Productivity, Capital-Intensity and Labour Quality at Sector Level in New Zealand and the UK

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Abstract

Understanding productivity performance is important to informing policy advice on how to improve productivity and therefore New Zealand's overall economic performance. Given data limitations inherent in international productivity comparisons, this paper is not intended to inform policy in isolation but forms an important element of a wide and expanding body of evidence on the performance of the New Zealand economy. Previous international productivity comparisons involving New Zealand have been confined to the aggregate economy or to broadly-defined sectors such as manufacturing. This paper reports on a New Zealand-UK comparison which distinguishes 21 different 'market sectors' (ie, excluding public administration, education, health, property services and some personal, social and community services). It confirms the prevailing consensus that, in aggregate, New Zealand market sectors compare unfavourably with the UK on average labour productivity (ALP) - and by implication compare even more unfavourably with other countries such as the US. However, beneath this overall story there is considerable sectoral variation. While some NZ sectors out-perform the UK on ALP and/or multi-factor productivity (MFP), there is a large group of sectors which fall short of the UK on both productivity measures. Most of these low-productivity sectors are relatively low in physical capital-intensity compared to the UK. Overall, roughly a quarter of the New Zealand-UK gap in ALP for aggregate market sectors in 2002 was attributable to differences in employment structure such as the relatively high shares of New Zealand employment in comparatively low value added sectors such as agriculture. The remaining three quarters of the ALP gap were accounted for by within-sector productivity differences.

JEL CLASSIFICATION J24, O47, P52

KEYWORDS productivity, capital-deepening, human capital

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1 Introduction

Productivity performance is now central to economic policy debates in New Zealand due to public concern about the country's decline relative to many other advanced industrial countries in measures of living standards such as average Gross Domestic Product (GDP) per head of population. For example, IMF (2002) noted that New Zealand's real GDP growth since 1985 had been below the OECD average and that the gap between New Zealand and Australia in real GDP per capita widened throughout this period. Schreyer (2006, Table 1) shows that low GDP per capita in New Zealand is not attributable to lower levels of labour utilisation (as measured by average hours worked per capita) compared to Australia, or indeed several other countries. By contrast, there is a clear link between relatively low levels of GDP per capita and weak performance on labour productivity (average output per hour worked).

IMF (2002) estimate that in 1999 average labour productivity (ALP) in market sectors in New Zealand was only 73% of the Australian level, down from 82% in 1988. Around three quarters of the Australian-New Zealand ALP gap is attributed to a relatively low level of physical capital per unit of labour input in New Zealand with the remainder attributed to lower multi-factor productivity (MFP) which captures, among other things, differences in the efficiency with which existing capital and labour resources are utilised. Hall and Scobie (2005) confirm the gap in capital intensity between New Zealand and Australia which is associated with a much lower cost of labour relative to capital in New Zealand compared to Australia. At the aggregate economy level Schreyer (2006) estimates that New Zealand ALP in 2002 was roughly 76% of the Australian level, 69% of the UK level and 61% of the US level. He also finds average physical capital-intensity and MFP in New Zealand to be markedly lower than in Australia, the UK or the US.

To date most productivity levels comparisons involving New Zealand have been confined to the aggregate economy or to broadly-defined sectors such as manufacturing. In part this has reflected gaps in sector-level data and the difficulties involved in the choice of appropriate exchange rates for converting sectoral outputs in different countries to a common currency. However, highly aggregated comparisons potentially conceal marked disparities between different sectors in New Zealand in relative productivity performance. Hence, there is a strong motivation to carry out cross-country productivity comparisons at a more disaggregated sectoral level than hitherto.

In this paper we present the results of a New Zealand-UK comparison which distinguishes 21 different sectors within the 'market economy'.[1] To achieve this we have drawn on a number of different data sources in the two countries, including customised data series prepared by Statistics New Zealand and a new set of sector-level purchasing power parity (PPP) exchange rate estimates for New Zealand prepared by the Groningen Growth and Development Centre (GGDC) at the University of Groningen in the Netherlands. Inevitably, our findings come with a number of caveats due to the inherent difficulties of comparing 'like with like' across countries. Therefore, the decisions we have taken in order to maximise data comparability across New Zealand and the UK are explained at some length in the main text and in an Appendix on Sources and Methods.

The paper is ordered as follows: Section 2 outlines our methodology, with particular reference to the choice of PPPs. Section 3 presents our benchmark estimates of comparative levels of ALP and MFP for total market sectors in New Zealand and the UK. Section 4 then presents our estimates of relative ALP levels at detailed sector level over the ten years from 1995-2004. Section 5 reports on cross-country differences in production inputs, focussing on capital stocks, capital-labour ratios and labour quality. Section 6 compares estimated MFP levels at sector level in the two countries over the same ten-year period and reports on the estimated contributions of physical and human capital inputs to cross-country differences in ALP. It then assesses recent trends in growth rates of output, labour input, ALP and MFP at sector level. Section 7 summarises the main findings of interest. Throughout the study we place New Zealand's relative productivity performance in wider perspective by drawing on recent comparisons of the UK, US, France and Germany which have been carried out at the National Institute of Economic and Social Research (NIESR).

[1] The 'market economy' is here defined to exclude public administration, education, health, property services and some personal, social and community services (see Section 3 for further details).

2 Methodology

2.1 Theoretical specification

Growth in Average Labour Productivity (ALP) is defined as the growth in average output per unit of labour input (for example, per worker-hour) over a specified period of time. By contrast, growth in another widely cited productivity measure -- Multi-Factor Productivity (MFP) -- is defined as the increase in output (net of intermediate inputs) that cannot be attributed to increases in the quantity or quality of physical capital and labour, for example, growth in output deriving from more efficient deployment of existing resources.

Thus MFP is evaluated as a residual after taking account of measured growth in other production inputs. As well as capturing improved efficiency in resource utilisation, it also includes the effects of 'disembodied' technical change, that is, technical improvements and innovations which are not embodied in measured capital inputs. Other variables which may be picked up by a MFP measure include economies of scale, capacity utilisation and measurement errors of different kinds.

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:

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

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:

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

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 at each point in time.

In order to estimate relative levels of multi-factor productivity (MFP) in different countries, we use growth accounting methods which have been employed extensively in international comparisons of productivity growth rates and levels, e.g. in Jorgenson, Gollop and Fraumeni (1987), O'Mahony (1999) and O'Mahony and van Ark (2003). 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 Törnqvist discrete approximation to the Divisia index, given by:

$$(3) \quad \ln(MFP_{iJ,K}) = \ln(RY_{iJ,K}) - \alpha_{iJ,K} \ln(RL_{iJ,K}) - (1-\alpha_{iJ,K}) \ln(RK_{iJ,K})$$

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 input, RK is relative capital stocks, and $\alpha_{J,K}$ is the share of labour in value added averaged over the two countries. Assuming constant returns to scale, the weight on capital is one minus labour's share of value added.

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

$$(4) \quad \ln MFP_{i,t} - \ln MFP_{i,t-1} = (\ln Y_{i,t} - \ln Y_{i,t-1}) - \varpi_{il} (\ln L_{i,t} - \ln L_{i,t-1}) - (1-\varpi_{il})(\ln K_{i,t} - \ln K_{i,t-1})$$

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

In addition, changes in the quality of labour input in each industry may be estimated by extending the growth accounting method to distinguish labour by skill type with each type weighted by its wage bill share. Hence, assuming there are *l* types of labour hours (*L*), a change in aggregate labour input can be estimated as:

$$(5) \quad dlabour = \sum_{l} \varpi^{k}_{il} (\ln L^{k}_{il,t} - \ln L^{k}_{il,t-1})$$

with weights equal to the share of each labour type in the total wage bill. A measure of labour quality change in each industry can be derived from the difference between *dlabour* as defined above and the growth in total worker-hours.

2.2 Data sources and measurement issues

For this study we make use of National Accounts data on gross output, value added, and labour inputs in each country while using production censuses such as the Annual Business Inquiry in the UK to obtain more disaggregated information as and when required. Throughout we use National Accounts aggregates as control totals since international conventions are employed in National Accounts measurement and so these data are usually the most internationally comparable.

In order to construct capital stocks series, we make use of capital investment data provided by the UK Office for National Statistics (ONS) and Statistics New Zealand (SNZ). For cross-country comparisons these estimates require assumptions on common sector-specific depreciation rates across the countries in question. Therefore our capital stocks estimates for both New Zealand and the UK are based on US depreciation rates, with assets divided into structures, vehicles, computers, other plant and machinery and intangibles (principally software).[2] Letting *c* denote types of capital, with *I* denoting investment and *d* the (geometric) depreciation rate, capital stocks are measured as:

$$(6) \quad K^{k}_{ic,t} = K^{k}_{ic,t-1}(1-d_{ic}) + I^{k}_{ic,t}$$

[2] We are grateful to Statistics NZ for providing estimates of productive capital stocks series on the basis of these common sector-specific depreciation rates.

The growth in aggregate capital is then calculated in an analogous manner to aggregate labour as in equation (5) above, with weights equal to the share of each asset type in the total value of capital. This provides a basis for benchmark estimates of relative capital stocks in each country with PPPs for investment goods employed to convert capital to a common currency. Further details are set out in Section 5.1.

The primary sources for data on employment and wages by skill type (proxied by qualifications category) are the Labour Force Survey (LFS) for the UK and the NZ Income Survey and NZ Census of Population and Dwellings. Previous research comparing labour force skills across countries has tended to divide the labour force into three or four categories of formal qualifications and then attempted to match those categories across countries (see, for example, O'Mahony, 1999). This method is sensitive to the allocation of qualifications to the various categories which is fraught with difficulty due to the differences in education and training institutions and formal qualifications systems in each country. Hence in this study our approach is to benchmark on the highest qualifications category (First/Bachelor degree and above) where comparability across countries is at its strongest and then use the ratios of mean wages in other qualification groups relative to mean graduate wages within each country to derive a country-specific measure of labour quality. This approach is explained in detail in Section 5.2.

For conversion of nominal value added to a common currency for sector-level productivity comparisons, one potential source of purchasing power parity (PPP) exchange rate estimates is the 'expenditure PPPs' produced by Eurostat and OECD. However, 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 unit value ratios (UVRs) calculated as sales of products divided by quantities produced. UVRs - which may be described as 'output PPPs' -- are clearly closer to the required producer price concept for sector-level comparisons. However, in practice, due to limited availability of quantity data in some sectors, as well as difficulties in matching products, it is necessary to employ a combination of output PPPs and expenditure PPPs, with the latter adjusted for relative trade and transportation margins and for taxes. For this project we make use of a new set of sector-level purchasing power parity (PPP) exchange rate estimates for New Zealand prepared by the Groningen Growth and Development Centre (GGDC) which comprise a mix of UVRs and adjusted expenditure PPPs.[3] Further details of the GGDC methodology are set out in Appendix Section A2.

[3] We are grateful to Gerard Ypma at GGDC for his work in preparing these estimates.

3 Productivity, capital-intensity and labour quality in the aggregate market economy

Before going on to present sector-level productivity estimates, we first present an overview of our findings at aggregate market economy level. 'Market sectors' are here defined to include agriculture, forestry and fishing; mining and quarrying; manufacturing; electricity, gas and water supply; construction; wholesale, retail and other distribution activities; hotels and restaurants; transport, storage and communications; financial services; business services (excluding property services); and cultural and recreational services. They equate to what Staistics NZ (2006a) defines as the New Zealand 'measured sector' plus Business Services (ANZSIC Division LC). The excluded sectors are those which are dominated by public ownership (eg, public administration, education and health) and/or where no satisfactory measures of output exist in one or both countries (eg, property services, including residential buildings, and some personal, social and community services). A full list of market sectors with matching industrial classifications is shown in Table 1.

Table 1 - Market sectors in New Zealand and the UK

UK SIC	ANZSIC	Sector name
01-05	AA, AB, AC	Agriculture, forestry and fishing
10-14	BA	Mining
15-16	CA	Food, beverage and tobacco manufacturing
17-19	CB	Textile and apparel manufacturing
20-21	CC	Wood and paper product manufacturing
22	CD	Printing, publishing and recorded media
23-25	CE	Petroleum, chemical, plastic and rubber product manufacturing
26	CF	Non-metallic mineral product manufacturing
27-28	CG	Metal product manufacturing
29-35	CH	Machinery and equipment manufacturing (mechanical, electrical, electronic and instrument engineering; vehicle manufacturing)
36	CI	Furniture and other manufacturing
40-41	DA	Electricity, gas and water supply
45	EA	Construction
51	FA	Wholesale trade
50, 52	GA	Retail trade
55	HA	Accommodation, restaurants and bars
60-63	IA	Transport and storage
64	JA	Communication services
65-67	KA	Finance and insurance
71-74	LC	Business services
92-93	PA	Cultural and recreational services

Using a market sectors PPP exchange rate derived by aggregating up from sector-level estimates (see Section 4.1), we estimate that in our chosen benchmark year (2002), average value added per hour worked in New Zealand market sectors was some 77% of the UK market sectors level, down from 82% in 1995 (Table 2). This differential may be compared against the estimate in Schreyer (2006, Table 1) that New Zealand GDP per hour worked in 2002 was roughly 69% of the UK level. The 8 pp difference between these

two results is not large considering that (1) non-market sectors are excluded in our case and (2) our results are based on sector-specific PPP exchange rates rather than on the GDP PPP exchange rates used by Schreyer (2006).

Table 2 - Relative levels of average labour productivity and multi-factor productivity, aggregate market sectors, New Zealand/UK, 1995-2004

			Estimated contributions to NZ/UK gap in ALP: proportions		
	Average labour productivity (UK=100)	Multi-factor productivity (UK=100)	Relative capital-intensity	Relative labour quality	Relative MFP
1995	82	86	0.52	-0.27	0.75
1996	80	85	0.49	-0.24	0.75
1997	80	84	0.44	-0.25	0.82
1998	77	81	0.38	-0.20	0.82
1999	74	79	0.36	-0.16	0.79
2000	75	81	0.40	-0.14	0.74
2001	77	85	0.49	-0.18	0.68
2002	77	87	0.57	-0.14	0.57
2003	76	87	0.53	-0.09	0.56
2004	75	87	0.53	-0.04	0.52

Notes: All estimates are for calendar years in contrast to the typical presentation of National Accounts data for years ending March 31st in New Zealand (see Appendix Section A1 for details of the assumptions made in order to convert March year data to a calendar year basis).

2002 benchmark estimates of average value added per hour worked have been extrapolated back to 1995 and forward to 2004 on the basis of movements in constant price value added and labour inputs in each country. See Appendix Section A2 for a discussion of the advantages and disadvantages of this use of 'constant PPPs' as compared to an alternative 'current PPPs' approach. For details of the aggregate market sectors PPP exchange rate in 2002 see Table 4 below.

As will be shown in Section 5 below, average physical capital per hour worked in New Zealand market sectors was some 69% of the UK level in 2002 while average labour quality, on the measure used in this report, was an estimated 7% above the UK level.[4] When account is taken of these New Zealand-UK differences in relative capital-intensity and labour quality, then the average MFP level in New Zealand market sectors in 2002 was some 87% of UK levels, much the same as in 1995 (Table 2, Column 2). Between 2002-04 our estimates show a small relative decline in the New Zealand position on the ALP measure but not on MFP.

Using growth accounting methods described in Section 2.1, we can decompose the New Zealand-UK differences in relative ALP levels into three components:

1 The proportion explained by differences in relative physical capital-intensity.

2 The proportion explained by differences in relative labour quality.

3 The residual MFP component.

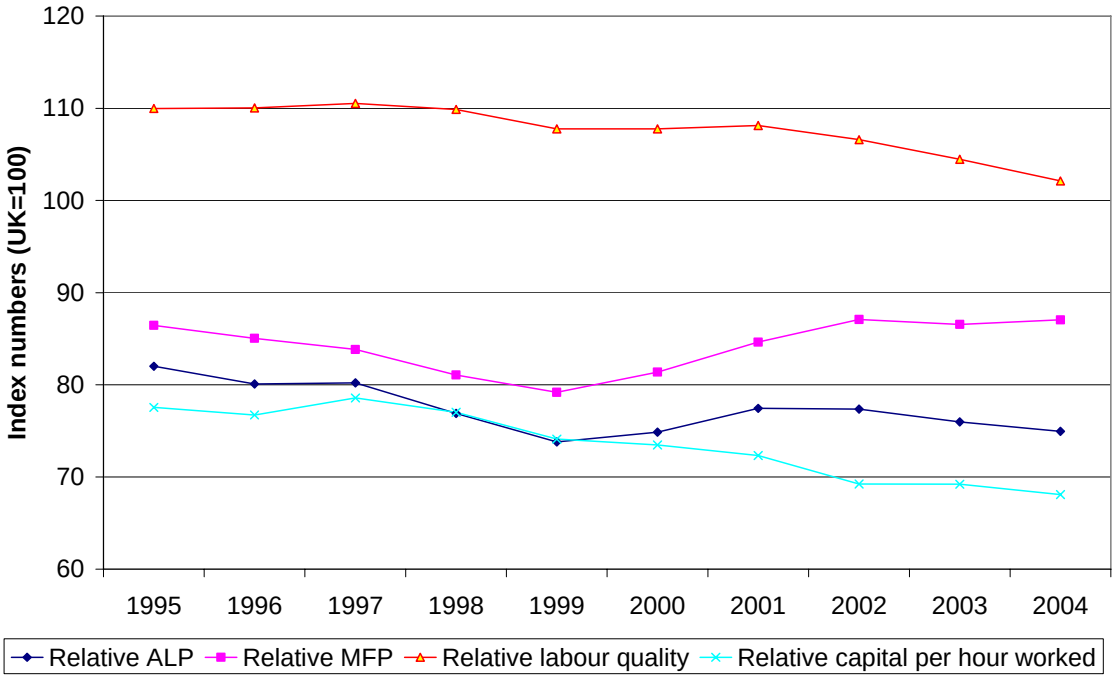
Columns 3-5 in Table 2 show that higher average physical capital per hour worked in the UK accounted for roughly 57% of the New Zealand-UK gap in ALP in 2002 and was partly offset by the higher average level of labour quality in New Zealand (-14%). The residual MFP contribution to the ALP gap was thus 57%. Trends over time in the relative capital-intensity and labour quality measures are shown in Figure 1 alongside the trends in relative ALP and

[4] Note that a number of caveats attach to this estimate of relative labour quality; see Section 5.2.

MFP. While New Zealand MFP increased relative to the UK between 1999-2002, it is still no higher than in 1995 and in recent years appears to have been largely offset by declines in relative capital-intensity and a narrowing of the NZ lead over the UK in labour quality.

In comparing New Zealand with the UK it should be borne in mind that the UK is by no means a productivity leader among advanced industrial nations. Recent NIESR estimates for 2002 show that the UK lagged some 40 pp behind the US in terms of ALP, 32 pp behind France and 22 pp behind Germany. As shown in Figure 2, these gaps in ALP were associated in large part with lower physical capital-intensity in the UK compared to the other three countries and to a much lesser extent with gaps in relative labour quality.

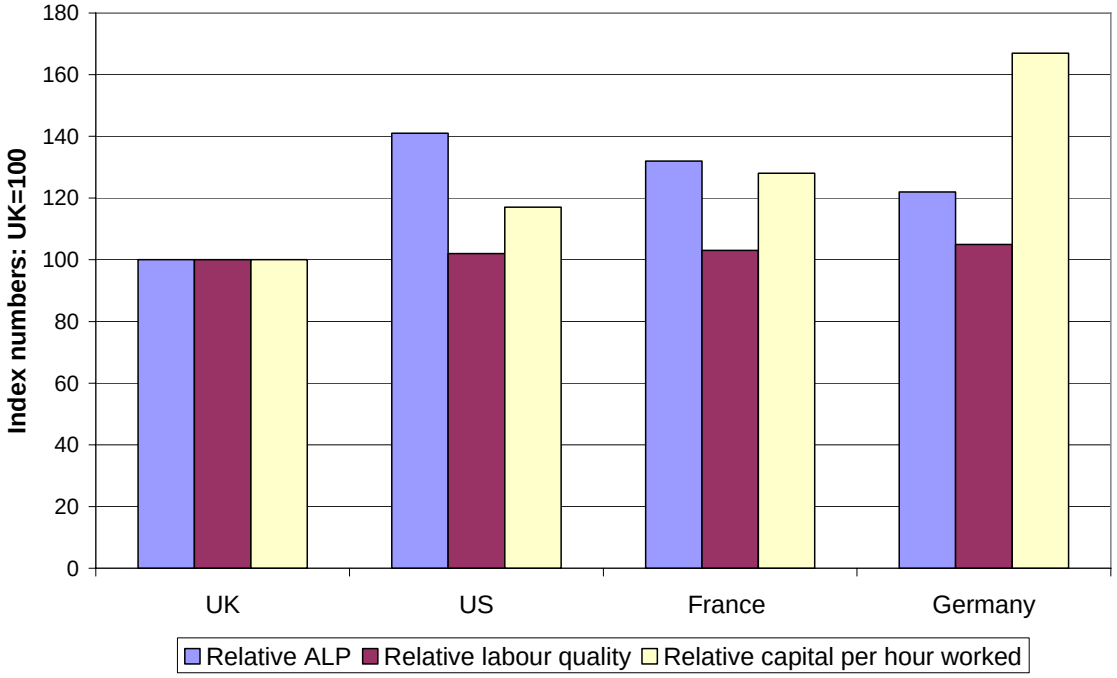
Figure 1 - Relative ALP, MFP, physical capital per hour worked and labour quality, aggregate market sectors, New Zealand/UK, 1995-2004



Notes: For details of calculations underlying the relative capital-intensity and labour quality measures, see Sections 5.1 and 5.2 respectively.

Another perspective on recent trends in productivity growth in New Zealand and the UK is provided by decomposing average annual rates of ALP growth in aggregate market sectors, firstly, between growth in output and hours worked; and secondly, between the respective contributions of growth in physical capital, labour quality and MFP. Over the whole period from 1995-2004, average annual growth in output in the two countries was much the same. However, New Zealand experienced faster growth in labour inputs over this period. Although this is a positive outcome in terms of job creation, the net outcome was slower growth in ALP (averaging 2% per annum in New Zealand compared to 3% in the UK (Table 3). Average annual growth rates in MFP were the same in both countries over this period but the UK also benefited from faster growth of physical capital-intensity and a positive (albeit small) impact of growth in measured labour quality which narrowed the NZ lead on this measure between 1998-2004. The bulk of the growth in labour inputs in New Zealand occurred during the period 2000-04 when output growth was considerably faster than in the UK but productivity growth in the UK was similar to New Zealand due to a reduction in annual hours worked and continued growth in physical capital.

Figure 2 - Relative ALP, physical capital-intensity and labour quality in the UK, US, France and Germany, aggregate market sectors, 2002 (Index numbers: UK=100)



Notes: Derived from Mason, O'Leary, O'Mahony and Robinson (2006).

Some differences between this 4-country study and the present study need to be noted:

(1) Total market sectors in the 4-country study includes some real estate activities (part of SIC 70) and social, community and personal services (UK SIC 90-91) which are not included in the definition of market sectors in the present study. In total these sectors account for just under 4% of total market sectors employment in the UK in the 4-country study.

(2) Average annual hours worked per employee in the 4-country study were derived from GGDC (2005) for all four countries, including the UK. However, for the present UK-New Zealand comparison new estimates of UK hours worked have been derived from Labour Force Survey data in order to achieve greater comparability with New Zealand hours data. This makes little difference to estimates of relative ALP at total market sectors level.

(3) Relative capital per hour worked in the four-country study is based on measures of three different types of capital asset: structures, plant and machinery and vehicles. For the present study we distinguish five different capital assets: structures, computers, other plant and machinery, vehicles and intangibles (principally software).

Table 3 - Decomposition of New Zealand-UK differences in growth rates of average labour productivity (ALP), aggregate market sectors, 1995-2004

	Average annual rates of growth (%):			Contributions to ALP growth (pp):		
	Output	Hours worked	Average labour productivity	Physical capital	Labour quality	MFP
1995-2004						
UK	3.4	0.5	3.0	1.1	0.3	1.5
NZ	3.6	1.6	2.0	0.6	-0.1	1.5
1995-2000						
UK	4.3	1.1	3.2	1.1	0.3	1.7
NZ	2.2	0.8	1.4	0.8	0.1	0.5
2000-2004						
UK	2.4	-0.3	2.6	1.0	0.3	1.2
NZ	5.3	2.6	2.7	0.4	-0.4	2.7

Note: All estimates are for calendar years in contrast to the typical presentation of National Accounts data for years ending March 31st in New Zealand. Hence the estimated growth rates for New Zealand are not directly comparable with those produced by Statistics New Zealand (see Appendix Section A1 for details of the assumptions made in order to convert March year data to a calendar year basis).

4 Comparative productivity at sector level

In order to carry out benchmark comparisons of ALP levels in 2002, nominal value added in each country was first converted to US dollar values using sector-specific PPP exchange rates (Table 4). For measures of labour inputs, total annual hours worked in the UK at sector level were estimated by multiplying total employment (employees plus self-employed) by estimates of average annual hours worked per person derived from the UK Labour Force Survey. For New Zealand estimates of total annual hours worked were derived from SNZ estimates of paid hours for all employed persons, described in SNZ (2006b), with an upward adjustment to an hours worked basis using NZ Household Labour Force Survey data (see Appendix Section A1.2 for further details).

The results in Table 5 show that the UK lead over New Zealand in total market sectors applies to both aggregate manufacturing and aggregate market services. In some manufacturing sectors the UK lead even exceeds 50 pp (for example, textiles and clothing, printing and publishing and petroleum and chemicals) and the New Zealand deficit is also substantial in large service sectors such as retail. However, the results also highlight areas of relatively strong performance in New Zealand which have hitherto been masked by comparisons at aggregate economy level.

Five sectors stand out where our estimates point to a New Zealand lead of 5 pp or more over the UK:

- Food, drink and tobacco
- Accommodation, restaurants and bars
- Communication services
- Finance and insurance
- Cultural and recreational services

In addition in metal product manufacturing New Zealand ALP is estimated to be just ahead of the UK level at 102. These six sectors account for roughly 30% of total output in New Zealand market sectors and 22% of total hours worked (Table 5, Columns 2 and 4).

Table 4 - Estimated purchasing power parity (PPP) exchange rates at sector level, New Zealand and the UK, 2002 (UVR = Unit Value Ratio; E-PPP = Expenditure PPP)

UK SIC	ANZSIC	Sector	NZ$ per US$	Type of PPP	UK £ per US$	Type of PPP
01-05	AA, AB, AC	Agriculture, forestry and fishing	2.65	UVR	0.67	UVR
10-14	BA	Mining	2.27	UVR	1.34	UVR
15-16	CA	Food, beverage and tobacco manufacturing	1.33	E-PPP	0.68	E-PPP
17-19	CB	Textile and apparel manufacturing	2.54	E-PPP	0.83	UVR/E-PPP
20-21	CC	Wood and paper product manufacturing	2.48	E-PPP	0.69	UVR
22	CD	Printing, publishing and recorded media	2.15	E-PPP	0.51	E-PPP
23-25	CE	Petroleum, chemical, plastic and rubber product manufacturing	2.34	E-PPP	0.55	UVR
26	CF	Non-metallic mineral product manufacturing	1.64	E-PPP	0.47	UVR
27-28	CG	Metal product manufacturing	1.34	E-PPP	0.64	UVR/E-PPP
29-35	CH	Machinery and equipment manufacturing	1.99	E-PPP	0.89	UVR/E-PPP
36	CI	Furniture and other manufacturing	1.73	E-PPP	0.69	UVR/E-PPP
40-41	DA	Electricity, gas and water supply	2.37	UVR/E-PPP	0.68	UVR/E-PPP
45	EA	Construction	1.35	E-PPP	0.69	E-PPP
51	FA	Wholesale trade	2.56	UVR/E-PPP	0.75	UVR/E-PPP
50, 52	GA	Retail trade	2.03	UVR/E-PPP	0.79	UVR/E-PPP
55	HA	Accommodation, restaurants and bars	1.26	E-PPP	1.12	E-PPP
60-63	IA	Transport and storage	1.98	UVR	0.83	UVR
64	JA	Communication services	2.33	UVR	0.61	UVR/E-PPP
65-67	KA	Finance and insurance	1.26	E-PPP	0.60	E-PPP
71-74	LC	Business services	1.29	E-PPP	0.68	E-PPP
92-93	PA	Cultural and recreational services	1.23	E-PPP	0.83	E-PPP
01-67; 71-74; 92-93		Total market sectors	1.75		0.73	
15-37		Manufacturing	1.68		0.67	
50-67; 71-74; 92-93		Market services	1.68		0.72	
01-14; 40-45		Other sectors	2.05		0.77	
		GDP PPP exchange rate	1.47		0.61	
		Average market exchange rate	2.16		0.67	

Notes: UK PPP exchange rates are taken from Mason et al (2006). New Zealand PPP exchange rates are GGDC estimates for 1997 updated to 2002 on the basis of producer price changes at sector level between 1997-2002 in New Zealand and the US, with additional adjustments for electricity, gas and water, wholesale and retail based on updated 1999 OECD expenditure PPPs in order to make the New Zealand PPPs for those industries more comparable with UK PPPs. GDP PPPs and market exchange rates are taken from OECD (2005, Table 1.12). Estimated PPPs for total market sectors are those implied by summing value added in US$ for each sector, as derived by using sector-specific PPPs, and then dividing these US$ totals by the sum of value added in New Zealand and UK domestic currencies. A similar approach derives estimated PPPs for aggregate manufacturing and market services. See Appendix Section A2 for further details.

Table 5 - Average value added per hour worked and shares of total gross value added and hours worked in market sectors, New Zealand/UK, 2002 (Index numbers: UK=100)

UK SIC	ANZSIC	Sector	NZ/UK Average labour productivity (UK=100)	% shares of total gross value added in aggregate market sectors		% shares of total hours worked in aggregate market sectors	
				NZ	UK	NZ	UK
01-05	AA, AB, AC	Agriculture, forestry and fishing *	78	10.4	1.3	12.2	2.6
10-14	BA	Mining	82	2.0	3.2	0.3	0.4
15-16	CA	Food, beverage and tobacco manufacturing	105	7.4	3.1	5.2	2.4
17-19	CB	Textile and apparel manufacturing	48	1.0	0.8	1.7	1.1
20-21	CC	Wood and paper product manufacturing	59	2.5	0.9	2.3	1.0
22	CD	Printing, publishing and recorded media	36	1.7	2.3	1.7	1.8
23-25	CE	Petroleum, chemical, plastic and rubber product manufacturing	38	2.3	3.8	1.8	2.5
26	CF	Non-metallic mineral product manufacturing	56	0.8	0.8	0.7	0.7
27-28	CG	Metal product manufacturing	102	2.3	2.2	2.5	2.6
29-35	CH	Machinery and equipment manufacturing	61	3.0	6.5	3.8	6.0
36	CI	Furniture and other manufacturing	46	0.6	1.0	1.2	1.2
40-41	DA	Electricity, gas and water supply	90	3.0	2.3	0.5	0.7
45	EA	Construction	70	5.8	8.0	10.0	10.0
51	FA	Wholesale trade	86	11.7	6.0	8.0	6.4
50, 52	GA	Retail trade	55	7.8	10.6	15.1	15.2
55	HA	Accommodation, restaurants and bars	113	2.3	4.2	5.6	7.0
60-63	IA	Transport and storage	88	6.7	6.5	5.8	6.2
64	JA	Communication services	115	6.0	4.1	2.0	3.1
65-67	KA	Finance and insurance	112	9.0	9.9	3.8	5.2
71-74	LC	Business services	89	10.9	18.7	12.6	19.3
92-93	PA	Cultural and recreational services	128	3.0	3.8	3.3	4.2
01-67; 71-74; 92-93		Total market sectors	77	100	100	100	100
15-37		Manufacturing	70	22	21	21	19
50-67; 71-74; 92-93		Market services	87	57	64	56	67
01-14; 40-45		Other sectors	62	21	15	23	14
		**Agriculture, forestry and fishing (Alternative estimate - see text below)*	*101*				

Note: All estimates are for calendar years in contrast to the typical presentation of National Accounts data for years ending March 31st in New Zealand (see Appendix Section A1 for further details).

In many respects these are plausible findings. For example, we might expect New Zealand to be more specialised than the UK in food processing, and the relative strength of metal products within New Zealand manufacturing may partly reflect the disproportionate influence of the large aluminium producer Comalco. In Section 5 below we assess the contributions of relative physical capital-intensity and labour quality to the New Zealand leads in these six sectors. However, before doing so we need to discuss the uncertainties underlying estimates of this kind and assess the sensitivity of some results to alternative reasonable assumptions regarding such variables as PPP exchange rates and labour inputs.

With regard to New Zealand PPPs, there was a shortage of matching revenue and quantity data for some manufacturing sectors which prevented the calculation of unit value ratios (UVRs) even though UVRs were available for those sectors in the UK (Table 4). The sectors affected were wood and paper products, petroleum and chemicals and non-metallic mineral products. Hence for these sectors we developed a sensitivity test based on the ratios of UVRs to expenditure PPPs for these same sectors in Australia, using estimates provided by GGDC. These ratios were then applied to the New Zealand expenditure PPPs used in our New Zealand-UK comparison. In two cases this led to a sharp increase in the estimated New Zealand ALP level relative to the UK - up from 59 to 75 in wood and paper products and 38 to 52 in petroleum and chemicals. However, in non-metallic mineral products relative ALP barely changed (down from 56 to 55). We conclude that in two of these three sectors the estimated size of the New Zealand ALP gap relative to the UK is highly sensitive to the type of PPP exchange rate which is used; however, the existence of a relatively large productivity gap in these sectors is not in doubt.

One industry where New Zealand-UK comparisons are particularly difficult to carry out is agriculture. Since previous comparisons have found ALP in New Zealand agriculture to be among the highest in world terms (Prasada Rao, 1993), it comes as a surprise to find that estimated ALP in New Zealand agriculture, forestry and fishing in 2002 is only 78% of the UK level (compared to 115% only five years earlier; see Table 6, Row 1).[5] The estimated agriculture PPP for New Zealand in 2002 seems high - NZ$2.65 to US$1.00 - but this represents an appropriate update from the much lower PPP that GGDC estimated for 1997 (NZ$1.56) since agricultural prices in New Zealand rose rapidly between 1997-2002 whereas in the US they declined for many products.[6] The main factor explaining the seeming rapid improvement in UK labour productivity compared to New Zealand turns out to be a reported decline in UK agricultural employment of 23% between 1997-2002 while real output rose by 7%.[7] In New Zealand the equivalent changes over the same period were a 7% increase in labour input and a 4% increase in real output.[8]

However, further investigation suggests that the UK National Accounts employment total for agriculture may be a considerable under-estimate since annual surveys carried out by the UK Department for the Environment, Food and Rural Affairs (DEFRA) report total employment roughly 26% higher than the National Accounts total for 2002, and show a slower rate of decline in employment (down approximately 15% between 1997-2002).[9] In view of these disparities in official information on UK agricultural employment, we report alternative estimates of relative ALP for this sector using DEFRA employment data which show New Zealand ahead at 133% of the UK level in 1997, then declining to near-parity in 2002 (Appendix Table A1, bottom row). In view of the data uncertainties, both sets of

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5 According to Prasada Rao (1993), New Zealand also ranked highly in terms of agricultural output per unit of *land* if land is defined as total arable land plus permanent crop land. However, if land is defined to include permanent meadows and pastures as well as arable land, then New Zealand output per hectare compares less favourably with many European countries because of the much more intensive use of land in European farming.

6 These different price movements largely reflect weak New Zealand exchange rates against the US dollar for much of this period combined with the very different composition of agricultural output in New Zealand and the US. For example, New Zealand producer prices per tonne of sheep meat rose by 41% between 1997-2002 while US producer prices per tonne of maize fell by 5.2%. Note that NZ sheep and goat meat production was 5.6 times higher than the US in 2002 while New Zealand maize production was less than 1% of US output (Source: http://faostat.fao.org/. These data illustrate the difficulties of identifying comparable products for which to gather price information in the two countries.

7 ONS, Blue Book, 2006, Tables 2.4 and 2.5.

8 See Appendix Section A1.2 for details of New Zealand data sources.

9 Source: NIESR estimates based on data from the *June Agricultural and Horticultural Survey,* DEFRA [available at: http://www.defra.gov.uk/esg/work_htm/publications/cs/farmstats_web/2_SURVEY_DATA_SEARCH/HISTORICAL_DATASETS/HISTORICAL_DATASETS/historical_datasets.htm

estimates for this sector must be regarded as unsatisfactory.[10] (For purely illustrative purposes all estimates relating to agriculture in subsequent tables are based on UK National Accounts employment totals).

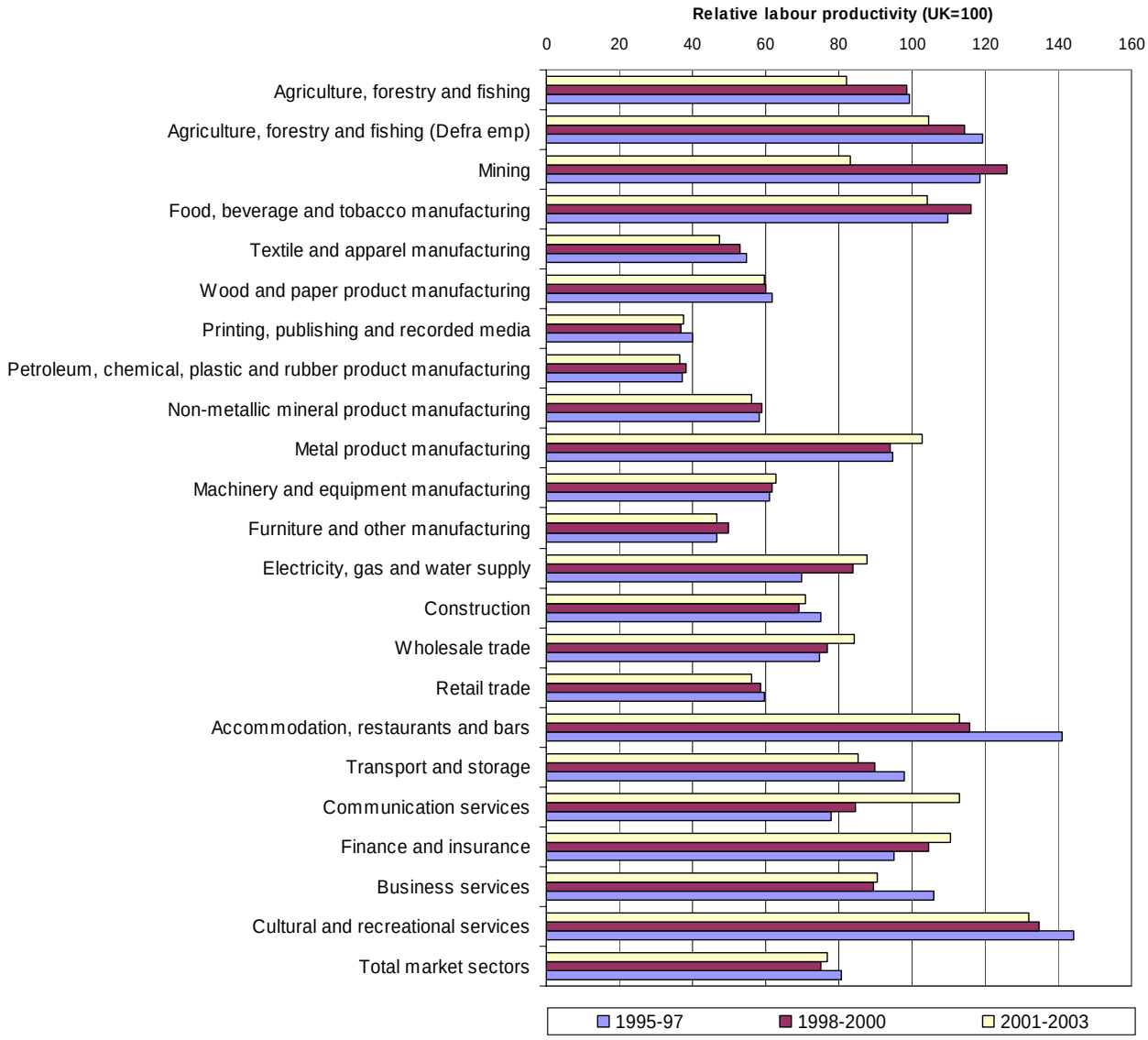
Apart from these problems specific to agriculture, our estimates are potentially sensitive to the choice of benchmark year due to different business cycle conditions in each country and underlying volatility in some sectoral data series. Figure 3 shows that in manufacturing New Zealand has a consistent lead on ALP in food processing from 1995-2003 while the UK retains a consistent lead in seven other manufacturing sectors over the same period. In service sectors New Zealand is ahead throughout 1995-2004 in accommodation and restaurants and cultural and recreational services while the UK lead remains intact in wholesale and retail. The UK is also well ahead over this period in utilities and construction, although the gap narrows in utilities from 1999 onwards.

This leaves three sectors - mining, transport and business services - where New Zealand recorded higher ALP than the UK in the mid-late 1990s but has subsequently fallen behind. Conversely, the NZ lead in communication services in our benchmark year (2002) has only developed in very recent years.

In nearly all the sectors where New Zealand consistently lags behind the UK on ALP, the implication of the recent UK-US-French-German comparative study is that New Zealand is even further behind the other four countries (see Appendix Table A4). For reasons pointed out in the notes to Table A4, as well as the different levels of sectoral disaggregation that are involved and problems of transitivity, caution is strongly advised in drawing inferences from reading across the two sets of results. However, there do appear to be some sectors where New Zealand may enjoy a productivity lead over other countries besides the UK, for example, in food processing and some branches of financial services relative to France and Germany. There do not appear to be any sectors where New Zealand is ahead of the US on ALP at this level of disaggregation.

[10] Some of the problems in estimating UK agricultural employment may partly be due to the extensive use of poorly-recorded migrant labour.

Figure 3 - Average labour productivity in market sectors, New Zealand and UK, 1995-97, 1998-2000, 2001-2003 (Index numbers: UK=100, Three-year averages)



Notes: Estimates are shown as three-year averages on a calendar year basis. 2002 benchmark estimates of average value added per hour worked have been extrapolated back to 1995 and forward to 2004 on the basis of movements in constant price value added and labour inputs in each country. See Appendix Table A1 for full time series. The second sector listed "Agriculture, forestry and fishing (Defra emp)" shows how New Zealand compares against the UK in this sector when alternative UK employment figures provided by the Department of Environment, Food and Rural Affairs (Defra) are used; see main text for details.

5 Relative physical capital-intensity and labour quality at sector level

5.1 Capital stocks and capital-labour ratios

In Section 2.2 above we outlined the perpetual inventory method of estimating capital stocks that cumulates constant price investments and deducts the value of depreciated assets. If we assume that depreciation rates are geometric, this has the advantage that they are easy to implement, in particular, if long time series of investments are not available but it is possible to make reasonable estimates of starting stocks. The disadvantage of this assumption 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.

In order to derive comparable estimates of net capital stocks in New Zealand and the UK, common sector-specific depreciation rates were applied to National Accounts investment data in each country. This approach follows O'Mahony (1993, 1999) who has shown that cross-country comparisons of official capital stocks figures are sensitive to differences in measurement techniques used by national statistical offices. Five asset types were distinguished: structures (non-residential buildings and other construction), computers, other plant and machinery, vehicles and intangibles (defined in the UK as consisting of patents, mineral exploration, artistic originals and the value of computer software). Investment data in national currencies were converted to US$ using OECD PPPs for investment goods by asset type. Finally, starting values for capital stocks were required in order to implement the perpetual inventory formula. In the UK starting values were set in 1948 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. [11] In New Zealand the starting year for applying this formula ranged from 1859 for buildings to 1964 for computers.

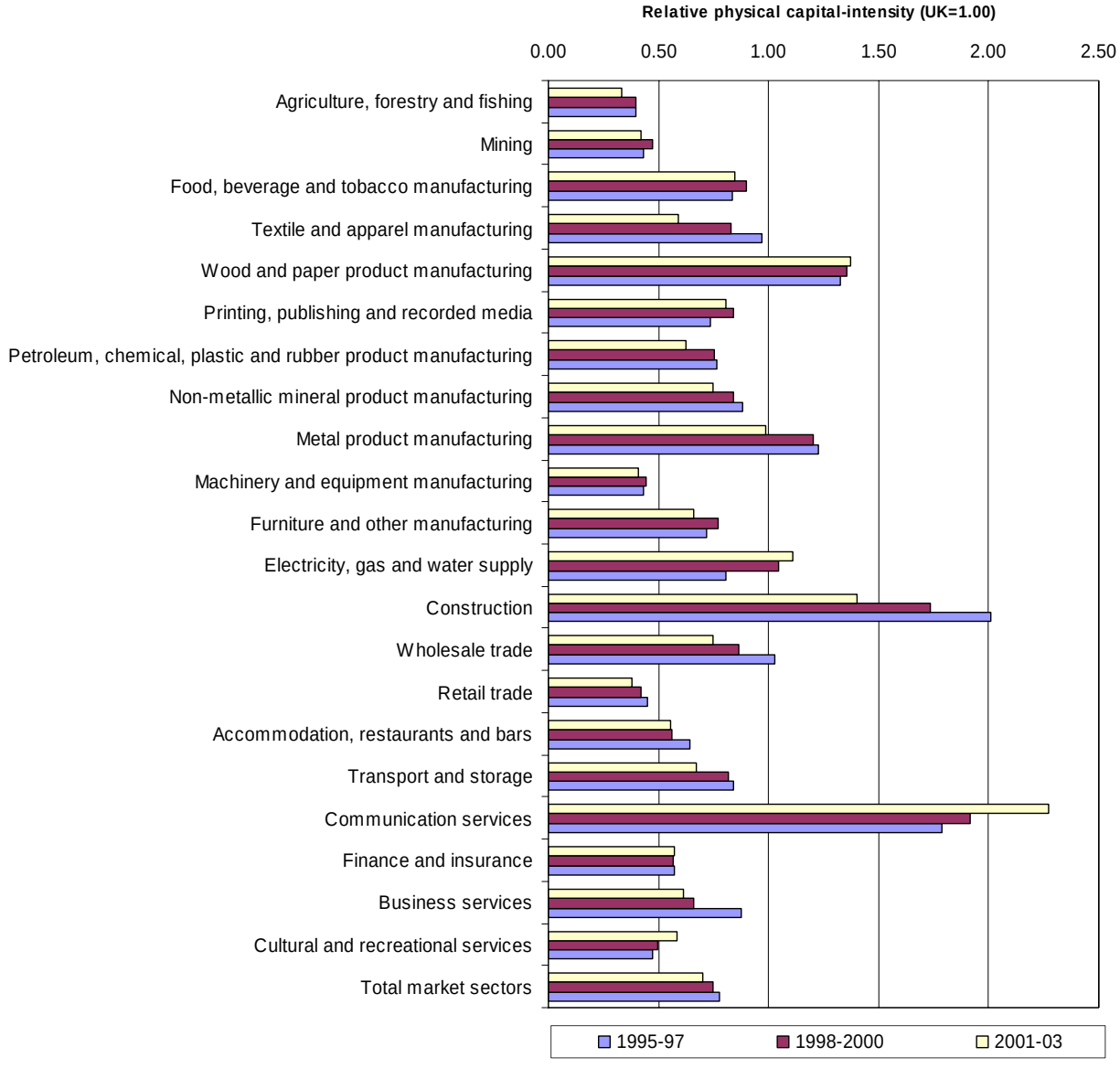
Across market sectors as a whole, average physical capital per hour worked in New Zealand is estimated at 69% of the UK level in 2002, down from 78% in 1995. This is broadly consistent with estimates at aggregate economy level reported by Schreyer (2006). As shown in Figure 4, in 14 of the 21 sectors New Zealand capital-intensity was relatively low compared to the UK throughout the 1995-2004 period: agriculture, forestry and fishing, mining, food processing, printing and publishing, petroleum and chemicals, non-metallic mineral products, machinery and equipment, furniture and other manufacturing, retail, hotels and catering, transport and storage, finance and insurance, business services and cultural and recreational services.

However, in four sectors New Zealand recorded higher capital-intensity than the UK for at least part of this period: textiles and clothing, metal products, electricity, gas and water supply and wholesale trade. And in another three sectors relative physical capital per hour worked has been consistently higher in New Zealand throughout the period: communication services, construction and wood and paper products.

[11] This is based on the idea that about 50% of an asset is depreciated within half its average life length. This kind of assumption is reasonable if the starting value is a long time before the capital stocks are employed in analysis (in this study 1995).

Given that the UK has on average invested much less in physical capital assets in recent decades than countries such as the US, France and Germany, it is important not to overstate the significance of New Zealand being more capital-intensive than the UK in certain sectors. Reading across from comparisons of the UK with the US, France and Germany (see Appendix Table A5) suggests that physical capital-intensity in communication services may be comparable with that in the US and France but physical capital per hour worked in construction and wood and paper products is still much lower in New Zealand than in the other three countries. Nonetheless, it is useful to be able to take account of sectoral variation in relative capital-intensity in New Zealand when seeking to evaluate the factors contributing to relatively weak overall productivity performance.

Figure 4 - Average physical capital per hour worked in market sectors, New Zealand/ UK, 1995-97, 1998-2000, 2001-03 (Index numbers: UK=1.00, Three-year averages)



Notes: Estimates are shown as three-year averages on a calendar year basis. Estimated productive capital stocks were initially supplied for New Zealand in constant price 1995-96 NZ$ and for the UK in 2002 constant price £ sterling. Both these series were converted to constant price 1999 US$ using 1999 OECD PPPs for non-ICT investment goods by asset type along with deflators based on movements in investment goods producer price indices in the UK, US and New Zealand. For computers and software (assumed to be representative of intangibles), US ICT capital stock deflators were used, obtained from http://www.csls.ca/data/ict.asp. Full time series shown in Appendix Table A2.

Disaggregation of productive capital stocks by asset-type shows that, across market sectors as a whole, New Zealand makes less intensive use of each different type of capital and - with the exception of vehicles in the late 1990s - this has been the case throughout 1995-2004 (Table 6). The less intensive use of computers and intangibles in New Zealand suggests that, if the capital stock indices were weighted by their shares in total user costs to yield a measure of capital services per hour worked, the New Zealand-UK gap on this measure would be even greater than on the capital stocks measure.[12]

Table 6 - Average physical capital per hour worked in aggregate market sectors, analysed by capital asset-type, New Zealand/UK, 1995-2004 (Index numbers: UK=1.00)

	Structures	Non-ICT equipment	Vehicles	Computers	Intangibles	Total capital
1995	0.78	0.70	1.01	0.56	0.71	0.78
1996	0.76	0.71	1.01	0.58	0.68	0.77
1997	0.77	0.74	1.05	0.65	0.63	0.79
1998	0.76	0.74	1.01	0.59	0.58	0.77
1999	0.73	0.72	0.96	0.56	0.57	0.74
2000	0.73	0.72	0.94	0.50	0.56	0.73
2001	0.72	0.73	0.90	0.48	0.54	0.72
2002	0.69	0.72	0.84	0.46	0.52	0.69
2003	0.68	0.72	0.85	0.48	0.53	0.69
2004	0.66	0.71	0.86	0.54	0.53	0.68

Again, disaggregation by sector for a recent year highlights some interesting variation beneath the aggregate results (Table 7). Four sectors in New Zealand do make more intensive use of computers than their UK counterparts: agriculture, forestry and fishing, mining, construction and cultural and recreational services. The two primary sectors also make more intensive use of intangibles (but in mining the disparity is so great as to suggest that there are marked differences between the two countries in the way that investments in intangibles in this industry are recorded). There are several sectors where New Zealand has accumulated (proportionately) more investments in structures and/or vehicles than in the UK and rather fewer where NZ is ahead in terms of investments in non-ICT machinery and equipment. The exceptions to this observation are wood and paper product manufacturing, transport services, communication services and cultural and recreational services which do make more intensive use of non-ICT equipment.

[12] This is because investment in short-lived ICT products which are subject to rapid price declines can typically only be justified by their higher productivity (hence higher shares of total user costs) relative to capital assets with longer service lives.

Table 7 - Average physical capital per hour worked in market sectors, analysed by capital asset-type, New Zealand/UK, 2002 (Index numbers: UK=1.00)

		Structures	Non-ICT equipment	Vehicles	Computers	Intangibles	Total capital
AA, AB, AC	Agriculture, forestry and fishing	0.27	0.26	1.80	11.57	3.13	0.33
BA	Mining	0.31	0.38	1.58	2.06	21.38	0.41
CA	Food, beverage and tobacco manufacturing	0.88	0.88	0.68	0.46	0.30	0.85
CB	Textile and apparel manufacturing	0.76	0.50	0.78	0.30	0.41	0.58
CC	Wood and paper product manufacturing	1.23	1.51	0.87	0.33	0.97	1.37
CD	Printing, publishing and recorded media	0.95	0.75	0.86	0.87	0.66	0.80
CE	Petroleum, chemical, plastic and rubber product manufacturing	0.70	0.60	1.20	0.44	0.33	0.63
CF	Non-metallic mineral product manufacturing	1.23	0.52	4.37	0.54	0.24	0.75
CG	Metal product manufacturing	1.23	0.83	1.62	0.61	0.58	0.96
CH	Machinery and equipment manufacturing	0.53	0.33	2.02	0.28	0.48	0.41
CI	Furniture and other manufacturing	1.14	0.46	0.80	0.47	0.37	0.65
DA	Electricity, gas and water supply	2.45	0.32	0.74	0.76	0.08	1.10
EA	Construction	1.50	0.98	2.18	1.50	0.56	1.37
FA	Wholesale trade	0.86	0.68	1.03	0.63	0.47	0.75
GA	Retail trade	0.23	0.58	0.96	0.52	0.47	0.37
HA	Accommodation, restaurants and bars	0.45	0.84	1.73	0.29	0.17	0.54
IA	Transport and storage	0.50	1.01	0.79	0.24	0.50	0.67
JA	Communication services	4.42	1.77	0.84	0.63	2.85	2.29
KA	Finance and insurance	0.29	0.71	1.37	0.57	1.05	0.56
LC	Business services	0.66	0.63	0.36	0.54	0.90	0.59
PA	Cultural and recreational services	0.36	1.70	0.56	1.66	0.38	0.58
	Total market sectors	0.69	0.72	0.84	0.46	0.52	0.69

5.2 Relative labour quality

In order to explore the impact of labour quality differences on relative productivity performance, estimates of relative skill levels have been derived on the basis of educational attainments and mean wage levels analysed by qualifications category in the UK and New Zealand for the period 1995 to 2004. This is an experimental approach building on current work at NIESR which seeks to develop labour quality measures that are more closely related to worker productivity than standard measures of educational inputs such as average years of schooling.

Using data from the UK Labour Force Survey, we group UK qualifications into the following four categories in order to obtain estimates of mean wages by qualifications category at sector level:

1 First / Bachelor degrees and above

2 Other NVQ4 plus NVQ3 or equivalent, eg A levels (academic qualifications for 17-18 year old school-leavers and technician- and craft-level vocational qualifications (NVQ = National Vocational Qualifications)

3 NVQ2 and NVQ1 or equivalent (relatively low-level qualifications associated with semi-skilled employment)

4 No qualifications

For New Zealand we use NZ Income Survey data to group New Zealand qualifications into three categories in order to obtain similar estimates of mean wages by qualifications category:

1 Bachelor degrees and above

2 Post-secondary school qualifications below Bachelor level (for example, Trade certificates, Advanced trade certificates, NZ certificates or diplomas and local polytech diplomas)

3 No post-school qualifications

Since there is no obvious way to match qualification groups below graduate level between the two countries, we follow the approach outlined in Mason, et al (2006) of benchmarking on graduate-level qualifications (where comparability across countries is at its strongest), and then using ratios of mean wages in non-graduate categories to mean graduate wages in each country as indicators of labour quality differences between the respective categories.

In more detail, we create an indicator of relative quality-adjusted labour input L^q in industry *i* for two countries *j* and *k* as follows, denoting the benchmark category of degree holders as *h* and the remainder of the workforce as *o*:

$$(7) \qquad L_i^{\overline{q(j,k)}} = s_{ih}(j,k)[\ln(L_{ih}^j) - \ln(L_{ih}^k)] + s_{io}(j,k)[\ln(L*_{io}^j) - \ln(L*_{io}^k)]$$

where

$$(8) \qquad L*_{io}^j = \sum_{p \neq h} \frac{w_p}{w_h} L_{io}^j \qquad \text{and similarly for } k,$$

and $s_{ih}(j,k)$ is the average share of labour compensation paid to group *h* in industry *i* across the two countries; $s_{io}(j,k)$ is the average of (1- s_{ih}) across the two countries; L_{ih} represents graduate-level labour input (hours worked) and L^*_{io} represents quality-adjusted non-graduate labour input where hours are weighted by the relative wage of non-graduate skill groups (w_p) to that of graduates (w_h). In this way, all non-graduate hours worked are calculated as 'effective units of labour' with a graduate base.

This is a relatively general model which has the advantage of allowing the relative marginal products across different qualification categories to vary across countries (as they may very well do in practice).

Two obvious underlying assumptions in this approach are (1) a broad similarity between countries in graduate-level productivity; and (2) that mean wage differentials between qualification categories reflect differences in the average productivity levels of persons

classified to each qualification category. With regard to assumption (1), we argue that graduates are notably more mobile across national borders than those in other qualification groups and there is widespread acceptance by employers in New Zealand and the UK from overseas. Assumption (2) is consistent with the standard growth accounting assumption of perfectly competitive markets (in which a firm hires an additional hour of labour up to the point where that person's marginal productivity equals his/her marginal cost). However, it makes no allowance for cross-country differences in labour market institutions such as minimum wage legislation and the role of trade unions in wage-setting. In spite of this shortcoming, we hope that the resulting measure of relative labour quality goes some way towards capturing variations in relative marginal products across different sub-graduate qualification categories in each country.

New Zealand-UK differences in the distribution of qualifications and in wage differentials in 2002 are shown in Table 8. Three things stand out in particular: (1) the higher graduate share of employment in the UK, 15% compared to 11% in New Zealand; (2) the smaller (38%) proportion of the New Zealand workforce with post-secondary school qualifications compared to 72% in the UK; (3) the relatively narrow wage differentials attached to holding degree-level qualifications rather than sub-degree qualifications or no post-school qualifications in New Zealand. This latter point could reflect relatively low returns to university study as compared to the UK or it could reflect relatively high returns to post-school work experience and (uncertified) training or a combination of both factors. Some part of the relatively high returns to 'No post-school qualifications' may also be due to the fact that this category includes academic qualifications attained by 17-18 year old school-leavers when they are the highest qualification attained by the individuals concerned whereas equivalent UK school-leaving qualifications such as A levels are included in the NVQ3 category in the UK.

Using this information on employment shares by qualification group and qualification-related wage differentials, we derive a measure of relative labour quality which shows New Zealand to be approximately 7% higher than the UK across total market sectors in 2002 but on a declining trend from a 10% lead in 1998 to only 2% in 2004 (Table 9). This progressive decline in the estimated labour quality differential reflects a continued reduction in the employment share of workers lacking formal qualifications in the UK coupled with a decline towards the end of the period in sub-graduate pay differentials in New Zealand (see Appendix Section A3).

Table 8 - Employment shares and relative wage ratios, aggregate market sectors, New Zealand and UK, 2002

	Employment shares (%)		Ratio of mean wages to mean graduate wages	
	UK	NZ	UK	NZ
Graduates	15	11	1.00	1.00
NVQ 3-4 (UK)	37		0.66	
Post-secondary school qualifications below Bachelor level (NZ)		38		0.72
NVQ 1-2 (UK)	35		0.53	
No post-school qualifications (NZ)		51		0.59
No qualifications (UK)	12		0.46	
TOTAL	100	100		

Sources: Derived from UK Labour Force Survey and the NZ Income Survey. See notes to Table 11 for further details.

However, a caveat needs to be entered about the estimates of qualification shares of employment in New Zealand which have been derived from the NZ Income Survey (NZIS). Data from the NZ Census of Population and Dwellings for 2001 point to the following, rather different employment shares in aggregate market sectors: Graduates 11%, Post-school qualifications below Bachelor level 22%; No post-school qualifications 67%. If these Census employment shares were applied to the NZIS wage data, then the estimated New Zealand lead in average labour quality in 2002 would be approximately halved and by 2004 it would disappear.

On the advice of Statistics NZ (discussed further in Appendix Section A3), we regard the NZIS data as more reliable but clearly the discrepancy between the two sources adds to the uncertainty attached to our estimates of labour quality. In addition to the data uncertainties, it is also of concern that mean annual pay for New Zealand graduates in 2002, converted to US dollars at GDP PPP exchange rates, was roughly a third below mean graduate pay in the UK. Clearly, a detailed analysis of graduate salaries in the two countries is beyond the scope of this report; however, if New Zealand graduates are typically low paid by international standards, this could contribute to relatively narrow pay differentials between graduates and non-graduates in New Zealand, thus artificially raising New Zealand labour quality according to the measure we have adopted. We therefore continue to use this measure in this report with some reservations.

Table 9 suggests considerable variation between sectors in measured labour quality with the New Zealand skills index ranging from 95% of the UK level in mining up to 14-15% above the UK level in textiles and clothing, wholesale, transport and communications. Since Mason et al (2006) found the UK to be lagging behind the US, France and Germany by 2-5 pp on a similar measure of relative labour quality, we conclude that, on this measure at least, average labour quality in New Zealand compares favourably with the other three countries (see Appendix Table A6).

In summary, the measured labour quality gap between New Zealand and the UK represents the net outcome of two main phenomena noted above, that is, the higher employment shares of persons holding certified qualifications in the UK and the relatively high returns to sub-graduate qualifications and uncertified experience and training in New Zealand. In spite of our reservations, our labour quality measure does seem to capture potentially interesting contrasts in skills formation between the two countries which are worthy of further investigation.

Table 9 - Relative labour quality worked in market sectors, New Zealand/UK, 1995-2004 (Index numbers: UK=1.00)

SIC	Sector	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AA, AB, AC	Agriculture, forestry and fishing	1.18	1.18	1.18	1.18	1.14	1.14	1.15	1.11	1.08	1.07
BA	Mining	1.05	1.06	1.03	1.04	1.00	1.00	0.97	0.95	0.90	0.93
CA	Food, beverage and tobacco manufacturing	1.20	1.18	1.21	1.18	1.07	1.07	1.09	1.11	1.14	1.13
CB	Textile and apparel manufacturing	1.24	1.21	1.26	1.25	1.10	1.10	1.10	1.15	1.16	1.14
CC	Wood and paper product manufacturing	1.21	1.18	1.22	1.18	1.10	1.10	1.09	1.13	1.15	1.14
CD	Printing, publishing and recorded media	1.13	1.12	1.13	1.12	1.01	1.01	1.00	1.04	1.08	1.07
CE	Petroleum, chemical, plastic and rubber product manufacturing	1.14	1.13	1.16	1.13	1.02	1.02	1.02	1.04	1.08	1.07
CF	Non-metallic mineral product manufacturing	1.18	1.18	1.21	1.20	1.08	1.08	1.10	1.11	1.15	1.14
CG	Metal product manufacturing	1.19	1.17	1.20	1.19	1.07	1.07	1.06	1.09	1.14	1.12
CH	Machinery and equipment manufacturing	1.16	1.14	1.17	1.15	1.04	1.04	1.03	1.06	1.11	1.10
CI	Furniture and other manufacturing	1.19	1.19	1.22	1.18	1.08	1.08	1.07	1.13	1.15	1.14
DA	Electricity, gas and water supply	1.13	1.12	1.10	1.11	1.11	1.11	1.13	1.12	1.07	1.06
EA	Construction	1.11	1.10	1.10	1.10	1.10	1.10	1.11	1.09	1.06	1.03
FA	Wholesale trade	1.15	1.15	1.14	1.14	1.13	1.13	1.15	1.14	1.11	1.06
GA	Retail trade	1.14	1.15	1.14	1.14	1.15	1.15	1.16	1.13	1.09	1.06
HA	Accommodation, restaurants and bars	1.18	1.17	1.16	1.16	1.17	1.17	1.17	1.15	1.11	1.07
IA	Transport and storage	1.14	1.15	1.15	1.15	1.15	1.15	1.16	1.14	1.11	1.08
JA	Communication services	1.16	1.15	1.15	1.14	1.14	1.14	1.15	1.14	1.11	1.08
KA	Finance and insurance	1.09	1.10	1.08	1.06	1.07	1.07	1.09	1.07	1.04	1.02
LC	Business services	1.08	1.07	1.05	1.05	1.04	1.04	1.06	1.05	1.03	1.03
PA	Cultural and recreational services	1.11	1.12	1.12	1.12	1.10	1.10	1.11	1.10	1.07	1.05
	Total market sectors	1.10	1.10	1.11	1.10	1.08	1.08	1.08	1.07	1.04	1.02

Notes: All estimates are for calendar years. UK estimates are derived from Labour Force Surveys 1995-2004. NZ estimates of employment shares by qualification group at sector level are derived from NZ Income Survey data at a relatively high level of sectoral aggregation with more disaggregated sectoral estimates based on NZ Census data for 1996 and 2001. Since NZIS data were only available for 1997-2004, the estimated series was then backdated to 1995 on the basis of rates of change between 1997-99. Estimates of qualification-related wage differentials for full-time workers were derived for aggregate manufacturing and aggregate market services in each country and then used to weight employment shares by qualification group in relevant sectors; for agriculture, mining, utilities and construction, employment shares were weighted by the wage differentials for aggregate market sectors. See Appendix Section A3 for further details.

6 Explaining New Zealand-UK differences in productivity levels and growth rates at sector level

6.1 Relative ALP and MFP levels

We now go on to assess the extent to which the relative importance to productivity performance of physical capital, labour quality and MFP varies between sectors in New Zealand and the UK. Table 10 shows relative levels of MFP at sector level along with a decomposition of the contributions made by differences in physical capital, labour quality and MFP to relative ALP performance.

Table 10 - Decomposition of New Zealand-UK differences in average labour productivity (ALP) levels and multi-factor productivity (MFP) levels, 2002

				Estimated contributions to gap in ALP: (proportions)		
SIC	Sector	ALP (UK=100)	MFP (UK=100)	Relative capital-intensity	Relative labour quality	Relative MFP
AA, AB, AC	Agriculture, forestry and fishing	78	138	3.05	-0.31	-1.73
BA	Mining	82	180	5.45	0.08	-4.53
CA	Food, beverage and tobacco mfg	105	107	-1.53	1.21	1.32
CB	Textile and apparel manufacturing	48	47	0.10	-0.11	1.01
CC	Wood and paper product manufacturing	59	49	-0.14	-0.10	1.24
CD	Printing, publishing and recorded media	36	38	0.04	-0.02	0.98
CE	Petroleum, chemical, plastic and rubber product manufacturing	38	44	0.12	-0.02	0.90
CF	Non-metallic mineral product mfg	56	58	0.13	-0.10	0.97
CG	Metal product manufacturing	102	96	-0.59	4.10	-2.51
CH	Machinery and equipment manufacturing	61	74	0.42	-0.09	0.67
CI	Furniture and other manufacturing	46	48	0.11	-0.08	0.97
DA	Electricity, gas and water supply	90	82	-0.66	-0.23	1.89
EA	Construction	70	60	-0.19	-0.13	1.32
FA	Wholesale trade	86	91	0.82	-0.52	0.70
GA	Retail trade	55	70	0.48	-0.13	0.66
HA	Accommodation, restaurants & bars	113	120	-1.56	1.00	1.55
IA	Transport and storage	88	89	0.88	-0.73	0.85
JA	Communication services	115	74	2.38	0.37	-1.75
KA	Finance and insurance	112	150	-3.43	0.37	4.06
LC	Business services	89	106	1.82	-0.29	-0.53
PA	Cultural and recreational services	128	145	-0.96	0.33	1.63
	Total market sectors	77	87	0.57	-0.14	0.57

The UK is ahead of New Zealand on MFP in 14 of the 21 sectors. The seven sectors where New Zealand is ahead comprise four where ALP is also above the UK level and three more where New Zealand ALP is lower but the New Zealand sectors apparently make more efficient use of existing resources than their UK counterparts (agriculture, forestry and fishing, mining and business services). In these sectors the UK lead on ALP is almost wholly attributable to their advantages in physical capital-intensity with MFP making a negative contribution.

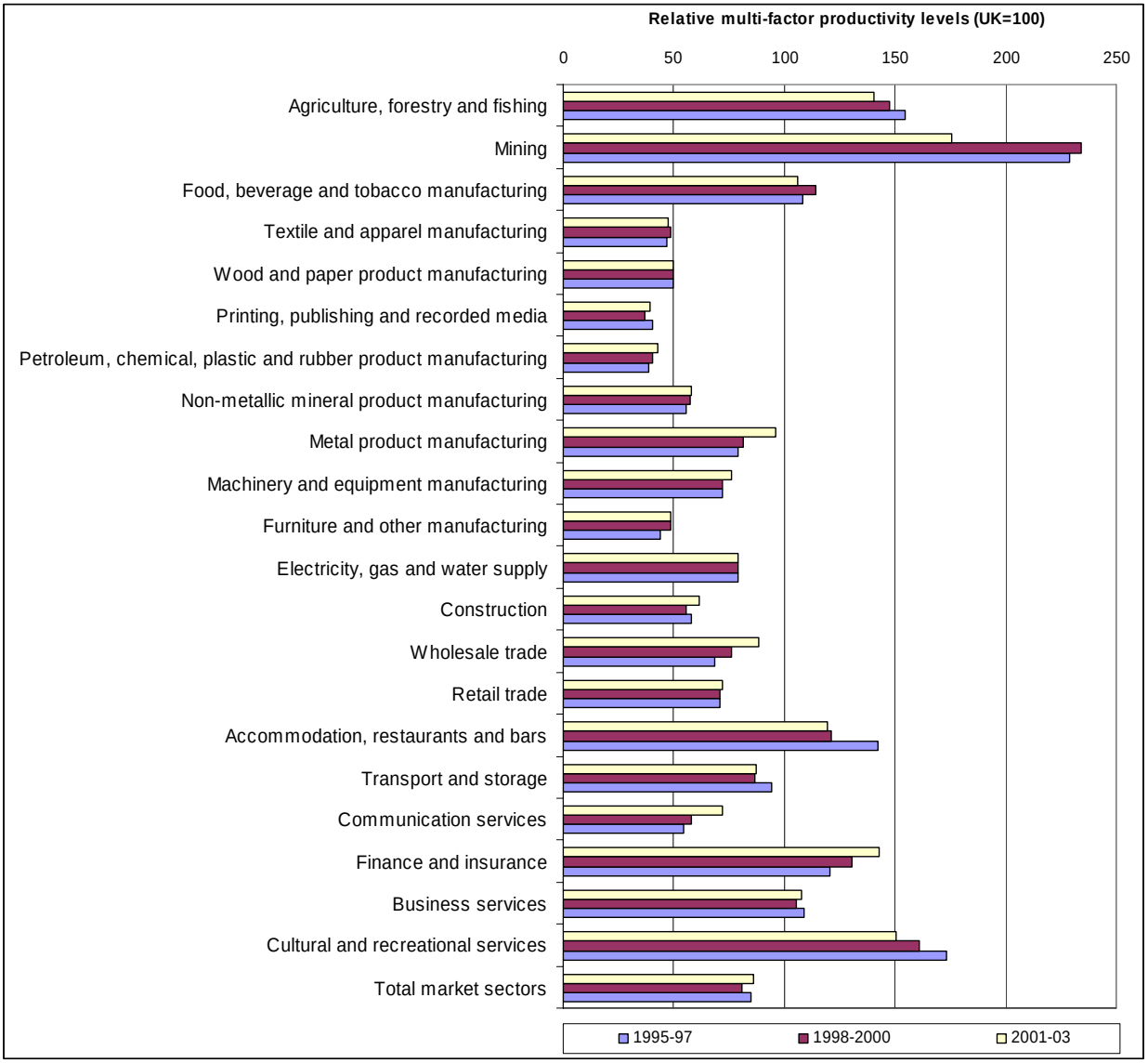
In the majority of other sectors where the UK is ahead on ALP, the positive contribution from MFP outweighs that from physical capital and more than offsets the effects of higher measured labour quality in New Zealand. The same is true of nearly all sectors where New Zealand is ahead on ALP, such as food processing, metal products, hotels and catering, finance and insurance and cultural and recreational services. The exception is communication services where New Zealand is ahead of the UK on ALP and this is largely due to higher physical capital-intensity with MFP making a negative contribution.

Figure 5 shows that the pattern of advantage in relative MFP levels identified in 2002 has prevailed in most sectors throughout the 1995-2004 period. The only real exception to this is metal products where New Zealand was behind the UK on MFP during the late 1990s but has evidently gained ground since 2000.

6.2 Comparative growth rates in ALP and TFP

As noted in Section 3, UK market sectors as a whole enjoyed faster average annual rates of ALP growth between 1995-2004 than did New Zealand. One way to explore the drivers of ALP growth rates is to compare growth rates in output with those in labour input at sector level across countries. Another is to compare the respective contributions of growth rates in physical capital, labour quality and MFP.

Figure 5 - Relative multi-factor productivity (MFP) levels in market sectors, New Zealand/UK, 1995-97, 1998-2000, 2002-04 (Index numbers: UK=100, Three-year averages)



Notes: Estimates are shown as three-year averages on a calendar year basis. Full time series shown in Appendix Table A6.

In general the slow rate of growth in UK labour input between 1995-2004 (which we identified in Section 3) was due to reductions in employment numbers in several manufacturing sectors and an overall decline of 3.5% over the period in average annual hours worked per employee.[13] In service sectors positive ALP growth in the UK typically reflected output growing much faster than labour inputs. By contrast, in New Zealand in most sectors output growth was slower and labour input growth was faster than in the UK (Table 11). As a result, there are only five sectors where average annual growth in ALP in New Zealand was above that in the UK: electricity, gas and water (which recorded sharp reductions in total hours worked), communication services and metal products (where output grew much more rapidly than labour input) and finance and insurance and wood products (where there was a slight reduction in labour input over the period).

13 The reduction in average annual hours worked per employee in the UK represents a continuation of a long-term downward trend (Green, 2001). It also represents the net outcome of a relatively high degree of polarisation between long-hours working and part-time employment in the UK compared to other European countries. In 1998 the UK implemented the European Commission's Working Time Directive which seeks to limit working time but employees are permitted to 'opt out' from its

Turning to an assessment of the respective contributions of physical capital-intensity, labour quality and MFP to average annual growth rates in ALP, Table 12A shows that in the UK growth in MFP exceeded growth in capital-intensity in 13 of the 21 sectors. The main exceptions were mining, electricity, gas and water, construction, wholesale, accommodation and restaurants and business services.

In New Zealand MFP growth also exceeded growth in physical capital in 13 of the 21 sectors. Three sectors even showed a decline in physical capital-intensity over the period: petroleum and chemicals, metal products and transport and storage. The highest rates of MFP growth occurred in communication services, metal products and wholesale trade. Communication services also recorded strong growth in capital-deepening as did electricity, gas and water, wood products and finance and insurance.

Table 11 - Average annual rates of growth in output, total hours worked and average labour productivity (ALP), New Zealand and the UK, 1995-2004

		UK			New Zealand		
		Output	Labour input	ALP	Output	Labour input	ALP
SIC	Sector	*Average annual rates of growth (%)*					
AA, AB, AC	Agriculture, forestry and fishing	0.1	-3.4	3.5	1.7	-0.6	2.3
BA	Mining	2.4	-1.7	4.1	0.9	-2.2	3.1
CA	Food, beverage and tobacco manufacturing	1.5	-0.7	2.2	2.2	1.5	0.8
CB	Textile and apparel manufacturing	-7.0	-10.4	3.4	-0.9	-3.5	2.6
CC	Wood and paper product manufacturing	1.0	-2.8	3.7	2.8	-0.2	3.1
CD	Printing, publishing and recorded media	2.0	-0.8	2.8	-0.3	-1.2	0.9
CE	Petroleum, chemical, plastic and rubber product manufacturing	0.0	-1.6	1.5	-0.1	-0.3	0.2
CF	Non-metallic mineral product manufacturing	-0.4	-2.6	2.2	2.8	1.3	1.4
CG	Metal product manufacturing	-1.3	-3.5	2.2	3.8	1.2	2.6
CH	Machinery and equipment manufacturing	1.5	-2.6	4.1	2.6	-0.2	2.8
CI	Furniture and other manufacturing	2.2	-0.5	2.7	0.7	-0.6	1.3
DA	Electricity, gas and water supply	2.5	-1.7	4.2	0.6	-6.1	6.6
EA	Construction	2.4	1.0	1.4	5.6	4.7	0.8
FA	Wholesale trade	2.9	-0.2	3.1	4.0	1.0	3.1
GA	Retail trade	4.0	0.6	3.4	3.6	1.4	2.2
HA	Accommodation, restaurants and bars	3.5	1.5	2.0	2.6	3.0	-0.4
IA	Transport and storage	4.6	1.0	3.6	3.3	1.6	1.7
JA	Communication services	5.7	1.1	4.6	9.4	0.2	9.2
KA	Finance and insurance	4.4	0.6	3.8	4.5	-0.3	4.8
LC	Business services	6.1	3.3	2.8	4.9	5.4	-0.5
PA	Cultural and recreational services	3.9	2.8	1.1	5.1	5.4	-0.3
	Total market sectors	3.4	0.5	3.0	3.6	1.6	2.0

regulations in collaboration with their employers. To date the net effects of this Directive on average working time are hard to determine.

Table 12A - Decomposition of average annual growth rates in average labour productivity (ALP) in market sectors, UK, 1995-2004

UK 1995-2004		Average annual rate of growth in ALP (%)	Physical capital-intensity	Labour quality	MFP
			Contributions to ALP growth (percentage points):		
AA, AB, AC	Agriculture, forestry and fishing	3.54	1.34	0.30	1.90
BA	Mining	4.10	2.33	0.11	1.66
CA	Food, beverage and tobacco manufacturing	2.20	0.51	0.42	1.27
CB	Textile and apparel manufacturing	3.38	1.28	0.76	1.33
CC	Wood and paper product manufacturing	3.74	0.97	0.60	2.17
CD	Printing, publishing and recorded media	2.81	0.32	0.53	1.96
CE	Petroleum, chemical, plastic and rubber product manufacturing	1.52	0.70	0.54	0.27
CF	Non-metallic mineral product manufacturing	2.23	0.83	0.35	1.05
CG	Metal product manufacturing	2.22	0.40	0.52	1.30
CH	Machinery and equipment manufacturing	4.11	0.93	0.45	2.73
CI	Furniture and other manufacturing	2.73	0.78	0.34	1.61
DA	Electricity, gas and water supply	4.25	3.53	0.11	0.61
EA	Construction	1.43	1.81	0.17	-0.55
FA	Wholesale trade	3.13	1.74	0.29	1.10
GA	Retail trade	3.37	1.53	0.28	1.56
HA	Accommodation, restaurants and bars	2.04	1.01	0.37	0.66
IA	Transport and storage	3.59	0.59	0.15	2.85
JA	Communication services	4.58	1.20	0.42	2.96
KA	Finance and insurance	3.84	1.51	0.39	1.93
LC	Business services	2.77	3.93	0.20	-1.35
PA	Cultural and recreational services	1.06	-0.28	0.35	0.99
	Total market sectors	2.96	1.09	0.35	1.52

Table 12B - Decomposition of average annual growth rates in average labour productivity (ALP) in market sectors, New Zealand, 1995-2004

New Zealand 1995-2004		Average annual rate of growth in ALP (%)	Physical capital-intensity	Labour quality	MFP
			Contributions to ALP growth (percentage points):		
AA, AB, AC	Agriculture, forestry and fishing	2.29	1.69	-0.22	0.81
BA	Mining	3.13	2.96	-0.09	0.26
CA	Food, beverage and tobacco manufacturing	0.76	0.96	0.05	-0.25
CB	Textile and apparel manufacturing	2.58	0.35	0.08	2.15
CC	Wood and paper product manufacturing	3.07	1.89	-0.02	1.20
CD	Printing, publishing and recorded media	0.94	0.38	0.05	0.52
CE	Petroleum, chemical, plastic and rubber product manufacturing	0.18	-0.64	-0.05	0.87
CF	Non-metallic mineral product manufacturing	1.45	0.03	0.06	1.36
CG	Metal product manufacturing	2.59	-0.57	0.00	3.15
CH	Machinery and equipment manufacturing	2.76	0.60	0.01	2.15
CI	Furniture and other manufacturing	1.25	-0.01	0.03	1.23
DA	Electricity, gas and water supply	6.63	7.36	-0.06	-0.67
EA	Construction	0.84	0.14	-0.41	1.12
FA	Wholesale trade	3.09	0.13	-0.20	3.16
GA	Retail trade	2.20	0.58	-0.28	1.90
HA	Accommodation, restaurants and bars	-0.37	0.68	-0.40	-0.66
IA	Transport and storage	1.71	-0.10	-0.22	2.03
JA	Communication services	9.16	4.03	-0.04	5.16
KA	Finance and insurance	4.80	1.90	0.00	2.90
LC	Business services	-0.52	0.51	-0.06	-0.97
PA	Cultural and recreational services	-0.25	0.61	-0.06	-0.80
	Total market sectors	1.96	0.59	-0.13	1.50

7 Summary and assessment

This study has confirmed the prevailing consensus that, in aggregate, New Zealand market sectors compare unfavourably with the UK on average labour productivity (ALP) - and by implication compare even more unfavourably with other countries such as the US. At total market sectors level the proximate causes for this relatively weak performance on ALP in New Zealand are lower multi-factor productivity (MFP) closely followed by lower physical capital-intensity.

However, beneath this overall story there is considerable sectoral variation. In 2002 there were five sectors in which New Zealand had an estimated lead on ALP of 5 pp or more over the UK: food, drink and tobacco, accommodation, restaurants and bars, communication services, finance and insurance, and cultural and recreational services. In addition, metal products is just ahead of the UK on ALP and there are two sectors -- mining and business services - where New Zealand is behind the UK on ALP but ahead on MFP. This suggests that, although New Zealand firms in these two sectors are on average less capital-intensive than their UK counterparts, many of them make more efficient use of existing resources.

The same is probably true of agriculture as well but due to the uncertainties about UK agricultural employment numbers which we have discussed in this report, we are unable to present a satisfactory New Zealand/UK comparison of ALP in agriculture.

This leaves 12 out of 21 sectors where New Zealand falls short of the UK on both ALP and MFP. These sectors comprise all other manufacturing apart from metal products, electricity, gas and water supply, construction, wholesale, retail and transport services. They represented just under 58% of total hours worked in New Zealand market sectors in 2002. With the exception of wood products, electricity, gas and water and construction, these sectors are all relatively low in physical capital-intensity compared to the UK.

With some reservations we have made use of a measure of relative labour quality which incorporates wage differentials between qualification groups (assumed to proxy productivity differences) as well as differences in the mix of certified qualifications in each country. On this measure New Zealand appears to be ahead of the UK in workforce skills in all sectors except for mining. However, the New Zealand lead has declined since 1998, partly due to increased numbers of UK workers holding certified qualifications and partly due to declining returns to sub-graduate qualifications in New Zealand as compared to degree-level qualifications. In growth accounting terms, the measured advantage in New Zealand skills does serve to partly offset UK advantages in physical-capital intensity and MFP in many sectors. However, the extent of the offset is fairly small, partly because the New Zealand skills lead itself is small and partly because in growth accounting the respective contributions of different production inputs are evaluated separately and thus do not take account of potential complementarities between inputs (such as the contribution of workforce skills to the effective selection and utilisation of capital equipment).

It is worth considering how much of the New Zealand-UK gap in ALP at aggregate market sectors level is due to differences in industrial structure. For example, if New Zealand employment tends to be concentrated in sectors with relatively low absolute levels of ALP (typically less capital-intensive sectors), this might help to explain the overall weakness in ALP relative to the UK. To examine this we follow van Ark et al (2002) in using a shift-share method which decomposes the UK-New Zealand ALP gap into two components with the UK as the base country:

$$(9) \qquad LP^{UK} - LP^{NZ} = \sum_{i=1}^{n}\left(LP_i^{UK} - LP_i^{NZ}\right)\frac{1}{2}\left(S_i^{NZ} + S_i^{UK}\right) + \sum_{i=1}^{n}\left(S_i^{UK} - S_i^{NZ}\right)\frac{1}{2}\left(LP_i^{NZ} + LP_i^{UK}\right)$$

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 9 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 13 suggest that roughly a quarter of the New Zealand-UK gap in ALP for aggregate market sectors is attributable to differences in employment structure such as the relatively high shares of UK employment in sectors with comparatively high value added per employee such as financial and communication services (even though New Zealand is actually ahead on ALP in those two sectors). The other side of this coin is the relatively high concentration of New Zealand employment in comparatively low value added sectors such as agriculture.

However, the remaining three quarters of the ALP gap are accounted for by within-sector productivity differences. To understand the sources of these differences, further research needs to go beyond growth accounting and investigate the factors underlying the proximate causes of the ALP gap which are emphasised in the growth accounting framework, namely, differences in accumulated stocks of physical and human capital and in MFP. For example, how do the cost and incentive structures confronting businesses making investment decisions in New Zealand compare with those in other countries? How well placed are New Zealand businesses to benefit from international knowledge spillovers which might help improve MFP performance through faster innovation and improved efficiency of resource utilisation? What are the effects on incentive structures and innovation performance of New Zealand-specific characteristics such as small population size, low population density and distance from large markets?

Table 13 - Shift-share decomposition of the New Zealand-UK gap in average labour productivity (ALP) in aggregate market sectors, 2002

ANZSIC (1)	Sector	Mean of NZ and UK ALP levels (US$)	NZ sector shares of total hours worked (%)	UK sector shares of total hours worked (%)	Within-sector product-ivity effect	Employ-ment structure effect	Total effect
AA, AB, AC	Agriculture, forestry and fishing	13	12.2	2.6	4.0	-21.1	-17.1
BA	Mining	100	0.3	0.4	1.2	0.9	2.2
CA	Food, beverage and tobacco manufacturing	36	5.2	2.4	-1.2	-17.8	-19.0
CB	Textile and apparel manufacturing	12	1.7	1.1	2.0	-1.3	0.8
CC	Wood and paper product manufacturing	20	2.3	1.0	2.9	-4.6	-1.6
CD	Printing, publishing and recorded media	32	1.7	1.8	8.8	0.9	9.7
CE	Petroleum, chemical, plastic and rubber product manufacturing	35	1.8	2.5	11.4	4.4	15.8
CF	Non-metallic mineral product manufacturing	34	0.7	0.7	2.3	0.1	2.4
CG	Metal product manufacturing	24	2.5	2.6	-0.2	0.7	0.5
CH	Machinery and equipment manufacturing	18	3.8	6.0	7.3	6.6	13.9
CI	Furniture and other manufacturing	16	1.2	1.2	2.4	-0.2	2.2
DA	Electricity, gas and water supply	89	0.5	0.7	0.9	2.5	3.4
EA	Construction	18	10.0	10.0	11.0	0.1	11.1
FA	Wholesale trade	22	8.0	6.4	3.8	-6.0	-2.2
GA	Retail trade	13	15.1	15.2	19.0	0.3	19.2
HA	Accommodation, restaurants and bars	11	5.6	7.0	-1.4	2.5	1.1
IA	Transport and storage	22	5.8	6.2	3.0	1.4	4.3
JA	Communication services	43	2.0	3.1	-2.6	8.7	6.1
KA	Finance and insurance	62	3.8	5.2	-5.5	15.6	10.1
LC	Business services	25	12.6	19.3	8.3	28.6	36.9
PA	Cultural and recreational services	23	3.3	4.2	-3.6	3.7	0.1
	Total market sectors	23	100	100	74.0	26.0	100

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Appendix - Tables

Appendix Table A1 - Average labour productivity in market sectors, New Zealand and UK, 1995-2004 (Index numbers: UK=100)

ANZ SIC	Sector	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AA, AB, AC	Agriculture, forestry and fishing*	88	95	115	106	90	101	95	78	74	78
BA	Mining	90	112	154	153	128	97	97	82	70	83
CA	Food, beverage and tobacco manufacturing	108	106	115	118	117	114	104	105	103	95
CB	Textile and apparel manufacturing	49	56	59	56	54	49	48	48	47	46
CC	Wood and paper product manufacturing	63	62	60	59	60	61	57	59	63	60
CD	Printing, publishing and recorded media	40	40	39	37	37	36	40	36	37	34
CE	Petroleum, chemical, plastic and rubber product manufacturing	36	37	39	37	37	41	37	38	34	32
CF	Non-metallic mineral product manufacturing	59	58	58	57	58	62	55	56	57	55
CG	Metal product manufacturing	95	93	95	91	91	100	100	102	107	99
CH	Machinery and equipment manufacturing	65	62	57	59	60	66	66	61	61	57
CI	Furniture and other manufacturing	49	44	46	50	48	51	45	46	49	43
DA	Electricity, gas and water supply	81	65	63	73	82	97	90	90	83	101
EA	Construction	73	75	77	67	69	71	70	70	73	69
FA	Wholesale trade	79	74	72	71	79	81	83	86	83	79
GA	Retail trade	61	58	60	57	59	59	58	55	55	55
HA	Accommodation, restaurants and bars	142	141	141	120	117	111	114	113	113	114
IA	Transport and storage	102	99	92	91	93	86	83	88	86	86
JA	Communication services	80	79	76	77	81	96	105	115	119	120
KA	Finance and insurance	96	91	98	107	102	106	108	112	111	105
LC	Business services	113	109	97	89	91	88	93	89	90	84
PA	Cultural and recreational services	147	148	138	140	138	127	134	128	134	131
	Total market sectors	82	80	80	77	74	75	77	77	76	75
	**Agriculture, forestry and fishing (Alternative estimates -see text)*	*108*	*117*	*133*	*122*	*107*	*115*	*117*	*101*	*97*	*105*

Notes: All estimates are for calendar years. 2002 benchmark estimates of average value added per hour worked have been extrapolated back to 1995 and forward to 2004 on the basis of movements in constant price value added and labour inputs in each country.

Appendix Table A2 - Average physical capital per hour worked in market sectors, New Zealand/UK, 1995-2004 (Index numbers: UK=1.00)

ANZ SIC	Sector	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AA, AB, AC	Agriculture, forestry and fishing	0.38	0.38	0.43	0.43	0.37	0.39	0.34	0.33	0.34	0.37
BA	Mining	0.35	0.45	0.50	0.46	0.46	0.50	0.49	0.41	0.37	0.39
CA	Food, beverage and tobacco manufacturing	0.81	0.82	0.87	0.89	0.91	0.91	0.86	0.85	0.84	0.83
CB	Textile and apparel manufacturing	0.87	0.96	1.07	0.96	0.80	0.73	0.65	0.58	0.53	0.49
CC	Wood and paper product manufacturing	1.31	1.31	1.35	1.47	1.37	1.23	1.35	1.37	1.40	1.30
CD	Printing, publishing and recorded media	0.72	0.74	0.74	0.80	0.87	0.85	0.84	0.80	0.77	0.70
CE	Petroleum, chemical, plastic and rubber product manufacturing	0.75	0.75	0.78	0.80	0.76	0.70	0.64	0.63	0.60	0.54
CF	Non-metallic mineral product manufacturing	0.91	0.86	0.87	0.86	0.81	0.86	0.79	0.75	0.71	0.69
CG	Metal product manufacturing	1.15	1.15	1.38	1.32	1.16	1.14	1.08	0.96	0.92	0.81
CH	Machinery and equipment manufacturing	0.44	0.42	0.44	0.45	0.44	0.45	0.41	0.41	0.40	0.37
CI	Furniture and other manufacturing	0.68	0.70	0.77	0.83	0.72	0.75	0.68	0.65	0.65	0.56
DA	Electricity, gas and water supply	0.85	0.77	0.80	0.89	1.02	1.23	1.15	1.10	1.08	1.20
EA	Construction	1.94	2.08	2.01	1.89	1.68	1.63	1.61	1.37	1.23	1.08
FA	Wholesale trade	1.05	1.05	0.99	0.94	0.85	0.81	0.77	0.75	0.73	0.71
GA	Retail trade	0.46	0.45	0.45	0.42	0.42	0.41	0.40	0.37	0.37	0.36
HA	Accommodation, restaurants and bars	0.67	0.60	0.66	0.58	0.57	0.53	0.53	0.54	0.60	0.64
IA	Transport and storage	0.85	0.84	0.84	0.85	0.84	0.77	0.71	0.67	0.64	0.63
JA	Communication services	1.80	1.80	1.76	1.89	1.81	2.05	2.20	2.29	2.32	2.25
KA	Finance and insurance	0.63	0.53	0.55	0.56	0.58	0.56	0.56	0.56	0.60	0.63
LC	Business services	0.91	0.88	0.83	0.71	0.65	0.61	0.63	0.59	0.61	0.60
PA	Cultural and recreational services	0.47	0.48	0.47	0.46	0.52	0.52	0.58	0.58	0.59	0.59
	Total market sectors	0.78	0.77	0.79	0.77	0.74	0.73	0.72	0.69	0.69	0.68

Notes: All estimates are for calendar years. Estimated productive capital stocks were initially supplied for New Zealand in constant price 1995-96 NZ$ and for the UK in 2002 constant price £ sterling. Both these series were converted to constant price 1999 US$ using 1999 OECD PPPs for non-ICT investment goods by asset type along with deflators based on movements in investment goods producer price indices in the UK, US and New Zealand. For computers and software (assumed to be representative of intangibles), US ICT capital stock deflators were used, obtained from http://www.csls.ca/data/ict.asp

Appendix Table A3 - Relative multi-factor productivity (MFP) levels in market sectors, New Zealand/UK, 1995-2004 (Index numbers: UK=100)

SIC	Sector name	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AA, AB, AC	Agriculture, forestry and fishing	143	153	168	149	140	153	156	138	127	129
BA	Mining	203	210	274	285	244	174	181	180	166	186
CA	Food, beverage and tobacco manufacturing	109	107	110	114	113	115	107	107	103	96
CB	Textile and apparel manufacturing	43	49	49	47	49	49	49	47	46	46
CC	Wood and paper product manufacturing	51	51	47	46	49	54	48	49	51	50
CD	Printing, publishing and recorded media	44	44	43	40	39	41	45	41	40	39
CE	Petroleum, chemical, plastic and rubber product manufacturing	38	38	39	38	38	46	44	44	40	38
CF	Non-metallic mineral product manufacturing	56	56	55	54	55	62	56	58	60	58
CG	Metal product manufacturing	81	80	76	74	79	92	94	96	99	95
CH	Machinery and equipment manufacturing	75	74	67	67	70	80	82	74	72	69
CI	Furniture and other manufacturing	47	42	42	47	46	53	48	48	50	46
DA	Electricity, gas and water supply	60	53	50	54	54	56	54	56	53	59
EA	Construction	57	57	59	53	57	58	57	60	66	66
FA	Wholesale trade	62	58	58	58	68	71	74	78	77	75
GA	Retail trade	70	70	71	70	70	71	70	70	74	74
HA	Accommodation, restaurants and bars	139	145	142	125	123	115	118	120	121	122
IA	Transport and storage	101	100	91	89	93	88	85	93	92	94
JA	Communication services	54	53	51	51	56	61	66	71	71	75
KA	Finance and insurance	129	130	137	149	137	142	144	164	161	150
LC	Business services	113	112	103	101	108	107	109	106	108	102
PA	Cultural and recreational services	175	177	168	173	162	148	150	145	156	152
	Total market sectors	86	85	84	81	79	81	85	87	87	87

Appendix Table A4 - Comparisons of average labour productivity at sector level, UK, US, France and Germany, 2002 (Index numbers: UK=100)

SIC	Sector	US	France	Germany
01-05	Agriculture, forestry and fishing	118	71	41
10-14	Mining and quarrying	74	47	22
15-16	Food, drink and tobacco	120	102	72
17	Textiles	115	169	113
18	Manufacture of wearing apparel; dressing and dyeing of fur	190	163	138
19	Leather and footwear	141	154	77
20	Wood and wood products	144	182	138
21	Pulp, paper and paper products	117	161	131
22	Printing and publishing	87	94	83
23	Mineral oil refining, coke and nuclear fuel	126	168	172
24	Chemicals	125	157	84
25	Rubber and plastics	110	134	96
26	Non-metallic mineral products	82	186	98
27	Basic metals	157	185	160
28	Fabricated metal products	127	139	105
29	Mechanical engineering	138	135	116
30	Computers and office machinery	94	91	109
31	Electrical machinery	179	186	124
32	Electronic components and capital goods	229	132	108
33	Medical, precision and optical instruments	149	126	92
34	Motor vehicles	229	222	161
35	Other transport equipment	134	154	127
36, 37	Manufacturing nec, Recycling	104	116	92
40, 41	Electricity, gas and water supply	154	82	53
45	Construction	129	94	96
50	Motor vehicle trade and repairs	119	102	89
51	Wholesale trade and commission trade	159	109	121
52	Retail trade and repair of household goods	176	158	107
55	Hotels and catering	149	259	77
60	Inland transport	158	120	74
61	Water transport	121	85	149
62	Air transport	157	138	269
63	Supporting and auxiliary transport activities; travel agents	116	133	78
64	Post and telecommunications	146	214	307
65	Financial services, except insurance and pension funding	194	122	91
66	Insurance and pension funding, except compulsory social security	75	43	54
67	Activities auxiliary to financial services	296	101	117
70	Real estate activities	171	148	213
71	Renting of machinery and equipment	153	164	505
72	Computer services and related activities	143	152	155
73	Research and development	172	119	124
74	Other business services	130	132	147
90, 91, 92, 93	Other community, social and personal services	140	81	172
	All market sectors	141	132	122

Notes: Derived from Mason, O'Leary, O'Mahony and Robinson (2006).

Some differences between this 4-country study and the present study need to be noted:

(1) Total market sectors in the 4-country study includes some real estate activities (part of SIC 70) and social, community and personal services (UK SIC 90-91) which are not included in the definition of market sectors in the present study. These sectors account for just under 4% of total market sectors employment in the UK in the 4-country study.

(2) Average annual hours worked per employee in the 4-country study were derived from GGDC (2005) for all four countries, including the UK. However, for the present UK-New Zealand comparison new estimates of UK hours worked have been derived from Labour Force Survey data in order to ensure comparability with New Zealand hours data.

Appendix Table A5 - Relative physical capital per hour worked, UK, US, France and Germany, 2002 (Index numbers UK = 100)

SIC	Sector	US/UK	France/UK	Germany/UK
		Index numbers (UK=100)		
01-05	Agriculture, forestry and fishing	72	97	94
10-14	Mining and quarrying	77	.	19
10-14, 23	Mining and quarrying; Mineral oil refining, coke and nuclear fuel	.	18	.
15-16	Food, drink and tobacco	88	137	126
17	Textiles	157	200	332
18	Manufacture of wearing apparel; dressing and dyeing of fur	100	.	341
18-19	Clothing and leather goods	.	145	.
19	Leather and footwear	677	.	206
20	Wood and wood products	148	.	236
20-21	Wood and paper products	.	178	.
21	Pulp, paper and paper products	179	.	239
22	Printing and publishing	102	116	178
23	Mineral oil refining, coke and nuclear fuel	142	.	159
24	Chemicals	136	.	174
24-25	Chemicals, rubber and plastics	.	159	.
25	Rubber and plastics	85	.	97
26	Non-metallic mineral products	118	215	226
27	Basic metals	124	.	126
27-28	Basic metals and fabricated metal products	.	148	.
28	Fabricated metal products	162	.	207
29	Mechanical engineering	179	133	166
30	Computers and office machinery	204	.	340
30-33	Computers, electronic and instrument engineering	.	147	.
31	Electrical machinery	217	.	213
32	Electronic components and capital goods	137	.	143
33	Medical, precision and optical instruments	218	.	180
34	Motor vehicles	76	160	152
35	Other transport equipment	144	184	185
36, 37	Manufacturing nec, Recycling	141	272	285
40, 41	Electricity, gas and water supply	139	92	123
45	Construction	195	227	260
50	Motor vehicle trade and repairs	116	146	191
51	Wholesale trade and commission trade	154	154	178
52	Retail trade and repair of household goods	168	167	78
55	Hotels and catering	107	185	83
60	Inland transport	134	.	241
60-63	Transport services	.	119	.
61	Water transport	303	.	194
62	Air transport	90	.	109
63	Supporting and auxiliary transport activities; travel agents	44	.	150
64	Post and telecommunications	208	93	255
65	Financial services, except insurance and pension funding	251	183	213
66	Insurance and pension funding, except compulsory social security	29	97	95
67	Activities auxiliary to financial services	382	.	.

SIC	Sector	US/UK	France/UK	Germany/UK
		Index numbers (UK=100)		
70	Real estate activities	128	44	.
71	Renting of machinery and equipment	208	.	753
71, 72, 74, 90	Rental, computer and other business services	.	120	.
72	Computer services and related activities	148	.	271
73	Research and development	119	136	182
74	Other business services	159	.	645
90, 91, 92, 93	Other community, social and personal services	60		175
01-74; 90-93	All market sectors	117	128	167

Notes: Derived from Mason, O'Leary, O'Mahony and Robinson (2006).

Note that relative capital per hour worked in this four-country study is based on measures of only three different types of capital asset: structures, plant and machinery and vehicles. For the present study we distinguish five different capital assets: structures, computers, other plant and machinery, vehicles and intangibles (principally software).

Appendix Table A6 - Estimates of relative labour quality in the UK, US, France and Germany, 2002 (Index numbers: UK=100)

SIC code	Sector	US/UK	France/UK	Germany/UK
01-05	Ariculture,hunting,Fishing,fish farms,hatcheries etc	98	99	109
10-14	Mining, quarrying etc	92	95	94
15-16	Food,beverage,tobacco products manufacture	93	90	105
17	Textile manufacture	95	109	112
18	Clothing,fur manufacture	95	100	115
19	Leather,leather goods manufacture	90	97	110
20	Wood,straw,cork,wood prods(not furn)	88	92	106
21	Pulp,paper,paper prods manufacture	101	103	107
22	Printing,publishing,recorded media	99	95	98
23	Coke,petrol prods,nuclear fuel man.	105	101	102
24	Chemicals,chemical products man.	103	92	98
25	Rubber,plastic products manufacture	99	96	109
26	Other non-metallic products man.	95	91	107
28	Fabric-metal prod (not mach,eqt) man.	91	91	104
29	Mach,eqt manufacture	94	97	106
30	Office mach,computer manufacture	112	115	105
31	Elec mach,eqt manufacture	109	93	109
32	Radio,TV,communication eqt man.	114	107	108
33	Medical,precision,optical eqt man.	105	97	101
34	Motor veh,trailer,etc manufacture	99	93	108
35	Other transport eqt manufacture	102	96	102
36	Furniture etc manufacture	96	94	107
40-41	Electricity, gas and water	101	99	103
45	Construction	93	92	105
50	Sales of motor vehs,parts,fuel etc	103	99	106
51	Wsale,commission trade (fee,contract)	116	109	107
52	Retail trade (not motor veh) repairs	105	104	108
55	Hotels,restaurants	95	101	104
60	Transport by land,pipeline	101	105	108
61	Water transport	104	132	109
62	Air transport	104	107	100
63	Aux transport activ.,travel agents	111	104	104
64	Post,telecommunications	111	106	106
65-67	Financial services	112	106	102
72	Computer,related activities	112	112	102
73	Research,development		98	103
74	Other business activities	110	103	101
90-93	Other services	99	101	105
01-74; 90-93	TOTAL market sectors	102	103	105

Note: Derived from Mason, O'Leary, O'Mahony and Robinson (2006). See text in Section 5.2 for details of calculations.

Appendix - Sources and Methods

A1 Principal data sources

A1.1 Output measures

For the UK National Accounts data on current price gross output and value added were derived from the Office of National Statistics (ONS) Blue Book (2006) and ONS Supply-Use Tables 1995-2004. Real value added series were then derived using chain-linked volume indices published in the Blue Book and unpublished industry-specific output deflators supplied by ONS.

For New Zealand data on current price gross output and value added were derived from the National Accounts (Revised): Year ended March 2005. The conversion of March year data to a calendar year basis was far from straightforward. Statistics NZ supplied quarterly data on gross domestic product by industry in the form of a seasonally-adjusted chain-volume series expressed in 1995-96 prices (ie, in prices relating to the 12 months ending March 31, 1996) together with a quarterly Producers Price Index - Output series disaggregated by industry. These two data series were used to generate an industry-level current price value added index on a calendar year basis. However, the problem still arose of how to estimate a set of current-price starting values for this series. In the event current price value added totals for the calendar year 1995 were assumed to consist of 25% of current price value added for the 12 months ending March 1995 plus 75% of current price value added for the 12 months ending March 1996. The precision of our productivity comparisons could therefore be improved if quarterly data on current price value added disaggregated by industry could be made available.

In both countries output deflators for aggregate market sectors were calculated using a Tornqvist index formula with sector-level deflators weighted by each sector's average share of total current price value added in adjacent years.

A1.2 Labour input measures

For UK employment ONS Blue Book totals at broad industry level were taken as control totals and then disaggregated to more detailed sector level using data on employment shares from the Annual Business Inquiry. Industry-level data on average annual hours worked per person engaged (including unpaid overtime) in the UK were derived from analysis of Labour Force Survey data.

For New Zealand the most reliable data series on labour inputs, described in Statistics New Zealand (2006b), shows total hours paid in a reference week in the middle of each quarter, including the self-employed as well as employees. Estimates of total annual hours worked by industry were 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 an aggregate market sectors ratio of hours worked to hours paid derived from NZ Household Labour Force Survey (HLFS) data. This procedure was carried out on the advice of Statistics NZ because of concerns about lack of robustness at industry level in the HLFS hours worked series.

Remaining concerns about the comparability of labour input data concern the treatment of annual leave and other forms of absence from work in each country. The New Zealand hours worked series is based on responses collected over 52 weeks of the year and should therefore capture all forms of absence from work (paid or unpaid). For the UK the Labour Force Survey data on actual hours worked by survey respondents refer to a specified reference week which is usually the week prior to each interview. In general, LFS estimates are believed to take reasonable account of reduced working hours due to annual leave and statutory holidays and LFS methodological notes refer to procedures for some interviews falling during the Christmas/New Year period. Hence, it is likely that the UK estimates take much the same account of annual leave and other absences from work as do the New Zealand estimates.

A1.3 Labour share of value added

For the UK estimates of the labour share of value added at industry level were derived from Annual Business Inquiry data on employee compensation and value added, with an upward adjustment to take account of self-employed persons based on estimates of the ratio of self-employed to employees derived from Labour Force Surveys.

For New Zealand the labour share of value added at industry level was estimated in a similar manner using National Accounts data on employee compensation and value added at industry level, with an upward adjustment to take account of self-employed persons based on estimates of the ratio of self-employed to employees in the SNZ hours paid labour volume series described above.

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 and van Ark (2003) in the light of US evidence of generally lower compensation for self-employed persons compared to employees.

A1.4 Capital stocks

Capital stocks series were constructed using a perpetual inventory method that cumulates constant price investments and deducts the value of depreciated assets. Capital investment data at industry level were provided by the UK Office for National Statistics and Statistics New Zealand. In order to derive comparable estimates of productive capital stocks in New Zealand and the UK, common sector-specific depreciation rates (based on US estimates) were applied to the investment data in each country. Five asset types were distinguished: structures (non-residential buildings and other construction), computers, other plant and machinery, vehicles and intangibles (defined in the UK as consisting of patents, mineral exploration, artistic originals and the value of computer software). Investment data in national currencies were converted to US$ using OECD PPPs for investment goods by asset type. Finally, starting values for capital stocks were required in order to implement the perpetual inventory formula. In the UK starting values were set in 1948 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.[14] In New Zealand the starting year for applying this formula ranged from 1859 for buildings to 1964 for computers.

[14] This is based on the idea that about 50% of an asset is depreciated within half its average life length. This kind of assumption is reasonable if the starting value is a long time before the capital stocks are employed in analysis (in this study 1995).

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

$$K^{k}_{ic,t} = K^{k}_{ic,t-1}(1 - d_{ic}) + I^{k}_{ic,t}$$

The growth in aggregate capital was then calculated using a Tornqvist index formula, with weights equal to the share of each asset type in the total value of capital.

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.

Estimated productive capital stocks were initially supplied for New Zealand in constant price 1995-96 NZ$ and for the UK in 2002 constant price £ sterling. Both these series were converted to constant price 1999 US$ using 1999 OECD PPPs for non-ICT investment goods by asset type along with deflators based on movements in investment goods producer price indices in the UK, US and New Zealand. For computers and software (assumed to be representative of intangibles), US ICT capital stock deflators were used, obtained from http://www.csls.ca/data/ict.asp

A2 Purchasing Power Parity (PPP) exchange rates

For the UK sector-level PPP exchange rate estimates for 2002 were derived by updating estimates of 1997 PPPs in O'Mahony (1999) using OECD 1999 expenditure PPPs and output deflators for the UK and the US. For New Zealand a new set of sector-level PPP estimates for 1997 were prepared by Gerard Ypma at the Groningen Growth and Development Centre (GGDC). They comprise a mix of unit value ratios (UVRs) calculated as sales of products divided by quantities produced UVRs and expenditure PPPs adjusted for relative trade and transportation margins and for taxes. These GGDC PPPs were updated to 2002 on the basis of producer price changes at sector level between 1997-2002 in New Zealand and the US, with additional adjustments for electricity, gas and water, wholesale and retail based on updated 1999 OECD expenditure PPPs in order to make the New Zealand PPPs for those industries more comparable with UK PPPs.

The basic GGDC approach to such estimates is as follows: European Union countries are compared on the basis of unit values, etc., derived from Prodcom, which is Eurostat's collective database of production censuses. All EU countries are compared bilaterally to Germany because it has the largest coverage. Germany is then compared bilaterally with the U.S., as are all other non-EU OECD countries. At industry level the results are then multilateralised using an Elteto-Köves-Szulc (EKS) weighting procedure. Therefore, in order to incorporate New Zealand into this multi-country PPP dataset, New Zealand output prices were systematically compared with those of the U.S. for a selected benchmark year. The same exercise was also carried out for Australia in order to facilitate the sensitivity tests described in Section 4 of the main text. The main sources used in this exercise are listed in Table A2.1

In an effort to develop criteria for deciding which type of PPP should best be used for cross-country sector-level productivity comparisons, GGDC researchers have recently analysed Supply-Use Tables for a number of countries to identify how expenditure prices and output prices are related. This analysis has then been used to develop a new dataset of industry PPPs for 45 industries and 25 countries for the year 1997. Time series are then applied to

update and backdate over time from this benchmark year. Full details of this dataset are provided in van Ark and Timmer (2001) and van Ark, Stuivenwold and Inklaar (2003).

In order to derive time series of New Zealand-UK ALP comparisons, we use 'constant PPPs' (estimated for 2002 and then updated and backdated using sectoral price deflators for both New Zealand and the UK relative to the US). This approach is preferred for estimates of productivity growth rates as the underlying price deflators are explicitly designed to capture changes through time. A disadvantage is that the weights employed to aggregate prices up to total market economy level do not vary though time, in contrast to a 'current PPPs' approach where the basket of goods and services that is priced changes annually. However, a current PPPs approach also has disadvantages, for example, revisions and methodological changes in the OECD-Eurostat PPP programme have contributed to considerable instability in data series based on current PPPs (Lau and Wallis, 2005).

Appendix Table A2.1 - Sources for PPP estimates for New Zealand, Australia and US

3-digit Gross Output set for 1997

-OECD STAN Database 2004

-Statistics New Zealand, Input-output table 95/96, Table 2 Use

-Statistics New Zealand, Rest of the Economy Survey 1996

-Australian Bureau of Statistics, Australia, Input-Output table 1997

-Australian Bureau of Statistics, Input-Output tables Product details 1996-1997

-Australian Bureau of Statistics (2003), Mineral Production, Quantity and Value by State, 2001-02 and 2002-03

-Groningen Growth and Development Centre, 60-Industry Database, October 2005, http://www.ggdc.net

-OECD, Structural Statistics for Industry and Services

Agriculture

FAOSTAT database, FAO prices and quantities for 1997

Mining

-Australian Bureau of Statistics (2003), Mineral Production, Quantity and Value by State, 2001-02 and 2002-03

-United Nations, 2001 Industrial Commodity Statistics Yearbook

-Statistics New Zealand, ACPs by ANZSCC

- Statistical Abstract of the United States 1999

-1997 US Census of Manufactures,

Manufacturing

-ICP PPPs and nominal values for basic headings for 1996 and 1999 from the OECD/Eurostat workgroup

- OECD (1999), Consumption Tax Trends, 1999 edition, Paris

- OECD and International Energy Agency (1999), Energy policies of IEA countries, 1999 review, Paris.

-OECD STAN Database 2004

-Trade Margins from Trade PPP calculations (see below)

-Groningen Growth and Development Centre, 60-Industry Database, October 2005, http://www.ggdc.net

- U.S. Census of Manufactures 1997

- Mulligen, P.H. Van (2002), Quality Differences And Hedonic Pricing In International Comparisons, Ph.D. Thesis, University Of Groningen.

Utilities

-United Nations, 1998 Energy Statistics Yearbook

-FAO, Aquastat Database 2002

-International Energy Agency's Energy Prices & Taxes (2nd quarter 2006)

-ICP PPPs and nominal values for basic headings for 1996 and 1999 from the OECD/Eurostat workgroup

Trade

-Statistics New Zealand, Annual Enterprise Survey - NZSIC-Based Financial Estimates and Sample Errors, 1995/96 Financial Year

-Statistics New Zealand, Actual Retail Sales By Quarter By Storetype, http://www.stats.govt.nz/domino/external/PASFull/pasfull.nsf/0/73250640e09aeaca4c25671a0016ba13/$FILE/alltabls.xls

-US Bureau of Census, 1997 Economic Census

-Australian Bureau of Statistics, Wholesale Industry Australia, 1998-1999, 2.1 Selected Income items by industry

-Australian Bureau of Statistics, Retail Industry Australia, 1998-1999, 2.1 Selected Income items by industry

Transport

-World Bank Railway Database

-ICAO, Civil Aviation Statistics of the World 1997

-United Nations, Annual Bulletin of Statistics for Europe and North America 1999

-OECD, Structural Statistics for Industry and Services

- Universal Postal Union, Universal Postal Database 2004

- OECD, Telecommunication Database 2003

-Bolland, Weir and Vincent (2005), Development of a New Zealand National Freight Matrix

-U.S. Department of Transportation, Bureau of Transportation Statistics (2002), National Transportation Statistics 2002, BTS02-08, Washington, DC, U.S. Government Printing Office, December 2002

-Statistics New Zealand, Input-output table 95/96, Table 2 Use

-Statistics New Zealand, Rest of the Economy Survey 1996

- Statistics New Zealand, National Accounts 2004

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A3 Labour quality measurement

Our approach to estimating and comparing average labour quality in New Zealand and the UK is described in detail in Section 5.2 of the main text. To recapitulate, this measure was derived by benchmarking on graduate-level qualifications (where comparability across countries is at its strongest), and then using ratios of mean wages in non-graduate categories to mean graduate wages in each country as indicators of labour quality differences between the respective categories.

For the UK estimates of qualification shares at industry level were derived from Labour Force Surveys 1995-2004. Following advice from NZ Statistics, estimates of employment shares by qualification group at sector level in New Zealand were based on the NZ Income Survey (NZIS) which is believed to collect higher quality data on qualifications than the NZ Census. It is also an advantage for comparative purposes that the NZIS is based on an interviewer-administered questionnaire as is the Labour Force Survey in the UK. However, since the qualifications data in the NZIS are only available at a relatively high level of sectoral aggregation, more disaggregated sectoral estimates did have to be based on NZ Census data for 1996 and 2001. In addition NZIS data were only available for 1997-2004 so the estimated series was backdated to 1995 on the basis of rates of change between 1997-99.

Data on weekly pay in the UK Labour Force Survey and annual pay in the NZIS were also used to derive estimates of qualification-related wage differentials for full-time workers for aggregate manufacturing and aggregate market services in each country. The focus on full-time workers is necessary since we do not have access to hourly wage data in either country which would be conceptually preferable as an indicator of productivity. These wage data for manufacturing and market services were then used to weight employment shares by qualification group in relevant sectors; for agriculture, mining, utilities and construction, employment shares were weighted by the wage differentials for aggregate market sectors. Table A3.2 below shows a fair degree of stability over time in the wage ratios for aggregate market sectors in each country, with the exception of the years 2003-04 in New Zealand when the survey data suggest a widening of the pay gap between graduates and non-graduates.

This approach constitutes a distinct advance on skill measures based on education inputs (eg, years of schooling) or attainments which make no effort to take account of productivity differences. However, the measure used here relies on two key assumptions (1) that relative mean pay by qualification group is reflective of productivity differences and (2) that graduate-level productivity is comparable across countries. Furthermore, as noted in Section 5.2 above, there are many concerns regarding New Zealand data on qualification levels and mean wages by qualifications group (partly due to small cell sizes in the surveys concerned). Hence, our estimates of relative labour quality need to be treated with due caution.

A more complex version of our labour quality measure would take account of inter-country differences 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. Hyslop, Mare and Timmins (2003) point out that the proportion of New Zealand workers holding degree-level qualifications roughly doubled between 1986 and 2001. This means that recent increases in qualifications are concentrated in younger (less experienced) age groups which may tend to reduce the wage premia attached to degree-level qualifications. It is beyond the scope of this paper to explore New Zealand-UK differences in this respect in detail. However, it is worth noting that the UK has experienced similar rapid growth in the graduate share of employment since the 1980s which has persisted into the early 2000s (Table A3.1).

Appendix Table A3.1 -Employment in aggregate market sectors, analysed by qualifications category, 1995-2004

A: UK

	Graduates	NVQ 3-4	NVQ 1-2	No qualifications above NVQ1 level	Total
1995	12	36	35	18	100
1996	12	36	35	17	100
1997	12	36	36	15	100
1998	13	36	36	14	100
1999	14	37	36	14	100
2000	15	37	35	13	100
2001	15	37	35	13	100
2002	15	37	35	12	100
2003	16	37	35	12	100
2004	16	37	35	12	100

B: New Zealand

	Graduates	Post-secondary school qualifications below Bachelor level	No post-school qualifications	Total
1995	9	37	54	100
1996	9	37	54	100
1997	10	38	52	100
1998	10	38	52	100
1999	11	38	51	100
2000	10	38	51	100
2001	11	39	50	100
2002	11	38	51	100
2003	12	37	51	100
2004	13	37	50	100

Sources: UK Labour Force Survey, NZ Income Survey and NZ Census of Population and Dwellings.

Appendix Table A3.2 - Pay differentials by qualification categories in aggregate market sectors, 1995-2004 (Index numbers: Mean graduate pay=1)

A: UK

	NVQ 3-4	NVQ 1-2	No qualifications above NVQ1 level
1995	0.67	0.53	0.47
1996	0.67	0.53	0.47
1997	0.67	0.53	0.46
1998	0.67	0.53	0.46
1999	0.67	0.53	0.46
2000	0.66	0.53	0.46
2001	0.66	0.53	0.46
2002	0.66	0.53	0.46
2003	0.66	0.54	0.47
2004	0.67	0.54	0.47

B: New Zealand

	Post-secondary school qualifications below Bachelor level	No post-school qualifications
1995	0.73	0.60
1996	0.73	0.60
1997	0.74	0.60
1998	0.74	0.60
1999	0.73	0.60
2000	0.73	0.60
2001	0.72	0.60
2002	0.72	0.59
2003	0.71	0.58
2004	0.70	0.56

Sources: UK Labour Force Survey and NZ Income Survey.