growth period 1992-2004 and two sub-periods 1992-1998 and 1998-2004. We also provide an analysis of the contributions made by individual sectors to the overall growth of Australian labour productivity[1] within each of these periods and sub-periods. The analysis is carried out at a fairly high level of disaggreagtion with over 49 separate sectors analysed. Particular attention is paid to the role of services sectors.

The report is not intended to provide an account of the factors affecting the rate of labour productivity growth in individual sectors of the Australian economy. Rather we take these factors as given and ask what impact the resulting sectoral patterns of productivity growth have had upon movements in labour productivity at the aggregate level. We do refer in an appendix to existing studies of the forces which have driven labour productivity growth in individual sectors when we reflect upon the characteristics of those sectors which we show have had the most impact in driving the overall acceleration in labour productivity growth rates.

Our analysis focuses on the market sector of the Australian economy. This excludes those sectors for which market-price based indicators of output are unavailable due to public provision, or because measurement problems make output indicators unreliable. This is in keeping with most Australian studies of Australian productivity which exclude from consideration public administration and defence, education, health and social work, other community, social and personal services and real estate activities..

Our results cover 69% of total output and 70% of total employment in the Australian economy in 2004.

Labour Productivity: Macroeconomic Trends and Industry Patterns

There is a large recent literature on the extent, nature and causes of improved labour productivity growth in the Australian economy in the period examined in this report. Whilst there has been some controversy over the determinants of the labour productivity growth rate patterns which

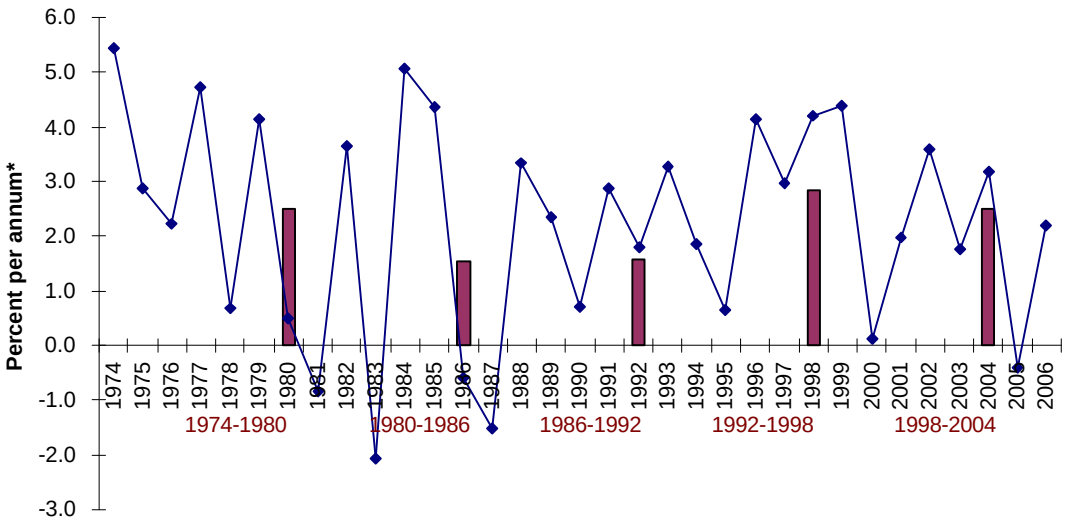
[1] Throughout this report (unless explicitly reported otherwise) we define labour productivity as real gross value added per hour worked. This is widely recognised as the most appropriate indicator of labour productivity and has been used extensively in recent analyses of Australian productivity performance (see, for example, Davis and Rahman, 2006, Gruen and Stevens, 2000 and Cobbold and Kulys, 2003).

have occurred, and on the role of ICT investment and of trade, capital and labour market deregulation in particular, the broad trends of labour productivity growth are well known.[2].

If we divide the period 1974-2004 into six year sub-periods, some broad trends emerge. Chart 1 shows a clear improvement in the growth of real GDP per hour worked in the 1990s compared with the 1980s. It is also clear, however, that there has been some deceleration in this measure of labour productivity growth in the 1998-2004 period[3].

Chart 1

Annual and Average Sub-Period Growth in Real GDP per Hour worked in the Australian Market Sector 1974-2006*



Source: Authors' own calculation based on Australian System of National Accounts, Cat No. 5204.0, 2005-06.

Note: Productivity in these official Australian statistics is defined as real GDP per hour worked. The market sector is the whole economy excluding property and business services, Government administration and defence, education, health and community services and personal and other services. The vertical bars on the chart represent the average annual growth rate in each of the 5 sub-periods shown under the horizontal axis. The bars are placed at the end of each sub-period. The average is calculated as the difference between the logs of opening and closing productivity levels divided by the number of years in each 6 year sub-period.

The high rate of growth of real GDP per hour over the past 15 years has been associated with a substantial increase in living standards in Australia over this period. This is shown in Chart 2

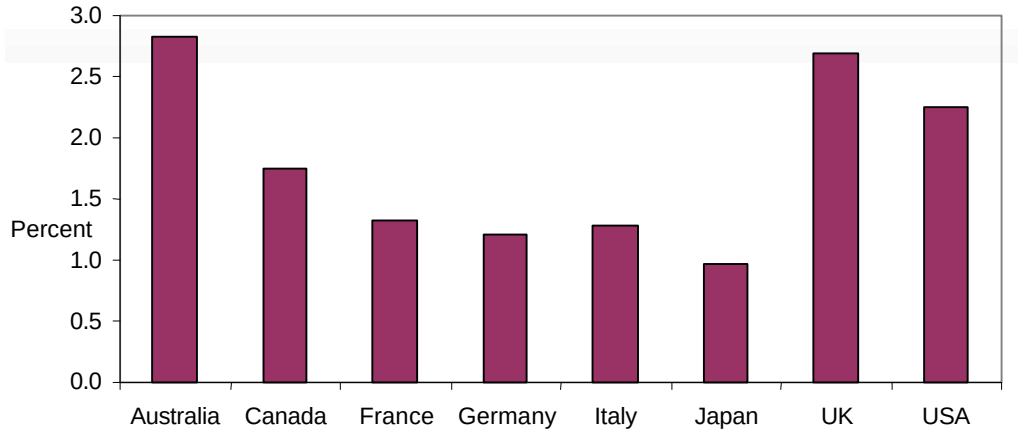
[2] See for example Dowrick (2001), Edwards (2006), Gruen (2001), Cobbold and Kulys (2003), Parham (2004), Davies and Rahman (2006), Dolman et al (2006). On the role of ICT see Gretton et al (2002), Johnson et al (2000), Productivity Commission (2004), Revesz et al (2005), Simon and Wardrop (2002). For discussion of the role of microeconomic policy impacts and other forces affecting this performance pattern see Forsyth (2001), Gruen and Stevens (2000), Quiggin (2000, 2001), Dowrick (2001), Parham (2004), Davis and Ewing (2005), Cobbold and Kulys (2003).

[3] For a similar conclusion using slightly different cyclically adjusted sub-periods and a gross value added based measure see Cobbold and Kulys (2003) and for a recent discussion confirming the labour productivity growth deceleration through to 2006 see Ewing et al (2007).

which shows that Australia in the period 1990-2004 experienced a rate of growth of household final consumption expenditure which outstripped a wide range of other OECD economies[4].

Chart 2

Per Capita Household Final Consumption Expenditure, annual growth 1990-2004



Source: Rowthorn (2007) based on World Bank 2006, World Development Indicators 2006, Table 4.9.

By 2004, although it still lagged considerably behind the United States, and despite the disadvantages of its relative geographic isolation and widely dispersed urban centres[5], Australia had a national income per head of the population comparable to the other major industrial countries in the OECD (Chart 3). The impact of the weakening of labour productivity growth on living standards since 2002 has been ameliorated as a result of the boom in Australian export prices in the mineral and energy sectors. These have taken off at the time at which labour productivity growth has slowed down. As Rowthorn (2007) shows raw material and energy price increases since 2002 have led to a massive improvement in the Australian terms of trade. Chart 4 shows that this change has contributed over half of the growth in real income since that date. Rowthorn concludes that

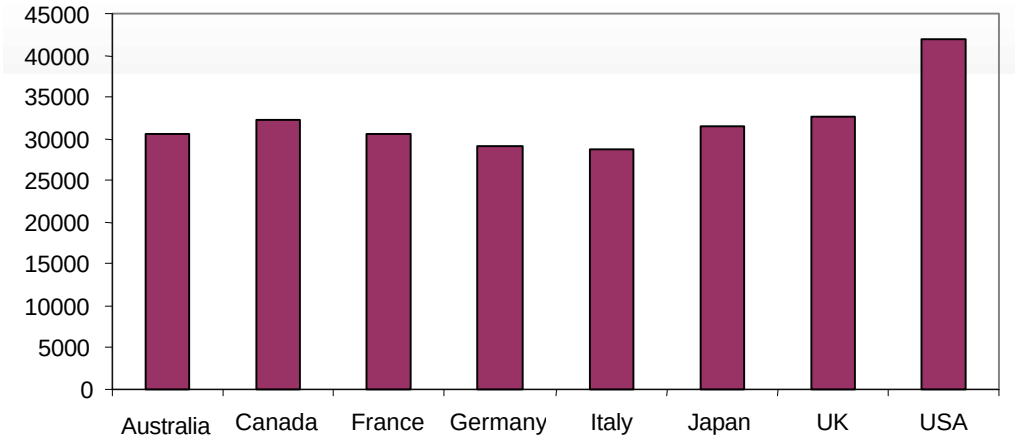
> "The global minerals and energy resources boom has allowed living standards in Australia to rise by more than 3% a year since 2002 despite a noticeable slow-down in domestic labour productivity growth" (Rowthorn, 2007, p.5).

[4] Charts 2-6 are drawn from Rowthorn (2007). We are grateful to Bob Rowthorn and to Telstra Business for permission to reproduce them here.

[5] On the adverse impact of the distance and disperson on Australian productivity levels and living standards see, for example, Winters and Martins (2004) and Battersby (2006).

Chart 3

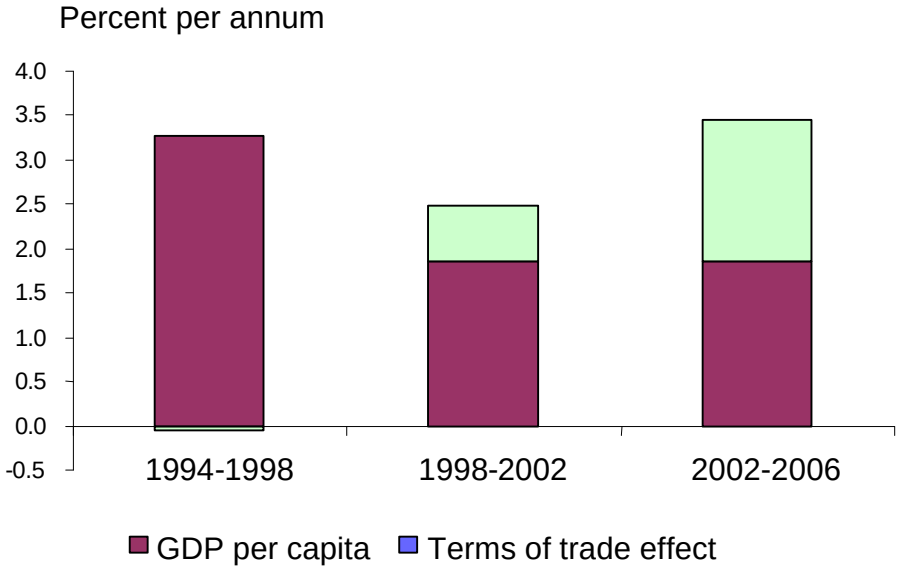
National Income per Capita in 2004, international dollars at Purchasing Power Parity



Source: Rowthorn (2007) based on World Bank 2006, World Development Indicators 2006, Table 1.1.

Chart 4

Contributions to Per Capita Real Income Growth, 1994-2006 (December to December)



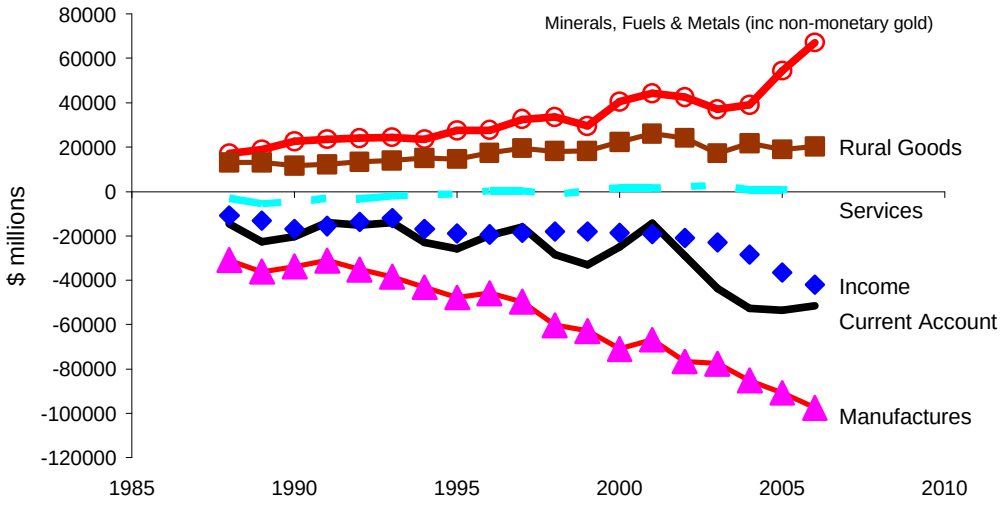
Source: Rowthorn (2007) based on ABS 2007, Australian National Accounts: National Income, Expenditure and Product, December 2006, Cat. No. 5206.0, Table 1.

The increase in mineral and energy exports has also helped finance rapidly growing imports in manufactures. As Chart 5 shows the current account on the Australian balance of payments has deteriorated significantly since 2000. The rise in mineral fuels and metals net exports has helped

to off-set a substantial decline in the net contribution of manufactures which marks a continuation of a steady decline in the manufacturing trade balance from the 1990s onwards. The historically large current account deficit of around 6% of GDP in the period 2002-2006 is substantial by historical standards (Chart 6). In terms of the balance of payments as a whole this deficit has as its capital account counterpart both inward investment flows in mining and other export industries (Rowthorn, 2007 and Gruen, 2006) and a massive increase in borrowing by Australian banks to fund domestic household expenditure. Australian overseas borrowing was twice as high in the decade and a half after 1991 as it was in the decade and a half up to 1991 (Edwards 2006).This echoed in the increase in the deficit on net income from interest payments and dividends shown in Chart 5

Chart 5

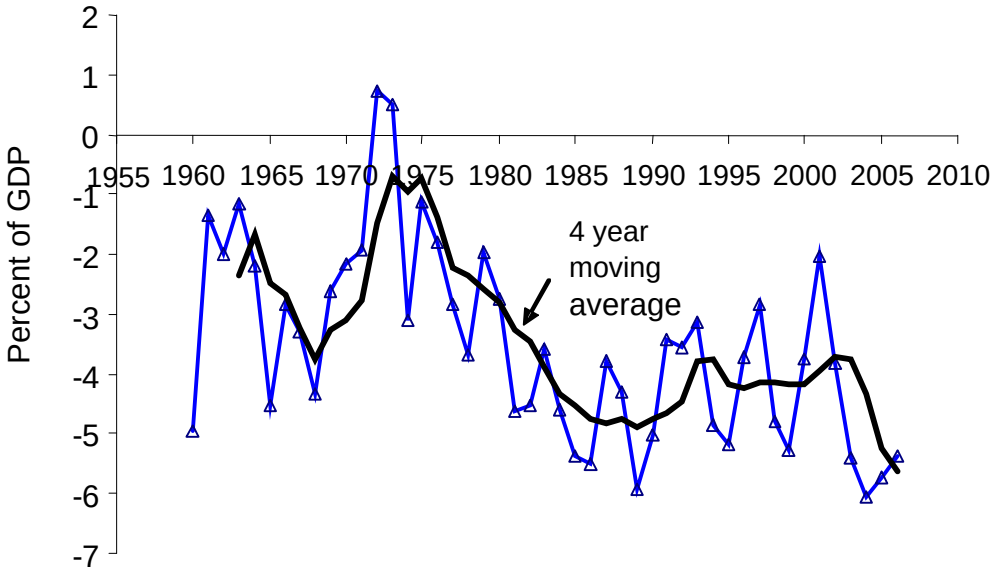
Australian Current Account Balance of Payments 1988-2006



Source: Rowthorn (2007) based on ABS 2007, Balance of Payments and International Investment Position, Australia: December 2006, March.

Chart 6

Australian Current Account Balance of Payments



Source: Rowthorn (2007) based on ABS 2007, Balance of Payments and International Investment Position, Australia: December 2006, March.

Given these structural changes and the importance of labour productivity growth to living standards and trade performance it is important to understand which sectors have made the most significant contributions to the change in overall labour productivity growth performance. In what follows, we compare the period of low productivity growth from 1980-1992 with the years 1992-2004 and ask which sectors accounted for the acceleration of productivity growth between those periods. We also carry out such an analysis based on comparing each of the sub-periods 1992-1998 and 1998-2004 with 1980-1992.

Decomposing Productivity Growth

The overall movement of labour productivity in an economy is composed of the weighted sum of the growth rates of labour productivity in the individual sectors which constitute that economy. An analysis which decomposes the overall productivity growth rate of an economy into these sectoral parts is of interest for a number of reasons. It permits a clearer understanding of the implications of actual and potential structural shifts in outputs and inputs across sectors for overall productivity growth. It reveals the extent to which past aggregate productivity growth is driven by the forces affecting particular sectors. This can permit a focus in analysis on the characteristics of those

sectors which may have led to their particular patterns of input/output and hence productivity growth. It can also lead to a focus in analysis on whether those forces which have operated in the past are likely to continue to do so in the future. The implications of structural changes and differential patterns of productivity growth also have an important bearing in so far as those sectors which are seen to drive productivity growth in aggregate are operating in sectors which have different degrees of exposure to trade and which carry different weights in the overall balance of trade. This may be particularly relevant if it is demonstrated that key forces underlying aggregate productivity growth are in sectors which have relatively weak or unclear future trade contributions to make. This kind of decomposition of growth within a period does not by itself tell us which sectors contributed most to the acceleration of productivity between periods. Thus a sector may in principle account for a high productivity growth within each of two successive periods, but contribute little to any change in overall productivity growth between them. We provide both a decomposition of labour productivity growth within periods and a decomposition of the acceleration between periods.

Decomposing Productivity Growth: The Case of the USA

The most striking recent example of the insights which can be gained from a sectoral decomposition of changes in aggregate productivity growth can be found in work on the United States economy. The productivity turnaround of the United States in the course of the 1990s has been widely remarked upon and has led to a prolonged debate about the forces driving it, and in particular the role played by high technology producing sectors, such as information technology, biotechnology and electronic and electrical engineering. In a series of studies carried out by Robert Solow and others for the McKinsey Global Institute it has been shown that the diffusion in new technologies, in particular IT as a general purpose technology, into “using” sectors rather than productivity growth in the technology “producing” sectors were the key component drivers of aggregate productivity growth.

Table 1.

US Productivity Growth

Growth of real GDP per hour	
1947-1972	2.9%
1972-1995	1.4%
1995-2000	2.5%
2000-2003	2.6%

Source: McKinsey Global Institute (2001) and Farrell et al (2005).

Table 1 drawn from this work shows the movement in aggregate US labour productivity growth from 1947-2003. The most striking feature of this table is the post-oil-shock fall in labour productivity growth rates after 1972. The turnaround in labour productivity growth has occurred essentially since 1995. It involves a return to the long-run trend rate of growth in labour productivity in the USA in the post-war period. The results of a sectoral decomposition of this acceleration of labour productivity performance are very revealing. On the basis of an analysis of 59 sectors Solow and his colleagues show that six accounted for all of the acceleration in productivity growth over the period 1995-2000 compared to earlier years. The *net* contribution of the other 53 sectors was zero. The leading three contributors to overall labour productivity acceleration in this period were wholesaling, retailing, and security and commodity broking. In an extension of the analysis to 2003 a similar analysis revealed that the top four sectors once again included retailing, financial insurance services, and wholesaling, joined this time by computer and electronic products the only non-services sector in the list. The next three sectors in the top seven (which together accounted for 85% of the labour productivity growth performance) were administrative and support services, real estate, and miscellaneous professional and scientific services. All of these are service industries (McKinsey Global Institute, 2001 and Farrell et al, 2005).

Decomposing Productivity Growth Within Periods: Previous Studies for Australia

There have been a number of analyses of sectoral patterns of Australian labour productivity growth which have decomposed labour productivity growth within periods (see e.g. Gruen and Stevens, 2000, Cobbold and Kulys, 2003 and Ewing et al, 2007[6]). The most comprehensive of these covers the period 1974-2002 (Cobbold and Kulys, 2003). Table 2 based on their work shows the breakdown of the contribution of 5 broad sectors (Primary, Manufacturing, Utilities Construction and Services) to labour productivity growth in the periods 1993-1999 and 1999-2002. The table shows considerable variation in contributions from one period to the next.

[6] Ewing et al (2007) provide a decomposition analysis of the movements in labour productivity growth since 2004 to highlight the role of deteriorating productivity growths in mining on the overall labour productivity growth standards.

Table 2

Sectoral Contributions to Average Annual Market Sector Labour Productivity Growth

1993/4 to 2001/2

	1993/4-1998/9	1998/9-2001/2
Primary	**0.67**	**0.73**
Agriculture Forestry Fishing	0.22	0.13
Mining	0.45	0.60
Manufacturing	**0.53**	**1.02**
Electricity Gas Water	**0.35**	**-0.07**
Construction	**0.25**	**-0.32**
Services	**1.79**	**1.12**
Wholesale Trade	0.56	0.30
Retail Trade	0.20	0.10
Accommodation Cafes Restaurants	0.07	0.02
Transport and Storage	0.19	0.37
Communications Services	0.28	0.09
Finance and Insurance	0.49	0.21
Cultural Recreational Services	-0.02	0.03

Source: Based on Cobbold and Kulys (2003) Figure 2.1 p.7 and Figure 2.2. p.9

Services as a whole makes the largest contribution in both of the periods shown in Table 2 with significant contributions within services in one, or both periods, from wholesaling and financial and insurance services. The contribution of manufacturing as a whole was less than one third of that in services in the first period but was much closer to services in the second period (1.02% for manufacturing compared to 1.12% for service). The primary sectors, especially mining, contributed strongly throughout. There was a notable fall in the contribution of utilities and construction, which both made negative contributions in the second period.

This and related studies provide evidence of the changing importance of sectoral contributions to labour productivity growth over time and confirm the importance of services in general to overall performance. They also reveal that there have been important changes in the contribution of certain services, of manufacturing and of mining. These analyses remain, however, at a relatively high level of aggregation, especially in manufacturing. Moreover, the most comprehensive study ends in 2002 and does not provide an analysis of which sectors account for changes in labour

productivity growth between periods. In the next section we provide an updated and more disaggregated decomposition analysis for 49 sectors of the Australian market economy within the periods 1980-1992 and 1992-2004 and within the two sub-periods 1992-1998 and 1998-2004. We also directly address the question of which sectors account for the change in productivity performance between periods.

Decomposing Australian Labour Productivity Growth 1992-2004 and the Acceleration of Productivity Growth in that period compared with 1980-1992

Methods and Data

In disaggregating Australian labour productivity growth we have chosen for reasons of comparability to follow the method adopted in the well-known studies carried out on behalf of the McKinsey Global Institute and which have been discussed earlier in this report. The method of decomposition involves essentially examining changes in productivity growth and in shares of output and hours worked in individual sectors across the relevant periods. The contribution of any given sector to aggregate productivity growth is essentially the contribution of that sector to aggregate growth in gross value added, minus its contribution to aggregate employment growth, multiplied by the ratio of opening to closing aggregate employment in the economy over the relevant period. This can be put more formally as set out in Equation 1[7] below.

Equation 1

Method of Decomposing Growth of real GVA per Hour Worked

$$Contribution \quad of \ i \cdot to \ \dot{P} = \left(\frac{Y_{i0}}{Y_0}\dot{Y}_i - \frac{L_{i0}}{L_0}\dot{L}_i\right)\frac{L_0}{L_1}$$

Contribution of sector i to aggregate productivity growth = (**Contribution of sector i to aggregate GVA growth** − **Contribution of sector i to aggregate employment growth**) X **Agg.employment in period 0 / Agg. employment in period 1**

Essentially the contribution of a sector *i* depends on its output growth weighted by its output share, minus its hours worked share multiplied by its hours worked growth, all multiplied by the ratio of opening to closing aggregate employment. This formula allows us to work out the contribution of any sector to productivity growth within a period. By comparing the change in this contribution

[7] Appendix 1 provides the full derivation of this formula.

between periods we can break down the overall change in labour productivity growth between those periods into those parts accounted for by each sector.

In order to carry out a sectoral decomposition it is necessary to have on a comparable basis measures of real gross value added and hours worked at a suitable level of disaggregation over the relevant time period. To do this we make use of a standardised international dataset of industry performance compiled by the Gröningen Growth and Development Centre. This provides data disaggregated by sixty sectors (http://www.ggdc.net). This dataset is the result of an international collaborative programme of research designed to provide standardised data to allow time series comparisons of industrial growth and structural change across economies. The data source is widely referred to and used in analyses of growth and productivity (see for example Davis and Rahman, 2006). It makes use of official statistics from the countries involved in the database adjusted to provide comparability across countries. This database provides annual data on gross value added, price indices and hours worked for sixty sectors for the period July 1980-July 2004. It therefore contains the necessary data to calculate real gross value added per hour worked per sector. The database includes a number of non-market sectors and sectors where output measurement may be relatively unreliable. This led to the exclusion from our analysis of sectors within government administration and defence, education, health, and property and real estate services. The final dataset covers 49 sectors in the period 1980 to 2004.

Real Gross Value Added, Hours Worked and Productivity Growth in the Australian Market Sectors 1992-2004

Table 3 provides an overview of the main trends in the sectoral shares in gross value added and hours worked. It also shows average annual growth rates in real gross value added, hours worked and real gross value added per hour. Data shown for the whole of the high labour productivity growth period 1992-2004 and for our two sub-periods[8].

[8] The coverage of the data in this table is somewhat different than that reported in Chart 1 which draws on Australian Bureau of Statistics GDP and hours worked data. The Gröningen Growth and Development Centre (GGDC) sectoral GVA and hours worked data used in this report are obtained from several sources such as Australian Bureau of Statistics, GGDC Agricultural database, and OECD Structural Analysis database. The adjustments made by the GGDC to achieve greater consistency of the series across countries may result in the aggregated estimates being slightly different from those reported by national statistical offices. The sector definitions and coverage are also slightly different (GGDC, 2006 and Appendix 2)

Table 3

Shares of GVA and Hours Worked and Average Annual Growth Rates of GVA, Hours Worked and GVA per Hour in Australia, 1992-2004

	Shares				Average annual growth rates								
	1992	2004	1992	2004	1992-2004			1992-1998			1998-2004		
	GVA		Hours		Real GVA	Hours worked	Real GVA per hour	Real GVA	Hours worked	Real GVA per hour	Real GVA	Hours worked	Real GVA per hour
All sectors	**100**	**100**	**100**	**100**	**3.8**	**1.4**	**2.3**	**3.9**	**1.7**	**2.2**	**3.6**	**1.2**	**2.4**
Agriculture, forestry, fishing	**5.7**	**5.5**	**8.4**	**6.5**	**3.5**	**-0.7**	**4.2**	**3.2**	**1.0**	**2.2**	**3.7**	**-2.4**	**6.1**
Mining and Quarrying	**7.0**	**6.2**	**1.9**	**1.7**	**2.6**	**0.9**	**1.7**	**3.7**	**-0.7**	**4.4**	**1.6**	**2.5**	**-0.9**
Manufacturing	**22.2**	**18.6**	**19.9**	**16.8**	**2.2**	**0.1**	**2.2**	**2.6**	**1.0**	**1.6**	**1.9**	**-0.9**	**2.8**
High-technology manufacturing	**10.3**	**9.3**	**9.3**	**7.6**	**2.9**	**-0.2**	**3.1**	**3.0**	**1.9**	**1.0**	**2.9**	**-2.3**	**5.3**
Conventional manufacturing	**11.9**	**9.3**	**10.5**	**9.2**	**1.6**	**0.3**	**1.3**	**2.3**	**0.2**	**2.1**	**1.0**	**0.4**	**0.6**
Electricity, gas and water supply	**4.1**	**3.2**	**1.9**	**1.2**	**1.6**	**-2.2**	**3.8**	**2.2**	**-7.5**	**9.6**	**1.0**	**3.1**	**-2.0**
Construction	**8.4**	**10.1**	**9.6**	**12.3**	**5.2**	**3.5**	**1.8**	**5.1**	**2.8**	**2.2**	**5.4**	**4.1**	**1.3**
Services, of which	**52.7**	**56.9**	**58.3**	**61.4**	**4.4**	**1.9**	**2.5**	**4.5**	**2.1**	**2.4**	**4.3**	**1.6**	**2.7**
Wholesale	**6.4**	**6.8**	**8.8**	**6.8**	**4.2**	**-0.7**	**4.9**	**4.0**	**0.2**	**3.8**	**4.4**	**-1.7**	**6.1**
Retail	**6.0**	**6.8**	**13.1**	**14.0**	**4.8**	**2.0**	**2.9**	**5.6**	**1.7**	**4.0**	**4.1**	**2.3**	**1.8**
Communications & computer and related	**4.8**	**5.7**	**2.4**	**2.7**	**7.9**	**6.0**	**1.9**	**11.8**	**6.7**	**5.0**	**3.9**	**5.3**	**-1.4**
Financial Services	**9.0**	**9.0**	**6.1**	**5.3**	**3.8**	**0.3**	**3.5**	**3.2**	**-1.2**	**4.4**	**4.3**	**1.7**	**2.6**
Other*	**26.5**	**28.6**	**27.9**	**32.7**	**3.8**	**2.3**	**1.5**	**2.9**	**3.0**	**-0.1**	**4.5**	**1.6**	**3.0**

Calculated for 49 market sectors from Gröningen Growth and Development Centre, 60-Industry Database, September 2006, http://www.ggdc.net

*Other include hotels and catering, inland, water and air transport, auxiliary transport activities, renting of machinery and equipment, R&D, legal, technical and advertising activities and other business activities.

The table covers an analysis for the market sector as a whole and is disaggregated to the broadly defined sectors of agriculture, forestry and fishing, mining and quarrying, manufacturing, electricity, gas and water supply, construction, and services. For manufacturing and services we also provide a further breakdown. In the case of manufacturing we distinguish between high technology manufacturing and conventional manufacturing using the procedures defined by Butchart (1987). Within services we distinguish between wholesaling, retailing, communications and computer-related activities, financial services and a miscellaneous other group of services which includes group of services which includes hotels and catering, inland, water and air transport, auxiliary transport activities, renting of machinery and equipment, R&D, legal, technical and advertising activities and other business activities. We have chosen to distinguish between high technology manufacturing and conventional manufacturing, because of the interest in the relative impact of so-called knowledge-based sectors in overall productivity growth. Within services we have identified sectors on the basis of their individual size within services and also, because of the desire to compare the results with the United States, where the wholesale, retail, and financial services sectors have played an important role in productivity growth acceleration. Similarly, we have identified communications as a separate sector, because of the widespread interest in the role of information technology and the impact it has had in the range of communications activity.

The first point to note from the first and second columns of the table, which show sectoral shares in real gross value added and hours worked respectively, is the dominant role of the services sector both in terms of real gross value added and in terms of hours worked. Not only did these account for 52.7% and 58.3% respectively of real gross value added and hours worked in 1992, but these have grown to 56.9% and 61.4% respectively by 2004. Over the same period, the share of manufacturing in real gross value added fell from 22.2% to 18.6% and the manufacturing share of hours worked from 19.9% to 16.8%. The shares of real gross value added in agriculture, forestry and fishing were virtually unchanged between 1992 and 2004 while the share of hours worked in that sector fell. This implies a relatively high rate of growth of GVA/hour over the whole period. This is borne out by looking at the third column of the table which shows the average annual growth rates of real gross value added, hours worked and real gross value added per hour over the 1992-2004 period. The rate of growth of labour productivity in agriculture, forestry and fishing is matched only by that of real gross value added per hour growth in wholesale services. Both of these sectors experienced average annual growth rates in productivity of over 4%. These were followed by rates of growth of labour productivity between 3% and 4% in electricity, gas and water supply, financial services and, interestingly, in high technology manufacturing. Labour productivity growth rates in mining and quarrying, in conventional manufacturing and in construction and other services have been relatively modest in comparison. Columns 4 and 5 provide a similar analysis to column 3, but in this case for each of our two sub-periods. This

analysis reveals some instability in labour productivity performance. Thus in mining, utilities and communications there was a deceleration in productivity growth in the second period compared to the first and on a beginning to end year basis productivity actually fell. On the other hand in agriculture, in high tech manufacturing and in other services there was an acceleration in productivity growth. Only wholesaling and, to a lesser extent, financial services maintained relatively high labour productivity growth over the two periods.

In the period 1992-1998, particularly strong productivity performance occurred in electricity, gas and water supply and in communications, along with financial services, the retail sector and mining and quarrying, all of which experienced productivity growth rates of over 4%, and in the case of electricity, gas and water supply a productivity growth rate of 9.6%. In the 1998-2004 period the most striking productivity growth rate performances were in agriculture, forestry and fishing, high technology manufacturing and wholesaling, all of which experienced growth rates over 5%, whilst other sectors experienced growth rates of 3% or less.

There is therefore considerable instability in the ranking of sectors by labour productivity growth across our two sub-periods. In our decomposition analysis we therefore provide separate analysis of the role of different sectors in overall productivity growth for the period as a whole and for each of our two sub-periods.

Decomposing Labour Productivity Growth 1980-1992 and 1992-2004

Using the formula set out in Equation 1 we carried out a decomposition analysis based on 49 sectors of the Australian market economy within the period 1992-2004. We also carried out a similar analysis for the period of low productivity growth from 1980-1992. We report in turn the results of analysing labour productivity growth components within these periods and the results of decomposing the acceleration in productivity growth between them. We also decompose the differences in productivity growth between each of our sub-periods and 1980-1992.

As explained earlier, the contribution to overall productivity growth within a period depends upon productivity growth and structural changes in the shares of output and hours worked. In order to present the results of our decomposition in a compact form we have presented in Table 4 below a summary of the results for 1980-1992 and 1992-2004 which picks out the top ten contributors to labour productivity growth within the period and then summarises the net positive and negative contributions of the other 39 sectors. The full analysis showing the individual contribution of each of the 49 sectors is shown in Appendix I.

The left hand panel of Table 4 shows a decomposition of labour productivity growth in the low growth period 1980-1992. The top ten sectors account for 95.2% of total labour productivity growth over this period. The three dominant contributors are mining and quarrying, communications, and electricity, gas and water supply. Between them these three sectors account for over 55% of the total growth in labour productivity over this period. Services sectors including insurance and pension funding, retailing, wholesale trading and activities auxiliary to financial intermediation also contribute to the overall labour productivity growth of 1.59% over this period. They are, however, are much less significant than mining and quarrying, the utilities and the communications sector.

Table 4

Labour Productivity Growth 1980-1992 and 1992-2004: The Top Ten Contributors and the Rest

Low productivity growth period (1980-1992)		High productivity growth period (1992-2004)	
Mining and quarrying	28.0	Wholesale trade	13.4
Communications	15.7	Communications	12.3
Electricity, gas and water supply	11.9	Financial intermediation	11.2
Insurance and pension funding	7.6	Agriculture	8.9
Retail trade	7.3	Mining and quarrying	6.7
Inland transport	5.8	Motor vehicles sales and auto fuel retail	6.2
Basic metals	5.3	Construction	6.1
Wholesale trade	4.7	Inland transport	6.0
Construction	4.5	Other business activities, n.e.c.	4.9
Activities auxiliary to financial intermediation	4.4	Electricity, gas and water supply	3.8
Top 10 total	95.2	Top 10 total	79.7
All other positive contributors	40.5	All other positive contributions	25.6
All other negative contributors	-35.8	All other negative contributions	-5.3
Total (corresponding to 1.59% per annum)	100.0	Total (corresponding to 2.32% per annum)	100.0

Note:Column totals may not sum to 100 due to rounding errors

If we turn to the 1992-2004 period, it is apparent from Table 4 that a small number of sectors once again contribute the majority of productivity growth in the period as a whole although the contributions are less concentrated than in the earlier period[9]. The top three sectors account for 37% of the overall rate of productivity growth in this period. These three sectors (wholesale trade and commission trade, communications and financial intermediation) each individually account for over 10% of the overall productivity growth in the Australian economy in this period. The remaining sectors in the top ten, each of which contributes individually 3.8% or more, are a

[9] This wider spread after 1992 may reflect both the widespread impact of ICT as a general purpose technology and the economy wide impact in the second period of the deregulatory reforms set in train by the Hawke and Keating administrations.

mixture of goods and services sectors. It is significant that agriculture and mining and quarrying each play a substantial role in overall productivity growth movements. Utilities, construction and Inland transport also play a significant role. Motor vehicle sales and the retailing of fuel accounts for 6.2% of the overall labour productivity growth performance of the Australian economy in this period. There are no manufacturing sectors in this list.

The most striking difference between the low productivity growth period of 1980-1992 and the high growth period 1992-2004 is the growth in importance of wholesaling and financial intermediation along with agriculture. Mining and quarrying played a much less important role as a contributor to labour productivity growth in the high growth period than it did in the period of low growth from 1980-1992. Communications played a dominant role in both periods. Thus taken as a whole the period of high productivity growth had a somewhat greater contribution from the services sectors than was the case in the period of low labour productivity growth 1980-1992.

Tables 5 and 6 provide similar decomposition results for our two sub-periods.

Table 5

Labour Productivity Growth 1992-1998: The Top Ten Contributors and the Rest

	1992-1998
Communications	20.1
Motor vehicles sales and automotive fuel retail	12.0
Mining and quarrying	11.7
Wholesale trade and commission trade	10.6
Financial intermediation	9.2
Electricity, gas and water supply	8.4
Construction	7.4
Inland transport	6.4
Retail trade & repair of personal and household goods	6.0
Insurance and pension funding	4.9
Top 10 total	96.7
All other positive contributions	31.6
All other negative contributions	-28.2
Total	100.0

Note: :Column totals may not sum to 100 due to rounding errors

Table 5 reveals that the contribution to productivity growth was much more concentrated in the period 1992-1998 than in the period as a whole. Thus the top ten sectors in terms of contribution

productivity growth accounted for 96.7% of the overall movement in labour productivity growth in the Australian market economy. Communications alone accounted for 20.1%. Motor vehicle retailing, mining and quarrying, and wholesale trade and commission trade also recorded high contributions of between 10% and 12%. Financial intermediation, utilities, construction, inland transport, retailing and insurance and pension funding also made substantial contributions and ranked within the top ten.

Table 6

Labour Productivity Growth 1998-2004: The Top Ten Contributors and the Rest

	1998-2004
Wholesale trade and commission trade	15.6
Financial intermediation	14.1
Agriculture	14.1
Legal, technical and advertising	9.8
Other business activities, n.e.c.	8.6
Communications	6.4
Inland transport	4.5
Food, drink & tobacco	3.8
Printing & publishing	3.7
Fabricated metal products	3.5
Top 10 total	84.0
All other positive contributions	27.2
All other negative contributions	-11.3
Total	100.0

Note: :Column totals may not sum to 100 due to rounding errors

Table 6 shows that there was some change in the pattern of contributions in the period 1998-2004 compared to the period 1992-1998. In the later period the top ten contributors accounted for 84% of overall productivity growth, whilst the top three, which were wholesaling, financial intermediation and agriculture, accounted for 43.8% - exactly the same as the top three in the previous period. The remaining seven sectors in the top ten are a mixture of manufacturing and services sectors. Legal, technical and advertising services and other business activities recorded contributions of between 8% and 10%. The contributions of the three manufacturing sectors (food, drink and tobacco, printing and publishing and fabricated metal products) were all less than 4%.

Decomposing the Acceleration in Productivity Growth from 1980-1992 to the 1992-2004 period

So far our analysis has focused on the decomposition of productivity growth performance within our various periods and sub-periods. We now turn to an analysis of which of those sectors contributed to the labour productivity growth change between periods. We first provide an analysis of the contributions to productivity change between 1992-2004 and 1980-1992. We then turn to a comparison between the sub-periods 1992-1998 compared with 1980-1992, and then sub-period 1998-2004 compared with the period 1980-1992.

In order to calculate the contribution which a sector makes to the change in overall labour productivity growth between the low and high productivity growth periods, we compare the percentage point contribution of a sector in the high growth period with its percentage point contribution in the low growth period. Thus, in the case of wholesale trade and commission trade, its contribution to productivity growth within the period 1980-1992 was 0.08 percentage points, compared with 0.31 percentage points in the 1992-2004 period (Table 7). The difference between these two is the contribution to labour productivity growth change between the two periods in percentage point terms. Thus wholesale trade and commission trade accounts for 0.24 percentage points [10] of the change in productivity between the two periods which is 0.72 percentage points.

Thus, in the tables which follow we take the overall average annual rate of productivity growth in a period and show the contribution in terms of percentage points made by the top ten sectors to productivity growth within that period. This is a presentation in a different form of the data contained in the previous contributions to productivity growth tables where we expressed each sector's contribution in terms of the percentage share of the overall change. Thus, if we look at the data contained in Table 7, which is an analysis of the contributions to the labour productivity growth change between the low and high growth periods as a whole, we find in the bottom row of column 2 the overall productivity growth of 2.32% in the period 1992-2004. These percentage points are then allocated in each row to the top ten sectors and the groups of positive and negative contributors. Thus wholesale trade and commission trade accounted for 0.31 of the 2.32 percentage point change in labour productivity over that period and so on.

As we pointed out in our earlier discussion of decomposition analysis, a sector may make a significant contribution to productivity growth within two successive periods and yet not make a major contribution to the change in labour productivity growth between the periods. Table 7

[10] Due to rounding errors the difference between the respective sectoral contributions may slightly deviate from the respective contribution to acceleration reported by Table 7. The same applies to Tables 8 and 9.

provides a good example of this. The communications sector made a significant contribution to labour productivity growth within both the period 1980-92 and the period 1992-2004. In these respective periods it contributed 0.29 and 0.25 percentage points respectively. However, the fact that this contribution was much the same in both periods means that its contribution to the change in labour productivity growth between the two periods is very low. In general, inspection of the table shows that if we consider the top ten contributors to productivity growth within the period 1992-2004, we find that only five shown in bold in the third column were ranked in the top ten in terms of contribution to change in labour productivity growth between the two periods. These five sectors were wholesale trade and commission trade, financial intermediation, agriculture, motor vehicle sales and other business activities not elsewhere classified. Thus four of the top five contributors to productivity growth acceleration in the 1992-2004 period were drawn from the services sector. The only exception was agriculture. The other five sectors which contributed to the change in labour productivity growth sufficiently to rank in the top ten contributors to such change were all services: hotels and catering (0.10 percentage points), water transport and supporting and auxiliary transport (0.13 and 0.11 percentage points respectively).

The top three contributors to productivity growth acceleration, namely financial intermediation, wholesale trade, and other business activities not elsewhere classified together contributed 0.69 percentage points to change between the two periods. Since the total change between the two periods was 0.72%, these three services sectors virtually contributed all (95%) of the productivity change in this period. The remaining sectors' contributions respectively cancelled each other out.

Table 7

Contribution to Productivity Growth and its Acceleration, 1992-2004 over 1980-1992

Top ten contributors in 1992-2004	Contribution to productivity growth, percentage points per year		Contribution to acceleration , percentage points per year
	1992-2004	1980-1992	1992-2004 over 1980-1992
Wholesale trade and commission trade	0.31	0.08	**0.24**
Communications	0.29	0.25	0.04
Financial intermediation	0.26	0.00	**0.26**
Agriculture	0.21	0.06	**0.15**
Mining and quarrying	0.15	0.45	-0.29
Motor vehicles sales and fuel retail	0.14	-0.03	**0.17**
Construction	0.14	0.07	**0.07**
Inland transport	0.14	0.09	**0.05**
Other business activities, nec	0.11	-0.08	**0.19**
Electricity, gas and water supply	0.09	0.19	-0.10
Top 10 total	1.85	1.08	0.77
All other positive contributors	0.59	0.98	-0.38
All other negative contributors	-0.12	-0.46	0.34
Total	2.32	1.59	0.72

Note: In addition to the sectors shown in bold in column 3, the top 10 contributors to productivity acceleration included water transport with 0.13 percentage points (pp), supporting and auxiliary transport (0.11 pp) and hotel and catering (0.10 pp).

Tables 8 and 9 provide a similar decomposition analysis. Table 8 analyses change in productivity growth between the period 1992-1998 compared with the low growth period 1980-1992. It shows that of the 0.62 percentage point difference in growth rates between these periods, motor vehicles and sales and fuel retailing, financial intermediation and communications accounted for more than the total change in labour productivity growth between the two periods (0.67 compared with 0.62). Communications and wholesale trade also made significant contributions to the overall acceleration in labour productivity growth. Thus these services sectors alone more than accounted for the overall acceleration in productivity growth in the 1992-1998 period, compared with the period 1980-1992.

Table 8

Contribution to Productivity Growth and its Acceleration, 1992-1998 over 1980-1992

Top ten contributors in 1992-1998	Contribution to productivity growth, percentage points per year		Contribution to acceleration, percentage points per year
	1992-1998	1980-1992	1992-1998 over 1980-1992
Communications	0.45	0.25	**0.19**
Motor vehicles sales and fuel retail	0.27	-0.03	**0.30**
Mining and quarrying	0.26	0.45	-0.19
Wholesale trade and commission trade	0.24	0.08	**0.16**
Financial intermediation	0.20	0.00	**0.20**
Electricity, gas and water supply	0.19	0.19	0.00
Construction	0.16	0.07	**0.09**
Inland transport	0.14	0.09	0.05
Retail trade	0.13	0.12	0.02
Insurance and pension funding	0.11	0.12	-0.01
Top 10 total	2.14	1.33	0.81
All other positive contributors	0.70	0.80	-0.10
All other negative contributors	-0.63	-0.54	-0.09
Total	2.22	1.59	0.62

Note: In addition to the sectors shown in bold in column 3, the top 10 contributors to productivity acceleration included computer and related activities, other business activities not elsewhere classified and motor vehicle manufacturing with 0.07 percentage points (pp) each, water transport (0.10 pp) and hotels and catering (0.08 pp).

Table 9 reveals a similar picture. Of the overall percentage point increase in labour productivity growth between the period 1998-2004 and 1980-1992 the top three contributors (wholesale trade and commission trade and financial intermediation and other business activities not elsewhere classified) on their own accounted for virtually all of the acceleration. Thus, once again, services sectors could be regarded as dominating the productivity change performance between these periods. In addition to the largest three contributors, legal, technical and advertising services also added 0.20 percentage points to the productivity growth change between these two periods. Only agriculture, which contributed 0.28 percentage points, lay outside the services sector. However, it

is worth noting that if all the high-tech manufacturing sectors are taken together they account for 0.19 percentage points change[11].

Table 9

Contribution to Productivity Growth and its Acceleration, 1998-2004 over 1980-1992

Top ten contributors in 1998-2004	Contribution to productivity growth, percentage points per year		Contribution to acceleration, percentage points per year
	1998-2004	1980-1992	1998-2004 over 1980-1992
Wholesale trade and commission trade	0.38	0.08	**0.30**
Financial intermediation	0.34	0.00	**0.34**
Agriculture	0.34	0.06	**0.28**
Legal, technical and advertising	0.24	0.04	**0.20**
Other business activities, nec	0.21	-0.08	**0.29**
Communications	0.16	0.25	-0.10
Inland transport	0.11	0.09	0.02
Food, drink & tobacco	0.09	0.07	0.03
Printing & publishing	0.09	0.03	**0.06**
Fabricated metal products	0.08	0.04	0.04
Top 10 total	2.04	0.58	1.47
All other positive contributors	0.66	1.51	-0.85
All other negative contributors	-0.27	-0.49	0.22
Total	2.43	1.59	0.84

Note: In addition to the sectors shown in bold in column 3, the top 10 contributors to productivity acceleration included supporting and auxiliary transport with 0.19 percentage points (pp), water transport (0.16 pp), hotels and catering (0.11 pp), motor vehicle sales and retail fuel sales (0.08 pp).

It is thus apparent that the acceleration in labour productivity growth in the 1990s compared to the 1980s and through to the early years of the 21st century has been dominated by the contribution of the services sectors. Mining and quarrying, which had played a positive role in labour productivity growth within each of our periods and sub-periods of analysis, nonetheless played a negative role in terms of productivity growth acceleration. This reflected a fall in the contribution that it made to productivity growth within the period 1980-1992, compared to the role it played in later periods.

It is also clear that in some sectors substantial contributions to overall productivity change were made only within certain sub-periods. Thus in the case of communications, its small overall contribution to the change between 1980-1992 and the period 1992-2004 as a whole masks the fact that it played a substantial role in contributing to productivity change between 1980-1992 and 1992-1998. Its small role overall is therefore due to a decline in its influence since 1998.

[11] To the extent that the disaggregation of manufacturing in sectoral data sets is finer than in services (and thus each individual sector correspondingly carries a smaller weight) there may be some bias against identifying major contributions from individual manufacturing sectors.

Comparison with the United States

The results of our analysis of the acceleration in productivity change in the Australian economy since the early 1990s have revealed a very similar pattern of contributions to productivity acceleration to that observed in the analysis for the United States referred to earlier in this report. In particular, services sectors have played a dominant role in both economies. This is particularly true in relation to wholesaling and financial intermediation. It is notable, however, that retailing has not played a significant part in the Australian context. Even though it has played a role as a significant top ten contributor to productivity growth within the period 1992-1998, its contribution has not changed between periods, so that it has made a small contribution to the acceleration in productivity growth. In relation to the overall concentration within particular sectors of the overall acceleration in productivity change, the picture is, if anything, more concentrated in the case of the Australian economy than is the case for the United States. Thus in most cases three or four sectors in the Australian context accounted for all or more than all of the total acceleration. A notable feature of the Australian productivity growth performance is the role of the agricultural sector. In this case our analysis shows that comparing the period 1980-1992 with 1992-2004, agriculture made a significant contribution to the overall change in labour productivity growth between those periods. The analysis also revealed that most of this impact was accounted for by productivity growth after 1998. The data for the US unfortunately excludes agriculture, so no comparison with Australia is possible.

Conclusions

In this report we have carried out a detailed sectoral analysis of Australian labour productivity growth both within periods and sub-periods of the last 25 years, and an analysis of which of those sectors accounted for the acceleration in productivity growth between selected periods. Our analysis has shown that services sectors have dominated the acceleration in productivity growth in each of the periods which we have analysed. Our analysis also shows that there are considerable variations in the importance played by different sectors when the analysis is carried out for different sub-periods. Thus some sectors which contribute to overall productivity growth acceleration in the 1990s compared with the 1980s, have done so on the basis of contributions in both sub-periods we have analysed since 1992. In other cases the contribution was concentrated either before or after 1998.

In relation to the overall developments of productivity growth in the Australian economy and its apparent levelling out or slowing down in the early part of the 21st century, our analysis suggests that the forces which have driven productivity growth in the services sectors have been central to the overall acceleration of labour productivity growth. This process of productivity growth in the

services sectors is intimately linked to the development and application of information technologies in the services sectors. It is beyond the scope of this report to analyse these changes in depth. They have been the subject of several detailed investigations and we briefly summarise some of the key findings in Appendix 3. The key lesson which emerges from these studies is that the transformation of productivity in the services sectors requires the effective development of a wide range of complementary investments in management and other organisational and often intangible assets to transform the productivity performance of these sectors. A key question is the extent to which past productivity gains from these sources can be expected to be as great in the future. One aspect of this is the extent to which lower unemployment is leading to tightening labour markets and a higher weight being placed on raising skill levels in pursuit of further output and productivity growth. Another is the extent to which major broadband infrastructure investments will be required to underpin further ICT based productivity gains.

In relation to the structure of trade and overall labour productivity growth performance, our analysis raises two interrelated questions about the net export potential of the services sectors which have dominated productivity growth acceleration. The first relates to the extent to which further gains in productivity growth in services can be expected in the future at the same pace as in the recent past. The second relates to the extent to which the sectors which have driven Australian productivity growth acceleration are capable of offsetting further deterioration in the current ability of the minerals, fuel and metals sectors to generate significant net surpluses, or any deterioration in the ability of Australian banks to borrow overseas as the capital account counterpart to the current account deficit.

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Appendix 1

Calculating sectoral contributions to labour productivity growth[12]

Stage 1 Separating aggregate GVA and employment growth from productivity growth.

The difference in national productivity between two points in time can be defined as:

$$P_1 - P_0 = \Delta P = \Delta(\frac{Y}{L}) = \frac{Y_1}{L_1} - \frac{Y_0}{L_0} = \frac{Y_1 L_0 - Y_0 L_1}{L_1 L_0} = \frac{Y_1 L_0 - Y_0 L_0 - Y_0 L_1 + Y_0 L_0}{L_1 L_0} = \frac{\Delta Y\ L_0 - \Delta L\ Y_0}{L_1 L_0}$$

(A.1),

where P, Y and L denote levels of productivity, GVA and employment respectively, with subscripts 0 and 1 indicating beginning and end of the period.

Then the productivity growth rate $\dot{P}$ at the aggregate national level is derived as

$$\dot{P} = \frac{\Delta P}{P_0} = \frac{\Delta Y\ L_0 - \Delta L\ Y_0}{L_1 L_0} \cdot \frac{L_0}{Y_0} = \frac{\Delta Y\ L_0}{Y_0 L_1} - \frac{\Delta L\ Y_0}{Y_0 L_1} = \dot{Y}\frac{L_0}{L_1} - \frac{\Delta L}{L_0} \cdot \frac{L_0}{L_1} = \frac{L_0}{L_1}(\dot{Y} - \dot{L})$$

(A.2)

Stage 2 Applying sector weights to calculate sector-level contributions[13]:

$$\dot{P} = \frac{\Delta P}{P_0} = \frac{L_0}{L_1}\sum_{i=1}^{n}(\frac{Y_{i0}}{Y_0}\dot{Y}i - \frac{L_{i0}}{L_0}\dot{L}i)$$

(A.3),

where $\frac{Y_{i0}}{Y_0}$ denotes a share of the i-th sector in national GVA in period 0. Similarly $\frac{L_{i0}}{L_0}$ denotes the i-th sector share in national employment in period 0.

Correspondingly, from Equation A.3:

$$Contribution\ of\ the\ i \cdot th\ \text{sector to}\ \dot{P} = \frac{L_0}{L_1}(\frac{Y_{i0}}{Y_0}\dot{Y}i - \frac{L_{i0}}{L_0}\dot{L}i)$$

(A.4)

[12] Based on Exhibits A3 and A4 from McKinsey Global Institute (2001).

[13] Following McKinsey Global Institute (2001), the non-additivity of price index deflated numbers was taken into consideration via applying the GDP growth contribution formula suggested by Moulton et al (1999).

Appendix 2

Labour Productivity Growth Contributions (%) by Sector

ISIC rev.3		1980-1992	1992-2004	1992-1998	1998-2004
01	Agriculture	3.8	8.9	3.8	14.1
02	Forestry	1.5	-0.3	-0.9	0.1
05	Fishing	1.1	0.1	0.6	-0.3
10-14	Mining and quarrying	28.0	6.7	11.7	2.7
15-16	Food, drink & tobacco	4.1	3.3	3.5	3.8
17	Textiles	1.5	-0.4	0.2	-0.9
18	Clothing	0.0	0.5	0.3	0.9
19	Leather and footwear	0.5	0.2	-0.4	0.7
20	Wood & products of wood and cork	-0.2	0.0	1.1	-1.2
21	Pulp, paper & paper products	1.0	0.1	0.0	0.3
22	Printing & publishing	1.7	1.8	-0.5	3.7
23	Mineral oil refining, coke & nuclear fuel	2.1	0.0	0.1	-0.2
24	Chemicals	1.6	0.8	1.6	0.3
25	Rubber & plastics	0.9	1.5	2.0	1.3
26	Non-metallic mineral products	0.6	1.7	1.4	2.0
27	Basic metals	5.3	1.1	1.3	1.0
28	Fabricated metal products	2.6	1.5	-0.5	3.5
29	Mechanical engineering	1.1	1.1	-1.0	2.9
30	Office machinery	0.1	0.1	0.2	0.1
313	Insulated wire	0.5	0.1	0.2	0.0
31-313	Other electrical machinery and apparatus nec	1.8	0.5	0.2	0.8
321	Electronic valves and tubes	1.7	0.3	0.3	0.4
322	Telecommunication equipment	1.6	0.3	0.6	0.2
331	Scientific instruments	0.1	0.6	-0.2	1.2
33-331	Other instruments	0.1	0.1	0.2	0.0
34	Motor vehicles	2.2	1.2	4.6	-1.1
351	Building and repairing of ships and boats	0.5	0.4	-0.1	0.8
353	Aircraft and spacecraft	-0.4	0.5	0.8	0.4
352+359	Railroad equipment and transport equipment nec	1.2	0.0	-0.2	0.2
36-37	Furniture, miscellaneous manufacturing; recycling	-0.7	-0.4	-0.6	-0.8
40-41	Electricity, gas and water supply	11.9	3.8	8.4	0.2
45	Construction	4.5	6.1	7.4	2.8
50	Motor vehicles sales and retail sale of fuel	-2.0	6.2	12.0	2.2
51	Wholesale trade and commission trade	4.7	13.4	10.6	15.6
52	Retail trade	7.3	2.5	6.0	-0.7
55	Hotels & catering	-5.8	0.3	-0.4	0.9
60	Inland transport	5.8	6.0	6.4	4.5
61	Water transport	-9.8	-1.0	-2.6	0.2
62	Air transport	2.2	2.1	2.4	2.1
63	Supporting and auxiliary transport activities	-10.7	-2.4	-6.7	0.9
64	Communications	15.7	12.3	20.1	6.4
65	Financial intermediation	0.0	11.2	9.2	14.1
66	Insurance and pension funding	7.6	1.4	4.9	-1.4
67	Activities auxiliary to financial intermediation	4.4	1.2	0.9	1.4
71	Renting of machinery and equipment	-0.5	0.1	0.5	-0.2
72	Computer and related activities	1.9	-0.1	4.7	-4.4
73	Research and development	-0.7	-0.1	-0.3	0.0
741-3	Legal, technical and advertising	2.5	-0.4	-13.7	9.8
749	Other business activities, nec	-4.9	4.9	-0.3	8.6
	Total	100	100	100	100
	Productivity growth (%) per annum	1.59	2.32	2.22	2.43

Note: :Column totals may not sum to 100 due to rounding errors

Appendix 3

Notes on drivers of productivity in selected sectors

Wholesale

Johnston et al (2000) discuss a number of factors contributing to productivity growth in the Australian wholesale sector in the 1990s. The first group of factors relates to the large scale introduction of productivity enhancing technologies such as barcoding and scanning coupled with changes in organisational and management practices. These led, for instance, to the development of electronically managed inventory replacement systems, minimisation of double handling and centralisation of distribution. The benefits of new technology based logistics systems were also reflected in a general decline in the ratio of inventories to output.

Apart from technology related improvements in logistics management, competition appeared to be another important driver of productivity growth in the wholesale sector. According to Johnston et al (2000) it is competition that caused an ongoing process of rationalisation in wholesale via mergers, acquisitions and firm exits resulting in lower labour requirements and the retirement of less productive capital. A significant rise in the demand in some of the wholesaling industries such as car wholesaling also had the positive effect on productivity growth. Finally, Johnston et al, 2000 refer to positive influences on productivity originating in regulatory reforms which increased workplace flexibility in the sector.

Most recently, Davies and Rahman (2006) and Dolman et al (2006) support the findings above stressing that it is a combination of ICT related innovation and increased competition that made it possible to improve productivity performance in wholesaling in the 1990s. Also, Revesz et al (2005) and Productivity Commission (2004) conclude that productivity growth rates in wholesaling are closely related to technological factors such as ICT investment.

Communications

Revesz et al (2005) note that exceptionally high productivity growth in this sector in the period from 1984-1985 to 2001-2002 was driven by rapid technological advances, which in turn led to increased demand owing to falling relative prices. In the 1990s the sector remained one of the largest investors in new ICT (Productivity Commission, 2004).

Financial Intermediation and Insurance

In the period 1994-2003 the finance and insurance sector was the largest investor in new ICT (Productivity Commission, 2004). Similar to the case of the communications sector, technological advances resulting in a decline in relative prices and an increase in demand were found to be key to productivity growth in the finance and insurance sector. The sector was also the subject of major regulatory reforms and rationalisation (DCITA, 2005).

Agriculture

According to Productivity Commission (2005) the main source of productivity growth in this sector in the period 1974-2004 was the development and adoption of new knowledge and technologies. These included more sophisticated farm machinery and equipment, improved herbicides and fertilizers as well as genetic modifications of plants. Among the other important factors mentioned are pressure from overseas producers, better use of available ICT, increases in farm size, shifts in enterprise mix, exit of lower performing farmers and regulatory arrangements including reforms to statutory marketing arrangements for several agricultural industries.

Mining and quarrying

Productivity Commission (2004) provides some evidence on the benefits resulting from the use of ICT in this sector. These include increased speed of information flow between mine sites and the headquarters of the mining services firms and between mining companies and their suppliers and customers. Mining companies now had live dispatch on trucks with GPS, making it possible to specify and transmit the quality of ore required direct to computer screen maps on bulldozers which show exactly where to excavate.

According to Dolman et al (2006), during the five years to 2003-2004 rising commodity prices gave mining companies an incentive to add labour to existing sites and invest in new facilities. It is this process that may have lowered mining productivity while new facilities awaited completion. Dolman et al (2006) note that if their interpretation is correct, mining productivity may be expected to rise over coming years.

Motor vehicles sales and retail fuel sales

There is a lack of detailed studies of this sector. In the 1990s, motor vehicle retailing recorded strong growth in sales reflecting an increase in affordability (Johnston et al, 2000). The sector as a whole and its small car segment in particular became more competitive owing to lower tariffs and the impact of Korean imports. Also, rationalisation was a key factor contributing to labour input savings with number of dealerships and service stations exiting the sector. In fuel retail one could see the growth of independent networks which led to increased competition.

Inland transport

Diffusion of ICT in the transport sector made it possible to sustain relatively high productivity growth during the 1990s. (Dolman et al, 2006). Interestingly, this sector was among those few sectors that appeared to benefit from technological advances outside ICT (Revesz et al, 2005). These significantly increased the efficiency of various transport equipment both in terms of labour requirements and fuel consumption. Still, some of these improvements were attributed to the incorporation of small computers to control fuel injection and engine ignition. Another important development was related to increasing usage of containerized cargo and the growing size of transport equipment which led to reduced freight costs. Also, the industry specific competition reforms were thought to improve the productivity performance of certain transport industries such as railways.

Electricity, gas and water supply (EGW)

Between 1984-1985 and 1998-1999 this sector saw its hours worked almost halve. According to Dolman et al (2006) this was partly due to the outsourcing of non-core services. There were also very large improvements in efficiency. Dolman et al (2006) link these with a long sequence of microeconomic reforms which are believed to improve work practices in government enterprises, bring pricing more closely into line with costs, increase competition, raise incentives to undertake innovation activities and reduce the extent of excess capacity.

Efficiency improvements in EGW have also been related to technological advances. As in the case of inland transport, EGW turned out to belong to the industries which benefited from ongoing significant technological advanced beyond ICT (Revesz et al, 2005) such as those related to power generation and transmission. Water treatment benefited from the introduction of new filtering and purification technologies. Productivity also improved due to computerised control of the electricity grid. The same applied to industries relying on pipelines and pumps, such as water and gas supply.

Most recently the EGW sector has seen its labour input outpace output resulting in a decline in productivity. Dolman et al (2006) note that the reasons for this are not entirely clear, adding,

however, that this is not very surprising given the remarkably strong earlier productivity growth performance reported by this sector.

Retail trade

Adoption of ICT, competition, rationalisation of the industry and regulatory reforms are among most widely mentioned drivers of productivity in the Australian retail sector (Johnston et al, 2000; Rahman, 2005; Dolman et al, 2006; Davis and Rahman, 2006). For instance, Johnston et al (2000) argue that competition was a key factor influencing rationalisation, investment in technology, greater integration of the supply chain and better management practices. Continuing deregulation of trading hours also appear to be an important factor. In addition, benign macroeconomic conditions of low inflation and low interest rates increased consumer confidence and boosted consumer demand.

Economies of scale in the supply chain and better store management systems facilitated by ICT have also enhanced productivity (Johnston et al, 2000). Davis and Rahman (2006) note, however, that Australian retailers have not adopted the big box format to the same extent as the US. They suggest that probably Australia's geography and size make the integration of supply chain and better inventory management more difficult to achieve, and, therefore, make the adoption of the big box format less profitable.

Revesz et al (2005) also point out that in retailing one can see the factors such as the influx of low paid casual or self employed persons that may well offset the positive impact of technological and organizational advances on the aggregate sectoral productivity growth.

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