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Investigating New Zealand-Australia productivity differences: New comparisons at industry level

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Author: Geoff Mason

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Author: Geoff Mason
National Institute of Economic and Social Research, London

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Information on the Productivity Commission can be found at www.productivity.govt.nz or by contacting +64 4 903 5150.

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Executive summary

Average labour productivity (ALP) levels in New Zealand across the whole economy are now almost a third lower than in Australia. This gap began to open up in the mid-1970s and, with some fluctuations, has largely tended to increase over the decades since. Although much attention has been paid to the apparent causes of this gap at the aggregate economy level, only a few efforts have been made to identify the particular industries in which the New Zealand disadvantage lies and to investigate whether there are any industries in which New Zealand performance compares more favourably against Australia.

In order to help fill this gap in knowledge, this report first presents new estimates of comparative ALP levels and growth rates for 24 market industries (that is, excluding industries that are dominated by public sector activities). These market industries account for just over three quarters of total hours worked in both New Zealand and Australia. We then draw on new estimates of physical capital-intensity and skills at industry level in each country to generate estimates of relative multi-factor productivity (MFP) levels and growth rates between 1997-2010. Since MFP captures the share of growth in ALP that cannot be attributed to measured growth in capital and skills per hour worked, it can be seen as a rough indicator of the efficiency with which capital and labour inputs are utilised. These estimates are based on standard growth accounting techniques which help to identify the 'proximate' causes of inter-country productivity differences. The 'ultimate' causes of Australian-New Zealand productivity differences must remain the subject of continued research and discussion.

Cross-country productivity comparisons depend heavily on the choice of purchasing power parity (PPP) exchange rates to convert nominal values of output in each country to a common currency. One source of PPP exchange rate estimates at industry level is the 'expenditure PPPs' produced by the OECD. These are designed to capture cross-country differences in standards of living rather than productivity differences and so the goods and services priced frequently include imported goods and do not include prices for intermediate products and services. An alternative source is estimates made by the Groningen Growth and Development Centre (GGDC) of unit value ratios (UVRs) that are calculated as sales of products divided by quantities produced. UVRs may be described as 'output PPPs' and are clearly closer to the required producer price concept for industry-level comparisons. However, in practice, due to limited availability of quantity data in some industries, as well as difficulties in matching products, the GGDC estimates typically comprise a combination of output PPPs and expenditure PPPs, with the latter adjusted for retail and wholesale trade and transportation margins and for taxes.

For this study our approach is, first, to estimate ALP levels in each country using updates of industry-level PPP exchange rate estimates prepared by the GGDC because these exchange rates are the most industry-specific of the PPPs available and exclude imported goods. However, since the price data underlying the original GGDC PPPs date back as far as 1997, it is important to compare our findings with estimates based on more recently-produced PPPs. Therefore, in a second stage, we test the sensitivity of our ALP estimates to the use of exchange rates based on OECD PPPs. The chosen benchmark year is 2009 (referring to the 12 months ending in March 2009 for New Zealand and June 2009 for Australia) since this is the year closest to the calendar year 2008 for which the most recently-produced OECD PPPs are available for comparison purposes.

In 2009 the estimated ALP level across total market industries in New Zealand was an estimated 62% of the Australian level when we use updated GGDC PPPs compared with 67% of the Australian level when we use OECD PPPs. Both these estimates of the gap in ALP levels in market

industries are consistent with published estimates of the gap in ALP for the aggregate economy in 2009.

Whichever set of PPPs is used, the Australian lead in ALP is found to apply across a wide range of industries, in particular, mining, agriculture, most branches of manufacturing, construction, retail and wholesale trade and financial and insurance services. However, New Zealand has areas of relatively strong performance in food and drink manufacturing, utilities (electricity, gas and water supply) and arts and recreation services. In some service areas such as professional, scientific and technical services and information media and telecommunications, it is hard to identify the productivity leader with any precision due to sensitivity to the choice of PPP exchange rate and other measurement problems. However, there are at least some signs of New Zealand comparing well in those industries.

Shift-share analysis suggests that roughly 30% of the New Zealand-Australia gap in ALP for aggregate market industries in 2009 was attributable to differences in industrial structure such as the higher shares of Australian employment in industries with comparatively high value added per employee, for example, mining, utilities (electricity, gas and water) and financial services (even though New Zealand is actually ahead on ALP in one of those three industries, namely, utilities). The other side of this coin is the relatively high concentration of New Zealand employment in comparatively low value added industries such as agriculture and food and drink manufacturing. These inter-country differences in industrial structure have grown sharply since the late 1990s, in part because of a recent tendency for New Zealand to restructure away from industries with relatively high absolute levels of ALP (such as financial services, rental and hiring services and transport, postal and warehousing services) and towards industries with lower absolute levels of ALP (for example, administrative and support services and accommodation and food services).

However, although differences in industrial structure help to explain a sizeable (and growing) proportion of the Australia-New Zealand gap in ALP, a very large (70%) share of the ALP gap is attributable to within-industry productivity differences. Therefore, in this report we focus on inter-country differences in the quantity and quality of production inputs and their utilisation, along with other factors driving within-industry productivity performance.

For example, one factor contributing to Australian leadership on ALP in many industries is higher levels of capital per hour worked, referring to four different types of capital asset identified in the report: structures and land improvements; machinery and equipment (including computers); vehicles and transport equipment; and intangible assets such as computer software. In 2009 capital per hour worked across total market industries in New Zealand was just over 60% of the Australian level. The Australian lead on capital-intensity applies to the great majority of market industries, covering a wide range of agricultural, manufacturing and service activities. New Zealand is more capital-intensive in only five of the 24 industries and only one of these (electricity, gas and water) is a significant user of capital equipment.

Australia is also found to be ahead in terms of skills – measured here using data on workforce qualifications and relative pay levels – but this gap is much narrower than that found for capital-intensity. Across Total market industries, Australian skill levels are estimated to be about 3% higher than in New Zealand, largely due to Australia having slightly higher employment shares of both university graduates and workers with vocational and other qualifications gained since leaving secondary school. The measured gap in skills only exceeds five percent in five industries: mining, chemicals, professional and scientific services, information media and telecommunications and finance and insurance.

Growth accounting estimates suggest that MFP levels in New Zealand market industries were on average about 22% below Australian levels in 2009, a gap that is 16 percentage points smaller than the estimated gap in ALP levels. This represented a slight improvement in New Zealand's

MFP performance relative to Australia since 1997, in large part because of a slump in Australian MFP growth rates between 2004-08. When the relative ALP gap for total market industries is decomposed between relative capital-intensity, skill and MFP levels, the estimated MFP contribution is found to have declined for much of the period but still accounted for a majority share (57%) of the ALP gap in 2009. The capital contribution rose from 26% in 1999 to 39% in 2009. The measured contribution of skill differences to the ALP gap was only 4% but this probably under-estimates the impact of skills since growth accounting is unable to take account of complementarities between skills and other production inputs.

The still predominant contribution of MFP to the overall ALP gap can be taken as indicating that New Zealand's productivity shortcomings owe more to comparatively inefficient use of capital and labour inputs than to lower levels of physical capital-intensity. But the capital contribution remains substantial and the residual MFP measure also picks up the effects of hard-to-measure capital investments in innovation and a range of other unmeasured influences on performance such as the effects of inter-country differences in production scale and the size and diversity of urban areas. The importance of these other contributing factors can only be gauged through further research at industry and firm level.

This report also shows that the relative importance of lower MFP and lower physical capital-intensity in accounting for labour productivity gaps varies greatly between industries. For example, in 8 of the 15 industries in which Australia was ahead on ALP in 2009, MFP plays a predominant role but in 6 of them higher ALP is largely due to higher levels of capital-intensity. In the remaining one of these 15 industries -- wholesale trade -- the contributions of MFP and capital-intensity to the Australian lead on ALP are roughly equal. In five of the seven industries where New Zealand is ahead on ALP, the main contribution to that lead comes from MFP. In the other two industries relative capital-intensity predominates but these are industries where absolute levels of capital-intensity are relatively low.

To gain a deeper understanding of within-industry productivity differences, future research needs to go beyond growth accounting and investigate the factors underlying the proximate causes of performance differences between the two countries. For example, new research at industry and firm level could aim to explore how far New Zealand's apparent inefficiencies in resource utilisation (signified by lower MFP) are attributable to comparative weakness in innovation or the effects of many firms operating with relatively small-scale production facilities or the workings of domestic product markets (for example, the speed with which resources are reallocated from comparatively inefficient producers to more efficient producers). Similarly, new research at industry and firm level could investigate the main factors – apart from differences in industrial structure – which have contributed to higher levels of capital investment in Australia than in New Zealand over recent decades.

1 Introduction

There is now considerable public interest in New Zealand in the country's productivity performance relative to Australia. This is partly because higher labour productivity levels in Australia contribute to higher real wages, which in turn attract continuing net outflows of New Zealand workers to Australia. At the same time, New Zealand policy-makers are also interested in developing policies that will enable New Zealand businesses to compete more effectively against rival firms in Australia and other competitor nations.

Estimates derived from the Conference Board database suggest that average labour productivity (ALP) levels in New Zealand across the whole economy in 2011 were almost a third lower than in Australia (Conference Board, 2012). Much of this gap has persisted over several decades. According to a recent study by Statistics New Zealand (SNZ) and the New Zealand Treasury (NZT), in the 'measured sector' (that is, excluding public services and some hard-to-measure branches of private services), New Zealand's ALP growth performance was slightly better than Australia between 1978-2008 (SNZ & NZT, 2010). However, as noted in this same study, this small advantage in productivity growth rates is actually 'disappointing' given the many mechanisms by which countries with relatively low ALP levels can be expected to narrow the gap with productivity leaders (2010: iv). 'Catch-up' mechanisms of this kind include technology and knowledge transfer through foreign direct investment and cross-border mobility of high-skilled workers and managers.

In spite of the attention paid to NZ-Australian productivity comparisons at the aggregate economy level, only a few efforts have been made to examine in which particular industries the New Zealand disadvantage lies and whether there are any industries in which New Zealand performance compares favourably against Australia (and perhaps against other countries as well). In 2002 researchers at the International Monetary Fund compared industry-level productivity differences between the two countries over the 1988-99 period using industry-specific expenditure PPP exchange rates produced by the OECD to convert output values in NZ and Australia to a common currency (IMF, 2002). More recently, NZIER (2011) produced comparative productivity estimates at broad industry level covering the 1990-2006 period, using market exchange rates for currency conversion purposes.

This approach has the disadvantages that market exchange rates are subject to short-term volatility and are only really relevant to internationally traded goods. The advantage of using estimates of PPP exchange rates at industry level is that they attempt to capture the prices in a common currency of purchasing the same quantities of industry output in both countries. PPP exchange rates also have disadvantages in that the relevant price data are time-consuming and difficult to collect so that PPP estimates are subject to methodological debate and potential measurement error. However, conceptually, the use of PPP exchange rates is generally considered to be preferable to market exchange rates for international productivity comparisons (World Bank, 2013).

This paper first presents new estimates of ALP performance for 24 market industries that account for just over three quarters of total hours worked in both New Zealand and Australia. In order to do so, it makes use of industry-level PPP exchange rate estimates prepared by the Groningen Growth and Development Centre (GGDC) as well as OECD PPP exchange rates. We then draw on new estimates of physical capital-intensity and skills in each country to generate estimates of relative multi-factor productivity (MFP) levels and growth rates between 1997-2010. These estimates are based on standard growth accounting techniques that help to identify the 'proximate' causes of inter-country productivity differences. In carrying out this analysis of relative productivity levels at a much more disaggregated industry level than has hitherto been

attempted, a key aim is to help clear the ground for new research into the 'ultimate' causes of New Zealand-Australian productivity differences.

The paper is ordered as follows: Section 2 examines background information on the evolution of the productivity gap between the two countries. Section 3 presents new estimates of ALP levels and growth rates at industry level for the 1997-2010 period, and also assesses the effects of differences in industrial structure on relative performance. Sections 4 and 5 compare capital-intensity and skills at industry level in each country. Section 6 presents new estimates of relative MFP levels and growth rates and evaluates the respective contributions of relative capital-intensity, skill and MFP levels to cross-country differences in ALP in each industry. Section 7 summarises and assesses the main findings.

2 New Zealand-Australia productivity differences in long-term perspective

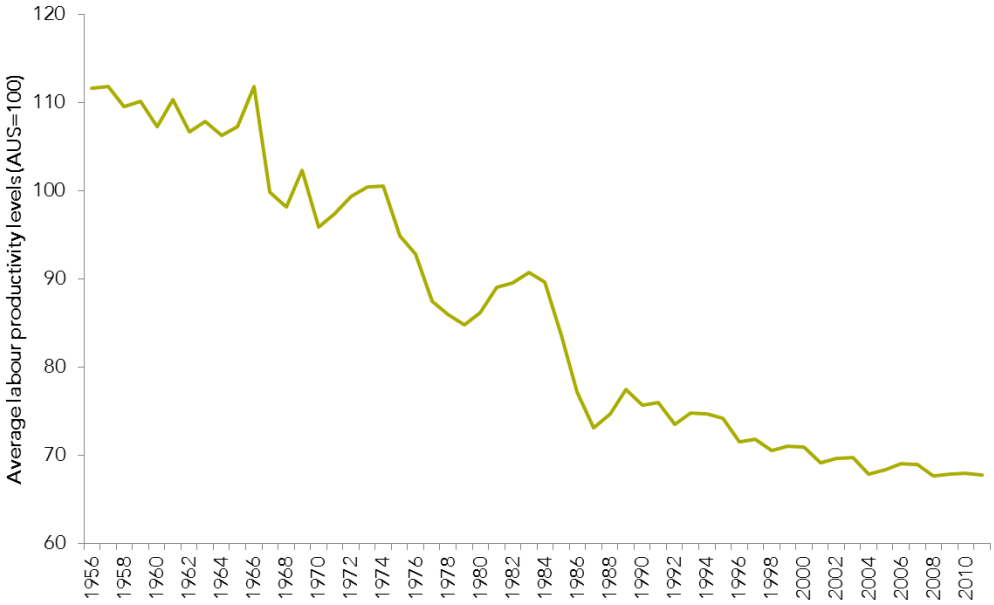
Immediately following World War II, estimated Gross Domestic Product (GDP) per capita levels in New Zealand were among the highest in the world and were almost 10% above Australian levels (Maddison, 2003). However, New Zealand performance relative to Australia gradually declined during the 1950s and early 1960s, due in large part to New Zealand's strong dependence on pastoral exports (for which demand declined after the Korean War-driven commodities boom ended) and Australia's greater opportunities to develop its mining industry (Easton, 1997; Greasley & Oxley, 2000).

A major turning point came in 1967 when world wool prices collapsed with severe knock-on effects on several other New Zealand industries (Easton, 1997). This turning point is captured in Figure 1 which draws on data assembled by the Conference Board. In 1967 ALP in New Zealand dropped to parity with the Australian level, down from an average 8% lead between 1960-66. After a brief period of apparent recovery in the early 1970s, ALP in New Zealand fell further in 1975 to 95% of the Australian level. It continued declining sharply until 1977, then recovered slightly for a few years before experiencing a very rapid decline from approximately 90% of the Australian level in 1984 to 73% in 1987. After another brief period of partial recovery, a ten-year period of gradual decline relative to Australia ensued from 1995 to 2004 since when the NZ-Australian differential has tended to level off, so that in 2011 ALP in New Zealand was an estimated 68% of the Australian level.

Another point of comparison is with ALP levels in the US. Figure 2 shows that ALP in Australia rose steadily from 78% of the US level in 1966 to 90% in 1984, since when it has fluctuated within a narrow band of 86-90% of the US level. By contrast, ALP in New Zealand has declined from 87% of the US level in 1966 to 58% in 2011.

As shown in Figure 3, total output in Australia in 2011 was some 4.4 times greater than in 1967 whereas in New Zealand total output in 2011 was only 2.8 times higher than in 1967. The faster rate of output growth in Australia was nearly all achieved through faster growth in ALP since (as shown in the same chart) estimated growth rates in total hours worked have been remarkably similar in New Zealand and Australia over most of the period since 1967. The main exception to this is the mid-1980s when total labour input in New Zealand grew sharply at a time of modest growth in output. Explanations advanced for these long-term disparities in output and ALP growth between the two countries include relatively low levels of physical capital-intensity in New Zealand, the relatively small size of the New Zealand market and the lack of urban scale compared to Australia (Greasley & Oxley, 2000; IMF, 2002; Hall & Scobie, 2005; McCann, 2009).

Figure 1 Average GDP per hour worked in New Zealand relative to Australia, 1956-2011, Index numbers: Australia=100

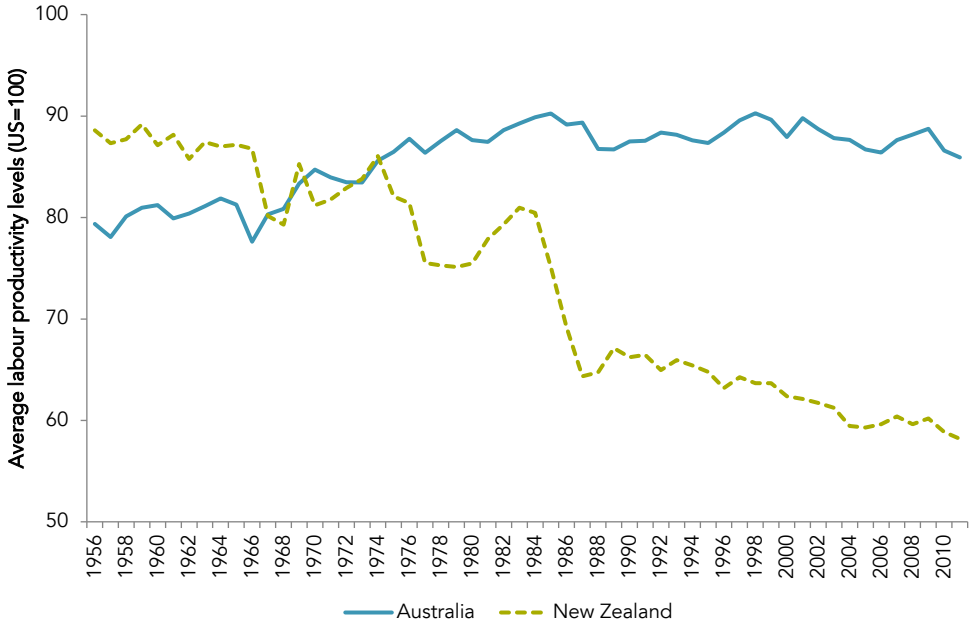


Source: Conference Board (2012).

Notes:

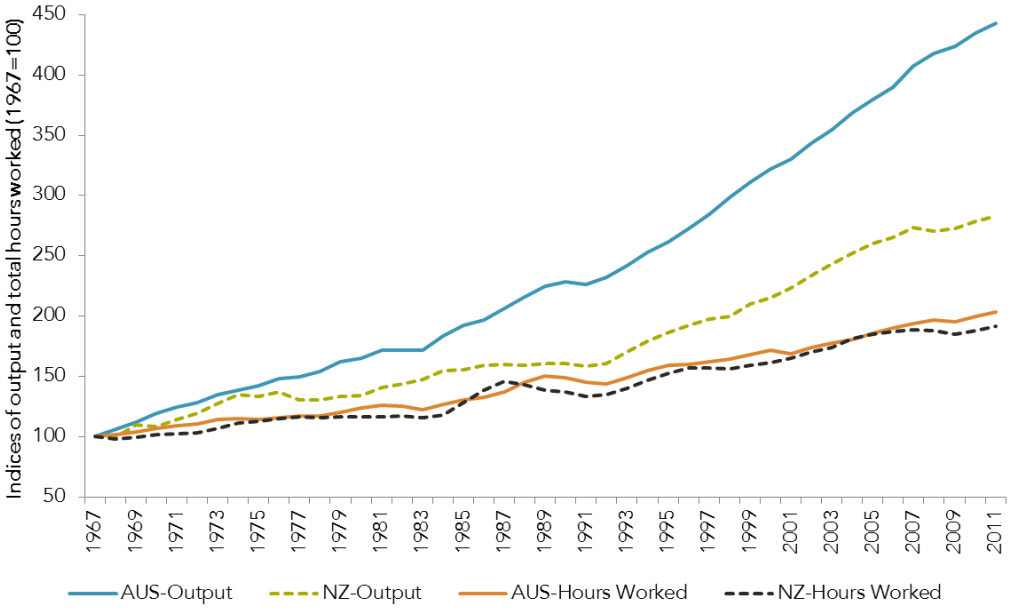
1. New Zealand labour input data between 1984-87 have been smoothed to adjust for an apparent discontinuity in the underlying labour volume series used by the Conference Board. See Hall & Scobie, 2005, Section 2.2 for a discussion of hours worked estimates covering this period.

Figure 2 Average GDP per hour worked in New Zealand and Australia, 1956-2011, Index numbers: US=100



Source and notes: See Figure 1

Figure 3 Total GDP and annual hours worked in New Zealand and Australia, 1956-2011, Index numbers: 1967=100

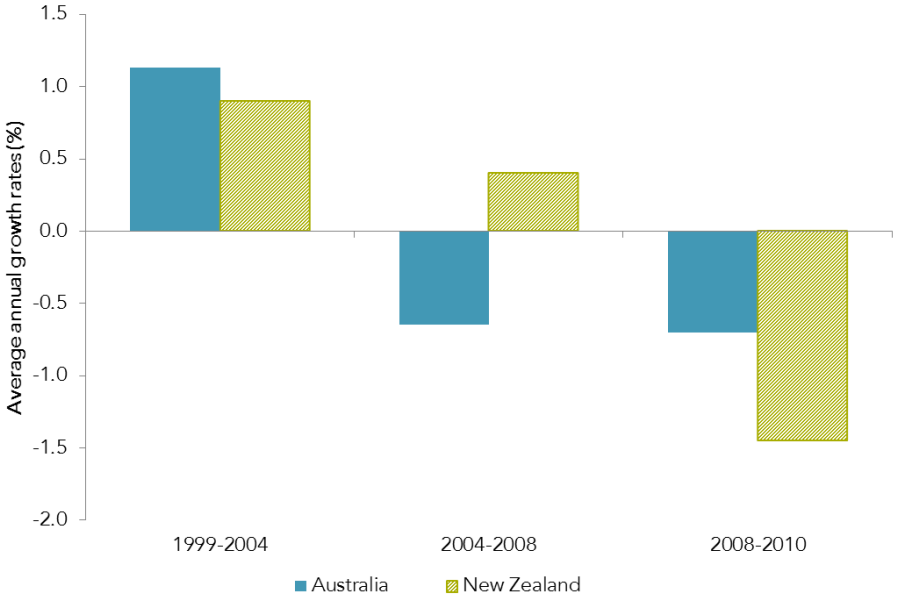


Source and notes: See Figure 1

From 1996 to 2012 ALP in the aggregate economy grew steadily by an average 1.6% per annum (pa) in Australia compared to 1.3% pa in New Zealand (SNZ, 2013a). If attention is confined to the 'measured sector' (excluding hard-to-measure public sector dominated industries), then the ALP growth differential in favour of Australia over this period widens to 0.7 percentage points pa (ibid). However, over the same period, growth in MFP was much the same in each country's measured sector, averaging 0.8% pa in Australia and 0.9% in New Zealand (ibid).

Among other things MFP captures the efficiency with which production inputs are utilised. Looking more closely at MFP growth rates in recent years, in both Australia and New Zealand, MFP growth in the measured sector declined sharply in the pre-recession years of 2004-08 compared to the previous five years. In Australia this took the form of a 'productivity growth slump' with average annual growth rates of -0.6% in MFP between 2004-08, due in large part to rapid accumulation of capital and labour inputs in mining and related industries as they adjusted to favourable shifts in the terms of trade (Parham, 2012). By contrast, in New Zealand average annual growth rates in MFP were a full percentage point higher than in Australia during this period. But with the onset of recession in 2008, MFP growth rates in New Zealand fell much more steeply than in Australia in the following two years (Figure 4). A key issue for this paper is to examine how these trends in MFP growth played out at industry level.

Figure 4 **Average annual growth rates in multi-factor productivity (MFP) in aggregate market industries (Australia) and the measured sector (New Zealand),** 1999-2010



Source: ABS (2012a) and SNZ (2013b).

Notes:

1. Estimates refer to MFP on a quality-adjusted hours worked basis for aggregate market industries in Australia and composition-adjusted MFP in the measured sector in New Zealand. For further information on industry coverage in each country, see main text in this section.

3 Relative labour productivity levels and growth rates in New Zealand and Australian market industries

3.1 Definition of market industries

All cross-country productivity comparisons are hampered by measurement difficulties. Recent investigations by New Zealand researchers have suggested that previous estimates of the ALP gap between New Zealand and Australia at aggregate economy level may have been inflated as a result of different decisions taken by government statisticians in each country with regard to the treatment of hard-to-measure variables such as residential dwellings, unreported cash-only services and financial intermediation services (SNZ & NZT, 2010; Bollard & Barrow, 2012; Warmke & Janssen, 2012). In the future SNZ expects such differences to be reduced as it implements a new set of international standards (Bascand, 2012).

In an effort to reduce measurement problems for the present study, we focus on market industries, defined as industries that are dominated by market-based providers of goods and services. Thus hard-to-measure public sector dominated activities such as public administration, health, education and social assistance are excluded as are residential property operations (Industry LL2 in the 2006 industrial classification). The full list of market industries shown below corresponds to the current official definition of the 'measured sector' by SNZ. It differs from 'aggregate market industries' as defined by the Australian Bureau of Statistics (ABS) in only one respect in that residential property operations are included in this category by the ABS.

Table 1 Market industries covered in this study

ANZSIC 06	Industry Code (this study)	
AA	1-3	Agriculture, forestry and fishing
BB1	4	Mining
CC1	5	Food, beverage and tobacco product manufacturing
CC2	6	Textile, leather, clothing and footwear manufacturing
CC3	7	Wood and paper products manufacturing
CC4	8	Printing
CC5	9	Petroleum, chemical, polymer and rubber product manufacturing
CC6	10	Non-metallic mineral product manufacturing
CC7	11	Metal product manufacturing
CC8	12	Transport equipment, machinery and equipment manufacturing
CC9	13	Furniture and other manufacturing
DD1	14	Electricity, gas, water and waste services
EE1	15	Construction
FF1	16	Wholesale trade
GH1	17	Retail trade
GH2	18	Accommodation and food services
II1	19	Transport, postal and warehousing
JJ1	20	Information media and telecommunications
KK1	21	Financial and insurance services
LL1	22	Rental, hiring and real estate services
MN1	23	Professional, scientific and technical services
MN2	24	Administrative and support services
RS1	25	Arts and recreation services
RS2	26	Other services

3.2 Methods and data sources

Letting *Y* denote nominal value added and *L* labour input, average labour productivity (ALP) for industry *i* and country *k* at time *t* is defined as:

$$ALP_{i,t}^{k} = \frac{Y_{i,t}^{k}}{L_{i,t}^{k}} \qquad (1)$$

Relative labour productivity levels comparing countries *k* and *j* can be derived as the ratio of labour productivity for both countries, but with value added *Y* denominated in a common currency. To achieve the latter it is necessary to multiply value added in *j* by the ratio of its prices to those in the numeraire country *k*. Thus relative labour productivity levels are given by:

$$ALP_{i,t}^{(j/k)} = \left(\frac{Y_{i,t}^{j} \dfrac{P_{i,t}^{k}}{P_{i,t}^{j}}}{L_{i,t}^{j}} \right) / \left(\frac{Y_{i,t}^{k}}{L_{i,t}^{k}} \right) \qquad (2)$$

ALP growth between periods *t* and *t-1* can be calculated from Equation 1 except that each country's domestic price indexes are employed to deflate nominal values. Combining levels with growth rates allows calculation of relative labour productivity levels at each point in time.

The primary data sources on gross value added for both New Zealand and Australia are the National Accounts in each country.[1] Time series of industry-level data based on the 2006 version of the Australian and New Zealand Standard Industrial Classification (ANZSIC) are now available backdated to 1996-97 for both countries and the present report makes use of these new data series. New Zealand output data are derived from the December 2012 release of National Accounts data in which financial intermediation services indirectly measured (FISIM) are included, thus enhancing comparability with Australian output data in which FISIM are accounted for.[2] For this study we also sought to improve comparability between the two countries by deducting the value of private rental dwellings from measured output in the New Zealand rental, hiring and real estate services industry since private rental dwellings are included as part of 'Ownership of dwellings' (alongside owner-occupied dwellings) in the Australian National Accounts.[3]

For measures of labour input, estimates of total hours worked at industry level in Australia are readily derivable from Labour Force Survey data. For New Zealand the most reliable data series on labour inputs show total hours paid in a reference week in the middle of each quarter. Estimates of total annual hours worked by industry were then obtained by summing the four weekly hours paid figures for each year, multiplying by 13 and then making a further adjustment to an hours worked basis, using estimated ratios of hours worked to hours paid which were derived by Statistics NZ from NZ Household Labour Force Survey (HLFS) data.[4]

SNZ (2013a) note that, across the measured sector as a whole, the use of the hours worked measure has the effect of slightly reducing estimated ALP growth (by about 0.2% pa) compared to using the hours paid measure of labour input because a small proportion of hours worked are

[1] For Australia we also made use of EUKLEMS estimates to subdivide gross value added in total manufacturing between nine branches of manufacturing for the years 1997-2006 (www.euklems.net).

[2] Adjustments for FISIM seek to capture the part of interest charged by banks and similar institutions which represents the value of the service provided (as distinct from the part of interest charges which represents a return to the owner of the borrowed funds and is therefore regarded as a cost of production). See SNZ (2012a) for further details.

[3] This adjustment was made using a new chain-linked output series provided by SNZ for rental, hiring and real estate services which excludes private rentals (SNZ, private communication).

[4] See SNZ (2012b) for a discussion of New Zealand data sources on hours worked as compared to hours paid.

unpaid. However, since the gap between hours paid and hours worked may vary between countries (partly because of institutional differences), total hours worked is clearly the most appropriate measure of labour inputs for international productivity comparisons.

In all but two respects the real output and labour input data on which we rely for comparisons of ALP levels and growth rates are broadly consistent with official output and labour input indices published by the ABS and SNZ during 2012 (ABS, 2012a; SNZ, 2012c). The key differences arise in the case of the real output series for New Zealand due to our decision to use more recent National Accounts data in which FISIM are accounted for and the need to adjust measured output in rental, hiring and real estate services to remove private rental operations. As described above, both sets of changes enhance comparability with Australia. In the case of growth rates in labour inputs, the estimates for New Zealand derived for this study based on hours worked remain broadly consistent with growth in the SNZ labour input series which is based on hours paid.

For comparisons of output at industry level, we convert nominal values of gross value added in each country to US dollars using estimates of PPP exchange rates expressed in that common currency. One source of PPP exchange rate estimates at industry level is the 'expenditure PPPs' produced by the OECD. These are designed to capture cross-country differences in standards of living rather than productivity differences and so the goods and services priced frequently include imported goods and do not include prices for intermediate products and services. An alternative source is estimates made by the Groningen Growth and Development Centre (GGDC) of unit value ratios (UVRs) which are calculated as sales of products divided by quantities produced. UVRs may be described as 'output PPPs' and are clearly closer to the required producer price concept for industry-level comparisons. However, in practice, due to limited availability of quantity data in some industries, as well as difficulties in matching products, the GGDC estimates typically comprise a combination of output PPPs and expenditure PPPs, with the latter adjusted for retail and wholesale trade and transportation margins and for taxes.

For this study our approach is, first, to estimate ALP levels in each country using industry-level PPP exchange rate estimates prepared by the GGDC because these exchange rates are the most industry-specific of the PPPs available and exclude imported goods.[5] However, since the price data underlying the GGDC PPPs date back as far as 1997, it is important to be able to compare our findings with estimates based on more recently-produced PPPs. Therefore, in a second stage, we test the sensitivity of our ALP estimates to the use of exchange rates based on OECD PPPs. The chosen benchmark year is 2009 (referring to the 12 months ending in March 2009 for New Zealand and June 2009 for Australia) since this is the year closest to the calendar year 2008 for which the most recently-produced OECD PPPs are available for comparison purposes.[6]

To update the GGDC PPP estimates for 1997 to 2009, we make use of industry-level price deflators for the United States as well as for New Zealand and Australia.[7] Another way of deriving the same estimates of relative ALP levels would have been to carry out comparisons for 1997 using the original GGDC PPP estimates for that year and then using post-1997 real output and labour input data series for the two countries to estimate movements in relative ALP levels since

[5] The GGDC estimates of New Zealand PPPs are derived from those which were specially commissioned from GGDC for an earlier NZ-UK comparison (Mason & Osborne, 2007).

[6] We considered trying to recalculate data in both countries on a calendar year basis but abandoned this idea because of the arbitrary assumptions which would be necessary to carry out such an adjustment in the case of variables for which quarterly data are not available in one or both countries. There are also strong arguments for working with the unadjusted data series which are regularly used by other researchers in this field.

[7] The GGDC PPP estimates were prepared for industries defined in terms of the European Community's NACE classification of economic activities. For 19 of the 24 industries shown in Table 2, there was a straightforward mapping between NACE and ANZSIC06. However, for five industries – wood and paper products; transport equipment, machinery and equipment manufacturing; retail trade; transport, postal and warehousing; and information media and telecommunications – we needed to make use of data from Supply-Use Tables and detailed National Accounts data at sub-industry level in order to produce output-weighted industry-specific estimates of updated GGDC PPPs.

1997.[8] Since we wish to compare estimates of relative ALP based on GGDC PPPs with estimates based on OECD PPPs in a recent year, we choose to make use of updated GGDC PPPs.[9]

The resulting PPP estimates for 24 market industries are set out in Table 2 alongside estimates of industry-level PPPs for 2008 which are derived from disaggregated PPP data obtained from the OECD.[10] Gaps in product coverage by the OECD meant that we could only obtain industry-specific estimates for 11 of the 24 industries. For the remaining industries we use PPPs derived for either GDP as a whole or for aggregated manufacturing or service industries (see Table 2, Column 7). All OECD-based PPP estimates were adjusted for retail and wholesale trade and transportation margins and for taxes with the aid of industry-level information derived from Supply-Use Tables for each country.

3.3 ALP levels estimates

Estimates of comparative ALP levels in 2009 based on updated GGDC PPP exchange rates are shown in Table 3, Column 1. The results for total market industries point to an estimated ALP level in New Zealand of about 62% of the Australian level. If the OECD's PPP estimate for GDP is applied, then the estimated gap declines slightly, showing ALP in New Zealand market industries at about 67% of the Australian level (Column 2). Both these estimates of the gap between New Zealand-Australian ALP levels in market industries are consistent with the estimated 32% gap in ALP for the aggregate economy in 2009 (Figure 1).

Looking first at the estimates based on GGDC PPPs, Australia is found to be ahead of New Zealand in 16 of the 24 industries, with its lead being particularly strong in mining, agriculture, most branches of manufacturing, construction, retail and wholesale trade, transport services and financial and insurance services. However, New Zealand also has areas of relatively strong performance in food and drink manufacturing, furniture and other manufacturing, utilities (electricity, gas and water supply) and several service activities including professional, scientific and technical services, arts and recreation services and other services (Table 3, Column 1).

If OECD PPPs are applied, most of these points of contrast between the two countries remain except that the estimated New Zealand lead in professional/ scientific services turns into a small gap in favour of Australia while the estimated New Zealand lead in arts and recreation services increases sharply. At the same time the estimated Australian lead in transport, postal and warehousing disappears if OECD PPPs are used (Table 3, Column 2). In information media and telecommunications, for which we have concerns about possible different measurement practices in each country,[11] an estimate of near-parity in relative ALP levels using GGDC PPPs turns into an estimated gap of 27 pp in favour of Australia if OECD PPPs are used. Thus considerable caution therefore needs to be applied to estimates for these four service industries, as is also the case for rental, hiring and real estate services due to the inconsistencies between the two countries (discussed above) in their statistical treatment of this industry.

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[8] The reason why the two methods obtain identical results is because the industry-level price deflators used to update the 1997 PPPs are the same as those used to derive the real output series from 1997 onwards.

[9] An alternative to using constant PPPs (based in a reference year) would have been to seek out means of estimating current PPPs for each year in the time series under consideration. However, current PPPs are vulnerable to instability due to changes in the underlying PPP data collection exercise over time (Lau & Wallis, 2005). For this study constant PPPs are considered preferable for estimates of productivity growth rates because the underlying price deflators are explicitly designed to capture changes through time.

[10] In more detail, these industry-specific OECD-based PPP estimates are based on expenditure-weighted averages of PPPs at the basic heading level (comprising about 150 different product or service groups). We are grateful to the OECD for making these basic heading data available.

[11] For information media and telecommunications, our estimates of implicit price deflators in New Zealand and Australia differed so sharply from each other that it seems likely that official statisticians in each country have used very different methods to estimate price changes and thus real output relating to this industry. Specifically, our estimates showed average price changes between 1997-2009 for this sector of +12% in Australia and -36% in New Zealand. Given these concerns we place particular emphasis on comparing results for this industry based on updated GGDC PPPs with alternative results based on OECD PPPs.

Table 4 shows that absolute values of ALP vary markedly between industries, with the highest levels of average gross value added per hour worked found in mining in both countries, in electricity, gas and water in New Zealand and in financial services in Australia. The industries with relatively low absolute values of ALP in both countries include textile and related manufacturing, furniture and other manufacturing, retail, accommodation and food services, administrative and support services and other services such as social and community services.

In most of the industries where Australia is found to lead using both GGDC and OECD PPPs, the estimates seem to be in line with previous research findings. For example, our findings of Australian leadership on ALP in agriculture, most branches of manufacturing, construction, wholesale trade and financial services are consistent with IMF (2002) estimates for 1999 (based on expenditure PPPs) as is our finding of New Zealand leadership on ALP in electricity, gas and water supply. However, the same does not apply to retail for which IMF (2002) found near-parity in relative ALP levels in 1999 or to arts and recreation services where IMF (2002) found Australia to be ahead.[12]

Turning to comparison with the more recent NZIER (2011) estimates for 2001-06 (which are based on market exchange rates rather than PPP exchange rates), our results are broadly consistent with theirs for manufacturing, construction, wholesale and retail and financial services.[13] However, it is striking that NZIER (2011) find a very substantial New Zealand lead on ALP in agriculture. This contrasts with both our new estimates and those of IMF (2002) who found that higher levels of capital-intensity in Australian agriculture contributed to Australian productivity leadership in this industry. In Section 4 below we report similar findings.

Clearly, productivity comparisons in agriculture are particularly sensitive to choice of exchange rate. Furthermore, it is reasonable to be concerned about marked differences between the two countries in the composition of output in this industry which may affect productivity comparisons. For example, sheep farming accounts for 20% of total value added in New Zealand agriculture, forestry and fishing compared to 8% in Australia while forestry represents 12% of total industry output in New Zealand compared to 4% in Australia.[14] In future productivity research it would be desirable to treat some of these activities separately if adequate data (for example, on labour inputs) can be found, and if reliable PPP exchange rates for each sub-industry within agriculture, forestry and fishing can be obtained.

3.4 Estimates of ALP growth rates

Between 1997-2008 output in total market industries grew by an average 3.8% per annum (pa) in Australia (Table 5A) of which 1.7 percentage points (pp) were attributable to growth in total hours worked (Table 4B) and 2.1 pp to growth in ALP (Table 5C). For New Zealand equivalent estimates show slightly slower growth in output (3.1% pa) and in ALP (1.6% pa) over this period. When we turn to the two years immediately following the onset of the global financial crisis in 2008, Australia remains in the lead with output rising by an average 1.5% pa compared to a decline of -2.3% pa in New Zealand while ALP grew by an average 1.5% pa in Australia compared to 0.2% pa in New Zealand (Table 5C).

However, as with ALP levels estimates, beneath this comparison at total market industries level we can identify some industries where New Zealand outperformed Australia in respect of output and/or ALP growth. For example, between 1997-2008, ALP growth in New Zealand was well

[12] See Table 13 below for our own estimates of relative ALP in 1999 which can be directly compared with the IMF (2002) findings.

[13] Note that the sector described as 'community services' in NZIER (2011) contains a mix of private and public service activities (NZIER, private communication) and is therefore not comparable with our results based solely on market sectors.

[14] Estimates derived from SNZ National Accounts and Supply-Use Tables, 2006-07, and ABS National Accounts, 2006-07 and Supply-Use Tables, 2005-06.

ahead of Australia in food and drink manufacturing, wood and paper products manufacturing, information media and telecommunications and other services (Table 5, Part C). Between 2008-10 New Zealand ALP growth rates were substantially higher in industries such as textiles and clothing, wood and paper products manufacturing, chemicals and financial/insurance services. Another industry which shows marked variation in recent ALP growth performance is mining where ALP fell by -4.7% pa in Australia between 2008-10, largely due to very rapid growth in labour inputs (Table 5B).

Combining our ALP levels and growth rates estimates for the 1997-2010 period sheds some light on how long the patterns of ALP advantage identified in 2009 have been in existence (Table 6).[15] In several industries Australian ALP leadership has persisted throughout this period, for example, agriculture, mining, most branches of manufacturing, construction, wholesale and retail trade, transport, postal and warehousing and financial services. Focussing on the industries where New Zealand compares favourably against Australia, our estimates suggest that the current New Zealand lead in food and drink manufacturing only emerged in the second half of the 2000s. The same applies to the estimated New Zealand lead in furniture and other manufacturing. However, there is evidence of consistent New Zealand leadership in ALP levels over the whole 1997-2010 period in electricity, gas and water supply and in some service industries, namely, professional/scientific, administrative/support and arts and recreation services.

3.5 Cross-country differences in industrial structure

To some extent the ALP gap between Australia and New Zealand may be due to the differences in industrial structure that have developed over time. For example, if New Zealand employment tends to be concentrated in industries with relatively low absolute levels of ALP (typically less capital-intensive industries), this might help to explain its overall weakness in ALP relative to Australia. To examine this we follow van Ark, Timmer & Inklaar (2002) in using a shift-share method which decomposes the Australia-New Zealand ALP gap into two components with Australia as the base country:

$$LP^{AUS} - LP^{NZ} = \sum_{i=1}^{n}\left(LP_i^{AUS} - LP_i^{NZ}\right)\frac{1}{2}\left(S_i^{NZ} + S_i^{AUS}\right) + \sum_{i=1}^{n}\left(S_i^{AUS} - S_i^{NZ}\right)\frac{1}{2}\left(LP_i^{NZ} + LP_i^{AUS}\right) \qquad (3)$$

where LP refers to the average labour productivity level in US$ terms and S_i refers to the employment share of industry i in each country. If ALP levels are the same in each country, then the first term on the right-hand side of Equation 3 is zero and the ALP gap is entirely due to differences in employment structure. Conversely, if employment shares are the same in each country, then the second term is zero and the ALP gap is solely attributable to productivity differences between the two countries at sector level.

The results shown in Table 7 suggest that roughly 30% of the New Zealand-Australia gap in ALP for aggregate market industries is attributable to differences in industrial structure such as the higher shares of Australian employment in industries with comparatively high value added per employee, for example, mining, utilities (electricity, gas and water) and financial services (even though New Zealand is actually ahead on ALP in one of those three industries, namely, utilities). The other side of this coin is the relatively high concentration of New Zealand employment in comparatively low value added industries such as agriculture and food and drink manufacturing. More generally, about 17% of New Zealand labour inputs are allocated to manufacturing compared to 13% of Australian labour inputs, and average value added per hour worked in

[15] This table shows trends in relative ALP based on GGDC PPPs since, as discussed in the main text, these benefit in the main from wider product coverage and greater industry-specificity than is the case for OECD PPPs.

manufacturing is lower than in knowledge-intensive services where 20% of Australian labour inputs are concentrated (compared to 18% in New Zealand).[16]

Additional shift-share analysis for 1997, the earliest year for which comparable industry-level data are available, suggests that these inter-country differences in industrial structure have grown sharply since the late 1990s. In 1997 ALP across total market industries in New Zealand was about 68% of the Australian level (compared to 62% in 2009) and about 18% of this smaller ALP gap in 1997 was attributable to differences in industrial structure (compared to 30% in 2009) (Table 8, Column 5).

In both 1997 and 2009 the most prominent industry contributing to these structural effects was mining, with continued growth between the two years in the employment share of that industry in Australia compared to New Zealand. However, the growing differences in industrial structure also reflect a recent tendency (noted by Proctor, 2013) for New Zealand to restructure away from industries with relatively high absolute levels of ALP and towards industries with relatively low ALP.

Thus, as shown in Table 9, in four of the top six industries ranked in terms of absolute ALP levels, New Zealand experienced reductions in employment shares between 1997 and 2009 – in marked contrast to Australia's growing employment shares in all six of these relatively high-ALP industries. While employment shares in high-ALP industries such as financial services, rental and hiring services and transport, postal and warehousing services declined in New Zealand, there were marked increases in the employment shares of industries with relatively modest or low ALP levels such as administrative and support services and accommodation and food services (Table 9).

In future research it would be useful to carry out a detailed investigation of the main drivers of these divergent trends in industrial structure in the two countries. For the present project it is more important to note that, while differences in industrial structure help to explain a sizeable (and growing) proportion of the Australia-New Zealand gap in ALP, the great majority of this gap remains to be accounted for by other factors such as differences in the quantity and quality of production inputs and their utilisation, to which we now turn.

[16] As noted above, knowledge-intensive service industries are here defined as information media and telecommunications, financial and insurance services, professional, scientific and technical services, administrative and support services and arts and recreation services.

Table 2 Estimated purchasing power parity (PPP) exchange rates used in ALP comparisons

Industry code		AUS USD 2009 GGDC (updated)	NZL USD 2009 GGDC (updated)	AUS USD 2008 OECD	NZL USD 2008 OECD	OECD PPP Expenditure category
		Purchasing power parity exchange rates				
1-3	Agriculture, forestry and fishing	1.75	2.29	1.43	1.44	GDP
4	Mining	1.44	2.84	1.57	1.53	GDP
5	Food, beverage and tobacco product manufacturing	1.54	1.75	1.68	2.04	Food, drink and tobacco
6	Textile, leather, clothing and footwear manufacturing	1.34	1.08	1.70	1.62	Textile, leather, clothing and footwear manufacturing
7	Wood and paper products manufacturing	1.83	1.63	1.63	1.85	Manufacturing
8	Printing	2.56	3.49	1.63	1.85	Manufacturing
9	Petroleum, chemical, polymer and rubber product manufacturing	1.74	2.20	1.63	1.85	Manufacturing
10	Non-metallic mineral product manufacturing	1.63	2.74	1.63	1.85	Manufacturing
11	Metal product manufacturing	2.04	1.66	1.63	1.85	Manufacturing
12	Transport equipment, machinery and equipment manufacturing	2.28	3.80	1.63	1.82	Transport equipment, machinery and equipment manufacturing
13	Furniture and other manufacturing	1.82	1.81	1.63	1.85	Manufacturing
14	Electricity, gas, water and waste services	0.61	0.57	2.42	2.86	Electricity, gas, water and waste services
15	Construction	0.58	0.98	1.54	1.77	Construction
16	Wholesale trade	3.81	4.82	2.02	2.21	Retail and repair
17	Retail trade	1.93	2.30	2.02	2.21	Retail and repair
18	Accommodation and food services	1.62	1.30	1.62	1.67	Accommodation and food services
19	Transport, postal and warehousing	0.92	1.11	2.29	1.56	Transport, postal and warehousing
20	Information media and telecommunications	2.32	1.92	1.43	1.64	Information media and telecommunications
21	Financial and insurance services	1.09	1.62	1.72	1.68	Market services
22	Rental, hiring and real estate services	1.90	1.36	1.72	1.68	Market services
23	Professional, scientific and technical services	1.64	0.88	1.72	1.68	Market services
24	Administrative and support services	1.68	0.92	1.72	1.68	Market services
25	Arts and recreation services	1.31	1.61	1.17	1.27	Arts and recreation services
26	Other services	1.54	1.25	1.72	1.68	Market services
1-26	**Total market industries**	**1.26**	**1.40**	**1.71**	**1.77**	**GDP**

Notes:

1. Both sets of PPP exchange rates have been adjusted for inter-country differences in retail and wholesale trade and transportation margins and in taxes. See main text for other details of estimation methods and data sources. Current exchange rates in 2009 averaged US$1.00 = AU$1.28 and US$1.00 = NZ$ 1.60.

Table 3 Average labour productivity levels in market industries, 2009, Index numbers: Australia=100

Industry code		Average labour productivity	
		AUS=100 GGDC PPPs (updated)	AUS=100 OECD PPPs (updated)
1-3	Agriculture, forestry and fishing	62	80
4	Mining	43	88
5	Food, beverage and tobacco product manufacturing	112	105
6	Textile, leather, clothing and footwear manufacturing	89	76
7	Wood and paper products manufacturing	77	61
8	Printing	23	27
9	Petroleum, chemical, polymer and rubber product manufacturing	67	75
10	Non-metallic mineral product manufacturing	46	69
11	Metal product manufacturing	49	36
12	Transport equipment, machinery and equipment manufacturing	48	71
13	Furniture and other manufacturing	134	118
14	Electricity, gas, water and waste services	179	141
15	Construction	36	53
16	Wholesale trade	52	60
17	Retail trade	62	68
18	Accommodation and food services	88	69
19	Transport, postal and warehousing	57	102
20	Information media and telecommunications	101	73
21	Financial and insurance services	30	46
22	Rental, hiring and real estate services	247	181
23	Professional, scientific and technical services	170	94
24	Administrative and support services	99	56
25	Arts and recreation services	108	121
26	Other services	115	96
1-26	**Total market industries**	**62**	**67**
5-13	Manufacturing	77	71
20-21, 23, 25	Knowledge-intensive services	75	68
16-19, 22, 24, 26	Other services	78	81

Table 4 Average labour productivity levels in market industries, 2009, NZ dollars

Industry code		AUS	NZL
		NZ $ (2009)	
1-3	Agriculture, forestry and fishing	49	30
4	Mining	599	260
5	Food, beverage and tobacco product manufacturing	58	64
6	Textile, leather, clothing and footwear manufacturing	30	27
7	Wood and paper products manufacturing	43	33
8	Printing	142	32
9	Petroleum, chemical, polymer and rubber product manufacturing	103	69
10	Non-metallic mineral product manufacturing	113	52
11	Metal product manufacturing	76	38
12	Transport equipment, machinery and equipment manufacturing	74	35
13	Furniture and other manufacturing	17	23
14	Electricity, gas, water and waste services	100	179
15	Construction	80	29
16	Wholesale trade	87	45
17	Retail trade	38	24
18	Accommodation and food services	22	20
19	Transport, postal and warehousing	67	39
20	Information media and telecommunications	81	82
21	Financial and insurance services	248	75
22	Rental, hiring and real estate services	53	130
23	Professional, scientific and technical services	28	47
24	Administrative and support services	30	30
25	Arts and recreation services	42	45
26	Other services	23	27
1-26	**Total market industries**	**68**	**43**
5-13	Manufacturing	61	47

Table 5 Average annual growth rates in total output, total hours worked and average labour productivity, 1997-2010

A: Average annual growth rates in output (%)

Industry code		Output AUS 1997-2008	Output AUS 2008-2010	Output NZL 1997-2008	Output NZL 2008-2010
1-3	Agriculture, forestry and fishing	1.6	7.6	0.0	4.5
4	Mining	2.8	4.3	0.4	-0.6
5	Food, beverage and tobacco product manufacturing	1.0	-5.8	2.9	-2.5
6	Textile, leather, clothing and footwear manufacturing	-5.2	-3.1	-2.8	-0.8
7	Wood and paper products manufacturing	0.3	-7.9	1.5	-4.9
8	Printing	1.3	-4.9	-0.8	-5.4
9	Petroleum, chemical, polymer and rubber product manufacturing	0.5	-4.9	0.1	-5.5
10	Non-metallic mineral product manufacturing	5.2	-2.3	3.5	-10.5
11	Metal product manufacturing	3.2	4.3	2.5	-14.9
12	Transport equipment, machinery and equipment manufacturing	2.5	-3.8	1.7	-8.1
13	Furniture and other manufacturing	1.8	-1.6	0.7	-9.9
14	Electricity, gas, water and waste services	1.4	3.2	1.7	2.3
15	Construction	6.0	1.8	4.9	-7.9
16	Wholesale trade	3.4	2.2	3.7	-5.5
17	Retail trade	4.4	0.9	4.1	-2.7
18	Accommodation and food services	3.3	-3.0	2.5	-1.3
19	Transport, postal and warehousing	4.0	0.6	2.9	-1.7
20	Information media and telecommunications	4.8	1.1	6.4	1.5
21	Financial and insurance services	7.2	0.5	4.7	1.8
22	Rental, hiring and real estate services	1.6	3.1	5.2	-2.0
23	Professional, scientific and technical services	4.7	6.1	4.1	-1.3
24	Administrative and support services	4.5	-4.0	4.7	-7.0
25	Arts and recreation services	4.1	3.7	3.8	-0.8
26	Other services	2.1	0.4	4.1	0.6
	Total market industries	**3.8**	**1.5**	**3.1**	**-2.3**
5-13	Manufacturing	1.7	-2.4	1.6	-5.8

Notes:

1. Estimates of average annual growth rates in output shown in Table 5A can be decomposed between average growth rates in hours worked (Table 5B) and average growth rates in ALP (Table 5C). Where output growth rates in hours worked and ALP do not sum precisely to output growth rates which are shown, this is due to rounding.

B: Average annual growth rates in total hours worked (%)

Industry code		Hours worked AUS 1997-2008	Hours worked AUS 2008-2010	Hours worked NZL 1997-2008	Hours worked NZL 2008-2010
1-3	Agriculture, forestry and fishing	-2.0	1.9	-0.8	0.6
4	Mining	4.3	9.0	3.0	1.9
5	Food, beverage and tobacco product manufacturing	0.7	-0.3	1.1	-2.0
6	Textile, leather, clothing and footwear manufacturing	-7.6	-5.2	-4.1	-11.1
7	Wood and paper products manufacturing	-0.5	-6.2	-0.9	-9.8
8	Printing	-2.3	-2.2	-1.4	-8.7
9	Petroleum, chemical, polymer and rubber product manufacturing	-1.4	-6.1	-1.0	-8.8
10	Non-metallic mineral product manufacturing	-1.4	-9.5	1.0	-11.1
11	Metal product manufacturing	-1.9	-5.5	0.6	-8.3
12	Transport equipment, machinery and equipment manufacturing	-1.0	-2.7	-0.2	-5.4
13	Furniture and other manufacturing	4.9	-3.1	-1.3	-11.1
14	Electricity, gas, water and waste services	4.2	7.6	0.6	4.2
15	Construction	4.5	1.2	4.4	-5.9
16	Wholesale trade	0.6	3.7	1.1	-2.3
17	Retail trade	2.5	-3.5	1.9	-1.3
18	Accommodation and food services	1.3	0.7	2.7	-0.9
19	Transport, postal and warehousing	1.9	1.0	1.1	-0.8
20	Information media and telecommunications	0.5	-4.6	0.8	-4.4
21	Financial and insurance services	2.1	0.0	0.4	-2.7
22	Rental, hiring and real estate services	3.5	-4.8	0.8	-3.6
23	Professional, scientific and technical services	3.4	2.7	3.6	0.2
24	Administrative and support services	2.7	3.7	5.7	-0.6
25	Arts and recreation services	3.2	-0.6	3.9	0.9
26	Other services	1.0	-2.9	0.9	-2.9
	Total market industries	**1.7**	**0.0**	**1.5**	**-2.5**
5-13	Manufacturing	-0.8	-3.6	-0.2	-6.5

C: Average annual growth rates in average labour productivity (%)

Industry code		ALP AUS 1997-2008	ALP AUS 2008-2010	ALP NZL 1997-2008	ALP NZL 2008-2010
1-3	Agriculture, forestry and fishing	3.6	5.7	0.7	3.9
4	Mining	-1.5	-4.7	-2.6	-2.6
5	Food, beverage and tobacco product manufacturing	0.3	-5.5	1.8	-0.5
6	Textile, leather, clothing and footwear manufacturing	2.3	2.1	1.3	10.3
7	Wood and paper products manufacturing	0.7	-1.8	2.5	4.9
8	Printing	3.7	-2.6	0.6	3.3
9	Petroleum, chemical, polymer and rubber product manufacturing	1.9	1.2	1.0	3.3
10	Non-metallic mineral product manufacturing	6.6	7.2	2.4	0.6
11	Metal product manufacturing	5.1	9.8	1.9	-6.6
12	Transport equipment, machinery and equipment manufacturing	3.5	-1.0	1.9	-2.7
13	Furniture and other manufacturing	-3.1	1.5	2.0	1.2
14	Electricity, gas, water and waste services	-2.8	-4.4	1.1	-1.9
15	Construction	1.5	0.5	0.5	-2.0
16	Wholesale trade	2.8	-1.4	2.6	-3.2
17	Retail trade	1.8	4.5	2.2	-1.4
18	Accommodation and food services	2.0	-3.7	-0.2	-0.4
19	Transport, postal and warehousing	2.1	-0.5	1.8	-1.0
20	Information media and telecommunications	4.4	5.7	5.5	5.9
21	Financial and insurance services	5.1	0.5	4.2	4.5
22	Rental, hiring and real estate services	-2.0	7.9	4.4	1.5
23	Professional, scientific and technical services	1.3	3.4	0.5	-1.5
24	Administrative and support services	1.9	-7.7	-1.0	-6.4
25	Arts and recreation services	0.8	4.3	-0.1	-1.7
26	Other services	1.1	3.3	3.2	3.5
	Total market industries	**2.1**	**1.5**	**1.6**	**0.2**
5-13	Manufacturing	2.5	1.1	1.9	0.6

Table 6 Relative labour productivity levels, New Zealand/Australia, 1997-2010, using GGDC PPP exchange rates (Index numbers: Australia = 100)

Industry code		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1-3	Agriculture, forestry and fishing	90	97	79	77	71	69	76	66	63	63	80	66	62	63
4	Mining	48	48	48	41	41	38	40	39	35	37	32	43	43	44
5	Food, beverage and tobacco product manufacturing	87	93	89	84	81	82	92	87	98	96	96	103	112	114
6	Textile, leather, clothing and footwear manufacturing	96	91	90	89	83	77	82	85	86	92	85	85	89	100
7	Wood and paper products manufacturing	59	62	56	67	65	63	67	71	70	75	78	71	77	81
8	Printing	30	31	27	28	27	27	27	25	25	23	21	22	23	24
9	Petroleum, chemical, polymer and rubber product manufacturing	75	70	75	81	79	77	75	62	60	60	60	68	67	71
10	Non-metallic mineral product manufacturing	78	73	67	73	59	54	58	55	44	45	42	50	46	44
	Metal product manufacturing	86	88	91	103	88	81	88	87	75	80	71	60	49	43
12	Transport equipment, machinery and equipment manufacturing	62	63	57	58	60	56	53	50	47	52	50	52	48	50
13	Furniture and other manufacturing	78	88	99	94	98	92	87	107	179	143	134	137	134	136
14	Electricity, gas, water and waste services	119	129	162	168	176	171	182	182	173	168	178	181	179	191
15	Construction	44	43	36	41	43	39	37	39	38	36	39	40	36	38
16	Wholesale trade	54	51	52	59	61	61	53	51	52	52	55	53	52	51
17	Retail trade	64	63	61	67	64	61	63	61	64	66	66	67	62	59
18	Accommodation and food services	109	103	93	95	93	88	85	85	88	85	84	86	88	92
19	Transport, postal and warehousing	57	57	60	60	59	56	54	54	55	55	51	56	57	55
20	Information media and telecommunications	90	82	81	102	112	102	111	106	112	109	109	103	101	103
21	Financial and insurance services	32	32	32	32	33	32	32	31	30	31	30	29	30	32
22	Rental, hiring and real estate services	137	129	132	136	154	173	190	219	223	240	286	275	247	243
23	Professional, scientific and technical services	205	199	183	193	176	168	174	164	165	172	180	189	170	171
24	Administrative and support services	146	137	127	128	135	119	129	124	123	122	117	106	99	109
25	Arts and recreation services	131	132	137	126	118	128	120	113	110	119	109	117	108	104
26	Other services	91	97	107	108	99	113	108	107	112	107	103	116	115	116
	Total market industries	**68**	**67**	**65**	**67**	**66**	**63**	**64**	**63**	**64**	**64**	**64**	**65**	**62**	**63**
5-13	Manufacturing	84	85	83	85	82	78	81	78	81	81	77	78	77	77
	Using OECD-based PPP														
20	Information media and telecommunications	65	59	59	74	81	74	81	77	81	79	79	74	73	75

Table 7 Shift-share decomposition of the Australia-New Zealand gap in ALP in aggregate market industries, 2009

Industry code	Industry name	Mean of NZ and Australian productivity levels (US$ per hour worked)	NZ industry shares of total hours worked (%)	Australian industry shares of total hours worked (%)	Within-industry productivity effect	Employment structure effect	Total effect
		2009	2009	2009	2009	2009	2009
1-3	Agriculture, forestry and fishing	17	9.8	5.3	3.4	-4.2	-0.8
4	Mining	151	0.5	2.6	10.2	16.9	27.1
5	Food, beverage and tobacco product manufacturing	35	5.1	2.8	-0.8	-4.4	-5.2
6	Textile, leather, clothing and footwear manufacturing	26	0.9	0.6	0.1	-0.5	-0.4
7	Wood and paper products manufacturing	23	1.8	0.9	0.4	-1.1	-0.7
8	Printing	25	0.8	0.6	1.2	-0.2	1.0
9	Petroleum, chemical, polymer and rubber product manufacturing	39	1.5	1.2	1.1	-0.8	0.3
10	Non-metallic mineral product manufacturing	30	0.6	0.5	0.7	-0.1	0.6
11	Metal product manufacturing	34	2.2	2.1	2.7	-0.3	2.4
12	Transport equipment, machinery and equipment manufacturing	14	3.1	2.8	1.6	-0.3	1.4
13	Furniture and other manufacturing	11	0.8	1.8	-0.2	0.6	0.4
14	Electricity, gas, water and waste services	243	1.1	1.7	-10.6	8.8	-1.8
15	Construction	55	12.0	13.1	35.4	3.3	38.7
16	Wholesale trade	14	6.5	5.3	2.8	-0.9	1.9
17	Retail trade	13	11.8	12.4	4.1	0.4	4.5
18	Accommodation and food services	16	6.1	7.0	0.7	0.8	1.6
19	Transport, postal and warehousing	48	6.5	7.8	10.0	3.4	13.3
20	Information media and telecommunications	42	2.3	2.8	-0.1	1.2	1.1
21	Financial and insurance services	99	4.1	5.0	26.3	5.1	31.4
22	Rental, hiring and real estate services	67	2.1	2.4	-6.9	1.3	-5.6
23	Professional, scientific and technical services	42	9.3	9.9	-11.5	1.5	-10.0
24	Administrative and support services	32	4.5	3.7	0.1	-1.4	-1.3
25	Arts and recreation services	27	2.0	2.1	-0.2	0.2	0.0
26	Other services	20	4.5	5.5	-0.8	1.0	0.2
	Total market industries	**40**	**100.0**	**100.0**	**69.8**	**30.2**	**100.0**

Table 8 Shift-share decomposition of the Australia-New Zealand gap in ALP in aggregate market industries, 1997

Industry code	Industry name	Mean of NZ and Australian productivity levels (US$ per hour worked)	NZ industry shares of total hours worked (%)	Australian industry shares of total hours worked (%)	Within-industry productivity effect	Employment structure effect	Total effect
		1997	1997	1997	1997	1997	1997
1-3	Agriculture, forestry and fishing	15	12.5	7.7	2.4	-10.2	-7.8
4	Mining	87	0.4	1.7	9.5	16.0	25.5
5	Food, beverage and tobacco product manufacturing	21	5.3	3.1	1.7	-6.7	-5.0
6	Textile, leather, clothing and footwear manufacturing	20	1.9	1.7	0.2	-0.7	-0.5
7	Wood and paper products manufacturing	17	2.5	1.2	2.3	-3.3	-1.0
8	Printing	17	1.1	1.1	3.0	-0.2	2.8
9	Petroleum, chemical, polymer and rubber product manufacturing	23	2.1	1.8	1.9	-1.0	0.9
10	Non-metallic mineral product manufacturing	13	0.7	0.8	0.3	0.3	0.6
11	Metal product manufacturing	18	2.6	3.3	1.2	1.8	3.0
12	Transport equipment, machinery and equipment manufacturing	17	3.7	4.0	4.4	0.6	5.0
13	Furniture and other manufacturing	11	1.2	1.3	0.7	0.1	0.8
14	Electricity, gas, water and waste services	185	1.1	1.2	-5.3	1.9	-3.3
15	Construction	25	8.8	9.4	25.4	2.1	27.5
16	Wholesale trade	10	6.8	5.8	5.6	-1.4	4.2
17	Retail trade	9	11.4	11.6	6.7	0.4	7.0
18	Accommodation and food services	10	5.5	7.4	-0.8	2.8	2.0
19	Transport, postal and warehousing	32	6.5	7.2	17.5	2.9	20.4
20	Information media and telecommunications	26	2.5	3.3	1.1	3.2	4.3
21	Financial and insurance services	48	4.7	4.9	34.4	1.3	35.7
22	Rental, hiring and real estate services	38	2.3	2.0	-3.7	-1.4	-5.2
23	Professional, scientific and technical services	28	7.2	8.3	-21.8	4.7	-17.2
24	Administrative and support services	25	2.7	3.4	-4.2	2.4	-1.8
25	Arts and recreation services	18	1.5	1.7	-1.1	0.7	-0.4
26	Other services	10	4.9	6.0	0.7	1.7	2.4
	Total market industries	**23**	**100.0**	**100.0**	**82.2**	**17.8**	**100.0**

Table 9 Changes in industry employment shares, 1997-2009, ordered by absolute levels of average labour productivity in 2009

	Percentage point change in New Zealand employment share, 1997-2009	Percentage point change in Australian employment share, 1997-2009	AUS-NZ difference in employment share changes, 1997-2009 (pp)	Mean of NZ and Australian productivity levels (US$ per hour worked)
Electricity, gas, water and waste services	-0.01	0.58	0.59	243
Mining	0.11	0.91	0.80	151
Financial and insurance services	-0.59	0.16	0.75	99
Rental, hiring and real estate services	-0.23	0.36	0.60	67
Construction	3.17	3.70	0.52	55
Transport, postal and warehousing	-0.09	0.59	0.68	48
Professional, scientific and technical services	2.12	1.63	-0.49	42
Information media and telecommunications	-0.17	-0.52	-0.35	42
Petroleum, chemical, polymer and rubber product manufacturing	-0.60	-0.67	-0.08	39
Food, beverage and tobacco product manufacturing	-0.21	-0.33	-0.11	35
Metal product manufacturing	-0.33	-1.16	-0.83	34
Administrative and support services	1.75	0.32	-1.43	32
Non-metallic mineral product manufacturing	-0.07	-0.29	-0.22	30
Arts and recreation services	0.52	0.40	-0.12	27
Textile, leather, clothing and footwear manufacturing	-0.98	-1.12	-0.14	26
Printing	-0.35	-0.41	-0.07	25
Wood and paper products manufacturing	-0.75	-0.26	0.49	23
Other services	-0.35	-0.57	-0.22	20
Agriculture, forestry and fishing	-2.69	-2.42	0.27	17
Accommodation and food services	0.60	-0.44	-1.04	16
Transport equipment, machinery and equipment manufacturing	-0.59	-1.16	-0.57	14
Wholesale trade	-0.34	-0.54	-0.20	14
Retail trade	0.46	0.74	0.28	13
Furniture and other manufacturing	-0.40	0.50	0.90	11

4 Relative capital-intensity

To carry out a benchmark comparison of capital stocks at industry level for each country, we make use of National Accounts data on gross fixed capital formation and then use a perpetual inventory method that cumulates constant price investments and deducts the value of depreciated assets. To derive comparable estimates of net capital stocks in New Zealand and Australia, common industry-specific depreciation rates (based on US estimates) are applied to the investment data for each country. This approach follows O'Mahony (1993, 1999) who has shown that cross-country comparisons based on official capital stocks estimates are sensitive to differences in measurement techniques used by national statistical offices.

SNZ (2013c) distinguishes the following six capital asset types relevant to industrial productivity analysis:

1. Non-residential buildings
2. Other construction
3. Land improvements (including capitalised expenditures on cultivated biological resources such as orchards and vineyards but not expenditures on livestock)
4. Transport equipment
5. Plant, machinery and equipment (including computers)
6. Intangible fixed assets (comprising oil and gas exploration, other exploration and computer software but not including expenditure on R&D or on literary or artistic originals)

Australian data on gross fixed capital formation differ from New Zealand data in the following main respects:

1. Land improvement is included in the non-dwelling construction category (ABS, 2012b, p635).
2. Cultivated biological resources are shown separately and include livestock as well as resources such as orchards and vineyards.
3. Data on intangible investments include estimates of R&D investments and on literary and artistic originals as well as the intangible assets listed above for New Zealand.
4. Computers are shown separately from other types of machinery and equipment.

In the light of these differences we distinguish the following four groups of capital assets which can be adequately compared between the two countries:

1. Structures (comprising non-residential buildings and other construction) and land improvement (excluding livestock)
2. Plant, machinery and equipment (including computers)
3. Transport equipment
4. Intangible assets (excluding R&D and literary and artistic originals)

The exclusion of livestock and intangibles such as R&D from our estimates of capital stocks means that the impacts of these capital assets on labour productivity performance will be picked up in our estimates of residual MFP.[17] We are also unable to take account of differences in land-intensity in agriculture. These exclusions are regrettable but, in common with IMF (2002), our prime concern is to ensure comparability between countries in our measurement of capital stocks.[18]

Having defined these four groups of capital assets, investment data in national currencies are converted to US$ using OECD PPPs for investment goods by asset type. Since New Zealand data on gross fixed capital formation by industry under the ANZSIC 2006 classification are only available since 1986, we confine our analysis for both countries to a 1986 starting point. In order to implement the perpetual inventory formula, starting values for capital stocks in that year are estimated by raising investment for that year by a factor equal to 0.5* ($1/d_j$) where d_j denotes the depreciation rate for asset type j.

Thus letting *c* denote types of capital, with *I* denoting investment and *d* the (geometric) depreciation rate, capital stocks are measured as:

$$K^k_{ic,t} = K^k_{ic,t-1}(1 - d_{ic}) + I^k_{ic,t} \qquad (4)$$

The assumption of geometric depreciation rates has the advantage that it is easy to implement. Its main disadvantage is that assets are depreciated rapidly at the beginning of the asset's life but depreciation then tails off subsequently. This assumption is more reasonable for assets where technological change is rapid than it is for assets such as structures.

This method yields benchmark comparisons of net capital stocks at industry level for 2009. In principle it would be preferable to derive a measure of capital services which takes account of the relative productivity of each type of asset but it is beyond the scope of this report to generate the required estimates of user costs of capital assets at industry level. Arguably, our use of industry-specific depreciation rates takes some account of inter-industry differences in the mix of capital assets in use (Arnaud et al., 2011). And the drawbacks of relying on a benchmark measure of net capital stocks are also mitigated by the use of official estimates of growth in capital services to derive time series of capital-labour ratios at industry level between 1997-2010 (described below).

In both Australia and New Zealand the highest absolute levels of capital-intensity are found in electricity, gas and water, mining, rental, hiring and real estate services, information media and telecommunications and in transport, postal and warehousing (Table 10, Columns 1-2). Across market industries as a whole average capital-intensity in New Zealand is about 62% of the Australian level (Column 3). This is consistent with previous estimates based on direct use of official capital stocks estimates for each country which also identified relatively low levels of capital-intensity in New Zealand compared to Australia (for example, Hall & Scobie, 2005; Schreyer, 2008; NZIER, 2011). This consistency is reassuring given the emphasis placed here on using common industry-specific depreciation rates when calculating capital stocks for each country. This choice was made to avoid the effects of arbitrary differences between national statistical offices in assumptions about depreciation rates; however, in some cases where the

[17] In the case of livestock we used ABS estimates of productive capital stocks by industry which itemised different types of biological resource to estimate the livestock shares of total investments in biological resources and then deducted livestock investments from gross fixed capital formation in Australian industries. Excluding R&D and literary and artistic originals from intangible assets in the Australian data was straightforward as the Australian National Accounts show investments in these assets separately from other types of intangible asset.

[18] Note that transfer costs associated with change of ownership are treated as part of gross fixed capital formation for each asset-type by SNZ. ABS (2012b, p438) states that 'ownership transfer costs relating to non-dwelling construction are allocated to industry using industry proportions of chain volume non-dwelling construction by industry. This approach assumes that the proportion of ownership transfer costs to non-dwelling construction at a point in time does not vary between industries'.

nature of capital equipment in use in particular industries varies greatly between countries, inter-country differences in assumed depreciation rates may be well-founded.

At industry level Australia exhibits higher capital-intensity in a wide range of production and service industries. This includes agriculture where relatively high levels of capital-intensity in Australia are partly attributed by Sheng, Nossal & Ball (2013) to an abundance of land leading to specialisation in activities which depend heavily on capital inputs such as cropping machinery. New Zealand is more capital-intensive in only five of the 24 industries and only one of these (electricity, gas and water) has a high absolute level of capital-intensity. The other four industries where New Zealand is ahead – furniture and other manufacturing, construction, professional/scientific services and other services – are all industries with relatively low absolute levels of capital-intensity in both countries.

Table 11 shows that, across all market industries, average capital per hour worked is higher in Australia for all four types of capital asset that have been identified. The only industry where New Zealand is ahead in respect of all four types of capital is electricity, gas and water. This industry provides a clear example of very different capital requirements in the two countries since about 55% of electricity generated in New Zealand derives from hydro-power facilities (compared to 6% in Australia) while some 79% of Australian electricity is coal-based (compared to 7% in New Zealand).[19]

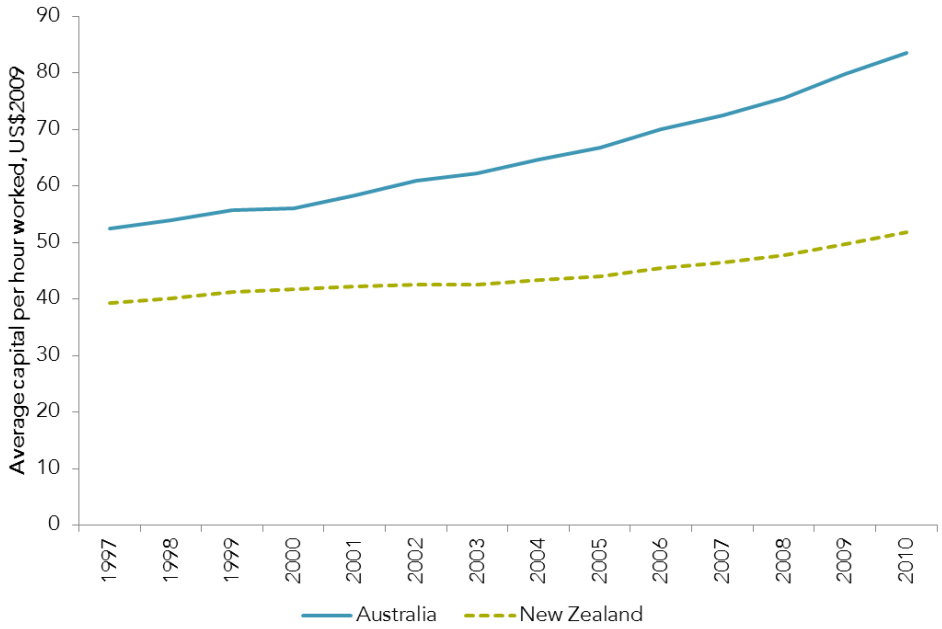
New Zealand also exhibits higher levels of intangible capital per hour worked in several industries but, as noted above, the restricted set of assets included in the intangibles category defined here omit key intangibles such as R&D and account for only a small proportion of total capital assets (Table 12). One striking finding shown in Table 11 is that the use of machinery and equipment (including computers) per hour worked in information media and telecommunications is more than twice as high in New Zealand as it is in Australia.[20] Further research on this industry would be useful to establish the reasons for this difference and its effects on relative performance. Australia is ahead on the intensity of machinery and equipment use in all other industries apart from electricity, gas and water and arts, recreation and other services.

Using the net capital stock levels estimated for 2009 as benchmarks, industry-level growth rates for capital stocks between 1997-2010 were derived using indices of capital services published by SNZ and ABS. Across total market industries average capital per hour worked in Australia grew by an average 3.6% pa during this period compared to 2.1% pa in New Zealand, with the gap widening most strongly from 2004 onwards (Figure 5). As a result the 38% gap identified above in relative capital-intensity levels in 2009 was an estimated 13 percentage points higher than it had been in 1997.

[19] These figures on fuel use for electricity generation refer to 2006-07. Sources: Ministry for the Environment (2009); Department of Resources, Energy & Tourism (2011).

[20] Although Table 11 also shows higher intangible assets per hour worked in information media and telecommunications in New Zealand than in Australia, these estimates need to be treated with caution since, for reasons described in the main text of this section, they exclude intangible assets such as R&D and literary and artistic originals which are important in this industry.

Figure 5 Average capital per hour worked (US$2009), total market industries, 1997-2010



Source: SNZ (2012c), ABS (2012a).

The evolution over time in relative capital-intensity at industry level is shown in Table 13. In seven industries New Zealand was ahead on capital-intensity at the beginning of the period but behind by 2009: food, drink and tobacco manufacturing; textiles and clothing; printing; non-metallic mineral product manufacturing; and administrative and support services. The only industries where capital-intensity in New Zealand increased relative to Australia over this period were electricity, gas and water, financial and insurance services and miscellaneous manufacturing.

Shift-share analysis in respect of capital-intensity (similar to that described in Section 3.5) suggests that almost 40% of the Australian lead on average capital per hour worked can be attributed to differences in industrial structure (Table 14). The key differences are the higher proportion of Australian hours worked in mining, utilities and transport, postal and warehousing (where capital-intensity levels are relatively high in both countries) and the higher proportion of New Zealand hours worked in agriculture where capital-intensity levels are closer to the average for market industries as a whole.

This still leaves a marked gap in business investment levels which underly the differences in capital-intensity between the two countries. This has been the subject of considerable discussion and debate in New Zealand. Some researchers emphasise the effects of relatively low labour costs in New Zealand compared to the costs of capital (IMF, 2002; Hall & Scobie, 2005). Others stress the relatively high costs of borrowing for investment purposes in New Zealand, which is partly linked to relatively low rates of domestic saving (see OECD, 2011, for a summary of evidence on these issues). A third line of analysis points to the negative effects of relatively low MFP levels on firms' investment intentions, since the expected efficiency of capital utilisation enters into firms' evaluations of the likely cost-effectiveness of potential new investments (Dupuy & Beard, 2008). However, as Hulten (2009) emphasises, there is likely to be two-way interdependence between MFP and capital-deepening since, among other things, increases in capital create scope for knowledge spillovers between firms that help to raise MFP. As will be discussed in Section 6, interdependencies of this kind complicate our evaluation of the relative importance of different factors contributing to the ALP gap.

Table 10 Average capital per hour worked, 2009, US$ and relative capital-intensity

Industry code		AUS	NZL	Relative capital-intensity
		US$	US$	Index numbers: AUS=100
1-3	Agriculture, forestry and fishing	92	53	58
4	Mining	383	356	93
5	Food, beverage and tobacco product manufacturing	57	49	86
6	Textile, leather, clothing and footwear manufacturing	24	14	58
7	Wood and paper products manufacturing	66	27	41
8	Printing	42	40	95
9	Petroleum, chemical, polymer and rubber product manufacturing	115	63	55
10	Non-metallic mineral product manufacturing	72	48	67
11	Metal product manufacturing	109	23	21
12	Transport equipment, machinery and equipment manufacturing	38	17	44
13	Furniture and other manufacturing	3	13	385
14	Electricity, gas, water and waste services	651	846	130
15	Construction	13	14	111
16	Wholesale trade	45	15	32
17	Retail trade	18	12	64
18	Accommodation and food services	44	18	40
19	Transport, postal and warehousing	196	123	63
20	Information media and telecommunications	235	171	73
21	Financial and insurance services	67	28	42
22	Rental, hiring and real estate services	285	274	96
23	Professional, scientific and technical services	13	13	102
24	Administrative and support services	17	8	46
25	Arts and recreation services	94	65	70
26	Other services	8	16	207
	Total market industries	**80**	**50**	**62**
5-13	Manufacturing	58	35	60

Table 11 Average capital per hour worked, 2009, analysed by asset type (Index numbers: Australia = 100)

Industry code		Structures and land improvements	Machinery and equipment, incl. computers	Vehicles, transport equipment	Intangibles	Total capital assets
		Average capital per hour worked: Australia = 100				
1-3	Agriculture, forestry and fishing	58	49	63	145	58
4	Mining	98	59	235	128	93
5-13	Manufacturing	44	84	56	148	60
14	Electricity, gas, water and waste services	131	113	156	169	130
15	Construction	128	80	115	127	111
16	Wholesale trade	23	44	45	74	32
17-18	Retail and accommodation services	42	87	36	99	50
19	Transport, postal and warehousing	56	75	96	57	63
20	Information media and telecommunications	47	230	50	248	73
21	Financial and insurance services	21	96	87	121	42
22	Rental, hiring and real estate services	98	41	125	106	96
23-24	Professional and administrative services	75	80	87	121	82
25-26	Arts, recreation and other services	95	143	63	193	98
1-26	**Total market industries**	**57**	**78**	**83**	**78**	**62**

Notes:

1. Some industries have been combined in this table because the underlying data on gross fixed capital formation are only available in New Zealand for these combinations of industries.

Table 12 Capital stocks, 2009, analysed by asset type

(A) Australia

Industry code		Structures and land improve-ments	Machinery and equipment, incl. computers	Vehicles, transport equipment	Intangibles	Total capital assets
		% of total capital assets				
1-3	Agriculture, forestry and fishing	79	12	8	0	100
4	Mining	74	20	2	4	100
5-13	Manufacturing	60	36	3	1	100
14	Electricity, gas, water and waste services	91	8	1	0	100
15	Construction	48	29	21	1	100
16	Wholesale trade	59	28	10	2	100
17-18	Retail and accommodation services	75	18	7	1	100
19	Transport, postal and warehousing	80	5	15	1	100
20	Information media and telecommunications	85	13	1	1	100
21	Financial and insurance services	73	15	6	6	100
22	Rental, hiring and real estate services	74	11	14	0	100
23-24	Professional and administrative services	43	36	14	7	100
25-26	Arts, recreation and other services	81	11	8	1	100
1-26	**Total market industries**	**76**	**15**	**7**	**2**	**100**

(B) New Zealand

Industry code		Structures and land improve-ments	Machinery and equipment, incl. computers	Vehicles, transport equipment	Intangibles	Total capital assets
		% of total capital assets				
1-3	Agriculture, forestry and fishing	80	11	9	0	100
4	Mining	78	13	4	6	100
5-13	Manufacturing	44	51	3	2	100
14	Electricity, gas, water and waste services	92	7	1	1	100
15	Construction	56	21	22	2	100
16	Wholesale trade	43	38	14	5	100
17-18	Retail and accommodation services	62	31	5	2	100
19	Transport, postal and warehousing	71	6	23	0	100
20	Information media and telecommunications	55	41	0	3	100
21	Financial and insurance services	37	34	13	16	100
22	Rental, hiring and real estate services	76	5	19	0	100
23-24	Professional and administrative services	39	36	15	11	100
25-26	Arts, recreation and other services	78	15	5	2	100
1-26	**Total market industries**	**69**	**19**	**10**	**2**	**100**

Table 13 **Average capital per hour worked, 1997-2010** (Index numbers: Australia = 100)

Industry code		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1-3	Agriculture, forestry and fishing	60	65	61	61	57	59	53	53	53	52	55	56	58	56
4	Mining	92	88	85	80	81	79	81	91	88	89	87	88	93	92
5	Food, beverage and tobacco product manufacturing	119	120	117	109	102	102	97	87	93	83	82	85	86	85
6	Textile, leather, clothing and footwear manufacturing	109	103	106	96	89	81	78	67	60	61	55	56	58	61
7	Wood and paper products manufacturing	48	50	50	49	48	48	48	52	44	43	43	38	41	39
8	Printing	139	140	131	130	125	120	127	115	113	98	94	95	95	104
9	Petroleum, chemical, polymer and rubber product manufacturing	80	73	79	83	77	78	75	64	55	51	52	58	55	58
10	Non-metallic mineral product manufacturing	120	113	114	113	96	95	97	87	70	69	62	70	67	70
11	Metal product manufacturing	37	36	35	34	32	28	28	25	21	23	23	22	21	22
12	Transport equipment, machinery and equipment manufacturing	68	69	62	62	59	60	58	53	49	49	49	47	44	48
13	Furniture and other manufacturing	238	267	288	250	287	288	272	294	424	322	319	357	385	402
14	Electricity, gas, water and waste services	90	102	124	136	144	146	147	140	133	133	132	125	130	130
15	Construction	110	113	113	118	110	107	106	111	112	114	124	118	111	111
16	Wholesale trade	55	52	49	52	49	46	42	40	36	35	36	32	32	33
17	Retail trade	77	76	74	77	73	71	70	69	70	70	70	68	64	59
18	Accommodation and food services	48	44	41	42	42	39	38	40	42	41	39	40	40	39
19	Transport, postal and warehousing	64	64	68	65	64	59	58	59	59	58	56	62	63	60
20	Information media and telecommunications	84	81	85	94	99	85	92	84	85	85	83	76	73	72
21	Financial and insurance services	34	35	36	35	36	38	38	39	38	38	37	38	42	46
22	Rental, hiring and real estate services	178	159	153	143	139	138	139	141	128	123	119	102	96	90
23	Professional, scientific and technical services	132	128	122	123	120	111	113	111	108	110	108	110	102	103
24	Administrative and support services	113	96	92	79	83	69	65	60	56	53	50	49	46	50
25	Arts and recreation services	90	81	79	71	68	70	65	65	67	71	68	71	70	64
26	Other services	439	397	386	373	341	345	305	284	267	247	231	230	207	189
	Total market industries	**75**	**75**	**74**	**74**	**72**	**70**	**68**	**67**	**66**	**65**	**64**	**63**	**62**	**62**
5-13	Manufacturing	84	83	82	79	75	73	72	66	64	60	59	60	60	61

Table 14 Shift-share decomposition of the Australia-New Zealand gap in average capital per hour worked in aggregate market industries, 2009

Industry code	Industry name	Mean of NZ and Australian capital-intensity levels (US$ per hour worked)	NZ industry shares of total hours worked (%)	Australian industry shares of total hours worked (%)	Within-industry productivity effect	Employment structure effect	Total effect
		2009	2009	2009	2009	2009	2009
1-3	Agriculture, forestry and fishing	73	9.8	5.3	9.8	-10.9	-1.1
4	Mining	370	0.5	2.6	1.4	25.3	26.7
5	Food, beverage and tobacco product manufacturing	53	5.1	2.8	1.0	-4.1	-3.1
6	Textile, leather, clothing and footwear manufacturing	19	0.9	0.6	0.3	-0.2	0.0
7	Wood and paper products manufacturing	47	1.8	0.9	1.7	-1.3	0.4
8	Printing	41	0.8	0.6	0.1	-0.2	-0.2
9	Petroleum, chemical, polymer and rubber product manufacturing	89	1.5	1.2	2.3	-1.1	1.2
10	Non-metallic mineral product manufacturing	60	0.6	0.5	0.5	-0.2	0.3
11	Metal product manufacturing	66	2.2	2.1	6.1	-0.3	5.8
12	Transport equipment, machinery and equipment manufacturing	28	3.1	2.8	2.1	-0.3	1.8
13	Furniture and other manufacturing	8	0.8	1.8	-0.4	0.3	-0.1
14	Electricity, gas, water and waste services	749	1.1	1.7	-9.2	16.5	7.3
15	Construction	14	12.0	13.1	-0.6	0.5	-0.1
16	Wholesale trade	30	6.5	5.3	6.0	-1.2	4.9
17	Retail trade	15	11.8	12.4	2.6	0.3	2.9
18	Accommodation and food services	31	6.1	7.0	5.7	1.0	6.7
19	Transport, postal and warehousing	159	6.5	7.8	17.2	6.9	24.1
20	Information media and telecommunications	203	2.3	2.8	5.4	3.4	8.9
21	Financial and insurance services	47	4.1	5.0	5.8	1.5	7.3
22	Rental, hiring and real estate services	280	2.1	2.4	0.8	3.2	4.1
23	Professional, scientific and technical services	13	9.3	9.9	-0.1	0.3	0.2
24	Administrative and support services	13	4.5	3.7	1.3	-0.3	0.9
25	Arts and recreation services	79	2.0	2.1	1.9	0.4	2.3
26	Other services	12	4.5	5.5	-1.4	0.4	-1.0
27	**Total market industries**	**65**	**100.0**	**100.0**	**60.5**	**39.5**	**100.0**

5 Cross-country differences in skills

As intangible assets, skills are notoriously difficult to measure and compare across countries. Typically, use is made of proxy measures of skill such as years of completed schooling or formal qualifications. The latter have the advantage of capturing something of what has actually been learned while undergoing education, rather than just signifying attendance. However, they have the disadvantage of being hard to compare across countries with different education systems and, like the years of schooling measure, they ignore skills acquired in the workplace without formal certification. One way to try and take account of uncertified skills as well as certified skills is to build on quality-adjusted skills measures developed for growth accounting purposes, as in Jorgenson, Ho & Stiroh (2005), which make use of educational qualifications data combined with relative earnings data in order to capture differences in relative productivity between different qualification groups. Since individual productivity reflects the possession of uncertified skills as well as certified educational attainments, we expect this approach to help to produce better skill measures than those which are based solely on formal qualifications.

The use of relative earnings data for this purpose rests on an assumption of perfectly competitive markets in which a firm will hire an additional hour of labour up to the point where that worker's marginal productivity equals his/her marginal cost. Under this assumption, a measure of quality-adjusted total labour input can be obtained by weighting each different type of labour input (as signified by qualification levels) by its relative wage rate or the share that each type of labour occupies in total labour compensation. In fact, of course, employee wages may deviate from their marginal products due to imperfect labour market conditions and the operations of country-specific labour market institutions such as collective bargaining procedures and minimum wage legislation. Nonetheless, wage-based measures of relative labour quality go further than any other type of available measure towards capturing variations in relative marginal products across different qualification groups in different countries (Mason, O'Leary & Vecchi, 2012).

Another problem in measuring skills is that even formal qualification categories may be hard to match across countries. For example, in Australia and New Zealand available data from the ABS Survey of Education and Work and the New Zealand Income Survey on the highest level of qualifications held by workers enable us to classify those workers to three ostensibly similar groups of qualifications at industry level:

1. Graduates – Bachelor degrees and higher degrees

2. Post-secondary school qualifications below Bachelor degree level

3. No post-school qualifications

But in each country these groups contain different mixes of qualifications which are not directly comparable with qualifications in the other country. For example, in Australia the 'Post-school qualifications below Bachelor degree level' group includes Advanced Diplomas, Diplomas and Certificates at Australian Levels I-IV and 'level not known'; in New Zealand this group includes qualifications at New Zealand Levels 1-6 such as Undergraduate Diplomas and Certificates, National Diplomas, Advanced Trade Certificates and Trade Certificates and National Certificates.

In an effort to surmount this problem, our approach is to benchmark on the relatively low-skilled 'No post-school qualifications' category and then use ratios of mean wages in the other two qualification groups to low-skilled wages in each country as indicators of labour quality differences between the respective qualification groups. In this way all hours worked by workers in Groups 1 and 2 can be calculated as 'effective units of labour' relative to Group 3.

Formally, we first derive a measure of quality-adjusted labour (QAL) by aggregating employment by qualification levels multiplied by the wage relative to the low-skilled category. For each industry *i* and country *j* we compute the following index:

$$QAL_{ij} = \sum_{1}^{\Theta} l_{i\,j\theta} * \frac{w_{ij\theta}}{w_{ij\_lowsk}} \qquad (5)$$

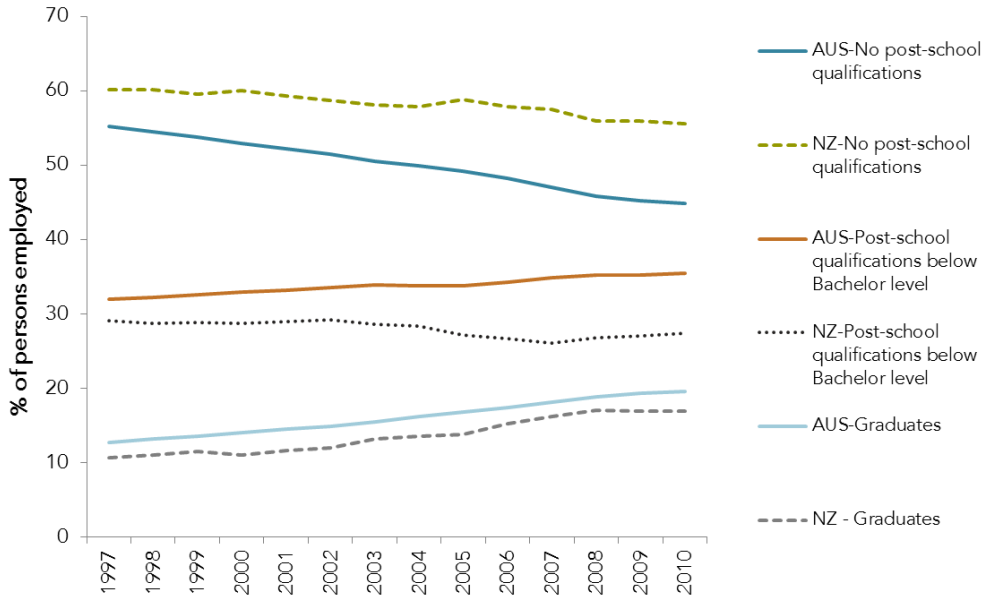
where $l_{ij\theta}$ is the total number of hours worked by qualification group θ in industry *i* and country *j*, Θ is the total number of qualification groups, $w_{ij\theta}$ is the average wage of workers in qualification group θ and w_{ij_lowsk} is the average wage of low-skilled workers. A measure of skills is then obtained by taking the ratio of quality-adjusted labour inputs to the total number of unadjusted hours worked (H_{ij}):

$$Skills_{ij} = \left(\frac{QAL_{ij}}{H_{ij}} \right) \qquad (6)$$

Figure 6 shows recent trends in the qualifications data underlying these calculations. Both countries have seen fairly similar increases in the graduate share of employment in total market industries since 1997, with workers in this category rising to 20% of total employment in Australia in 2010 and 17% in New Zealand. The intermediate skills category – post-school qualifications below Bachelor degree level (which includes many vocational qualifications) – also rose steadily over this period in Australia (accounting for 35% of employment in 2010). But in New Zealand the employment share of this group declined slightly from 29% between 1997-2003 to 27% in 2010. As a result the share of low-skilled workers – those without post-secondary school qualification – declined much more sharply in Australia over this period than it did in New Zealand.

As shown in Table 15, there are marked variations between industries in the mix of qualifications with the highest graduate shares in both countries occurring in industries such as professional and scientific services, information media and telecommunications, finance and insurance and utilities. The same is true of post-school qualifications below Bachelor degree level (such as trade certificates) which are most common in industries such as machinery and equipment manufacturing and construction in both countries.

Figure 6 Highest qualifications held by workers in total market industries, 1997-2010



Source: Derived from ABS, Survey of Education and Work, 1998-2010 (extrapolated back to 1997) and SNZ, New Zealand Income Survey, 1997-2010.

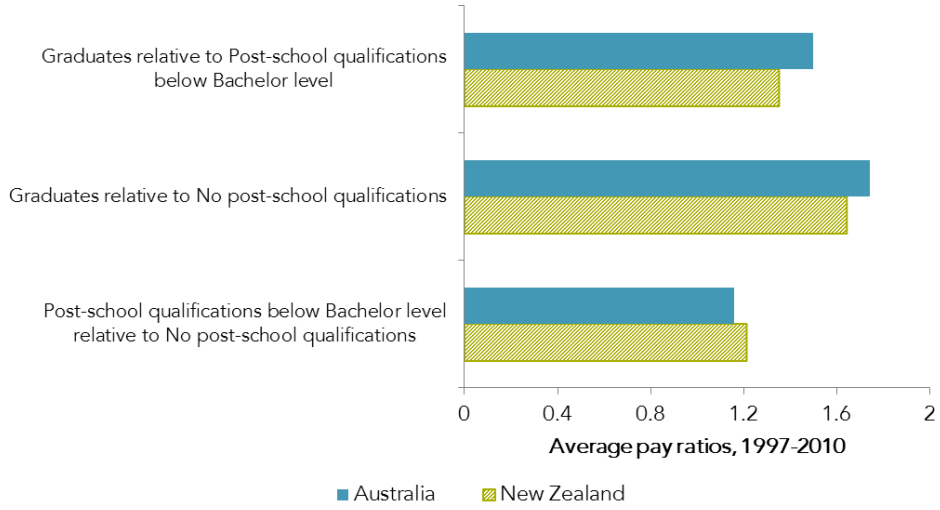
Table 15 Highest qualifications held by workers, by industry (percent of total industry workforce, 2009)

Sector name	NZ Graduates 2009	AUS Graduates 2009	NZ Post-school below Bachelor level 2009	AUS Post-school below Bachelor level 2009	NZ No post-school qualifications 2009	AUS No post-school qualifications 2009	NZ Total 2009	AUS Total 2009
Agriculture, forestry and fishing	9	11	25	33	66	56	100	100
Mining	13	23	29	42	57	36	100	100
Food, beverage and tobacco manufacturing	10	15	21	29	69	56	100	100
Textile and apparel manufacturing	8	12	20	28	72	60	100	100
Wood and paper product manufacturing	6	9	32	41	61	50	100	100
Printing	9	15	38	48	53	37	100	100
Petroleum, chemical, plastic and rubber product manufacturing	16	25	25	32	58	43	100	100
Non-metallic mineral product manufacturing	9	11	26	36	65	53	100	100
Metal product manufacturing	7	11	35	46	58	43	100	100
Machinery and equipment manufacturing	12	17	42	47	45	37	100	100
Furniture and other manufacturing	8	10	33	43	59	47	100	100
Electricity, gas and water supply	23	24	30	45	47	31	100	100
Construction	6	8	41	53	53	39	100	100
Wholesale trade	15	19	24	32	60	49	100	100
Retail trade	10	12	20	28	70	61	100	100
Accommodation and food services	11	11	21	28	68	61	100	100
Transport, postal and warehousing	8	13	23	34	69	53	100	100
Information media and telecommunications	30	38	24	27	46	35	100	100
Finance and insurance	32	40	19	27	49	33	100	100
Rental, hiring and real estate services	18	18	28	43	54	39	100	100
Professional, scientific and technical services	47	55	22	24	31	21	100	100
Administrative and support services	19	18	24	34	56	48	100	100
Arts and recreation services	26	26	24	32	50	42	100	100
Other services	15	13	41	51	44	36	100	100
Total market industries	**17**	**19**	**27**	**35**	**56**	**45**	**100**	**100**
Manufacturing	10	14	30	40	61	46	100	100

Source: Derived from ABS, Survey of Education and Work and SNZ, New Zealand Income Survey and Census 2006.

The two countries vary in terms of the pay premia attached to each qualification group: between 1997-2010 graduate salaries in Australia were roughly 50% higher on average than the salaries earned by holders of post-school qualifications below Bachelor level, compared to a 35% pay differential in New Zealand. By contrast, the average pay differential between the intermediate skills group and the low-skilled group over this period was slightly wider in New Zealand than Australia (Figure 7).

Figure 7 Average pay ratios, 1997-2010, analysed by qualifications group



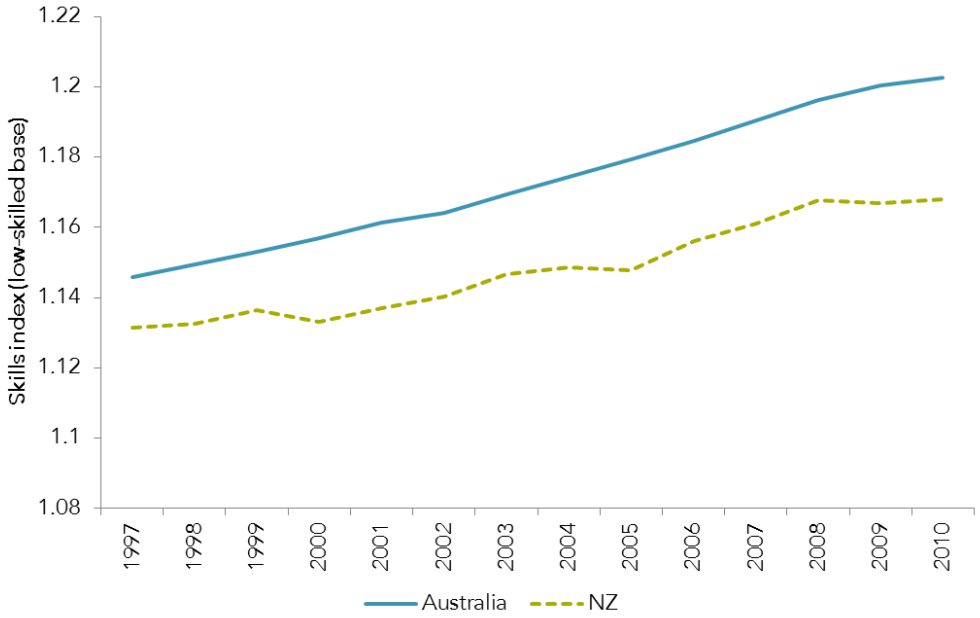
Source: Derived from ABS, Survey of Education and Work, 1998-2010 (extrapolated back to 1997) and SNZ, New Zealand Income Survey, 1997-2010.

When the estimates of qualification group employment shares and relative pay levels are brought together to form a skills index (as described in Equations 5-6), the outcome shows Australia to have a narrow lead over New Zealand in total market industries of about three percentage points in 2009. Between 1997-2010 the Australian skills index grew by an average 0.38% pa compared to 0.26% pa in New Zealand (Figure 8).

In the case of Australia this estimated growth rate in skills is very close to ABS estimates of labour quality growth in aggregate market industries which take account of changes in workers' experience levels as well as their formal qualifications. But in the New Zealand case the estimated growth rate in our skills index is substantially below SNZ estimates of composition-adjusted growth in labour inputs in the measured sector.[21] Further research would be necessary to establish the causes of this disparity, for example, whether it reflects the relatively narrow pay gap between graduates and non-graduates in New Zealand or whether it is due to our skills index not taking account of changes in the age-distribution of workers in each qualification group (since age is generally correlated with work experience and opportunities for on-the-job skills acquisition).

[21] In these alternative calculations, labour quality growth rates are defined as QAL growth rates less hours worked growth rates where QAL = ABS/SNZ estimates of growth rates in quality-adjusted (or composition-adjusted) labour inputs (ABS (2012a), SNZ (2012d)).

Figure 8 Trends in estimated skills index in total market industries, 1997-2010



Source: See Figure 6 and Figure 7

Notes:

1. The skills index runs from a potential minimum value of 1.00 if all workers are in the low-skilled category to a potential maximum of 1.50 in Australia (1.35 in New Zealand) if all workers are graduates.

In any event the outcome, using our new skills indices, is a relatively narrow gap in measured skills between the two countries, with Australia in the lead in 2009. This contrasts with IMF (2002) estimates which found New Zealand to be about 1% ahead of Australia in terms of measured labour quality in 1999 but clearly the absolute difference between the two sets of estimates is not great. As shown in Table 16, Australia's narrow lead on measured skills in 2009 prevails in all individual market industries. The gap only exceeds five percent in five industries: mining, chemicals, professional and scientific services, information media and telecommunications and finance and insurance.

We now go on to assess how much differences in measured skills, as well as differences in capital-intensity, have contributed to the pattern of differences in industrial productivity performance identified in Section 3.

Table 16 Relative skill levels, 1997-2010, analysed by industry (Index numbers: Australia=100)

Industry code		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1-3	Agriculture, forestry and fishing	101	101	100	99	99	99	98	98	98	98	99	98	98	98
4	Mining	92	92	92	92	91	92	91	91	90	92	94	94	93	93
5	Food, beverage and tobacco product manufacturing	96	96	95	95	95	95	95	95	95	96	96	96	96	95
6	Textile, leather, clothing and footwear manufacturing	97	97	96	96	96	96	96	96	96	97	97	97	97	96
7	Wood and paper products manufacturing	98	98	98	97	97	98	97	97	97	98	98	98	98	98
8	Printing	97	96	96	96	96	95	95	95	95	96	96	96	96	96
9	Petroleum, chemical, polymer and rubber product manufacturing	94	94	93	92	92	93	93	93	93	94	94	94	94	94
10	Non-metallic mineral product manufacturing	97	97	97	96	96	97	97	97	97	97	98	98	98	97
11	Metal product manufacturing	97	97	97	96	96	97	97	97	97	97	97	97	97	97
12	Transport equipment, machinery and equipment manufacturing	97	97	97	96	96	96	96	97	97	97	98	98	97	97
13	Furniture and other manufacturing	98	98	98	97	97	97	97	98	98	98	98	99	98	98
14	Electricity, gas, water and waste services	93	93	94	96	96	95	94	94	93	95	97	98	97	97
15	Construction	98	98	99	100	100	100	99	99	99	98	98	99	99	99
16	Wholesale trade	97	97	98	98	98	98	98	98	98	98	97	97	97	97
17	Retail trade	100	100	100	100	100	100	99	99	99	99	98	98	98	98
18	Accommodation and food services	99	99	99	99	99	99	99	98	98	99	100	100	99	99
19	Transport, postal and warehousing	99	99	99	99	99	99	98	97	96	96	97	97	96	96
20	Information media and telecommunications	103	103	104	104	104	104	104	104	101	100	98	96	94	94
21	Financial and insurance services	99	98	98	98	98	97	96	95	93	93	93	94	93	93
22	Rental, hiring and real estate services	98	98	97	98	98	99	99	100	99	98	98	98	98	97
23	Professional, scientific and technical services	94	94	93	94	94	95	95	95	94	93	93	93	93	93
24	Administrative and support services	99	99	99	99	99	100	101	101	100	100	99	99	99	99
25	Arts and recreation services	99	99	99	98	98	97	97	97	97	97	98	98	98	98
26	Other services	98	98	98	98	98	98	98	98	98	99	99	100	100	100
1-26	**Total market industries**	**99**	**98**	**98**	**98**	**98**	**98**	**98**	**98**	**97**	**97**	**97**	**97**	**97**	**97**
5-13	Manufacturing	97	97	96	96	96	96	96	96	96	96	97	97	96	96

6 Relative multi-factor productivity levels and growth rates

6.1 Methods

In order to estimate relative levels of MFP in Australia and New Zealand, we use standard growth accounting methods which have been employed extensively in international comparisons of productivity growth rates and levels (Jorgenson, Gollop & Fraumeni, 1987; O'Mahony & van Ark, 2003; and van Ark, O'Mahony & Timmer, 2008). The theoretical underpinning for this approach is the neoclassical growth model, with underlying assumptions that all markets are competitive and that all factors in the production process are paid their marginal products, the sum of which exhausts all returns from pursuing those activities. In addition the use of value added to measure output involves the assumption that material input is separable from other inputs in the production function.

Under these assumptions MFP levels in country J relative to country K in industry i can be calculated using the Tōrnqvist discrete approximation to the Divisia index, given by:

$$\ln(MFP_{iJ,K}) = \ln(RY_{iJ,K}) - \alpha_{iJ,K}\ln(RL_{iJ,K}) - (1-\alpha_{iJ,K})\ln(RK_{iJ,K}) \qquad (7)$$

where $RY_{J,K}$ denotes value added in country J relative to country K (with nominal output converted to a common currency), RL is relative labour inputs, RK is relative capital stocks, and $\alpha_{J,K}$ is the share of labour in value added averaged over the two countries.[22] Assuming constant returns to scale, the weight on capital is one minus labour's share of value added.[23]

Analogously, comparing periods *t* and *t-1*, again letting *Y* denote real output, L labour and K capital, and dropping the country subscript, the Tōrnqvist MFP growth index is given by:

$$\ln MFP_{i,t} - \ln MFP_{i,t-1} = (\ln Y_{i,t} - \ln Y_{i,t-1}) - \varpi_{il}(\ln L_{i,t} - \ln L_{i,t-1}) - (1-\varpi_{il})(\ln K_{i,t} - \ln K_{i,t-1}) \qquad (8)$$

where ϖ_{il} is the share of labour in the value of output, averaged across periods *t* and *t-1*.

Further, if the underlying production function is rearranged to take growth in ALP (average value added per hour worked) as dependent variable and we measure labour inputs on a quality-adjusted basis, then for industry *i* in country *j*:

$$\Delta\ln(Y_{ij}/H_{ij}) = (1-\alpha)\,\Delta\ln(K_{ij}/H_{ij}) + \alpha\,(\Delta\ln QAL_{ij} - \Delta\ln H_{ij}) + \Delta\ln MFP_{ij} \qquad (9)$$

where QAL = quality-adjusted labour inputs and H = unadjusted hours worked.

Thus growth in ALP can be decomposed between growth in capital-deepening (K/H), growth in labour quality (QAL/H = Skills, as defined in Section 5) and growth in MFP. Since MFP is estimated

[22] For both countries estimates of the labour share of value added at industry level are derived from National Accounts data on employee compensation and value added, with an upward adjustment to take account of self-employed persons. Estimates of the ratio of self-employed to employees are derived from Linked Employer-Employee Data (LEED) for New Zealand and Labour Force Survey data for Australia. For both countries we assume that self-employed hourly earnings are 70% of average hourly wages for employees. This procedure follows an approach suggested in O'Mahony & van Ark (2003) in the light of US evidence of generally lower compensation for self-employed persons compared to employees.

[23] In future research it would be desirable to be able to relax this assumption in order to explore the extent of non-constant returns to scale in each country. However, to do this would require a new and different means of estimating capital's share of value added at industry level.

residually, it captures that share of growth in ALP which cannot be attributed to measured growth in capital and skills per hour worked, and can therefore be seen as an indicator of the efficiency with which capital and labour inputs are utilised. However, the MFP measure will also pick up the effects of unmeasured capital inputs such as land and investments in R&D and innovation which were not included in our capital stocks measure in order to ensure comparability between Australia and New Zealand in our estimates of relative capital-intensity. In addition the MFP measure will reflect a range of other unmeasured influences on performance such as the effects of inter-country differences in production scale and the scope for economies of agglomeration (through urban scale) as well as the effects of any measurement errors.

6.2 Relative MFP levels

Estimates of Equation 7 suggest that MFP levels in New Zealand market industries were on average about 22% below Australian levels in 2009, a gap which is 16 percentage points (pp) smaller than the estimated gap in ALP levels. This represented a slight improvement in New Zealand's MFP performance relative to Australia since 1997, in contrast to the growing gap in ALP levels between the two countries (Figure 9). When the ALP gap for total market industries is decomposed between relative capital, skills and MFP levels, the estimated MFP contribution is found to have declined for much of the period but still accounted for a majority share (57%) of the ALP gap in 2009 (Figure 10). The capital contribution rose from 26% in 1999 to 39% in 2009.

By contrast relative skill differences contributed only 2-3% of the measured gap in ALP between 1997-2009. This small skills contribution partly reflects the narrow gap in measured skills between the two countries (see Section 5) but it is also partly attributable to the fact that growth accounting can only evaluate the separate contributions of different production inputs. Thus it is unable to take account of potential complementarities between skills and other inputs such as the role of skills in facilitating the effective use of new technologies.[24] (In this context it should be noted that growth accounting is also unable to take account of interdependence between capital-deepening and MFP of the kinds described in Section 4).

[24] Skill effects of this kind are more likely to be identified through multivariate regression analysis.

Figure 9 Relative ALP and MFP levels in total market industries, 1997-2010 (Index numbers: Australia = 100)

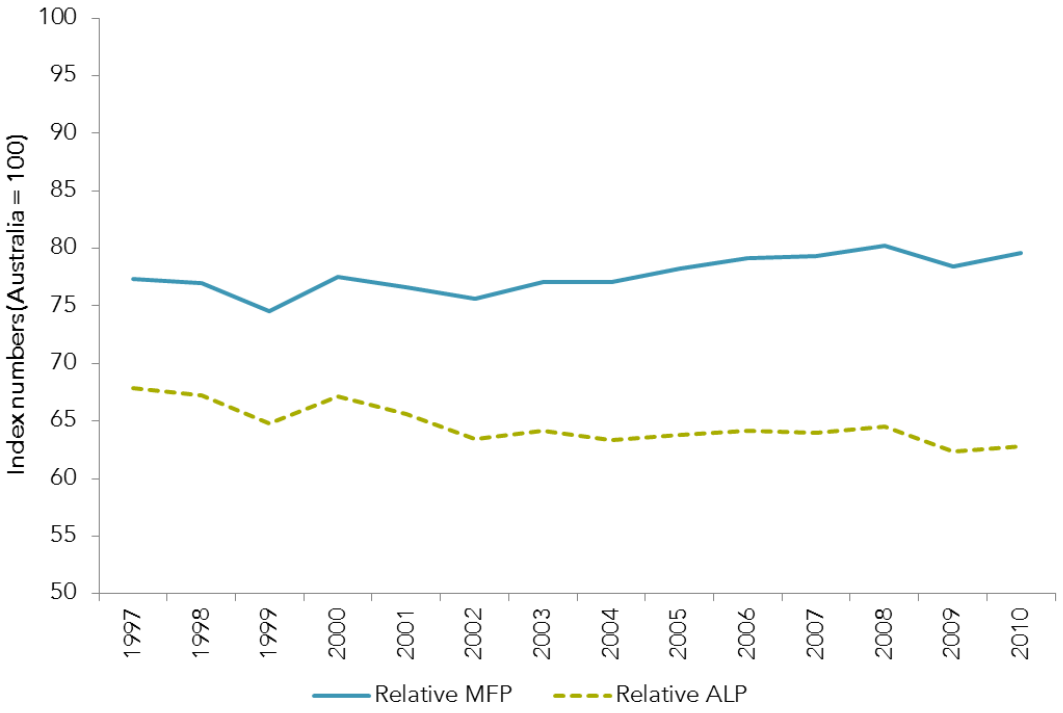
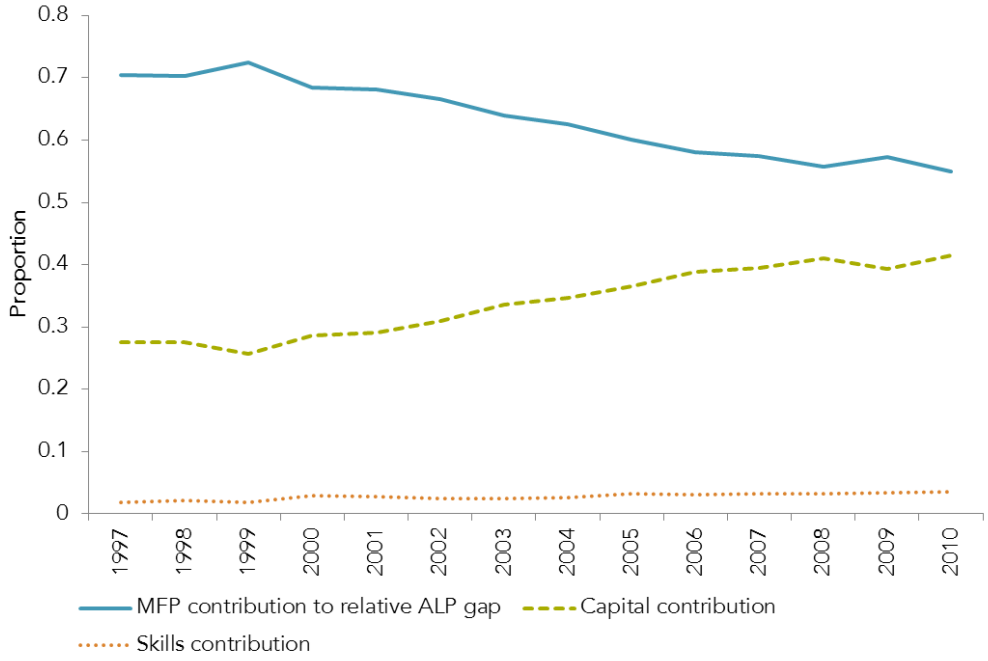


Figure 10 Estimated contributions of relative capital-intensity, skills and MFP to the relative ALP gap in total market industries, 1997-2010



With due caution given these limitations of growth accounting, our estimates suggest that Australia is ahead on both ALP and MFP in 12 industries, including agriculture, mining, printing, transport equipment and machinery, construction, wholesale and retail, transport, postal and warehousing and financial services (Table 17, Columns 1 and 4). New Zealand is ahead on both ALP and MFP in five industries: food and drink manufacturing, electricity, gas and water, rental, hiring and real estate services, professional/scientific services and arts and recreation service. In three industries New Zealand is ahead on MFP but behind on ALP: textiles and clothing manufacturing, wood and paper products and accommodation and food services.

Where a country is doing better on MFP than on ALP, the implication is that it benefits from advantages in some of the unmeasured or poorly measured variables which are captured in estimates of residual MFP, for example, in the efficiency with which resources are utilised (for example, higher capacity utilisation) or in unmeasured skills and investments in innovation. Further research at industry and firm level would be useful to shed detailed light on the extent and nature of these diverse influences on performance

Our estimates point to a striking degree of variation between industries in the relative importance of capital-intensity and MFP in their contributions to ALP differentials. If we focus first on the 15 industries in which Australia was ahead on ALP in 2009, then in six of them higher levels of capital-intensity are found to play a predominant role: metal product manufacturing, agriculture, forestry and fishing, chemicals and related industries, wood and paper products manufacturing, accommodation and food services and textiles and clothing manufacturing (Table 17, Column 5). In another eight industries it is MFP which contributes most to the Australian lead on ALP: printing, financial services, construction, mining, non-metallic mineral manufacturing, transport equipment and machinery, transport, postal and warehousing and retail trade (Table 17, Column 7). In wholesale trade the contributions of MFP and capital-intensity to the Australian lead on ALP are roughly equal.

In five of the seven industries where New Zealand is ahead on ALP, the main contribution to that lead comes from MFP: rental, hiring and real estate services, electricity, gas and water, professional/scientific services, food and drink manufacturing and arts and recreation services. The impact of relative capital-intensity exceeds that of MFP in miscellaneous manufacturing and other services but, as noted in Section 4, these are industry groupings where absolute levels of capital-intensity are low in both countries. The one sector where New Zealand is ahead on ALP and relative capital-intensity is important is electricity, gas and water where capital accounts for just under 40% of New Zealand's ALP lead, still only two thirds of the MFP contribution (Table 17, Columns 5 and 7).

These estimates are all based on the use of updated GGDC PPP exchange rates. In the case of information media and telecommunications (where we have doubts about the comparability of real output deflators, as discussed in Section 3.1), our findings point to rough parity in ALP levels in the two countries. When we test the impact of using OECD PPPs, this produces an estimated ALP gap of 27 pp in favour of Australia. About 55% of this gap can be attributed to higher capital-intensity in Australia while 38% of the gap is linked to higher MFP and 7% to higher skills (Table 17, bottom row).

In the majority of industries the lead on MFP has not changed between countries over the 1997-2010 period. Three exceptions are branches of manufacturing -- food and drink, textiles and clothing and wood and paper products – where the New Zealand lead on MFP in 2009 only developed in the second half of the 2000s. In two industries – agriculture and metal product manufacturing – New Zealand was ahead on MFP in the late 1990s and early 2000s but had lost this lead by 2009 (Table 18).

Table 17 Relative multi-factor productivity (MFP) and estimated contributions of relative capital-intensity and MFP to gaps in relative labour productivity 2009 – based on updated GGDC PPP exchange rates (Shaded cells denote predominant contributions to ALP differentials)

		Average labour productivity (ALP) GGDC exchange rates AUS=100	Relative capital-intensity AUS=100	Relative skills AUS=100	Relative multi-factor productivity (MFP) AUS=100	Estimated contributions to gap in ALP (proportions)		
						Relative capital-intensity	Relative skills	Relative MFP
AUSTRALIAN LEAD ON ALP								
1-26	Total market industries	62	62	97	78	0.39	0.03	0.58
5-13	Manufacturing	77	60	96	98	0.83	0.07	0.10
8	Printing	23	95	96	24	0.01	0.01	0.99
21	Financial and insurance services	30	42	93	48	0.23	0.02	0.75
15	Construction	36	111	99	35	-0.02	0.01	1.01
4	Mining	43	93	93	47	0.05	0.01	0.94
10	Non-metallic mineral product manufacturing	46	67	98	56	0.17	0.01	0.82
12	Transport equipment, machinery and equipment manufacturing	48	44	97	62	0.25	0.02	0.73
11	Metal product manufacturing	49	21	97	96	0.89	0.02	0.10
16	Wholesale trade	52	32	97	77	0.49	0.02	0.48
19	Transport, postal and warehousing	57	63	96	71	0.28	0.03	0.68
1-3	Agriculture, forestry and fishing	62	58	98	86	0.63	0.01	0.36
17	Retail trade	62	64	98	72	0.23	0.03	0.74
9	Petroleum, chemical, polymer and rubber product manufacturing	67	55	94	94	0.74	0.06	0.20
7	Wood and paper products manufacturing	77	41	98	105	1.16	0.05	-0.21
18	Accommodation and food services	88	40	99	115	1.17	0.01	-0.18
6	Textile, leather, clothing and footwear manufacturing	89	58	97	110	1.74	0.19	-0.93
PARITY ON ALP								
24	Administrative and support services	99	46	99	112			
20	Information media and telecommunications	101	73	94	125			
NEW ZEALAND LEAD ON ALP								
25	Arts and recreation services	108	70	98	127	-0.50	-0.04	1.54
5	Food, beverage and tobacco product manufacturing	112	86	96	123	-0.73	-0.21	1.94
26	Other services	115	207	100	100	1.03	-0.01	-0.03
13	Furniture and other manufacturing	134	385	98	91	1.28	-0.05	-0.23
23	Professional, scientific and technical services	170	102	93	178	0.01	-0.12	1.11
14	Electricity, gas, water and waste services	179	130	97	149	0.39	-0.02	0.63
22	Rental, hiring and real estate services	247	96	98	255	-0.04	-0.01	1.06
Using OECD 2008 PPP for Information media and telecommunications industry AUSTRALIAN LEAD ON ALP								
20	Information media and telecommunications	73	73	94	90	0.55	0.07	0.38

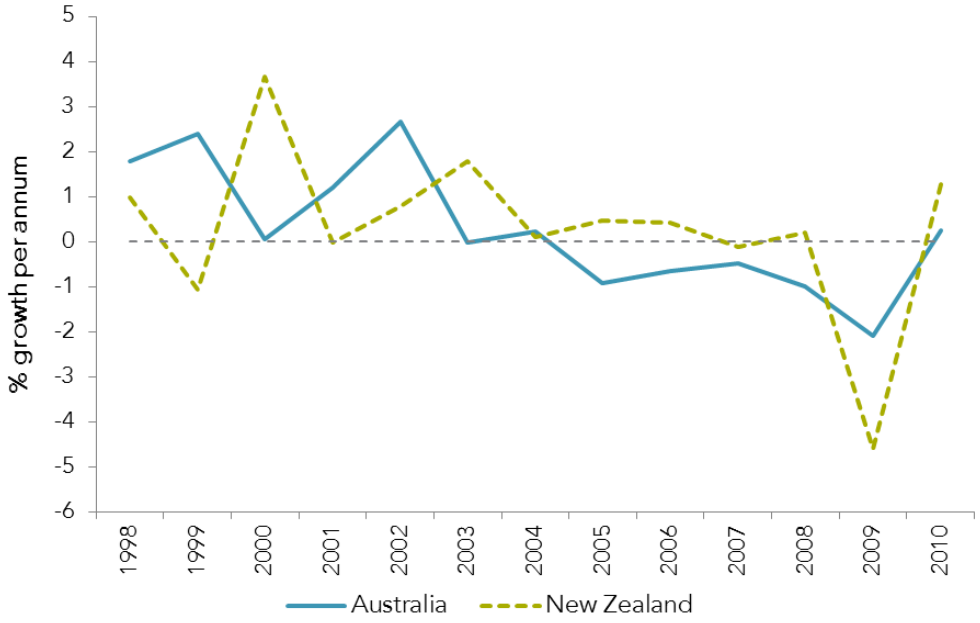
Table 18 Relative MFP levels in market industries, 1997-2010 (Index numbers: Australia=100)

Ind code		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1-3	Agriculture, forestry and fishing	118	123	105	103	102	99	112	99	93	94	114	96	86	93
4	Mining	52	54	56	50	49	47	48	43	39	42	36	48	47	48
5	Food, beverage and tobacco product manufacturing	83	87	85	83	83	83	96	96	105	108	108	113	123	125
6	Textile, leather, clothing and footwear manufacturing	95	93	90	93	89	85	92	100	104	110	104	106	110	124
7	Wood and paper products manufacturing	80	82	73	92	93	87	93	96	100	106	109	107	105	116
8	Printing	27	28	25	26	25	26	25	24	25	24	22	23	24	25
9	Petroleum, chemical, polymer and rubber product manufacturing	88	87	89	94	96	92	93	85	90	94	91	97	94	98
10	Non-metallic mineral product manufacturing	73	70	65	71	61	57	60	60	54	55	54	60	56	52
11	Metal product manufacturing	137	148	154	177	154	151	165	178	163	166	152	130	96	77
12	Transport equipment, machinery and equipment manufacturing	71	72	68	70	73	69	65	64	62	67	62	67	62	64
13	Furniture and other manufacturing	60	64	71	69	70	66	62	73	109	95	93	89	91	88
14	Electricity, gas, water and waste services	131	130	140	134	135	131	139	142	142	138	147	155	149	159
15	Construction	43	41	35	39	41	38	37	38	37	35	37	38	35	37
16	Wholesale trade	69	67	69	77	81	84	77	77	80	80	82	82	77	76
17	Retail trade	70	69	67	73	71	69	72	70	73	75	76	76	72	71
18	Accommodation and food services	132	130	120	121	120	116	115	114	117	115	112	114	115	123
19	Transport, postal and warehousing	67	68	70	71	71	70	68	69	71	70	66	70	71	71
20	Information media and telecommunications	99	92	88	105	111	111	116	117	123	120	123	123	125	129
21	Financial and insurance services	52	52	50	53	54	53	53	50	50	50	48	46	48	50
22	Rental, hiring and real estate services	90	94	98	106	123	138	151	174	190	211	257	273	255	263
23	Professional, scientific and technical services	201	198	185	193	178	171	176	165	169	177	186	194	178	177
24	Administrative and support services	144	140	130	134	140	126	138	134	135	136	130	120	112	122
25	Arts and recreation services	136	145	152	149	141	152	147	141	136	142	131	138	127	127
26	Other services	65	71	79	81	77	86	82	82	89	88	88	98	100	101
1-26	**Total market industries**	**77**	**77**	**75**	**77**	**77**	**76**	**77**	**77**	**78**	**79**	**79**	**80**	**78**	**80**
5-13	Manufacturing	92	94	93	97	96	92	97	98	102	104	99	100	98	97

6.3 MFP growth rates

The declining (though still important) contribution of MFP to the Australia-New Zealand ALP gap between 1999-2008 strongly reflects inter-country differences in MFP growth. As shown in Figure 11, MFP growth across total market industries in New Zealand exceeded Australian MFP growth rates in seven of those nine years and particularly during the 2004-08 period of 'productivity growth slump' in Australia (described in Section 2).

Figure 11 Annual growth rates in MFP in total market industries, 1997-2010



In eight industries MFP in Australia during this period declined by an average -4% pa or even more: mining, food and drink manufacturing, chemicals and related industries, miscellaneous manufacturing, electricity, gas and water, financial and insurance services and rental, hiring and real estate services (Table 19). According to Parham (2012), much of this decline reflected 'unrequited' growth in production inputs in Australia in response to transitory factors such as drought and more favourable terms of trade facing Australian producers. However, this period of adjustment may be over. Between 2004-08 many New Zealand firms in these industries fared much better in terms of MFP growth but, when recession hit in 2008-09, New Zealand was much more strongly affected than Australia in a range of industries (Table 19). As will be discussed in our concluding section, more research at industry and firm level would be useful to learn more about whether this MFP reversal in New Zealand will itself prove to be transitory (as in Australia) or whether it reflects more permanent sources of weakness.

Table 19 Average annual growth rates (%) in MFP, 1999-2010, analysed by industry

		Australia			New Zealand		
		99-04	04-08	08-10	99-04	04-08	08-10
1-3	Agriculture, forestry and fishing	4.8	-1.9	5.9	0.6	-2.9	4.0
4	Mining	-0.7	-4.0	-6.2	-4.8	-1.2	-6.2
5	Food, beverage and tobacco product manufacturing	1.1	-5.3	-6.3	2.6	-1.2	-1.1
6	Textile, leather, clothing and footwear manufacturing	-5.0	1.2	-0.1	-3.7	2.7	6.4
7	Wood and paper products manufacturing	-0.3	-2.1	-4.9	1.9	1.0	2.2
8	Printing	2.4	-0.7	-4.1	0.3	-2.5	0.7
9	Petroleum, chemical, polymer and rubber product manufacturing	0.0	-4.8	-2.7	-0.6	-1.4	-1.3
10	Non-metallic mineral product manufacturing	4.9	1.9	2.2	2.0	1.8	-4.1
11	Metal product manufacturing	0.9	3.0	6.6	4.2	-4.3	-9.4
12	Transport equipment, machinery and equipment manufacturing	3.2	-0.6	-2.5	1.0	1.1	-3.9
13	Furniture and other manufacturing	-1.0	-6.0	-0.1	1.9	-2.0	-1.6
14	Electricity, gas, water and waste services	-2.2	-4.8	-3.8	-0.8	-2.8	-2.3
15	Construction	1.7	0.5	-2.2	0.0	0.7	-3.1
16	Wholesale trade	0.9	-0.7	-1.3	2.5	2.3	-3.4
17	Retail trade	0.8	-0.4	2.5	0.9	1.8	-1.2
18	Accommodation and food services	1.2	0.1	-4.5	-1.9	-0.1	-0.6
19	Transport, postal and warehousing	1.1	0.4	-2.5	1.0	0.7	-1.6
20	Information media and telecommunications	-0.5	-0.8	-0.3	3.6	0.7	3.1
21	Financial and insurance services	2.2	4.0	-0.7	0.8	3.0	-0.7
22	Rental, hiring and real estate services	-4.6	-7.9	2.3	4.7	1.2	-2.1
23	Professional, scientific and technical services	3.1	-4.0	2.4	-1.7	-0.8	-2.0
24	Administrative and support services	0.3	3.1	-7.9	-1.0	-0.4	-7.3
25	Arts and recreation services	0.6	-1.8	1.9	-0.8	-2.1	-1.9
26	Other services	0.2	-3.8	0.6	3.5	-0.4	3.1
27	**Total market industries**	**1.1**	**-0.8**	**-0.9**	**0.9**	**0.2**	**-1.7**
28	Manufacturing	1.1	-1.6	-1.0	1.6	-0.8	-1.8

7 Summary and assessment

Average labour productivity (ALP) levels in New Zealand across the whole economy are now almost a third lower than in Australia. This gap began to open up in the mid-1970s and, with some fluctuations, has largely tended to increase over the decades since. Although much attention has been paid to the apparent causes of this gap at aggregate economy level, only a few efforts have been made to examine in which particular industries the New Zealand disadvantage lies and whether there are any industries in which New Zealand performance compares more favourably against Australia.

In order to help fill this gap in knowledge, this report first presents new estimates of comparative ALP levels and growth rates for 24 market industries (that is, excluding industries which are dominated by public sector activities). These market industries account for just over three quarters of total hours worked in both New Zealand and Australia. In order to carry out this comparison, we make use of industry-level purchasing power parity (PPP) exchange rate estimates prepared by the Groningen Growth and Development Centre (GGDC) as well as OECD PPP exchange rates.

We then draw on new estimates of physical capital-intensity and skills at industry level in each country in order to generate estimates of relative MFP levels and growth rates between 1997-2010. Since MFP captures the share of growth in ALP which cannot be attributed to measured growth in capital and skills per hour worked, it can be seen as a rough indicator of the efficiency with which capital and labour inputs are utilised. These estimates are based on standard growth accounting techniques which help to identify the 'proximate' causes of inter-country productivity differences. The 'ultimate' causes of Australian-New Zealand productivity differences must remain the subject of continued research and discussion.

In our chosen benchmark year of 2009, the ALP level across total market industries in New Zealand was an estimated 62% of the Australian level. This Australian lead was found to apply across a wide range of industries, in particular, mining, agriculture, most branches of manufacturing, construction, retail and wholesale trade and financial and insurance services. However, New Zealand has areas of relatively strong performance in food and drink manufacturing, utilities (electricity, gas and water supply) and arts and recreation services. In some service areas such as professional, scientific and technical services and information media and telecommunications, it is hard to identify the productivity leader with any precision due to sensitivity to the choice of PPP exchange rate and other measurement problems. However, there are at least some signs of New Zealand comparing well in those industries.

One factor contributing to Australian leadership on ALP is higher levels of capital per hour worked, referring to four different types of capital asset identified in the report: structures and land improvements; machinery and equipment (including computers); vehicles and transport equipment; and intangible assets such as computer software. In 2009 capital per hour worked across total market industries in New Zealand was just over 60% of the Australian level. The Australian lead on capital-intensity applies to the great majority of market industries, covering a wide range of agricultural, manufacturing and service activities. New Zealand is more capital-intensive in only five of the 24 industries and only one of these (electricity, gas and water) is a significant user of capital equipment.

Australia is also found to be ahead in terms of skills -- measured here using data on workforce qualifications and relative pay levels – but this gap is much narrower than that found for capital-intensity. Across total market industries, Australian skill levels are estimated to be about 3% higher than in New Zealand, largely due to Australia having slightly higher employment shares of both university graduates and workers with vocational and other qualifications gained since leaving

secondary school. The measured gap in skills only exceeds five percent in five industries: mining, chemicals, professional and scientific services, information media and telecommunications and finance and insurance.

Growth accounting estimates suggest that MFP levels in New Zealand market industries were on average about 22% below Australian levels in 2009, a gap which is 16 percentage points smaller than the estimated gap in ALP levels. This represented a slight improvement in New Zealand's MFP performance relative to Australia since 1997, in large part because of a slump in Australian MFP growth rates between 2004-08. When the relative ALP gap for total market industries is decomposed between relative capital-intensity, skill and MFP levels, the estimated MFP contribution is found to have declined for much of the period but still accounted for a majority share (57%) of the ALP gap in 2009. The capital contribution rose from 26% in 1999 to 39% in 2009. The measured contribution of skill differences to the ALP gap was only 4% but this probably under-estimates the impact of skills since growth accounting is unable to take account of complementarities between skills and other production inputs.

The still predominant contribution of MFP to the overall ALP gap can be taken as indicating that New Zealand's productivity shortcomings owe more to comparatively inefficient use of capital and labour inputs than to lower levels of physical capital-intensity. But the capital contribution remains substantial and the residual MFP measure also picks up the effects of hard-to-measure capital investments in innovation and a range of other unmeasured influences on performance such as the effects of inter-country differences in production scale and the size and diversity of urban areas. The importance of these other contributing factors can only be gauged through further research at industry and firm level.

This report also shows that the relative importance of lower MFP and lower physical capital-intensity in accounting for labour productivity gaps varies greatly between industries. For example, in eight of the 15 industries in which Australia was ahead on ALP in 2009, MFP plays a predominant role but in six of them higher ALP is largely due to higher levels of capital-intensity. In the remaining one of these 15 industries -- wholesale trade -- the contributions of MFP and capital-intensity to the Australian lead on ALP are roughly equal. In five of the seven industries where New Zealand is ahead on ALP, the main contribution to that lead comes from MFP. In the other two industries relative capital-intensity predominates but these are industries where absolute levels of capital-intensity are relatively low.

In spite of growing differences in industrial structure between Australia and New Zealand, a very large (70%) share of the ALP gap is still accounted for by within-industry productivity differences. To understand the sources of these differences, future research needs to go beyond growth accounting and investigate the factors underlying the proximate causes of the ALP gap between the two countries. For example, new research at industry and firm level could aim to explore how far New Zealand's apparent inefficiencies in resource utilisation (signified by lower MFP) are attributable to comparative weakness in innovation or the effects of many firms operating with relatively small-scale production facilities or the workings of domestic product markets (for example, the speed with which resources are reallocated from comparatively inefficient producers to more efficient producers). Similarly, new research at industry and firm level could investigate the main factors – apart from differences in industrial structure – which have contributed to higher levels of capital investment in Australia than in New Zealand over recent decades.

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